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Globalisation and Agriculture: Impacts on Environmental Degradation & Rural Poverty in India

S.S.P. Sharma & Chaiti Sharma Biswas

Globalisation reduces diversity of genetic material used commercially in agriculture, encourages the supply of standardised produces and increases uniformity of methods used in agricultural production. In the long run these trends may be inimical to agricultural sustainability. The rise in input costs of production encourages farmers to use less chemical fertilisers and the pesticides. This encourages environmental conservation but in absence of other options, farmers adopt other measures that harm the environment. This paper examines the impact of globalisation on environmental degradation and rural poverty in India.

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India produces over 200 million tons of food grain, yet thousands of rural poor are not receiving two square meals a day. The advancement of science and information technology has not helped much to protect the degrading rural environment and has not promoted environment-friendly agricultural growth in the country.

While population growth has contributed to the extension of area under cultivation, it is difficult to subscribe to an oversimplified view about the relationship between population growth and environmental degradation. If population growth had been anticipated and public investments had been stepped up to cope with its consequences, by augmenting the yield potential of the land resources already under the plough, environmental degradation would have been substantially less than what has been observed. Similarly, successful implementation of land reform measures would have also reduced pressure for bringing new areas under cultivation.

However, it is important to recognise that pressure on grazing land and forest resources arise fundamentally from the rising demand. If population growth could, in fact, be contained substantially, by the same token, there would have been a significant increase in per capita income, and since the demand for milk, meat, timber, etc., is highly income elastic, the total demand for such products would have persisted resulting in environmental degradation, in the absence of countervailing measures. With slower population growth, the area under the plough would have been less but it is unlikely that this by itself would have made a notable difference to the overall state of environmental degradation.

The breakdown of the traditional institutions of management of common property resources after inde-

pendence and the failure of new institutions to fill in the vacuum have contributed substantially to ecological degradation. The breakdown of traditional institutions have reduced the private cost of grazing animals and felling trees to the individuals in relation to the returns for them. However, on account of adverse externalities of such individual actions, the costs of unregulated or free grazing and felling of trees to the society and to the future generations have increased. The breakdown of traditional management practices is itself traceable, in a considerable measure, to the increasing pressures for subsistence from the poor as well as the demand-induced prospects for quick and sustainable commercial profits by contractors from the illegal felling of valuable trees.

Whereas the breakdown of traditional institutions of management has led to the degradation of common lands, the degradation caused to the private lands is much less. This points to the role of property rights and tenurial arrangements in the conservation of natural resources and the protection of environment in general. For instance, despite population pressure and the increase in the man-land ratios, the quality of land among the small holdings is, on an average, better than among large holdings (Khusro, 1973) which is indeed explained by population pressure itself as small farms have more family labour for exploiting ground-water and for making other improvements on land (Rao, 1966).

The incidence of infertile and degraded land is greater (as a proportion of area held) among large farms owing, among other things, to the low man-land ratios. However, the available evidence from the village studies done by individual scholars suggests that the number of trees per hectare is probably higher among the large farms as compared to the small farms (Rao, 1966) although the position is quite the opposite with regard to crop output per hectare. Large farms are able to allocate a larger proportion of their holding to the growing of trees, because of their better staying power or the capacity to wait and also on account of the much lower cost on hired labour for growing and maintaining trees when compared to crops. The small farmers, on the other hand, owing to their pressures for immediate subsistence do not have enough staying power and have to allocate their area for annual crops. However, in semi-arid regions where crop production does not have a comparative advantage, small farmers seem to optimise the use of their resources by growing a larger number of trees per hectare than large farmers (Gupta, 1985). Even in regions where irrigation facilities are available, large farmers seem to account for large number of trees per hectare (Gupta, 1985).

This tendency has been reinforced recently with the steep rise in the prices of timber and fuel wood relative to those of field crops. Large farmers even in the irrigated tracts are converting areas under wheat and rice into commercial tree plantations. This is also reflected in the relative success of farm forestry when compared to social forestry. There is no doubt that such commercial tree farming reduces pressure on the forests and thus contributes to arresting eco-degradation. However, it considerably reduces the employment and incomes of the rural poor who have been depending on wage employment for the cultivation of field crops. Besides, it is wrong to believe that such commercial farming of trees can contribute to eco-development in the same way as the planned afforestation on degraded common land. Eco-development requires afforestation in the ecological vulnerable tracts like hill slopes, catchments areas for reservoirs, tanks and ponds, etc. such afforestation has to be undertaken essentially on a community basis wherever necessary with usufructuary rights for the poorer households. For the same reasons, privatisation of common lands for developing captive plantations for meeting the raw material requirements of paper mills, etc., by exempting them from the operation of land ceiling laws cannot serve as an efficient means of eco-development, although it may contribute to reducing the pressure on forests for raw materials. Besides, commercial farming is bound to be highly capital-intensive and, in the absence of alternative employment opportunities, the landless poor may be driven to the unregulated exploitation of natural resources, thus contributing to the further degradation of rural environment.

So long as land was plentiful and nature bountiful in relation to population and demand, management and technology could be ignored without much loss of benefits, at least in the short run. But the time has come when management (including the protection of trees) and technology (choice of sites, species to be planted, method of nurturing, etc.) have become crucial for augmenting the biomass in general and therefore, offers large returns. The privatisation of common lands for individual commercial farming on big holdings will deprive the poor of large returns, which can otherwise accrue to them from modern management through community participation.

What community management through collective vigilance (or 'social fencing' as against barbed wire fencing) does, among other things, is to provide an assurance to every individual participant that no other individual will encroach upon common resources for private benefit to the detriment of others' interests; because the penalties for such violation are prohibitive. In the process, the gains for every individual participant from such cooperative management would be much greater than when there is free or unregulated exploita-

tion of resources. This institutional arrangement, therefore, offers considerable potential for the participation of the people.

Paradoxically, despite the potential, this kind of management is perhaps the most difficult to achieve and, therefore, constitutes the most challenging task in rural development. This is because, in the first place, government policy in regard to the exploitation of common property resources is not often clear and even when clear, is not implemented vigorously by simplifying the rules and regulation in the allotment of land, for example, giving tree-pattas (ownership right of trees) to the poor and providing other complimentary assistance. Secondly, the prevailing rural social structure operates very much against the allotment of common lands to the poor even on usufructuary basis, as they are a source of exploitation by the contractors for being employed in forests at lower than minimum wage, for selling minor forest produce at throw-away prices and for getting consumption loans at exorbitant rates of interest. Therefore, the main hurdles in the way of community management through people's participation is the alliance between the big landowner, contractor, moneylender and the petty bureaucrat.

It follows from the above that active government intervention to simplify the rules and procedures and to delegate authority to people's institutions including voluntary organisation, easy allotment of land through tree-pattas, measures for doing away with the contractor system, provisions of institutional credit to the poor for consumption purposes, strict enforcement of minimum wages and ensuring remunerative prices for minor forest produce are essential for ensuring benefits to the poor through their participation in eco-development projects.

Disaggregated View of Rural Poverty in India

The impact of economic reforms on the rural poor in India so far has not been as bad as in the Latin American countries. On the other hand, it has been not as favourable as in some of the East Asian Countries.

In a large country like India, it is more important to look at trends in poverty at a disaggregate level. While estimating poverty ratios, adjustments were carried out to consumer price index numbers for agricultural labours by updating the national price of firewood. The estimates for 1987-88 and 1993-94 are based on large samples while those for 1990-91 and 1992 are based on 'thin samples'. The poverty ratios show that as compared to 1990-91 rural poverty increased significantly in 1992 in all the states except West Bengal. On the other hand, urban poverty recorded an increase in only six states (Andhra Pradesh, Bihar, Karnataka, Orissa, Uttar Pradesh and West Bengal). Four states (Assam, Gujarat, Madhya Pradesh, Tamil Nadu) showed a decline in urban poverty during the same period (Tables 1 and 2).

As compared to the year 1992, however, rural poverty declined significantly in all the states in 1993-94, except in Punjab, Haryana and Orissa. If we concentrate only on quinquennial surveys because of large samples, rural poverty declined in most of the States except in four states (Assam, Bihar, Haryana and Uttar Pradesh) in 1993-94.

As compared to those for 1987-88, the rate of decline in rural poverty during the period 1987-88 to 1993-98 was lower in most of the states as compared to the periods 1983 to 1987-88 and 1977-78 to 1983 periods. Urban poverty showed higher rate of decline in nine of 17 states during 1987-88 to 1993-94 as compared to the previous period. The state level analysis also shows similar trends in both rural and urban poverty regarding the impact of reforms of the poor. The poverty increased in the first two years of reforms period and showed a decline on 1993-94, but the rate of decline was lower than for the 1980s.

If we look at long-term changes, the ranks of states in terms of head count ratio are quite different in average over 1990-94 as compared to those in average over 1957-60. For example, Kerala, which had the second highest incidence of rural poverty around 1960, moved to the rank of the fifth lowest in the 1990s. States like Andhra Pradesh, Orissa and Tamil Nadu have also moved up significantly in these ranking – similar changes in ranking were noticed in urban areas. However, some difference in poverty at state level persisted over time. Punjab and Haryana had the lowest incidence of poverty in both the 1960s and 1990s, while Bihar had much higher incidence of poverty for the last three decades (for further details see Daft, 1998).

Rural Poverty During Pre-Reform Period

The Planning Commission has estimated incidence of poverty since the sixth five year plan, on the basis of recommendations of the task force on projections of minimum needs and effective consumption demand (Government of India, 1979). Estimates of national and state level poverty were made on the basis of this methodology for the years 1973-74, 1977-78, 1983 and 1987-88 using National Sample Survey Organisation (NSSO) data on consumption expenditure. These estimates were based on uniform rural and urban poverty lines. However, this method of computing poverty was

severely criticised mainly on two grounds, first, on one rural and one urban poverty lines for all the states in presence of inter-state differentials in prices within rural and urban areas and, second, uniform upward revision of NSSO data.

Rural poverty in India declined from 56.44 per cent in 1973-74 to 53.07 per cent in 1977-78, to 45.65 per cent in 1983, to 39.09 per cent in 1987-88 (Government of India, 1997a), to 34.4 per cent (thin sample, June-July) in 1989-90 then increased to 35.0 per cent in 1990-91 (July-June) (Chandrasekhar and Sen, 1996). The rate of decline was faster during the decade of the eighties as compared to the decade of the seventies, when economy was on higher growth path as compared to earlier years. A faster decline in rural poverty during the eighties can be attributed to higher growth in agricultural production, slower growth in food grain prices and presence of safety nets. Safety nets are in the form of drought and flood relief programmes during the years of natural calamities and widespread public distribution system (PDS) during the decade of the eighties as compared to decade of the seventies.

According to Ahluwalia (1978), aggregate time series data on rural poverty shows a pattern of fluctuation, with the incidence of poverty falling in the periods of good agricultural performance and rising in the periods of poor performance, leading to some evidence of trickle down associated with agricultural growth. However, at the state level, a significant inverse relationship exists between the incidence of rural poverty and per capita agricultural NDP, in at least seven states accounting for three-quarters of rural poor is achieved. However, the decline in rural poverty in 1987-88 is a deviation from the trend observed by Ahluwalia for the period from 1956-57 to 1973- 74. In 1987-88 decline in rural poverty was possible through a large volume of PDS achieved by depletion of Government stock rather than increase in procurement. This process of increasing PDS prevented the flow of grain from the rural areas to the urban areas. This is the single largest factor in the decline in rural poverty in 1987-88 (Tendulkar and Jain, 1995).

Rural Poverty during the Reforms

As mentioned earlier, the reform process that started since mid-1991 had a wide range of steps, ranging from price, tax, and fiscal, monetary to trade reforms. These reforms make an impact on prices and income. Liberalisation of agricultural trade and removal of agricultural trade embargo for private traders shifted cropping pattern and increased prices of food grains at least in the short-run. Incidence of rural poverty in 1992 (January-December) is estimated as 44.0 per cent (Chandrasekhar and Sen, 1996), Table 1 provides state wise estimates of rural poverty for the years 1989-90, 1990-91 and 1992. Increase in poverty is substantial for the first 18 months of reform. At the all-India level, there is evidence that rural poverty increased significantly during the first 18 months of reform period (see Table 1). According to Tendulkar and Jain (1995), rural areas in Andhra Pradesh, Assam, Bihar, Karnataka, Maharashtra and Rajasthan experienced reasonably sharp reduction in real average per capita total expenditure. Rural poverty in these states increased sharply during the reform period. Same conclusions can be drawn from the three different indicators of rural poverty calculated by the World Bank. World Bank estimates of head count ratio, poverty gap ratio and squared poverty gap ratio clearly shows the worsening of the situation of rural poverty from 1990-91 onwards. The poverty gap ratio in 1992 increased to 10.9, higher than the estimate for the year 1986-87, indicating that economic reforms are hitting the rural poor very hard.

Table 1: Consumer Expenditure, Per Capita Income, and Incidence of Poverty

State/ India	Consumer Expenditure per month		Rate of increase in per capita consumer expenditure in 1993-94 over 1987-88		Per capita income in 1998-99 at 1993-94 prices	Population below the Poverty line
	Rural	Urban	Rural	Urban		
Bihar	218.30	353.03	59.9	89.5	4397	54.26
Madhya Pradesh	252.01	408.06	76.8	72.9	7350	42.52
Orissa	219.80	402.54	72.4	79.3	5698	48.56
Uttar Pradesh	273.83	388.97	84.3	79.2	6117	40.85
West Bengal	278.78	474.15	85.6	78.7	8900	35.66
India	281.40	458.04	80.7	83.3	9733	35.97

Source: Levels and Pattern of Consumer Expenditure 1993-4, July 93-June 94, Department of Statistics, Government of India, 1996; Report of the Expert Group on Estimation of Proportion and Number of poor, Planning Commission, 1993.

A Case Study: Rural Poor in Bihar

The levels of income as well as consumption in Bihar are quite low. Per capita state domestic product in 1998-99 at 1993-94 prices was as low as Rs 4397. This is much lower than the corresponding figures for prosperous states such as Delhi (Rs 21,388), Punjab (Rs 14,007), and Haryana (Rs 12,766). Even the neighbouring states of Uttar Pradesh (Rs 6117), Madhya Pradesh

(Rs 7330), and West Bengal (Rs 8900) have per capita incomes that are at substantially higher levels than Bihar. Orissa, one of the poor states, has a per capita income (Rs 5648) marginally higher than that of Bihar. In fact, the per capita income of Bihar is the lowest among the states (Table 2 above).

Table 2: Average Monthly Per Capita Consumption Expenditure in 1999-2000

(Rs. In current prices)

Sl. No.	State	1999-2000 per capita expenditure		Urban to rural Ratio
		Rural	Urban	
1.	Andhra Pradesh	496	870	1.76
2.	Assam	450	925	2.06
3.	Bihar	410	717	1.75
4.	Gujarat	598	1005	1.68
5.	Haryana	745	1019	1.37
6.	Himachal Pradesh	781	1451	1.81
7.	Karnataka	539	1065	1.98
8.	Kerala	848	1092	1.29
9.	Madhya Pradesh	429	792	1.85
10.	Maharashtra	542	1136	2.10
11.	Orissa	392	702	1.79
12.	Punjab	786	1001	1.27
13.	Rajasthan	597	927	1.55
14.	Tamil Nadu	547	1055	1.93
15.	Uttar Pradesh	505	806	1.60
16.	West Bengal	487	970	1.99
	All India	525	980	1.87

Source: As of Table 1.

The per capita consumer expenditure per month in Bihar in 1987-8 was Rs 136.50 in rural areas and Rs 186.32 in Urban area. These figures are much lower than the corresponding figures of Rs 155.75 and Rs 249.93 for the country as a whole and are fairly low among the states and union territories. Among 30 states and union territories, rural Bihar lags behind 27 in terms of per capita consumption. Per capita consumption in urban Bihar is the lowest among all states and union territories. The trend in 1993-4 was not very different either. For rural Bihar, the per capita consumer expenditure was still much lower than that for India and was the lowest among the select states. As far as urban data is concerned, though the figure of Bihar was not the lowest (Uttar Pradesh, having a lower per capita consumer expenditure), it was much below the all-India average. Not only were the absolute values of consumer expenditure low for Bihar, the rate of increase in 1993-4 over 1987-8 was also the lowest for both urban and rural Bihar.

Indebtedness from traditional sources is widely prevalent in rural Bihar, and the incidence is particularly high among agricultural labourers—about 85 per cent for casual labourers. They loans are seldom able to repay their debts. This often leads to debt bondage due to their current consumption, exceptional social expenditure and health expenditure. With regard to loans from institutional sources, the level is not only low in Bihar, but such loans have been mainly grabbed by the upper classes and big landowners.

Female-headed households are found to be relatively poorer. Scheduled castes are invariably poor, followed by Muslims and backward castes. Attached labourers, who constitute about one-third of total labour, are relatively poorer than casual wage labourers and generally belong to the scheduled castes.

The people of the villages were hardly taken into confidence while envisaging the schemes. It was found that the objectives of the National Rural Employment Programme (NREP) were not clear to high-level functionaries and also to lower level functionaries and executing agents. It appeared that different development agencies lacked co-ordination. Yet another study of the performance of the NREP in the district of Siwan shows that the programme did not contribute significantly either to the improvement of wage rates or of bargaining power of the poor. In overall terms, it had some positive impact too. At least in some seasons and in some operations, it exerted pressure on wage rates through intervention in the labour market. It was found that the wage rate in non-agricultural operations was close to the minimum.

There have been some important changes in the programme since the merger of NREP into Jawahar Rojgar Yojna (JRY). Not only do the panchayats 'directly' receive the money, but also the responsibility for executing the programme/scheme lies with the village panchayat itself instead of block officials or their contractors. It is believed that the new arrangement has produced relatively better results. The better management of JRY by panchayats compared to the bureaucracy is because of people growing consciousness about these programmes and their pressures on the elected representatives to deliver the goods. In the specific context of Bihar, the existence of various groups (based on caste, class or any other consideration) and intra-village rivalry exerts some pressure on the panchayat functionaries to do something. Though the panchayat leaders are as corrupt as the

bureaucracy, the fear of facing the next election and the dynamics of village life forces them to work and deliver to some extent. The bureaucracy faces no such compulsion and accountability. Also it has probably not as competent as understanding of village problems as the panchayat functionaries. Although it would be naive to expect spectacular results given the prevailing socio-economic milieu, even this relatively better performance of the panchayats compared to the bureaucracy has important implications for the implementation of government programmes.

As a matter of fact JRY is the most visible rural development programme in the state. During the last few years the programme has expanded in several respects – in terms of funds allocated and utilised as well as man-days of employment generated. In 1991-92, 837 lakh man-days of employment were generated, which increased to 1,036 lakh in 1992-93 and further to 1,474 lakh man- days in 1993-94. Achievement of employment generation to targeted employment was 100 per cent in 1993-94. In spite of several defects, the programmes have made an impact in rural areas in several ways by providing employment, however small; constructing houses for the poor under Indira Awas Yojana; and providing some social infrastructure like school buildings, drainage, etc.

Considering the fact that the selection procedure was not proper and monitoring of the scheme was also not effective, it is rather surprising to note that the scheme has shown moderate to high success in the five blocks under study. Although the percentage of beneficiaries crossing the poverty line of Rs. 6,400 is very small (except in Nawada), many families have crossed the line of Rs. 3,500-ranging from 50.4 per cent to 40.7 per cent. This additional income is closely related to additional employment generation. Finally, it might be noted that the scheme is under severe stress as the percentage of beneficiaries who are paying their loan installments regularly is very low (around 40 per cent); in Nalanda it reaches a moderate figure of 66.9 per cent. Contrary to rational expectations, the repayment behaviour in different blocks is not related to increase in income. In Nawada, the increase in income is only 11.3 per cent, but repayment is most satisfactory there; whereas although the average per capita income has increased by 30.2 per cent in Ranchi, the repayment position there is the weakest. One may thus conclude that the administrative efficiency of the development administrative and the banks along with the populist stand of the political authorities are responsible for the financial mismanagement of the scheme.

Who Are the Poor in the Villages?

The Wealth Ranking Exercise yielded a composite picture of poor households and the ways in which they differ from the better off. The poor were found to be a highly heterogeneous group whose situation is characterised by a complex set of social and economic relationships. These relationships often do not work to their advantage, and they perceive themselves as highly vulnerable. The poor face many barriers in escaping from poverty, and know these barriers and means and opportunities for rising out of poverty. In contrast, informants identified a typical poor household as one, which is at the low end of the caste hierarchy (Musahar) – most often a member of the Scheduled Castes (SC). The SC households are usually grouped in a separate hamlet at the edge of the village, but a few of these families occupy a homestead plot in the village, which belongs to their upper-caste employer. Landlessness in terms of lack of access to fertile, well-watered agricultural land was mentioned as a cause and characteristic of poverty in every village. The less poor (e.g. the best-off among poor households) are generally those who own a small amount of agricultural land, but land does not constitute a significant source of wealth unless it is fertile.

Some less poor households have begun to diversify their earnings portfolio, e.g. through petty trading or small business activities often linked to agriculture or livestock (selling eggs or milk, producing sweets or simple prepared foods). Many of these are members of the Extremely Backward Castes (OBCs) and Other backward Castes (OBCs); both are higher in the caste hierarchy than SC/STs. In this dry region, access to inputs and especially irrigation water is required if land is to yield wealth. Better-off households are more likely to own private ponds and pump-sets, or they are able to utilise political contacts outside their villages to ensure that public wells and pump-sets are located on or near their own fields. Among those who have no private water source and no political influence, land may lie fallow due to lack of irrigation water. In many cases, the dividing line between the poor and the less poor was said to be a function not of land but of food security (Sharma, 2002). Those households which are able to produce enough food, either through agriculture or employment, to feed all family members throughout the twelve months of the year were identified as those which can attain a steady state or may even have the potential for advancement. Those who can feed themselves for only part of the year are expected to lose ground and to fall into chronic debt.

Agriculture and Environment Linkages

The developed countries will have to evolve well-coordinated policies and ensure that environmental

considerations relating to habitat become an integral part of their future policies. Problems associated with agriculture are those of over supply and use of inputs and the consequent environmental disturbance in developed countries. Modern agriculture is becoming increasingly capital and resource intensive and dependent upon highly special-ised energy inputs, chemicals and management skills.

Realistic estimates of how far modern agricultural practices are damaging to the environment, except application of fertilisers and pesticides, are not available. In developed countries there is little evidence of seriousness of soil erosion or damage to soil structure due to intensive cultivation and increasing shift to monoculture.

Pesticides are becoming expensive because effective formulations have to meet tough regulatory controls and requirements. Most pesticides recently synthesised are pest-specific and do not have recalcitrance. These factors add enormously to R&D costs. But long term impact on the environment due to extensive and intensive pesticide use is of concern. This prompted The British Royal High Commission on Agriculture as far back as in 1979 to recommend that more attention should be given to integrated pesticide management.

The countries should adopt the following policies. Evolve rigorous codes of practice and impose strict penalties for improper application of chemicals including aerial spraying where drift is a serious environmental issue. Fund R&D through taxes on pesticides and chemicals strengthen research on integrated pest and fertiliser management and on-farm testing of safe plant protection and plant nutrition technologies.

Economic assessment of alternate pest and disease control technologies and integrated plant nutrient management should be worked out taking into account the range of influences on agrochemical industry. An environmental tax on agrochemicals can be levied to fund research on alternative pest and disease control strategies.

In developing countries, the fertiliser and pesticide use is on the increase, particularly in irrigated areas where intensive agriculture has taken firm roots. Strategies to minimise pesticide use and optimise fertiliser use should obviously be a policy directive. Several countries in the Asia Pacific region like India, Bangladesh, Pakistan, Nepal, China, Korea, Malaysia, Indonesia and Philippines have been grappling with problems associated with increased pesticide use and balanced use of fertilisers. There is yet no clear policy directive to optimise the use of these inputs. In these countries due to population pressure and declining per capita land availability, sustaining agricultural productivity is essential to ensure economic returns to farmers and food security.

Technologies for integrated pest and disease management have emerged out of research efforts of scientists working on these aspects in these countries. IPM for rice, cotton, groundnut and chillies have been worked out and tried in on-farm trails with a fair degree of success, acceptance and adoption by farmers. Regeneration of natural parasites and predators has been recorded to bring the pest population under control. These technologies have to be promoted for adoption on a large scale and research on evolving such pest and increased funding should support disease control strategies. Where such technologies have already been worked out for some crops, they need to promote large-scale adoption by the farmers. Problems of pesticide residues, ill effects of fertiliser residues on the ecosystem have been widely researched and reported to be really threatening particularly in the irrigated, intensively cultivated areas. Pest resurgence due to development of pest resistance to pesticides in rice, cotton, wheat and several other crops have stagnated the yields of these crops. Minor pests such as gall midge, brown plant hopper, gundhi bug, and leaf Webber have been threatening the cultivation of crops such as rice, cotton and groundnut. Each of the developing countries in the Asia-Pacific region has its own specific pest resistance and resurgence problems created by improper use of pesticides. Resistant/tolerant varieties of several crops have been bred. But due to weak research-extension in several countries, the technology spread in limited and slow. Some varieties bred and released three decades back are still in circulation allowing the pests and diseases to proliferate due to breakdown of resistance. Hence, one of the options to deal with problems of diseases and pests is to provide varieties with resistance to different biotic stresses constantly through research efforts and promote the cultivation of the newer varieties.

Seed supply in needed quantities and in time, is yet another problem not limited to India alone. With some emphasis in agriculture shifting from meeting domestic needs to exports, it is all the more essential that pesticides are used judiciously.

Fertiliser use is sub-optimal in rain fed regions of all the countries in Asia-Pacific region except in Japan, China and a few others. This is due to the fact that agriculture in dry land areas in several of these countries is risky because of dependence on fertiliser use. In most of these countries the irrigated areas present a contrasting situation where fertiliser use is high. The fertiliser use in some countries of the Asia-Pacific region is presented in Table 4. The areas where fertiliser use is high have been reported to be prone to

ground water pollution, eutrophication of surface waters and emission of green-house gases such as sulphur dioxide, nitrogen oxides and methane. China has shown the way by adopting integrated nutrient management strategy effectively. None of these countries can afford to change over to organic farming exclusively as they cannot afford to sacrifice the yield levels during the stabilisation period extending to 3-5 years. Additionally the levels of productivity attained with fertiliser use can be achieved only with very high levels of application of organic sources of plant nutrients. Therefore even though organic farming has been recognised as an extremely eco-friendly, technology, it cannot be adopted to the exclusion of fertiliser. In all the developing countries organic farming continues to be adapted to the exclusion of fertilisers. In all the developing countries organic farming countries to be synonymous, though mistakenly, with integrated plant nutrient and pest management strategies to reduce dependence on pesticides and fertilisers. Soil degradation due to shifting cultivation, destruction of forests causing thereby severe erosion, improper planning and execution of irrigation projects, injudicious use of irrigation waters leading to soil salinisation, wind erosion, have been well documented in India and most other countries. These countries have highly trained manpower and a broad-based infrastructure to monitor and assess environmental degradation as related to agriculture. Some countries have organised facilities to monitor land and water resource degradation through remote sensing capabilities. These countries can get together to cooperate and utilise the individual capabilities and joint wisdom by sharing expertise and information for mutual benefit.

A matter of great concern that needs immediate attention, is to halt land degradation and harness water resources with care. Each one of these countries should include land degradation and water resource management in their priorities for policy and planning. Ground water depletion and surface water conservation, conveyance and proper use of irrigation water are crucial to national development and should find a place as important as industrial planning in policy perspectives. Very few countries regard land and water as national resources; Israel is one, which has strongly enshrined this aspect in the National Policy and Planning perspectives. India is grappling with a national water policy. A national land use policy also has to be evolved by all the developing countries because most of the countries carrying a "developing country" tag are agrarian and their incomes and prosperity are intricately-linked to land, water, their genetic base and their harnessing through agriculture, animal husbandry, fisheries and dwindling resource and the other related activities.

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Forests are yet another dwindling resource which is a cause for worry. Soil degradation is one aspect of degradation. But loss of biodiversity is yet another more important aspect associated with loss of forests. A clear-cut forest policy to harness the resource on a sustainable basis can help in reversing the trend of deforestation. As has been pointed out earlier, loss of forests is fairly substantial and exceeds the world average in several Asian countries. The problems associated with meeting the fuel and timber needs of the population, conservation of biodiversity, protection of natural rain forests, waste land utilisation, integration of forestry with agriculture, horticulture and animal husbandry, forestry as a source of forest produce and rural employment are the components which could be the basis for a national forest policy.

Impact of Extensive versus Intensive Cultivation on Environment

The degradation of rural environment arise from two major sources first from deforestation and degradation of land on account of the loss of vegetative cover, resulting in low water table and loss of top soil. These have a direct bearing on the productivity of soil, its vulnerability to rainfall variations, scarcities of drinking water, fodder and fuel wood causing hardships to the rural poor, particularly women and children. The second major source of environmental degradation in rural areas is the mis- application of yield-increasing inputs like water, chemical fertilisers and pesticides, causing water logging, salinity and pollution of drinking water, loss of fish, etc.

Of these two major sources, deforestation and chemical use in agriculture, the former constitutes a much greater threat to rural ecology at the present stage of agricultural development in India. This is because Indian agriculture has been operating at the extensive margin until recently and we are far from reaching the intensive margin in large parts of the country even under the existing technology. The use of chemicals of agriculture may pose a greater threat to rural ecology at much higher levels of application of chemical fertilisers and pesticides as in the western countries.

With technology remaining roughly the same up to the mid-1960s and with sluggish growth of irrigation the extension of cultivation to new areas rather than increasing the yield per unit of land, constituted a major source of growth in India. The failure of land reform measures to effect a significant redistribution of land to the landless and the political compulsions of a democracy to provide the wherewithal for the landless also contributed substantially to the encroachment of village common lands and forest lands by bringing them under the plough. It is estimated that out of the total forest cover lost in the country, as much as half this has been brought under the plough. Of the various techniques for increasing crop production, the increase in area under cultivation as the largest requirement of human and bullock labour. The extension of cultivation, therefore, was associated with a significant increase in the cattle population exerting pressure on grazing land. Since much of the area brought under cultivation or subject to pressures for grazing is marginal and submarginal, its impact on soil erosion and eco-degradation has been substantial.

While population growth did contribute to the extension of area under cultivation, it is difficult to subscribe to an over simplified view about the relationship between population growth and ecological degradation. If population growth had been anticipated and public investments could be stepped up to cope with the consequence, by augmenting the yield potential of the land resources already under the plough, eco-degradation would have been observed, similarly, successful implementation of land reform measures would have also reduced pressure for bringing new areas under cultivation.

If agricultural growth in some Indian states has been associated with a reduction in the proportion of rural population below the poverty line, despite a significant decline in labour input per unit of output, it is mainly due to the high rate of growth of crop production, the expansion of employment opportunities in non-crop enterprises and the consequent rise in wages.

The persistence of rural poverty in such regions has exerted pressure on forest resources on two counts: since the prices of fuel wood have been rising in the urban and semi-urban areas, felling of trees became an attractive source of income for the rural poor. The only cost of felling of trees for them is the family labour-time spent. In many cases, they are financed and otherwise protected by the contractors and the middlemen. The persistence of poverty has reduced the opportunity cost of labour. In many of these areas, the actual wages are significantly lower than (quite often only about half) the statutory fixed minimum wages. In such a situation, they become a cheaper source of exploitation for the contractors who employ them for the illegal felling of trees in the forests as well as for their transportation.

Dr. M.S. Swaminathan the well-known Indian scientist and one of the greatest thinkers of our times has stressed the need for "Ecological Agriculture which calls for accelerated research in blending traditional and frontier technologies. The frontier technologies are biotechnology, remote sensing, weather forecasting, exploitation of renewable energy resources, information technology and computer sciences and management systems. The concept also involves substitution of chemicals and capital with knowledge and farm grown biological inputs. This can be achieved only through location-specific and farming community-based approach to technology development and dissemination". Agriculture, the world over is faced with several problems. If it has to be sustainable, there is a need to reorient research priorities and bring about changes in public policies. Land degradation and other types of environmental damage disturb the foundations for sustainable agriculture. The problem of rural unemployment is also assuming serious proportions in several developing countries. The future policies and programme should address these problems. The aspects that have relevance to sustainable agriculture (Swaminathan, 1993) are:

- Promote eco-friendly technologies in agriculture
- Prevent "jobless growth"
- Implement anticipatory research programmes to meet contingencies arising out of climate change, sea level rise, green-house effect and ozone layer depletion.
- Conserve native germplasm as a national priority.

Dr. Swaminathan calls for—"a Global Scientific Consensus on patenting of research findings having a bearing on planet protection as well as on food and livelihood security of the economically and socially disadvantaged sections of human population". He has called upon science academics to evolve policies and procedures, which can harmonise the often conflicting requirements of the market driven private profit approach with the human security.

Agriculture and environment are inseparably linked. An input, which is used to promote and protect crops, leaves behind residues, which have impacts on the environment. Irrigation water, clearing of forests for agriculture, tillage and cultivation practices employed also does have its individual effects on soil and water

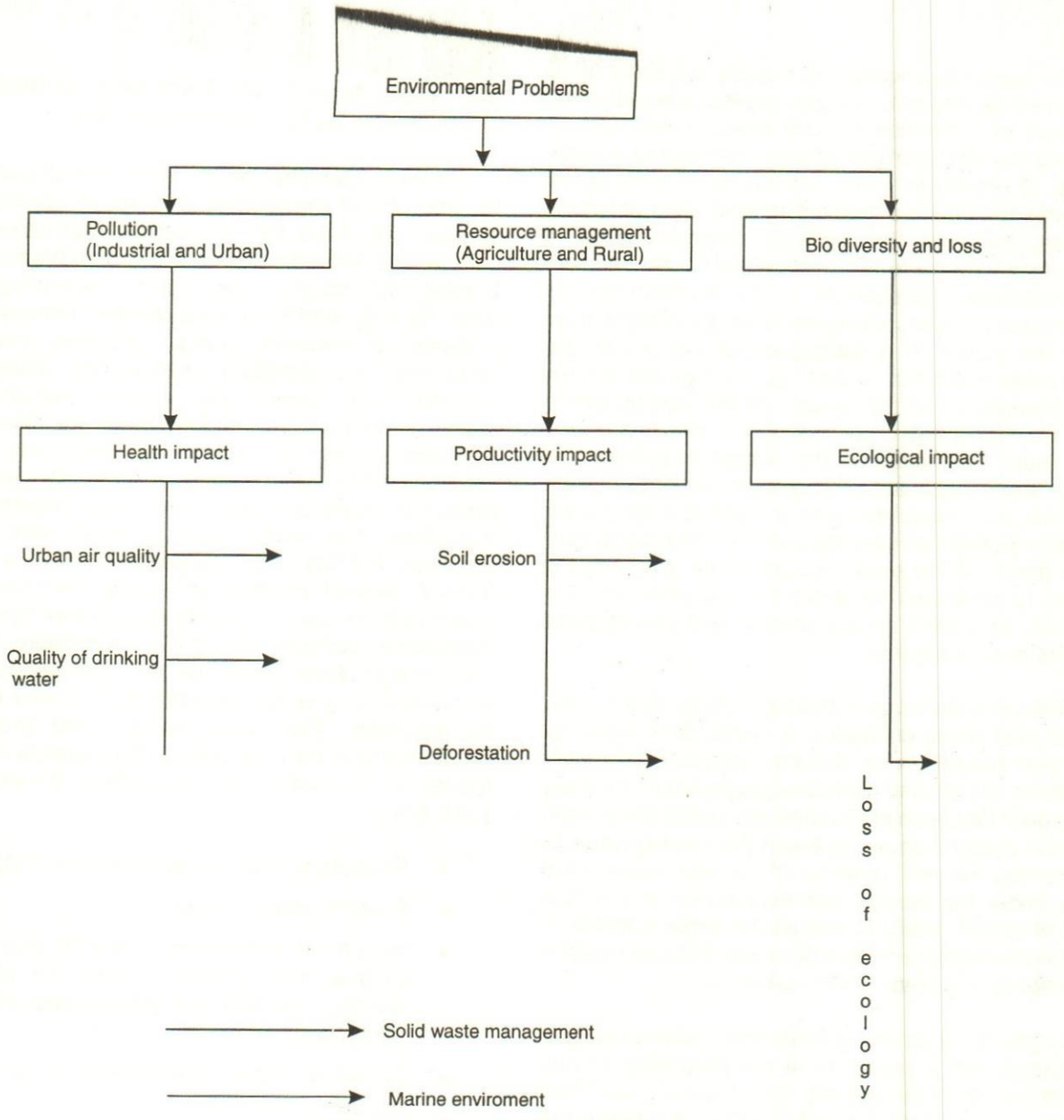

Fig. 1. Human Activities and Environment

regimes. Selective breeding of crops for higher yields and deforestation are the two primary reasons for the narrowing of genetic base. Technologies for assessing the impact of agricultural operations on the environment are available and have been employed by various countries to assess such impacts. Frontier technologies like Remote Sensing, Preservation of Germplasm under controlled conditions, use of sophisticated analytical equipment to detect pollution causing compounds and substances in soil, water and atmosphere are within the reach of several developing countries. Assessment of environmental degradation should lead to its logical end of formulating policy initiatives to reduce the impact of degradation on ecosystems. Soil degradation, water resource depletion and deterioration and prevention of atmospheric pollution calls for major policy initiatives.

Some countries have National Water and Land Use Policies and Forest Policy. It is time that such policies are evolved by the other countries so as to plan for preventing environmental degradation. Environmental education is yet another aspect which has to be considered by several countries. Specific initiatives are needed to convey the message of environmental degradation and abatement to the citizens of the country. Particularly with respect to agriculture and environment, the farmers have to receive the information on environmental degradation and protection. The education should start at the basic school level for the children and for the adult farmers, and different strategies are needed to put across the messages. It is hoped that the study meeting of this type will prove to be beneficial to realise the importance of environmental

protection and to initiate specific efforts to reduce the impact of agricultural activities on the environment.

The land-saving technological change in crop production can be the most important positive factor in protecting the environment by containing the increase in the net sown area, by augmenting animal feed and bio-mass in general, and by contributing to the reduction in rural poverty through the rise in agricultural income and wages. The demand for timber, fuel-wood, meat, etc. originating in the rest of the economy exerts pressure on the rural environment. Rural poverty ensures the availability of cheap labour to satisfy this rising demand by cutting trees or rearing animals. The rural populations own requirement for fuel wood also add to the pressure on the environment.

The demand for forest product is likely to increase unless substitute sources, which are cheaper, are made available. For example, adequate availability of soft coke and kerosene can substantially reduce the demand for fuel-wood, particularly from the urban areas. However, the demand for milk, meat and wool is likely to reduce the pressure on the environment.

Brandon and Hommann (1995) have presented a rough estimate of the total magnitude of economic costs associated with environmental degradation in India. The major problem considered here can be presented in terms of Figure 1.

Since health and life are both non-marketable goods one has to develop some indirect method for estimating shadow prices. Biologists find out the dose-response functions through controlled laboratory experiments. These functions suggest the magnitude of the adverse impact on health of different pollutants when subjects are exposed to them in different degrees.

Conclusion

The consequence of the globalisation process, as far as agriculture is concerned, is that economic globalisation can be expected to encourage agricultural specialisation (Tisdell, 1999). It may therefore eliminate mixed or environmentally balanced types of agricultural systems, as were common in Asia. It tends to encourage monocultures, for instance. Globalisation reduces diversity of genetic material used commercially in agriculture, encourages the supply of standardised produces and increases uniformity of methods used in agricultural production. In longer terms, these trends may be inimical to agricultural sustainability.

Another aspect is that India has many small and marginal farmers. They are dependent entirely on agriculture. The rise in input costs of production encourages farmers to use less chemical fertilisers and pesticides. This encourages environmental conservation but in absence of other options, farmers adopt other measures that harm environment. The most crucial impact of globalisation is on small and marginal farmers in some of the states like Andhra Pradesh and Karnataka. Every day in these two states, farmers are committing suicide. The reasons are non-remunerative prices of farm products and the failure of monsoon rains. The positive impact of globalisation is felt only in capital-intensive larger farming units that constitute the smallest share of total Indian agriculture.

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India's Experiment with Decentralization

Om Prakash Mathur

This paper presents a critique of the progress of implementing the Constitution (seventy-third) Amendment Act, 1992 on Panchayats and the Constitution (seventy-fourth) Amendment Act, 1992 on Municipalities. The two amendments have come to represent what is seen as by far the boldest experiment in the country with decentralization and empowerment of local bodies.

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Until the incorporation of the seventy-third and seventy-fourth amendments into the Constitution, decentralization in India was understood in terms of establishing democratically-elected governments at local levels, and assigning to them such powers and responsibilities as would enable them to function as institutions of self-government. The implicit assumption in this concept was that the democratically-elected governments compared to other forms of government were in a better position to assess the needs and developmental priorities of the areas that they represented, and provide an outcome that was closest to the preferences of the people. This concept was the anchor of several earlier attempts that were made to introduce a panchayati raj system in the country[2].

In the general design of the India's federal structure, local governments until the Constitutional amendments were an *exclusive* concern of the state governments[3]. Drawing strength from the different provisions of the Constitution under which the subject of local government formed a part of the state list, the state governments determined the expenditure responsibilities and fiscal powers and authority of local governments and defined the degree of autonomy within which they could function. Discussion on how to improve the financial viability of local bodies or streamline the flow of funds to them, or carry out reform of local taxes took place within the parameters of state control over local bodies.

The Constitution (seventy-third) Amendment Act, 1992 on Panchayats and the Constitution (seventy-fourth) Amendment Act, 1992 on Municipalities have changed the erstwhile relations between the state governments and local bodies. These amendments have ushered in the country an era of democratic decentralization, incorporating specific provisions for the empowerment of local governments[4]. Coinciding with what is happening in the other parts of the world[5], these amendments provide for a Constitutional recognition of local bodies, which was non-existent in the pre-amendment period, and simultaneously lay out a platform for initiating wide-spectrum reform in such

areas as local electoral systems, mechanisms for local planning and development, and state-local relations in matters concerning functional and fiscal powers and responsibility.

The basic postulate of the Constitutional amendments is that local bodies cannot be strengthened and empowered without altering the existing relations and arrangements between the different tiers of government. Nor can the performance of public services be improved without changing the relationship between the state and local governments[6].

This paper presents the decentralization agenda as embodied in the Constitutional amendments and the progress that has taken place since the amendments. It begins with an overview of the key features of the Constitutional amendments, referring particularly to those features that deal with the fiscal empowerment of local bodies. The progress on the implementation of the relevant provisions of the amendments including the approach of the central finance commission to promote fiscal decentralization is then discussed and reviewed. The closing section sums up the record of decentralization, and offers suggestions on a possible road map that might strengthen the forces of decentralization in the country.

The concept and meaning of decentralization are discussed extensively in public finance literature. For purposes of this paper, *the term decentralization has a limited meaning, referring to decentralization of powers, responsibilities and authority to local bodies and their capacity to be able to efficiently and effectively discharge them.* This paper looks at those provisions that point to the role and place of local bodies in the country's federal structure, the autonomy with which they are able to exercise the powers and authority assigned to, or devolved on, them under the Constitution or the law, and the extent to which the state-local relations have been changed to enable local bodies to function as institutions of local self-government. No reference is made in this paper to centre-state relations.

The Constitutional and Legal Framework of Decentralization

Until the passage of the Constitution (seventy-third) and (seventy-fourth) Amendment Acts, 1992, the only reference in the Constitution to local bodies was in the Directive Principles of State Policy which stated: "The State shall take steps to organize village panchayats and endow them with such powers and authority as may be necessary to enable them to function as units of self-government". The Constitution did not lay down how village panchayats might be constituted. Nor did it prescribe any procedure for determining their powers and authority. The Constitution made no reference to urban local bodies.

The 1992 amendments aim at empowerment of local bodies by requiring the state governments to –

- establish an adequately-represented electoral base at local levels with a fixed tenure of five years, and a provision for holding elections within six months in the event of pre-mature dissolution of local councils;
- set up mechanisms for consolidating and coordinating planning and development initiatives and actions of the panchayats and municipalities; and
- consider expanding the role of the panchayats and municipalities, and correspondingly strengthen their fiscal jurisdiction and power and authority.

It is important to briefly dwell on them.

Constitution and Composition of the Panchayats and Municipalities

The Constitutional amendments lay down that every state shall constitute panchayats at the village, intermediate and district levels with the proviso that a state having a population not exceeding two million may not constitute a panchayat at intermediate levels. For urban settlements, the amendments further lay down that every state shall constitute:

(a) a nagar panchayat for a transitional area, that is to say, an area in transition from a rural area to an urban area

(b) a municipal council for a smaller urban area, and

(c) a municipal corporation for a larger area[7].

An important provision in the amended Constitution is that every panchayat and every municipality shall have an elected body, which will be elected for a term of five years; if it is dissolved sooner, the Constitution requires that elections be held within six months. The Constitution makes a specific provision for the representation of women and other disadvantaged groups on the local bodies in order to impart participation of those sections of local communities, which had been outside of the mainstream of development. Under the Constitutional

amendments, not less than one-third of the total number of seats on local bodies are to be reserved for women.

Other disadvantaged groups are to be represented on a proportionate basis. Thus, the two amendments not only provide for a constitutionally-safeguarded third stratum of government, but also confer uniformity in their structure[8]. The discretion of the state governments in constituting panchayats and municipalities, or in determining their structure, or keeping them under dissolution or suspension for long periods, as was the case in the pre-amendment period, has been done away with in the new Constitutional framework.

Institutional Arrangements for Planning for Economic and Social Development

The amended Constitution provides for the constitution of district planning committees (DPCs) and metropolitan planning committees (MPCs). Articles providing for the constitution of such committees are a significant step in the direction of initiating a process of planning from below. The DPCs are to be responsible for the consolidation of plans prepared by the panchayats and the municipalities, and preparation of draft development plans. The MPCs are to be responsible for the preparation of draft development plans for the metropolitan areas[9]. The draft development plans of districts are, *inter alia*, expected to take into account matters of common interest between the panchayats and the municipalities including spatial planning, sharing of water and others physical and natural resources, integrated development of infrastructure, and environmental conservation. The draft development plans of metropolitan areas take into account the overall objectives and priorities that may be set by the Government of India for metropolitan development as also the extent and nature of investments likely to be made in the metropolitan areas by the Government of India or its agencies.

Financial and Fiscal Powers of the Panchayats and Municipalities

Setting appropriate expenditure and tax assignment and other revenue-sharing powers for each tier of government are a crucial component in any decentralization policy. Both theory and experience suggest that it is important to specify expenditure responsibilities as clearly as possible in order to enhance accountability, and reduce unproductive overlap, duplication of authority and legal challenge. In theory, decision-making should occur at the lowest level of government consistent with the principle of subsidiarity.

The Constitutional amendments have maintained the erstwhile division of subjects between the Union (central government) and state governments, under which the subject of local government stands assigned to state governments. The amendments maintain that the legislature of a state will continue to have powers to endow the panchayats and municipalities with such powers and authority as it may consider necessary to enable them to function as institutions of self-government. However, two schedules, viz. Schedule XI (243 G) and Schedule XII (243W) have been incorporated into the Constitution, which comprise a list of functions that are considered appropriate for assignment to panchayats and municipalities. Although illustrative in nature, the two Schedules point to a potentially larger role of local bodies in the country.

In tandem, the Constitutional amendments have maintained the prerogative of the state legislature to decide which taxes, duties, tolls and fees should be assigned to local bodies and which of them should be shared between the state and local bodies. The Constitution does not lay down a fiscal domain for municipalities. However, recognizing that the state-local fiscal relations in the country have historically been marked by *ad-hocism* and tentativeness, and that there is a need to bring order and stability in their relations, the Constitution has provided for the setting up of a finance commission in every state for the purpose of reviewing the financial position of the panchayats and municipalities, and making recommendations on the principles that would govern

- the distribution between the state and panchayats and between the state and municipalities of the net proceeds of the taxes, duties, tolls and fees may be leviable by the state; but
- the determination of the taxes, duties, tolls and fees which may be assigned to, or appropriated by, the panchayats and municipalities;
- the grants-in-aid to the panchayats and municipalities from the consolidated fund of the state; and
- any other measure that would improve the finances of the panchayats and municipalities.

The new fiscal arrangement has simultaneously effected a major change in the scope of the tasks of the central finance commission which, until the amendment of Article 280 under which central finance commissions are set up[10], was confined to the distribution of divisible taxes between the Union and the states and of grants-in-aid to states under Article 275 of the Constitution.

The new arrangement requires the central finance commission to suggest measures needed to augment the consolidated fund of a state to supplement the resources of local bodies on the basis of the recommendations made by the finance commission of states.

These provisions in the Constitution envision a major vertical and horizontal restructuring in the state-local and center-local fiscal relations. It has provided to states a unique opportunity to redesign the existing fiscal system that is coherent and flexible enough to meet the rapidly changing local needs and responsibilities. It has also provided to the Central Finance Commission an opportunity to strengthen the financial base of local bodies.

It needs to be reiterated that notwithstanding the provisions dealing with the spending responsibilities and provisions dealing with the constitution of a finance commission in every state, the absolute rights of the state legislatures over what functions should be assigned to, or devolved on, the panchayats and municipalities, or withdrawn from them, and which taxes should be assigned to them or shared with them have not been altered by the recent amendments. This arrangement, like the system during the pre-amendment period, implies concurrency of functions and tax powers between the states and local bodies. It implies that the panchayats and municipalities do not possess what are referred to as general competency powers, permitting them to take actions not explicitly prohibited or assigned elsewhere; they possess the legally delegated powers and functions under the doctrine of utlra vires (Dillon.s rule) that limit local choice and diversity. They "are to take nothing from the general sovereignty except what is expressly granted"[11].

The mandatory provisions of the Constitution (seventy-third) and (seventy-fourth) amendments have been incorporated in the state-level panchayat and municipal legislation. Thus, the amended state-level legislatures provide for the constitution of a three-tier panchayati raj system for rural settlements, and three grades of municipalities for urban settlements. These lay down the procedures for election, including the establishment of a state election commission, constitution of a finance commission, and likewise, of the district and metropolitan planning committees. In several state legislations, the illustrative list of functions for panchayats and municipalities as given in Schedules XI and XII has also been incorporated.

Decentralization in Practice

The Constitutional (seventy-third) and (seventy-fourth) Amendment Acts, 1992 have established in the country a decentralized framework under which –

- local governments have a Constitutional legitimacy with appropriate safeguards against arbitrary suspension and dissolution;
- local bodies have a representative base which now comprises women and underprivileged sections of population;
- mechanisms for coordinating developmental initiatives of the panchayats and municipalities are either in place or being introduced;
- opportunities have been created for the state governments to expand the functional jurisdiction of local governments;
- provisions have been made to constitute, once in five years, a finance commission in every state to determine the principles for deciding which taxes, duties, levies and tools should be assigned to, or devolved on, the local governments and which of them should be shared between the state and local governments; and
- provision is made for augmenting the resources of state governments in order they can supplement the resources of the panchayats and municipalities.

The past 6-7 years have witnessed in India substantial progress in promoting decentralization and decentralized governance. In accordance with the Constitutional provisions and state laws, elections to panchayats and municipalities have been held in over 90 per cent of the rural and urban constituencies. Approximately 2.6 million persons of which 33 per cent are women have been elected to the panchayats and over 62,570 persons have been elected to the municipalities creating what would, by any yardstick, be the largest democratically-elected base to be observed anywhere in the world. In 12 states, district planning committees (DPCs) have been constituted and made responsible for the consolidation of plans prepared by the panchayats and municipalities[12].

Central to any decentralization agenda is the division of the functional and fiscal powers and authority between the state and local governments. The nature of the functional responsibilities that is devolved on local governments combined with their assigned fiscal powers determine the extent to which a country stands committed to decentralization.

Note should be made here of the fact that the fiscal relations between the 28 states and over 3,500

municipalities and 230,000 panchayats in India are diverse and complex, with much of it rooted in the Constitution itself which, as indicated earlier, lays down neither a functional domain nor a fiscal jurisdiction for local bodies. These are defined by the state governments and coded in the state laws. The state governments, out of its own powers and responsibilities enumerated in the Constitution, assign certain functions and duties to local bodies. Historically, these have consisted of public health and sanitation, roads and bridges, water, markets and fairs, libraries, museums, and similar institutions and burial and cremation grounds. The functional domain of local bodies has witnessed periodic shifts and changes, on account of the withdrawal of functions from them or entrusting them with new responsibilities such as poverty alleviation.

Similarly, the state governments determine the fiscal options of local governments. The state laws specify the taxes that the local bodies can levy and collect; the state governments, out of its own tax powers, devolve certain tax powers to local bodies which typically have included tax objects that are less mobile, not easily exportable, and thus fitting into the model that says that the choice of the tax instruments should conform to the rule that each jurisdiction pays for its own benefits.

Local government finances in India have been in a shambles. Studies on local government finance have pointed out that local governments own revenues are able to meet only a part of their expenditure, and that transfers from the state governments for meeting the revenue gap of local governments which account for anywhere between 15.95 per cent are *ad-hoc* and discretionary, and often even distortionary. The administration of local taxes is unsatisfactory, and reflected in low collection to demand ratios, inability of local governments to periodically adjust property values, tax rates, and user charges to inflation.

Finance Commission of States (SFC) and Local Government Finance

Articles 243 I and Article 243 Y of the Constitution under which each state is required to constitute a Finance Commission are designed to correct the fiscal disabilities and imbalances of local bodies. The Constitution and the corresponding state laws lay down that the Finance Commission of states (SFCs) will examine not only the taxing powers and authority of local bodies but the entire gamut of issues consisting of revenue-sharing arrangements between the state and local bodies, grants-in-aid system, and even such issues as local autonomy[13].

What has been the approach of the finance commission of states (SFCs) to the finances of local bodies? To what extent have the SFCs been able to expand their fiscal base? Key recommendations of the SFCs are highlighted below.

(i) ***Assignment of taxes, duties, tolls and fees:*** The Finance Commission of states have generally recommended maintenance of the *status quo* in respect of the tax powers of local bodies. The tax jurisdiction of local bodies or more appropriately, taxes that have been assigned to them continue to consist of land revenues; taxes on land and buildings; taxes on the entry of goods into a local area for consumption, use, or sale therein; taxes on advertisement; and taxes on animals and boats. The finance commissions have recognized that entertainment taxes and profession taxes are intrinsically local in character, but on grounds of cost efficiency, have allowed them to be collected by the state governments and their proceeds to be redistributed to local bodies. Other taxes in the state list do not meet the criteria of local taxes. Another reason that appears to have weighed in maintaining the *status quo* lies in the inadequate use of taxes that already vest with the local bodies. However, concerned with the stagnation in yields of local taxes, the Finance Commissions have made suggestions relating to the (a) reform of property taxation, and (b) extension of autonomy to municipalities in terms of tax-rate setting and determining the coverage of tax bases.

(ii) ***State Transfers to Local Governments:*** The Finance Commission of states has advanced general principles in respect of transfers from the states to panchayats and municipalities.

These principles include, in the main, the following—

- The transfer system should be predictable, and designed in a way that the local bodies are able to estimate their share in state-level taxes and thereby to better plan out their activities.
- Transfers should be based on objective measurable criteria and be transparent.
- Transfers should be automatically adjustable to inflation.
- The system of transfers should be based on the principles of simplicity, transparency, dynamism, pragmatism and predictability.

(a) Revenue-sharing Arrangements

The approach of the Finance Commissions to transfers on account of revenue-sharing falls into four categories:

- create a divisible or distribution pool of the state's resources, and share the same pool with the panchayats and municipalities in such proportions as may be considered appropriate;
- share the individual state-level taxes with local bodies with the proviso that the share may be pre-determined;
- transfer fixed sums to local bodies;
- allocate out of the state allocation of central taxes a share to local bodies.

The approach to transfers is marked by significant inter-state variations, which relate to (i) the composition of the divisible pool of state resources, and (ii) the proportion in which this pool should shared with the local bodies. Thus, the divisible pool consists of the *total* tax and non-tax revenue receipts of the states; *net* proceeds of total revenues of states; *net tax* proceeds, and state's share of central taxes. The main merit of creating a divisible pool as advanced by the SFCs is that it is easier to predict the growth behaviour of a pool rather than of individual taxes. It is also administratively efficient and, in this respect, constitutes a significant improvement over the earlier system.

(b) Grants-in-aid System

The approach to the grants-in-aid, as distinct from transfers on account of revenue-sharing, appears to reflect the position that grants are an instrument that can be used for a variety of purposes, including for the implementation of the central-level and state-level priorities and programmes. The approach in this respect falls into three groups:

- continue with the existing system of grants-in-aid, i.e., continue with the system of multiple grants that currently accrue to local bodies in the form of general-purpose grants, specific-purpose grants, establishment grants, maintenance grants, incentive grants, compensatory grants and the like
- limit the use of grants for specific purposes such as the implementation of the centrally-sponsored and state-level schemes, and
- extend grants for purposes of improving the efficiency of local bodies in matters relating to revenue generation, and tax collection and administration.

The approach of the Finance Commissions to state-local fiscal relations can be summed up as follows:

- Approach to dealing with the finances of the panchayats and municipalities vary between States. While variation in approaches may be justified in the light of the vastly different local situations, its long-term implications are far from evident. It implies that decentralization in the different states will be asymmetrical, and occur at different paces and via different routes.
- Does not recommend or foresee any noticeable change in the tax (including the non-tax) jurisdiction of local bodies. However, the SFCs suggest better use of the existing tax jurisdiction, by reforming the system of property taxation and giving greater autonomy to local bodies in matters relating to tax-rate setting.
- Places greater reliance on transfers for bridging the gap between what the local bodies are able to raise and what they need to fulfil their spending responsibilities.
- There appears to be a clear preference for creating a divisible pool of resources at the level of states, and allocating a proportion of the same to local bodies. The size of the pool and the criteria for its allocation to local bodies vary, depending on such factors as the spending responsibilities of local bodies.

The Central Finance Commission and Local Government Finance

The Constitutional amendments have provided that the Central Finance Commission should recommend measures for the augmentation of the resources of states in order that they can supplement the financial resources of local bodies. This provision is significant in that it has permitted a central body (as distinct from a state body) to assess the supplementary financial requirements of local bodies and make appropriate recommendations in this regard.

The Central Finance Commission is a Constitutional body and is set up once in five years to make recommendations on –

- the distribution between the Union and the states of the net proceeds of taxes which are to be, or may be, divided between them and the allocation between the states of the respective shares of such proceeds

- the principles which should govern the grants-in-aid of the revenues of the states out of the Consolidated Fund of India and the sums to be paid to the states which are in need of assistance by way of grants-in-aid
- the measures needed to augment the consolidated fund of a state to supplement the resources of the panchayats in the state on the basis of the recommendations made by the Finance Commission of the state; and
- the measures needed to augment the consolidated fund of a state to supplement the resources of the municipalities in the state on the basis of the recommendations made by the Finance Commission of the state 14.

The Central (Eleventh) Finance Commission has made elaborate recommendations for supplementing the resources of local bodies and bringing about a sustained improvement in their fiscal performance.

These include the following:

- a provision of Rs. 100,000 million to supplement the resources of the panchayats and municipalities
- establishing a set of criteria for the allocation of Rs. 100,000 million between states for disbursement among the different tiers of panchayats and grades of municipalities
- institutional mechanisms for auditing of the accounts of the panchayats and municipalities, and
- improving the finance data base of the panchayats and municipalities.

The recommended grant of Rs. 100,000 million is meant to supplement the funds that would normally flow from the state governments to local bodies during the period 2000-2005. This grant is dedicated to improving the maintenance of civic services such as primary education, primary health care, safe drinking water, street lightening, sanitation, maintenance of cremation and burial grounds, and other common property resources.

The Central (Eleventh) Finance Commission has established a comprehensive framework for the allocation of grant for local bodies. The framework consists of a set of multiple criteria, with each criterion assigned with a weight as shown in Table 1.

The principle underlying the framework is that apart from the size of local governments – represented by population and geographical area – which is a major determinant of the financial requirement of local bodies and which consequently command a larger weight, grants should be allocated on the basis of a set of complementary criteria of efficiency, measured by the revenue-raising effort of local bodies, and equity, represented by the distance of the state's average per capita gross domestic product from the highest per capita gross state domestic product (GSDP).

Table 1: Criteria for Determining the Allocation of Funds to States for Panchayats and Municipalities

Weight	Panchayats	Municipalities
40%	Rural population, 1991	Urban population, 1991
10%	Geographical rural area, 1991	Geographical urban area, 1991
20%	Distance from per capita agricultural income	Distance from per capita non-agriculture income
10%	Own revenue effort of the panchayats	Own revenue efforts of urban local bodies.
20%	Index of decentralization	Index of decentralization

The former is meant to serve as an incentive for local bodies to boost their revenue effort, while the latter provides funds for the fiscally-disadvantaged local bodies. An important criterion that commands a 20% weight in the grant allocation relates to decentralization as envisaged in the Constitutional amendments.

An index of decentralization has been proposed for measuring decentralization.

Index of Decentralization

- Enactment of state legislations in conformity with the Constitutional amendments of 1992.
- Intervention/restriction in the functioning of the panchayats and municipalities.
- Assignment of functions to the local bodies in the state laws vis-a-vis Schedule XI and Schedule XII.
- Transfer of functions to the local bodies by way of rules/notifications/orders of the state governments.
- Assignment of taxation powers to local bodies as per the state laws.
- Levy of taxes by the local bodies.
- Constitution of the State Finance Commission (SFC) and submission of Action Taken Report (ATR).

- Action taken on the major recommendations of the State Finance Commission (SFC).
- Election to local bodies.
- Constitution of district planning committees.

Decentralization in India: A Summing Up

Decentralization as envisioned in the Constitution (seventy-third) Amendment Act, 1992 and Constitution (seventy-fourth) Amendment Act, 1992 has entered the eighth year of experimentation. It is natural to ask: what do the various measures that have been taken to implement the Constitutional amendments amount to? Have the two amendments found a place in the country's federal system? Are the local bodies in India today stronger and financially viable than in the pre-amendment period? Such questions are difficult to address in the absence of any empirical evidence or systematic examination. At most, a few observations are possible. On the positive side, the democratic base of the Indian polity has been significantly widened. Prior to the Constitutional amendments, the democratic structure in the country was confined to the two Houses of Parliament, and state assemblies. Although local councils formed a part of the federal structure even in the pre-amendment period, these enjoyed neither a constitutional legitimacy nor any stability. The amendments have put in place local councils in 532 district panchayats, over 5910 intermediate-level panchayats, and nearly 230,000 village panchayats on the one hand, and 95 city corporations, 1436 town municipalities, and nearly 2050 nagar panchayats, on the other. Although the local councils have no legislative powers, the qualitative change that has come about as a result of the two amendments has important implications for developing local development priorities.

Second: an important aspect of the Constitutional amendments is the inclusion of women in the local governance structure. Women head about 175 district panchayats, about 1900 intermediate-level panchayats, and over 70,000 village-level panchayats. On the urban front, women head 22 city corporations, nearly 50 per cent of town municipalities have women chairpersons, and 685 nagar panchayats have women chairpersons.

Third: the Finance Commission of states have set in motion a process of assessing the financial position of local bodies and making recommendations on their fiscal domain and structure. The central (Eleventh) finance commission has also made important15 recommendations on accelerating the process of fiscal decentralization in the country.

Beyond the creation of the democratically-elected bodies at the level of the panchayats and municipalities, the progress on decentralization has, at best, been slow and tardy. First: no worthwhile decentralization of powers and responsibilities had occurred or is in sight. There exists no evidence that powers and responsibilities of local governments have, in de-facto terms, been expanded in accordance with Schedule XI and Schedule XII. A far more disconcerting fact is the absence of clarity in respect to the functions of local governments. Second: although the state governments have enacted the conformity legislations incorporating the provisions of the Constitutional amendments, the formulation of rules and by-laws to put those provisions into effect has lagged behind. Third, it is not clear if the recommendations of the Finance Commission of states have been acted upon, and if these have led to any improvement in the finances of local governments.

What should be done to provide a fresh impetus to the process of decentralization? Which are the short-term actions? What should be the long-run strategy to accelerate the implementation of the Constitutional amendments and strengthen the decentralization agenda? At best, a tentative response can be offered here. For the short run, two actions seem imminent in order to break the current impasse:

- Set clearly and unambiguously the expenditure responsibilities of the panchayats and municipalities, particularly in relation to Schedule XI and Schedule XII referred to earlier in the paper. Note should be made of the fact that there may not exist any agreement on what expenditure responsibilities should be devolved on the local bodies, as what may be appropriate for one state may not be so for another, but the need for determining them is of paramount importance in pushing the decentralization programme[16].
- Ensure that the panchayats and municipalities have the necessary resources in the form of revenue raising powers and transfers to meet the expenditure responsibilities. The role of transfers is not to fill in the *actual* gap that may exist or arise between revenues raised and revenues needed, but to meet the gap that is carefully worked out on certain normative considerations[17].

A long-run strategy should aim at effective devolution of powers and responsibilities to the panchayats and municipalities. At least two components of such a strategy are possible to be identified:

- Imparting a degree of autonomy to local governments that is commensurate with the expenditure/spending responsibilities. Setting the tax rates (and rates of fees, fines, charges and the like) is an extremely important instrument with any level of government for adjusting its resources and financial requirements. Fears about local fiscal autonomy[18] that it could lead to fiscal irresponsibility or affect stability at the higher levels, are unfounded, given the fact that what the local bodies spend today constitutes a small percentage of the total government spending.
- Building and creating local capacities are a prerequisite for implementing and sustaining the decentralization programme. The existing capacities of the panchayats and municipalities are extremely inadequate and grossly irrelevant for advancing the decentralization agenda.

Finally, it must be emphasized that political reforms without the devolution of powers are incomplete, and far from conducive for producing socially effective results. Although made in the context of another country, Richard Bird's remarks aptly describe the current status of decentralization in India[19].

"The process currently under way appears to assume that the extent, nature and timing of devolution is essentially a political question. Any economic and fiscal question relating to devolution seems to be viewed as simply details to be cleared up later, once a political solution is reached. The premise of this argument is sound. Devolution is essentially a political matter. *The conclusion is mistaken. Careful attention must be paid to the economic and fiscal aspects of devolution from the beginning* (emphasis added)".

Conclusions

The review of the implementation of the Constitution (seventy-third) Amendment Act, 1992 on Panchayats and the Constitution (seventy-fourth) Amendment Act, 1992 on Municipalities reveals that the two amendments have come to represent what is seen in the country as a bold experiment in decentralization and empowerment of local governments.

(i) Until the incorporation of these two amendments into the Constitution, decentralization in India was understood in terms of establishing democratically-elected governments at local levels, and assigning to them such powers and responsibilities as would enable them to function as institutions of self government. The implicit assumption in this concept was that the democratically-elected local governments compared with other forms of government were in a better position to assess the needs and development priorities of the areas they represented, and provide an outcome that was closest to the preferences of the people.

(ii) In the design of the federal structure, local governments in India until the amendments were an exclusive concern of the state governments. Drawing strength from the different provisions of the Constitution under which the subject of local government formed a part of the state list, the state governments determined the expenditure responsibilities and fiscal powers and authority of local governments, and defined the degree of autonomy within which they could function. Discussion on how to improve the financial viability of local bodies or streamline the flow of funds to them, or carry out reform of local taxes took place within the parameters of state control over local bodies.

(iii) The Constitution (seventy-third) Amendment Act, 1992 on Panchayats and the Constitution (seventy-fourth) Amendment Act, 1992 on Municipalities have changed the erstwhile state-local relations. Changes aim at broad-based strengthening of local governments and relate to.

(a) the reform of the electoral system at local levels under which the state governments are required to hold regular elections as is the case with elections at higher levels of government, and to hold elections within six months, if locally-elected body is dissolved sooner than its tenure;

(b) the representation of women and other disadvantaged groups on local councils, with the mandate that thirty-three per cent of seats in the councils be reserved for women and proportionate reservation be made for scheduled tribes and castes;

(c) the institutional framework for planning and development, requiring the state governments to constitute Planning Committees for each district (DPCs) and Planning Committees for each Metropolitan area (MPCs), for purposes of consolidating the plans prepared by local governments and formulating overall development plans; and

(d) the fiscal powers and authority of local bodies under which every state government is expected to constitute, once in five years, a

Finance Commission and to entrust it with the tasks of reviewing the financial position of local bodies and making recommendations as to the principles that should govern -

- the distribution between the state and the local bodies of the net proceeds of the taxes, duties, tolls and fees leviable by the state;
- the determination of the taxes, duties, tolls and fees that may be assigned to, or appropriated by, the local bodies, and
- the grants-in-aid to local bodies from the consolidated fund of the state.

(iv) The new fiscal arrangement under the Constitution also requires the Central Finance Commission to suggest measures for the augmentation of the financial resources of states for supplementing the resources of local bodies.

(v) Substantial progress has been achieved over the past 6-7 years in terms of implementing the mandatory provisions of the Constitutional amendments. With few exceptions, elections to panchayats and municipalities have been held with the requisite representation of women and other disadvantaged groups. In several states, district and metropolitan planning committees have been constituted.

(vi) Defining the fiscal powers and responsibilities of local bodies is at the centre of the Constitutional amendments. The issue requires the Finance Commission of states to examine not only the revenue-sharing arrangement between the state governments and local bodies, but the entire gamut of issues consisting of the assignment of taxing powers, transfers and the transfer mechanism, and even such issues as the borrowing powers of local bodies, local autonomy, and the like. The approach of the first Finance Commission of states varies. Their recommendations do not envisage any noticeable change in the tax jurisdiction of local bodies, but instead places greater reliance on transfers for bridging the gap between what the local bodies are able to raise and what they need to fulfil their spending responsibilities.

(vii) The Central Finance Commission has taken a proactive role in promoting decentralization by prescribing a five-fold criteria for the allocation of supplementary grant to local bodies. The principle used for the allocation is that apart from the size of local bodies – represented by population and geographical area – grants should be allocated on the basis of *efficiency*, measured by the revenue-sharing effort of local bodies, and *equity* represented by the distance of the state's average per capita gross domestic product from highest average per capita GSDP. An important criterion that commands a 20% weight in the grant allocation relates to decentralization as envisaged in the Constitutional amendments. The Central Finance Commission has proposed an index of decentralization for measuring decentralization.

(viii) What do these measures amount to? Have these measures strengthened local bodies? Enough evidence to conclusively address these questions is still to come. Limited evidence suggests that:

(a) *decentralization in different states is asymmetrical and has occurred at different paces and via different routes,*

(b) *decentralization has not advanced beyond the creation of democratically-elected local bodies at the level of panchayats and municipalities,*

(c) *no worthwhile decentralization of powers and responsibilities has occurred, and*

(d) *far less attention has been given to issues of autonomy of local bodies. Emphasis on political reforms without the devolution of powers is incomplete decentralization and far from conducive to producing socially effective results.*

Notes:

1 Panchayats refer to rural local bodies and municipalities refer to urban local bodies.

2 See in particular, the Balvantray Mehta Committee (1959) and Asoka Mehta Committee on Panchayati Raj Institutions (1978). The Balvantray Mehta Committee recommended setting up of a three-tier structure of panchayati raj institutions for effective decentralization. The Asoka Mehta Committee emphasized that the psychic dividends of the association of rural people with the planning and development process are crux of the matter. A Committee set up by the National Planning Commission to review the progress in the sphere of decentralization identified absence of financial autonomy and the primacy of government officials as against people's representatives as major weaknesses.

3 The Constitution of India consists of three lists: a central list of subjects over which the central government has exclusive control, a state list of subjects with exclusive control by the state governments, and a concurrent list of subjects.

4 The "why" of the amendments to the Constitution as embodied in the Statement of Objects and Reasons published in the Gazette of India (September 16, 1991) is that in many states, local bodies have become weak and ineffective on account of a variety of reasons, including the failure to hold regular elections, prolonged suppression and inadequate devolution of powers and functions. As a result, local bodies are not able to

perform effectively as vibrant democratic units of self-governments. Having regard to these inadequacies, it is necessary that provisions relating to (i) the functions and taxation powers, (ii) arrangements for revenue sharing, (iii) conduct of regular elections and timely elections in the case of suppression, and (iv) adequate representation to the weaker sections and women in the local councils are specified in the Constitution.

5 Decentralization in other parts of the world is explained by factors as varied as the advent of multiparty political systems in Africa; the deepening of democratization in Latin America; the transition from a command to a market economy in Eastern Europe and the erstwhile Soviet Union; the need to improve service delivery to large populations in centralized countries of East Asia; the challenge of ethnic and geographic diversity in South Asia and indeed, the attempt to keep centrifugal forces at bay by forging a symmetrical federation, and the plain and simple reality that the higher level governments in several countries have failed to provide public services. See Jennie Litvack, Junaid Ahmad and Richard Bird, "Rethinking Decentralization at the World Bank.. 1998 mimeo; Vito Tanzi, "Fiscal Federalism and Macroeconomic Aspects", Annual World Conference on Development Economics, The World Bank – Washington D.C. 1995; Antonio Estache. Decentralizing Infrastructure; Advantages and Limitation, World Bank Discussion Paper No. 290, Washington D.C. 1995; and Shahid Javed Burke et. al, Beyond the Center: Decentralizing the State, World Bank Latin American and Caribbean Studies. Washington D.C. 1979.

6 There is ample evidence to show that problems in public service delivery cannot be addressed by attempting to change the behavior of local governments, in isolation. The constraints on public services do not lie only in factors that are under the control of local government. See. William Dillinger, "Decentralization, Politics and Public Services", in Antonio Estache, ibid.

7 The gradation of an area into transitional, small or large is to be determined by the Governor of a state on the basis of such factors as population, area, density, revenue generated for local administration, employment in non-agricultural activities, and other factors that point to the economic importance of the area [243 (Q) (2)].

8 The 1991 Census listed thirty-eight types of urban local bodies.

9 A metropolitan area means an area having a population of one million or more and consisting of two or more municipalities or panchayats or other contiguous areas, specified and notified as a metropolitan area.

10 The Central Finance Commission is a Constitutional body, and is set up, once in five years, in pursuance of the provisions of Article 280 of the Constitution of India and of the Finance Commission (Miscellaneous Provisions) Act, 1951.

11 Justice Dillon's rule is generally accepted. "Municipal corporations owe their origin to, and derive their powers and rights wholly from the legislature. It breathes into them life, without which they can not exist. As it creates, so may it destroy. If it may destroy, it may abridge and control". See. J.F. Dillon. Commentaries on the Law of Municipal Corporations. 1911. Boston.

12 The states, which have constituted the DPCs, include Assam, Gujarat, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Tripura and West Bengal.

13 Literature on fiscal federalism shows that there is no consensus among policy-makers on which taxes should be assigned to which level of government. But the general principle that guides the division of fiscal powers is that the local governments should be assigned those taxes whose burdens are likely to be locally absorbed i.e., which are not easily exportable to residents who do not benefit from the local services that are being financed by the revenues raised. Similarly, transfers are seen as a compromise in the debate over the division of revenue-raising authority and expenditure responsibility. Transfers allow the higher levels of government to retain the authority to tax more productive tax bases, but ensure a flow of resources to local bodies. See. Teresa Ter-Minsassian (Ed)., 1997. Fiscal Federalism in Theory and Practice, International Monetary Fund, Washington, D.C.

14 The terms of reference of the Central (Eleventh) Finance Commission further provide that where the reports of the state finance commissions are not available, the Central Finance Commission may make its our assessment about the manner and extent of augmentation of the consolidated fund of the state to supplement the resources of the panchayats and municipalities in the state. See, Report of the Eleventh Finance Commission for 2000.2005. June 2001.

15 Lest an impression is created that local councils are the creation of the constitutional amendments, it should be noted that the state laws in the pre-amendment period provided for elected councils for local governments. The difference in the post-amendment period is that these councils can not be arbitraly dissolved or if dissolved, elections are to be held within sic months.

16 On the issue of the allocation of functions and powers between levels of government, William Dillinger notes: There is no road map here "the world now consists of more than 200 experiments". See his Decentralization and Its Implications for Urban Service Delivery. 1994. The World Bank/UNCHS/UNDP: Washington D.C.

17 While decentralizing expenditure responsibilities should be matched with decentralizing revenue raising, it is often argued that decentralization of taxation can lead to inequities and inefficiencies in the economy. The role of transfers in such circumstances is said to be important.

18 The macroeconomic threat of local governments is commonly observed in the developing as also the developed countries. It is this that explains the State governments control over the activities of local bodies, particularly in setting upper limit for taxes; or fixing bands for tax rates, and the like.

19 Richard Bird. 1996. Fiscal aspects of Devolution in Sri Lanka. Mimeo.

Annexures

Annex-1: India: Number of Villages Classified by Population Size, 1991.

Population size	Villages		Population	
	Number	% of total number of villages	Number (million)	% of total population
Less than 200	103,952	17.9	10.53	1.7
200-499	141,143	24.3	48.46	7.8
500-999	144,998	25.0	104.36	16.8
1,000-1,999	114,395	19.7	160.29	25.7
2,000-4,999	62,915	10.8	185.57	29.8
5,000-9,999	10,597	1.8	69.84	11.2
10,000 and above	2,779	0.5	43.76	7.0
Total	580,779	100.0	622.81	100.0

Source: Census of India: General Population Tables (Table A.1 to A.3), Part II.A, Office of the Registrar General and Census Commission, India.

Annex-2: India: Number of Urban Agglomerations by Population Size, 1991.

Population size	Urban Agglomeration		Urban Population	
	Number	% of total	Number (million)	% of total
Less than 5,000	185	5.13	0.61	0.29
5,000-9,999	725	20.08	5.53	2.60
10,000-19,999	1,135	31.45	16.53	7.76
20,000-49,999	927	25.68	28.08	13.19
50,000-99,999	341	9.45	23.31	10.95
100,000 and above	296	8.20	138.80	65.21
Total	3,609	100.0	212.86	100.0

(Excluding Assam and Jammu and Kashmir)

Source: Census of India. Paper 2 of 1991.

Annex-3: Eleventh schedule (Article 243G)

1. Agriculture, including agricultural extension.
2. Land improvement, implementation of land reforms, land consolidation and soil conservation.
3. Minor irrigation, water management and watershed development.
4. Animal husbandry, dairying and poultry.
5. Fisheries.
6. Social forestry and farm forestry
7. Minor forest produce.
8. Small scale industries, including food processing industries.
9. Khadi, village and cottage industries.
10. Rural housing.
11. Drinking water.
12. Fuel and fodder.
13. Roads, culverts, bridges, ferries, waterways and other means of communication.
14. Rural electrification, including distribution of electricity.
15. Non-conventional energy sources.
16. Poverty alleviation program.
17. Education, including primary and secondary schools.
18. Technical training and vocational education.
19. Adult and non-formal education.
20. Libraries.
21. Cultural activities.
22. Markets and fairs.
23. Health and sanitation, including hospitals, primary health centers and dispensaries.
24. Family welfare.
25. Women and child development.
26. Social welfare including welfare of the handicapped and mentally retarded.
27. Welfare of the weaker sections, and in particular, of the Scheduled Castes and the Scheduled Tribes.
28. Public distribution system.
29. Maintenance of community assets.

Annex-4: Twelfth Schedule (Article 243W)

1. Urban planning including town planning.
2. Regulation of land-use and construction of buildings.
3. Planning for economic and social development.
4. Roads and bridges.
5. Water supply for domestic, industrial and commercial purposes.
6. Public health, sanitation conservancy and solid waste management.
7. Fire services.
8. Urban forestry, protection of the environment and promotion of ecological aspects.
9. Safeguarding the interests of weaker sections of society, including the handicapped and mentally retarded.
10. Slum improvement and upgrading.
11. Urban Poverty alleviation.
12. Provision of urban amenities and facilities such as parks, gardens, and playgrounds.
13. Promotion of cultural educational and aesthetic aspects.
14. Burials and burial grounds: cremations, cremation grounds and electric crematoriums.
15. Cattle pounds; prevention of cruelty to animals.
16. Vital statistics including registration of births and deaths.
17. Public amenities including street lighting parking lots, bus stops and public conveniences.
18. Regulation of slaughterhouses and tanneries.

Annex-5: Number of Panchayats (as on May 31, 1998)

States/Uts	GPs	PSs	ZPs	Total
Andhra Pradesh	21943	1098	22	23063
Arunachal Pradesh	2012	79	12	2103
Assam	2489	202	21,	2712
Bihar	12181	725	55	12961
Goa	183	2	185	
Gujarat	13316	184	19	13519
Haryana	5958	110	16	6084
Himachal Pradesh	2922	72	12	3006
J & K	2683		14	
Karnataka	5675	175	20	5870
Kerala	991	152	14	1157
Madhya Pradesh	30922	459	45	31426
Maharashtra	27619	319	29	27967
Manipur	166		3	169
Meghalaya			Traditional Councils	
Mizoram			Traditional Councils	
Nagaland			Traditional Councils	
Orissa	5261	314	30	5605
Punjab	11591	138	17	11746
Rajasthan	9185	237	31	9453
Sikkim	148	4	152	
Tamil Nadu	12584	384	28	12996
Tripura	525	16	3	544
Uttar Pradesh	58605	901	68	59574
West Bengal	3314	341	17	3672
A & N Islands	67		1	68
Chandigarh				
D & N Haveli	11		1	12
Daman & Diu	10		2	12
NCT Delhi				
Lakshadweep	10		1	11
Pondicherry	10		1	11
Total	227698	5906	474	234078

Annex-6: Number of Elected Members in Panchayats (as on May 31, 1998)

States/Uts	Gram Panchayats	Panchayat Samiti	Zila Parishad
Andhra Pradesh	230529	14644	1093
Arunachal Pradesh*			
Assam	24860	2486	
Bihar			
Goa	1281		
Gujarat	123470	3814	761
Haryana	54159	2418	303
Himachal Pradesh	18258	1661	252
Jammu & Kashmir			
Karnataka	80627	3340	919
Kerala	10270	1547	300
Madhya Pradesh	474351	9097	946
Maharashtra	303545	3524	1762
Manipur	1556		61
Orissa	81077	5260	854
Punjab	78983	2441	274
Rajasthan	119419	5257	997
Sikkim	1827		145
Tamil Nadu	94304	6499	648
Tripura	5427	196	70
Uttar Pradesh	682670	58165	2551
West Bengal	62172	9516	664
A & N Islands	667		30
Chandigarh	109	6	10
D & N Haveli	135		16
Daman & Diu	63		15
Lakshadweep Pondicherry			
Total	2449759	129871	12671

Annex-7: Election to Urban Local Bodies

State	Municipal Corpo-rations	Municipal Councils	Nagar Pancha-yats	Total
Andhra Pradesh	07	94	15	116
Assam	01	25	42	68
Bihar*	06	70	93	169
Goa	-	13	-	13
Gujarat	06	86	60	152
Haryana	01	20	61	82
Himachal Pradesh	01	19	29	49
Karnataka	06	121	87	214
Kerala	03	55	-	58
Madhya Pradesh	18	103	281	402
Maharashtra	13	233	-	246
Manipur	-	07	20	27
Orissa	02	30	70	102
Punjab	03	97	34	134
Rajasthan	03	11	168	182
Tamil Nadu	06	104	635	745
Tripura	-	01	12	13
Uttar Pradesh	11	226	444	681
West Bengal	06	112	4	122
A & N Islands	-	01	-	01
Chandigarh	01	-	-	01
Delhi	01	01	-	02
Pondicherry*	-	05	-	05
Daman & Diu	-	02	-	02
Total	95	1436	2055	3586

*Election not held due to court cases.

Note: There is no Municipality in Arunachal Pradesh. Jammu & Kashmir has yet to adopt the 74th CAA. No Municipality has been constituted in Meghalaya. In Mizoram, Municipal Act under the 74th CAA is under consideration of State Government. No urban local body exists in Nagaland. In Sikkin, the Municipal Act has been enacted and positions of elections yet to be ascertained. In Dadar & Nagar Haveli and Lakshadweep, there is no urban local body.

Annex-8: Number on Elected Representatives in Municipalities (as of July 2000)

State/U.T.	Municipal Corpo-rations	Municipal Councils	Nagar Pancha-yats	Total
Andhra Pradesh	395	2833	314	3542
Assam	-	353	204	557
Goa	-	155	-	155
Gujarat	468	2745	1260	4473
Haryana	-	-	-	1359
Himachal Pradesh	25	183	221	429
Karnataka	410	3196	1355	4961
Kerala	298	1597	-	1895
Madhya Pradesh	1067	2527	4537	8131
Maharashtra	1417	4901	-	6318
Orissa	70 560	1056	1686	
Punjab	-	-	-	1699
Rajasthan	-	-	-	4412
Tamil Nadu	480	3494	9794	13768
Uttar Pradesh	841	5970	5518	12329
West Bengal	-	-	-	2706
Delhi	-	-	-	134
Total	-	-	-	68554

Note: indicates non-availability of break-up. □

Effectiveness of Development Programmes on Poverty Reduction in Rural India

Shyam Sunder Pd Sharma

Since the Sixth Plan, the Government introduced several direct anti-poverty programmes for the poor in India. This paper investigates the effectiveness of development programmes on poverty reduction in rural India. There is a perceptible decline in poverty in the 1980s and a less perceptible decline in the 1990s.

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Growth of the economy and development programmes have been tried as major tools. There has always been a difference of opinion among Indian economists and planners, however, on whether 'growth per se' can solve the poverty problems or whether a specific distribution policy is also needed to meet the objective.

The realized growth of the economy was very low right until the mid-1970s. No opportunity, therefore, arose to test the so-called 'percolation theory of growth' hypothesis. The economy did not shift from the low Hindu rate of growth of around 3.5 per cent to above 5.5 per cent per annum until the 1980s. This was also the period when poverty decreased and the government launched a large number of target-oriented poverty alleviation programmes. Poverty reduction during this period may, therefore, be ascribed both to growth and to redistributive measures. During the pre-and-post 90s, the country's poverty ratio (i.e. percentage of people below the poverty line) fell by -3.0 per cent per annum and declined only to 0.2 per cent respectively, i.e. it remained almost stagnant between 1990-91 and 1997 (Gupta, 2000). This paper addresses the issues mainly concerned with the impact and the long-term effects of specific programme of rural development i.e. programmes of poverty alleviation and employment generation for the poor, particularly in rural areas.

Direct Approach of Rural Development

It is not surprising that poverty alleviation is no longer regarded as something that can be safely left to the process of growth and the operation of automatic 'trickle down' processes alone. On the contrary, it is now widely accepted that poverty alleviation must be treated as an explicit objective and development strategies must be consciously structured to achieve this objective. The static picture of the factors affecting income levels of the poor pointed to two possible types of poverty alleviation strategies. One is the 'direct

approach' based on the proposition that since the poor lack land, capital, credit and employment, the strategy for poverty alleviation must be to fill these gaps directly through government intervention. Typically this involves direct intervention in the form of targeted programmes aimed at giving land (either title or security of tenure), credit in support of self-employment schemes, or direct employment in government-funded employment programmes (Ahluwalia, 1990).

The second direction, which poverty alleviation strategies can take, is what Bhagwati (1988) has called the 'indirect approach'. This approach focuses on the poverty reducing potential of the growth process by appropriate choice of policies and development strategies, which would enhance the flow of benefit to the poor. The difference between the direct and the indirect approach is principally that the former focuses directly on the present production occupations of the poor, and seeks to enhance their income earning capacity in those occupations, whereas the indirect approach focuses on identifying strategies which will influence the total operation of economy to strengthen the poverty-reducing impact of growth.

Poverty, defined as inadequacy of income to meet a minimum level of consumption, has afflicted a sizable part of the Indian population. According to the official estimates for 1993-94 about 19 per cent of India's population, about 169 million, live below the poverty line, defined in terms of the average total expenditure of the household meeting the per capita food consumption norm of 2400 calories in rural areas and 2100 calories in urban areas. These estimated figures show a substantial decline in the incidence of poverty over the years. Comparable estimates of incidence of poverty for 1973-74 for rural and urban areas were 54 per cent and 41 per cent respectively. Estimates based on Expert Group Methodology (Government of India, Planning Commission, 1993), however, show that about 36 per cent of the population was below poverty line (37 per cent in rural and 35 per cent urban) even in 1993-94 (with an absolute number of poor estimated at around 296 million), compared to 54.1 and 41.2 per cent in rural and urban areas respectively in 1973-74 (Papola and Sharma, 1996).

In recent times, experiences of several countries refuted the hypothesis that the rate of growth and poverty reduction is directly correlated. Regarding the relationship between growth and employment, there are questions raised on whether growth necessarily creates corresponding employment and reduces poverty. The experiences of individual countries differ. For example in many countries, employment elasticity declined significantly with faster GDP growth. In fact, there are instances where employment in absolute terms actually declined with higher growth and poverty ratio (i.e. percentage of people below poverty line) between 1983 and 1990-91 fell by -3.0 per cent per annum and declined only to -0.2 per cent in the 1990s, i.e. it remained almost stagnant between 1990-91 and 1997. In contrast to this, the GDP growth in India between 1983 and 1991 was around 5.6%, and between 1991 and 1997 this was expected to go above 5.8%. The inverse relationship observed between the GDP and poverty reduction becomes even more prominent if one looks at the trends in recent years. For example, between 1993-94 and 1998, the estimates of poverty went up when poverty percentage (i.e. people below poverty line) increased from 35.95% and 39.89 per cent in aggregate (Gupta, 2000). This is the period when GDP growth rate increased to around 6.9 per cent per annum, the highest ever, witnessed consecutively for four years (see. Table 1).

Table 1: GDP Growth at Factor Cost (at 1980-81 Prices)

Year	GDP Growth Rate	Year	GDP Growth Rate
1980-81	6.1	1994-95*	7.8
1985-86	4.1	1995-96*	7.6
1990-91	5.4	1996-97*	7.8
1991-92	0.8	1997-98*	5.0
1992-93	5.3	1998-99*	7.8
1993-94	6.2	1999-2000	6.5

Note: * Calculated on the revised base year, 1993-94.
Source: Gupta, 2000.

Poverty trends can be examined here on consumption data. It is called the direct method. India is perhaps the only developing country that has the largest time series of national household surveys starting from the early 1990s. Till 1973-74, NSS data were available annually. Between 1972-73 and 1993-94 five quniquennial surveys have been carried out with a large sample village. The remaining NSS round in the 1980s and 1990s are based on the so-called 'thin' sample of two households per sample village. The 'thin' samples are good enough to provide reliable estimates at the all-India level and the variance may be high at the state level. The trends during the first 24 years of pre-reform period (1951 to 1973-74) shows that the (a) rural poverty varied between 44 per cent and 64 per cent, and (b) urban poverty varied between 36 per cent and 53 per cent without any significant trends. However, both rural and urban poverty ratios showed a decline in the late 1970s and in the 1980s.

Has poverty worsened in the post-reform period? Since the introduction of economic reforms in 1991, there has been a debate on whether the reform

measures have adverse effects on the social sector and the poor. First, we look at the estimates based on both large and thin samples. The estimates for the period 1973-74 to 1998 are given in Table 2. Datt's estimates presented in Table 2 show that rural poverty declined in 1980s and it has not declined in the 1990s as compared to 1990-91.

Table 2: Trends in Poverty: 1973-74 to 1998, All India

Year	Datta Estimates		S.P. Guptas Estimates		
	Rural	Urban	Rural	Urban	Total
1973-74	55.72	47.96	-	-	-
1977-78	50.60	40.50	45.65	40.79	44.48
1983	45.31	35.65	45.65	40.79	44.48
1986-87	38.81	34.29	-	-	-
1987-88	39.23	36.20	39.09	38.20	38.86
1988-89	39.05	36.00	-	-	34.28
1989-90	34.30	33.40	33.70	36.00	34.28
1990-91	36.43	32.76	35.04	36.29	35.11
1991	37.42	33.23	-	-	-
1992	43.47	33.73	41.70	37.80	40.70
1993-94	36.66	30.51	37.27	32.36	35.07
1994-95	41.02	33.50	38.03	34.24	36.98
1995-96	37.15	28.04	38.29	30.10	36.08
1997	35.78	29.99	38.46	33.97	37.23
1998	(6 months)	-	45.25	34.58	43.08

Sources: Estimates based on NSS, data on consumer expenditure.

Infact, it increased to above 40 per cent in 1992 and 1994-95. On the other hand, urban poverty declined significantly in the 1990s. Gupta's estimates also show similar trends on rural poverty. However, in 1998, the rural poverty increased around 45 per cent. His study also indicates that probably growth was not trickling down in the 1990s. Next, we look at estimates based on quniquennial surveys for the pre and post-reform period. The estimates based on expert group method and approved by the Planning Commission are presented in Table 3. It shows that the 1980s recorded faster decline in rural poverty and the decline slowed down considerably after the introduction of reforms (Rao, 1998). On the other hand, urban poverty showed faster decline in the post-reform period.

Three conclusions emerge from the above assessment of the all-India poverty situation. These are as follows: (a) Rural and urban poverty increased during the first two years of the reform period; (b) The phenomenon of faster decline of poverty in the 1980s has been halted in the post-1991 period; if we compare 1987-88 and 1993-94, the rate of decline in poverty has been much slower as compared to that of the 1980s; (c) Urban poverty declined much faster than rural poverty in the post-reform period.

To sum up, the impact of economic reforms on the rural poor in India so far has not been as bad as in the Latin American countries. On the other, it has been not as favourable as in some of the East Asian countries.

In a continental economy like India, it is more important to look at trends in poverty at a disaggregate level. Table 4 provides state-level poverty estimates which are computed broadly by following the Expert Group Method (Datt, 1998). While estimating poverty ratios, adjustments were carried out to consumer price index numbers for agricultural labours by updating the national price of firewood. The estimates for 1987-88 and 1993-94 are based on large samples, while those for 1990-91 and 1992 are based on 'thin samples'. The poverty ratios show that as compared to 1990-91 rural poverty increased significantly in 1992 in all the states except West Bengal. On the other hand, urban poverty recorded an increase in only six states (Andhra Pradesh, Bihar, Karnataka, Orissa, Utter Pradesh and West Bengal). Four states (Assam, Gujarat, Madhya Pradesh, Tamil Nadu) showed a decline in urban poverty during the same period.

As compared to 1992, however, rural poverty declined significantly in all the states in 1993-94, except

Table 3: Percentage of Population Below the Poverty Line

Year	Datt Estimates			S.P. Gupta Estimates		
	Poverty Ratio	Annual Achievement	Poverty Ratio	Annual Achievement	Poverty Ratio	Annual Achievement
1977	7853.00	-	43.2	-	51.3	-
1983	45.7	-3.24	40.8	-2.25	45.5	-3.11
1987-88	-8839.1	-3.41	38.2	-1.45	38.9	-2.95
1993-94	-9437.3	-0.78	32.4	-2.71	36.0	-1.29

Source: Government of India, Economic Survey, 1997-98.

in Punjab, Haryana and Orissa. If we concentrate only on quinquennial surveys because of large samples, rural poverty declined in most of the States except in four states (Assam, Bihar, Haryana and Uttar Pradesh) in 1993-94.

As compared to those for 1987-88, the rate of decline in rural poverty during the period 1987-88 to 1993-98 was lower in most of the states as compared to the periods 1983 to 1987-88 and 1977-78 to 1983 periods. Urban poverty showed a higher rate of decline in nine of 17 states during 1987-88 to 1993-94 as compared to the previous period. The state-level analysis also shows similar trends in both rural and urban poverty, with regard to the impact of reforms on the poor. The poverty increased in the first two years of the reform period and showed a decline in 1993-94, but the rate of decline was lower than for the 1980s.

If we look at long-term changes, the ranks of states in terms of head count ratio are quite different in average over 1990-94 as compared to those in average over 1957-60. For example, Kerala, which had the second highest incidence of rural poverty around 1960, moved to the rank of the fifth lowest in the 1990s. States like Andhra Pradesh, Orissa and Tamil Nadu have also moved up significantly in these rankings: Similar changes in ranking were noticed in urban areas. However, some of the difference in poverty at state-level persisted over time. Punjab & Haryana had the lowest incidence of poverty in both 1960s and 1990 while Bihar had much higher incidence of poverty over the last three decades (Datt 1998).

The disparity in the incidence of poverty is much higher if we look at the level of NSS regions (below state level). Dubey and Gangopadhyay (1998) estimated head count ratios at the level of NSS region of the years 1987-88 and 88 and 1993-94. The estimates are based on expert group methodology for 58 major regions, so that rural poverty varies from around 5% in Northern Punjab to 69% in Southern Orissa in 1993-94. Similarly, in urban areas it varies from 5% in Assam hills to 67% in southern Uttar Pradesh. Change in incidence of rural poverty by quartiles reveals that 19 regions got poorer while 18 regions have improved their positions in 1993-94 as compared to those for 1987-88. In the case of urban areas, 14 regions got poorer while 15 improved in terms of moving to the fourth quartile during the same period. There are also significant intra-state variations in some of the states.

Since, the sixth plan, the Government has been introducing several direct anti-poverty programmes for the poor in India, which can be broadly divided into the following three categories: (a) Wage Employment Programmes (Public works): (b) Self Employment Programmes (IRDP); (c) Public Distribution System (PDS) and Nutrition Programme (Integrated Child Development Services).

Table 4: Poverty Across States: Head Count Ratio 1987-88 to 1993-94

States	1987-88 June-July	1990-91 July-June	1992 Jan.-Dec.	1993 July-June
Rural				
Andhra Pradesh	34.02	36.90	41.85	28.93
Assam	43.01	42.40	56.61	48.99
Bihar	58.57	58.29	67.81	63.51
Gujarat	42.93	43.13	46.78	35.35
Karnataka	43.49	42.73	56.94	40.97
Kerala	34.67	33.80	34.15	31.07
Madhya Pradesh	47.80	47.93	56.09	45.36
Maharasthra	52.32	43.05	60.03	47.81
Orissa	47.98	27.14	36.57	40.28
Punjab & Haryana	20.00	18.55	18.17	25.23
Rajasthan	50.35	38.96	60.90	47.52
Tamil Nadu	48.35	42.02	46.65	36.74
Uttar Pradesh	41.36	36.88	46.67	41.60
West Bengal	34.87	39.11	28.15	27.27
All India	39.23	36.43	43.47	36.66
Urban				
Andhra Pradesh	39.98	31.96	33.03	30.82
Assam	12.26	19.34	6.55	9.95
Bihar	52.94	41.13	46.32	39.72
Gujarat	38.51	44.19	37.14	30.46
Karnataka	42.04	34.80	37.76	29.71
Kerala	38.02	34.77	34.01	27.07
Madhya Pradesh	43.45	40.22	48.74	40.76
Maharasthra	38.79	38.03	38.15	36.23
Orissa	47.53	40.42	48.74	40.76
Punjab & Haryana	19.25	13.44	16.02	11.42
Rajasthan	37.68	29.98	29.13	29.38
Tamil Nadu	39.74	33.80	30.50	31.32
Uttar Pradesh	41.36	36.88	46.67	41.60
West Bengal	32.19	23.77	25.66	22.45
All India	36.20	32.76	33.73	30.51

Source: Adapted from Datta (1998)

The perceptible decline in poverty in 1980s was the combined result of acceleration in the growth rate in GDP, spread of Green Revolution to the poorer areas, increased allocation for poverty alleviation programmes and strengthening of public distribution system for food grains. In the post-reform period of early 1990s,

however, the growth rate in GDP had come shown significantly, the rate of inflation was high, persisting around 10% consecutively for 4 years, and the expenditure on social sectors including the poverty alleviation programme slowed down. The consumer price index by agricultural labourers increased by 50 per cent over the five years ending 1993-94. This is because among other things, the drive to reduce food subsidies led to a steep increase in the issue prices of food grain supplies under the PDS. The difference between the free market and PDS prices narrowed down significantly, leading to reduce off-take from the PDS and the decline in the per capita availability of food grains (Rao and Radhakrishna, 1997). These factors may explain the slow pace of reduction in rural poverty in this period compared to the 1980s.

Equally significant would be the indirect contribution of agriculture to rural poverty alleviation through its contribution to overall economic growth on account of its strong linkages with the rest of the economy and by strengthening food securities. The rise in agricultural wages itself is attributed mainly to the rise in the demand for labour in non-agricultural activities, notably construction and services (Bhalla, Sheila et al 1991). This may indeed explain why across the countries of east and South East Asia, rural poverty reduction bears a stronger correlation with overall economic growth than with agricultural growth per se (ESCAP 1996).

Regional Imbalance in Poverty Alleviation and Income Trends

Indian Experiences

With the achievement of relative significance in the food grains and with the gradual size in per capita income in the country, the demand for livestock products such as milk and meat has been rising, as the demand for these products in highly income elastic when compared to demand for food grains. Therefore, the importance of livestock enterprises as a source of income in the rural sector (including for the rural poor) has been rising while the total demand for work animals has reached a saturation point and even started showing some decline. Since livestock enterprises are an important source of income for the rural poor, they have a bearing on the levels of poverty. Similarly, the pattern of crop production and livestock growth have an impact on the rural environment directly through the pressure they exert for expansion of area under cultivation and grazing and indirectly through the effect they have on the livelihood of the rural poor. The latter drive a good part of their income from village common (Jodha, 1986) and are also a source of cheap labour for the contractors for felling trees as well as their transportation. There is, therefore, a need to understand the causes of environmental degradation in the context of technological change in agriculture, the impact of livestock economy and rural poverty.

IRDP, Livestock and Environment: An Overview

The Integrated Rural Development Programme (IRDP) effectively started in 1980-81. It provides support to the rural households below the poverty line, with a package of assistance consisting of subsidy and bank loans to enable them to acquire productive assets like livestock, manufacturing and processing equipment and business space. Assistance is provided to households with annual income below a certain cut off, which is generally fixed at a level lower than the poverty line income in order to reach the poorest among the poor.

The recent debate on the IRDP as a policy intervention for the alleviation of rural poverty has focused attention on two major issues: First, it has been argued that the poorest of the poor in rural areas may have neither the skills, nor the capacity to bear the risks necessary for undertaking asset-oriented activities under IRDP. It was, therefore, feared that leakages from such investment and the rate of default in the repayment of loans would be high for the poorest of the poor. On account of this, it was suggested that greater reliance on the provision of wage-employment for them might be better strategy than the endowment of income-earning assets under IRDP (Rath, 1985; for a critique of this view see Dantwala, 1985; see also Hirway, 1985). Secondly, on the basis of results from a number of surveys, it was pointed out that a very small proportion of IRDP-assisted families could infact cross the poverty line. This was generally interpreted as signifying the failure of the programme to fulfill its objective on account of alleged inefficiencies and leakages (Dredge, 1990).

Livestock, whether work animals, milch animals, or sheep and goats exert pressure on the environment basically through grazing on uncultivated land and including forests. To the extent that their feed requirements are met from the by-products of crop output or green fodder raised on the farms; the pressure on uncultivated area will be relieved. Therefore, the two important variables to be considered are the number of animals (in each category) and the extent of their dependence on areas other than the cultivated area. It is understood, however, that the expansion of the area under cultivation, particularly on marginal and sub-marginal land would, by itself, have a negative impact on the environment (Sharma, 2002).

IRDP puts emphasis on the creation of self-employment status to the poor in the economy, depending

upon the expansion on livestock for gainful jobs. It would appear that buffaloes in milk, whose number increased much faster (42%) than work animals (1.6 per cent) and total livestock (25 per cent) between 1961 and 1982, are ecologically least injurious (Rao, 1994) as they are maintained essentially by resource-rich farmers in irrigated areas. From all indications their number may continue to increase at a rapid rate. Sheep and goats, whose number has increased by 24 and 62 per cent respectively during this period and which together accounted for 35 per cent of the total livestock in 1982 (Rao, 1991), seem to be maintained essentially by resource-poor farmers and regions. These have quite a negative impact on the environment. In view of the steep rise in the price of meat and in view of the fact that sheep and goats fit well into the economy of resource-poor households, their number may continue to increase at a rapid rate for quite some time to come. The number of goats has been increasing faster in states where the growth of crop output is low, the correlation coefficient being –.0.57 (Rao, 1991). Goat rearing among the poor could be getting an impetus because of the slow growth of employment and income in the crop sector.

The work animals seem to belong to an intermediate position in so far as their impact on the environment is concerned. However, their growth has been negative and even negative. The pressure they exert on the environment could arise mainly because of their increasing concentration among small and marginal farmers, who are short of land. In this sense, the question of pressure from livestock (a major component of IRDP) on the environment, whether from sheep, goats or work animals, gets linked with poverty or resource-scarcity of households and regions.

Income Trends in Rural vis-à-vis Urban Areas

In brief, the share of rural areas in the national income is now falling far faster than its share in population. This has led, in the 1990s, to a sudden widening of the rural-urban per capita income gap. Deceleration of rural income growth rates during the 1990s, combined with the acceleration of urban income growth rates may foreshadow a further deepening of the rural-urban divide.

At the start of the 1970s, 62 per cent of India's national income was generated in rural areas (Table 5), and only 38 per cent it arose in urban locations. Today, the urban population earns a little more than half the national income; and the rural population now earns a little less than half. Thus in income generation terms, the centre of gravity in the Indian economy has shifted fairly recently from rural to urban areas. The vast majority of income earners, however, continue to live and work in rural areas.

Table 5: Rural India's Share in National Income and Total Population: Specified Years

Share of rural Areas (%)

Year	1970-71	1980-81	1993-94	1999-00
1. Share in National Income	62.35	58.91	54.27	49.52
2. Share in Total Population	80.22	76.88	73.51	71.62

Sources: (i) For the years 1970-71 to 1993-94: Govt. of India (2000) National Accounts Statistics, 2000. CSO July pp 202-203.

(ii) For 1990-2000: Govt. of India: Net Domestic Product by Economic Activity in Rural/Urban Areas, 1999-2000 CSO (mimeo) n.d.

Notes: 1. National income is measured by net domestic product at factor cost.

2. In the official documents separate rural and urban figures are given in current prices only. Deflators to derive constant price estimates were derived from figures for rural and urban areas combined given on pages 37 and 39 of Economic and Political Weekly Research Foundation (2002) National Accounts Statistics of India 1950-51 to 2000-01: New linked Series with 1993-94 as Base Year Mumbai (July).

One result is that urban per capita income in 1999-2000 had risen to almost two and a half times rural per capita incomes: a figure somewhat higher than the corresponding figure for 1970-71, and substantially higher than the intervening period. During the 1970s and 1980s, the rural-urban per capita income gap had narrowed considerably, only to widen again, rather suddenly, during the second half of the 1990s.

Table 6: Urban to Rural Ratios for National Income and Per Capita Income: Specified Years

Urban/Rural Ratios

Years	1970-71	1980-81	1993-94	1999-2000
1. National Income	0.60	0.69	0.84	1.02
2. Per Capita Income	2.45	2.32	2.34	2.57

Source: (i) For the years 1970-71 to 1993-94: Govt. of India (2000) National Accounts Statistics, 2000, CSO July pp 202-203

(ii) For 1999-2000: Govt. of India: Net Domestic Product by Economic Activity in Rural/Urban Areas, 1999-2000, CSO.

Notes: 1. National Income is measured by net domestic product at factor cost.

2 In the official documents separate rural and urban figures are given in current prices only. Deflators to derive constant.

Price estimates were derived from figures for rural and urban areas combined given on pages 37 and 39 of Economic and Political Weekly Research Foundation (2002) National Accounts Statistics of India 1950-51 to

2000-01: New Linked Series with 1993-94 as Base Year, Mumbai, July.

A change in the income growth trajectories of rural and urban areas led to this deepening of the rural-urban divides. The relatively rapid growth rates of urban income accelerated continuously from 1970-71 to 1999-2000. The relatively rapid growth rates of rural income decelerated marginally during the 1990s. Restated in per capita income terms, the two trajectories cross, as shown in Table 6 and Fig. 1. In short, the gaps between rural and urban growth rates have widened over time, most noticeably during the most recent period. This does not augur well for the future economic welfare of rural India's population.

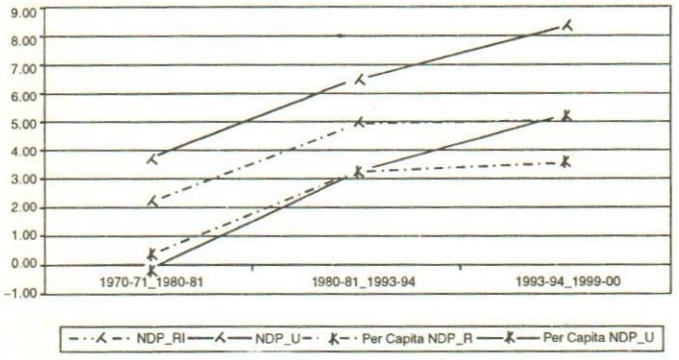

Fig. 1. Rural and Urban Growth Rates in National Income and Per Capita Income

Employment Programmes and their Effectiveness on Poverty Alleviation

With a view to creating more employment opportunities, making use of rural labour force, strengthening the rural infrastructure and providing community assets to improve the overall quality of life of the rural masses, a large number of employment-intensive programmes were launched since the seventies. For instance, Small Farmers Development Agency (1971), Marginal Farmers and Agricultural Labourers, Crash Scheme for Rural Employment (1971), Pilot Intensive Rural Employment Programme (1972), Food for Work Programme (1977), National Rural Employment Programme (1980), and Rural Landless Employment Guarantee Programme (1983) were implemented. In 1989-90, Jawahar Rozgar Yojna (JRY) was introduced by merging NREP and RLEGP. As this programme did not generate adequate employment opportunities and benefit the rural poor, and was also associated with several malpractices, it has been streamlined and restructured with a new name from April 1999: Jawahar Gram Samridhi Yojna (JGSY). This gave a renewed emphasis to provide a demand-driven infrastructure to meet the requirements of the market-driven economy and create sustained employment for the rural poor.

Meanwhile, the Employment Assistance Scheme (EAS) was also launched in 1993 with a view to providing 100 days of assured casual manual employment to those living below the poverty line, especially during the slack seasons of agriculture, and creation of economic infrastructure and community assets. Further to meet an unusual high demand for wage employment and food security due to calamities, the Food for Work Programme (FWP) was also introduced in January 2001. However, the employment opportunities were not adequately created. The number of man-days of employment progressively declined from 1995-96. The need was, therefore, felt that the multiple wage employment programmes be merged and one single ambitious programme be introduced which would cover food security, additional wage employment and village infrastructure and community durable assets at the same time. With this noble idea, a new wage employment programmes, known as Sampoorna Grameen Rozgar Yojna (SGRY) was introduced on 15th August 2001 by merging EAS and JGSY. But, the EAS and JGSY were separately implemented for the convenience of accounts maintenance and release of the funds during 2001-02, and they were officially merged with the SGRY from 2002-03 onwards.

It has been found that the physical performance of the previous wage employment programmes was not satisfactory. Table 7 presents the data on man-days of employment targeted and generated under the NREP+RLEGP, JRY, and JGSY during the period between 1985-86 and 2000-01, and also the man-days of employment generated under the EAS during 1993-94 to 2000-01. The data, prima facie, shows that the total number of man-days of employment generated under the wage employment programmes had been on the decline, with a few exceptions in the late nineties as compared to the early nineties and even to the mid-eighties. Interestingly, the percentage of achievements in generating the man-days of employment was more than the targets till 1992-93; but it started to decline subsequently. In the case of the EAS, the total man-days of employment generated also declined rapidly from 1997-98.

The total fund available under the EAS was roughly Rs. 550 crore during 1993-94 and rose to over Rs.3350 crore by the end of the nineties. However, judging from the magnitude of number of poor in the rural areas, the total employment generated was very marginal (Table 8). For example, the total man-days of employment generated during 2000-01 to 2003-03 was in the order of 575 million. This is as opposed to the total rural population below the poverty line numbering about 380 million

Table 7: Man-days of Employment Generated under Wage Employment Programmes in India during 1985-86 to 2000-01 (Crore Man-days)

Year	No of Man - days Generated under				Total
	NREP + RLEGP,JRY & JGSY			EAS,	
	Target	Achieve-ment	% of A to T	Achieve-ment	
1985-86	43.37	56.40	130	-	56.40
1986-87	51.15	70.15	137	-	70.15
1987-88	63.20	67.47	107	-	67.47
1988-89	60.31	69.15	115	-	69.15
1989-90	87.57	86.44	99	-	86.44
1990-91	92.91	87.46	94	-	87.46
1991-92	73.54	80.92	110	-	80.92
1992-93	75.38	78.22	104	-	78.22
1993-94	103.83	102.56	99	4.95	107.51
1994-95	98.65	95.17	96	27.40	122.57
1995-96	84.80	89.58	106	34.65	124.24
1996-97	41.41	40.06	97	40.30	80.36
1997-98	38.67	39.58	102	38.17	77.75
1998-99	39.67	37.52	95	41.65	79.17
1999-00	-	19.45	-	27.86	47.32
2000-01	-	26.83	-	21.84	48.67

Source: Various Annual Reports, Ministry of Rural Development, Government of India New, Delhi.

during the end of 1999. This was mainly due to the fact that the EAS was taken up in large areas resulting in the thin spread of resources. An evaluation of the EAS programme by the Programme Evaluation Organisation found that on an average only 31 days of employment are generated on EAS works and only 25 per cent of those who were registered got employed. Often the schemes under EAS could not deliver the desired benefits due to poor quality of assets created, incomplete works and so on, besides technical and financial shortcomings. Therefore, addressing the issue of poverty through such employment schemes is not only inadequate but also not capable of providing sustained employment opportunities in the rural areas. However, these programmes have certain strengths as well. One of the major strengths of this programme observed was its ability to provide targeted employment.

(I) Self-Employment Programmes: Poverty alleviation programmes have been in operation for several years. The specifically designed anti-poverty programmes for generation of self-employment and wage employment in rural areas have been redesigned and restructured to improve their efficacy/impact on the poor. An outlay of Rs. 9.65 billion has been provided in 1999-2000 (B.E) as against Rs. 9.34 billion in 1998-99 (R.E). Integrated Rural Development Programmes such as

Table 8: Employment Generated under Employment Assurance Scheme and Estimated Number of Rural Poor in Various States

S. No.	State	Employ-ment Generated under EAS during 2000-01 to 2002-03 (lakh Man-days)	Estimated Number of Rural Poor during 1999-2000(Lakh Number)	Average Number of Days Per Person Below Poverty Line
1.	Andhra Pradesh	324.01	58.13	5.6
2.	Arunachal Pradesh	28.92	3.8	7.6
3.	Assam	282.65	92.17	3.1
4.	Bihar	437.94	376.51	1.2
5.	Goa	1.05	0.11	9.5
6.	Gujarat	130.28	39.8	3.3
7.	Haryana	82.63	11.94	6.9
8.	Himachal Pradesh	30.84	4.84	6.4
9.	Jammu & Kashmir	44.67	2.97	15.0
10.	Karnataka	315.48	59.91	5.3
11.	Kerala	74.62	20.97	3.6
12.	Madhya Pradesh	480.08	217.32	202
13.	Maharashtra	522.14	125.12	4.2
14.	Manipur	3.97	6.53	0.6
15.	Meghalaya	19.21	7.89	2.4
16.	Mizoram	14.46	1.4	10.3
17.	Nagaland	38.48	5.21	7.4
18.	Orissa	531.83	143.69	3.7
19.	Punjab	29.22	10.2	2.9
20.	Rajasthan	196.04	55.06	3.6
21.	Sikkim	13.17	2	6.6
22.	Tamil Nadu	287.24	80.51	3.6
23.	Tripura	71.47	12.53	5.7
24.	Uttar Pradesh	707.25	412.01	1.7
25.	West Bengal	32.18	180.11	0.2
	India	5754.15	3864.85	1.5

Training of Rural Youth for Self Employment (TRYSEM), Development of Women and Children in Rural Areas (DWCRA) and Million Wells Scheme (MWS) have been restructured into a single self employment programme called the Swarnjayanti Gram Swarozgar Yojana (SGSY) from April 1999 with the following objectives: (I) focused approach to poverty alleviation; (ii) capitalizing advantages of group lending; and (iii) overcoming the problems associated with multiplicity of programmes. SGSY is to bring the existing poor families above the poverty line by providing them income generating assets through a mix of bank credit and government subsidy and ensuring that an assisted family has a monthly net income of at least Rs. 2000. Subsidy to under SGSY is

uniform at 20 per cent of the project cost subject to a maximum of Rs. 7500, in respect of Scheduled Castes and Scheduled Tribes; it is 50 per cent subject to a maximum Rs. 10000. For groups, the subsidy is 50 per cent subject to a ceiling of Rs. 1.25 lakhs. There is no monetary limit on subsidy for irrigation projects.

(a) *Jawahar Gram Samridhi Yojana (JGSY):* Jawahar Rozgar Yojana (JRY) – (Jawahar Villages Enrichment Programme – Jawahar Employment Programmes) has been restructured and streamlined with effect from April 1999, and has been renamed as JGSY. The primary objective of JGSY is creation of demand driven village infrastructure including durable assets at the village level to enable the rural poor to increase the opportunities for sustained employment. The secondary objective is generation of employment for sustained unemployment in the rural area. The wage employment under the programme is given to Below Poverty Line (BPL) families.

(b) *The Employment Assurance Scheme (EAS):* Launched on October 2, 1993 in 1772 identified backward blocks situated in drought-prone, desert, tribal and hill areas, this scheme has been restructured as a single wage employment programme from April, 1999 with a fixed annual outlay. The programme is presently being implemented in all the 5448 rural blocks. The primary objective of the EAS is creation of additional wage employment opportunities during the period of acute shortage of wage employment through manual works for the rural poor living below the poverty line. The secondary objective is the creation of durable commodity, social and economic assets to sustain future employment and development.

Since the inception of JRY 6203.63 billion man-days of employment has been generated up to March 1996. The total expenditure during the same period was about Rs. 230 billion (Papola and Sharma, 1996). The programme is probably the largest wage employment programme of its kind implemented anywhere in the world. It is seen as a major instrument for alleviating rural poverty and of late, also as an important element of the safety net to prevent deterioration in the condition of the rural poor due to the possible short-run adverse affect of structural adjustment. There are two specific aspects currently under debate in relation to the asset creation objective of JRY (JGSY). First, it is claimed by states and implementing agencies that 60:40 wages to material ratio stipulated under the programme limits the scope of building durable all weather roads, culverts, brides, irrigation works, schools and other communities buildings, and therefore, only work quality and temporary assets can be created. It is now widely recognized that the process of growth in most countries and in India, also even if not as equitable as might be wished, at least led to significant improvements in the conditions of living of the poor (Dev et al. 1992). The main plan of action in this respect, the JRY, is little more than the small skills capital-intensive public work programmes. The notion that the JRY will lead to substantial reduction in rural unemployment and poverty is another instance of self delusion (Dreze, 1990).

Indeed, the development and not environment is the prime concern of the developing country, including India. At about the time of the Stockholm Conference on Environment and Development (1972), poverty was seen as the worst form of pollution. Environmental concerns had to be subservient to the need to promote development and alleviate poverty. The trade-off implicit in this perception reflects the dilemmas facing India and other developing countries burdened with mass poverty. The country feels that excessive concern with environment, it is feared, can dampen the development effort and hamper poverty alleviation.

There is no doubt that a large number of public works have been taken up at the village level and that the rural people have been satisfied with the works. The assets created under JRY include social forestry, soil conservation works, minor irrigation and flood control, construction of village tanks, land development, drinking water wells/ponds, construction of rural roads, construction of school building, panchayats ghars, mahila mandal and housing especially for schedule caste and schedule tribes (SCs/STs). The preliminary findings of the concurrent evaluation of JRY conducted in 1992 also reveal that 73 per cent of the funds were spent by village panchayats on community, assets. While these created immediate employment opportunities for the rural poor, they also provided some of the necessary infrastructure for more sustained development of the village, which arouses an environmental awareness (Sharma, 1998). However, overriding attention was given to the construction of link roads in several states and about 45 per cent of the expenditure was incurred on the creation of rural roads.

Concluding Observations

Discussion in this paper suggests that development without care of environment ultimately proves to be more harmful to the poor. The last five decades of development in country, through planning efforts, has contributed definitely to the reduction of poverty. It has raised income and affected the consumption pattern of the urban-rich

and the rural-poor. This change in the living style of the people is demanding the more use of resources, causing the depletion of resources in the country. The direct attack on poverty through the various development programmes has created employment for the poor living below the poverty line. But it takes a toll on the meagre resources available for the development on the one hand, and the improper utilization of common property resources, on the other. The development of modern science and technology, of which India can be genuinely proud of, will not be able to penetrate the depth of rural poverty in India (Sen, Amartya, 2000).

Rural poverty in the country has been falling, but at a slow rate. Poverty reduction rate slowed down during the post-reform period (Rao Humantha, 1995, Guhan, S. 1995). Direct rural development programmes are not able to cope with the poverty problem in country. Some economists are of the view that these programmes are draining of the resources. Bhagwati (1998) says: 'To those who use the cliché of development with human face to decry efficiency, growth, and the economic reforms, I respond, 'Yes, indeed'. But remember that the face cannot exist by itself, except as a mask in a museum, but must be joined to the body; and if the body is emaciated, the face must wither no matter how much we seek to humanize and pretty it up". Direct public intervention for eradication of poverty is a must for the country like India. Economic growth is, of course important, but it is valuable precisely because it helps to eradicate deprivation and to improve the capabilities and the quality of life of ordinary people (Dreze and Sen 1996).

Better basic education and health care improve the quality of life directly; they also increase a person's ability to earn an income and be free of income-poverty as well. The more inclusive the reach of basic education and health care, the more likely it is that even the potential poor would have a better chance and overcoming penury (Sen, Amartya, 1999).

Development programmes have not remained successful in creating self-awareness among the rural poor about the sustenance of wherewithall and about the harm that emerges due to excessive use of resources. Billion of rupees are spent every year in the country without proper care for natural resources. The education sector remains neglected.

Population is another causative factor, where the country still seems to be groping in the darkness. Population, growth, education and health are the major components, which need immediate emphasis for the sustenance of growth, alleviation of poverty and the control on environmental degradation in the country.

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Focus

Relative Variability in Yields of Foodgrains Across Regions and Over Time

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This paper analyses the instability in the yield of foodgrains over a long period of time 1955-2000.

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Agriculture plays an important role in food security of the nation and concerted efforts have been made by both researchers and policy makers for increasing food production. This has pulled the country out of food scarcity and led to a state of food surplus. Nevertheless, it is often debated that the increased production has been accompanied by an increase in yield instability. It is hypothesized that the new seed-fertilizer technology increases the crop production as well as yield variability.

The critics of the Green Revolution (GR) argue that GR technology has led to new production risks that made agriculture more unstable as compared to the pre-GR period (Dantawala, 1987). Hazell (1984, 1985, 1986) concluded that the instability in cereal production and yield, increased with the advent of Green Revolution in the country. Mehra (1981) observed that the yield variability of rice and wheat increased in more than 50 per cent of the states, during the period 1967/68 to 1977/78 compared to the period 1952/53 to 1964/65. Singh and Byerlee (1990) on studying the yield variability of wheat crop for 57 countries, observed that the variability declined by 23% from 1951-65 to 1976-86. However, the above mentioned studies have limitations including the number of crops studied and time span included. It is in this background that a study was taken up with the objective of studying the instability in yields of major food crops in a longer-time context and to analyse the factors having a bearing on the yield instability. It is hypothesized that the immediate impact of new technology may be destabilizing but as the new technology is more widely diffused, the variability in yield declines.

The yield instability of food crops has been analysed for four sub-periods between 1955-2000. This allows for a comparison in the pre-green revolution period (1955-65), green revolution period (1966-76), post-green revolution period (1976-85) and the period encompassing the economic reforms in the country (1986-2000).

Data Sources and Analytical Procedure

The yield data of various crops for the period 1956-1969 was obtained from "Area and Production of Principal Crops in India", Directorate of Economics and Statistics, Ministry of Agriculture, and data for the period 1970-2000 was obtained from the Center for Monitoring Indian Economy (CMIE), 2001. Data on road density was taken from various issues of CMIE. Data on NPK use, area under high yielding varieties and per cent irrigated area were obtained from various issues of Fertilizer Statistics, Fertilizer Association of India, New Delhi.

Yield variability was measured in relative terms by the Cuddy-Della Valle index, used in recent years as a measure of instability in time series data (Weber and Sever, 1985). The Cuddy-Della Valle index is given as

$$CV = (CV^*)(1-R^2)^{.5}$$

Where,

CV^* = Simple estimate of coefficient of variation (in per cent), and

R^2 = coefficient of determination from a time trend regression adjusted by the number of degrees of freedom.

The instability, henceforth, in the study refers to the adjusted Coefficient of Variation. Quadratic function was used to study the trend in yield. The factors affecting the yield variability across states have been studied for the period of 1976-00 using the functional form

$$CV = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4$$

Where,

CV = Variability index of cereal crops in different states during the period 1976-00.

X_1 = average of NPK (Kg /ha) during the period 1976-00.

X_2 = average gross irrigated area (%)

X_3 = Average of Natural log of area under crop in state during the period

X_4 = Normal rainfall in mm of the state.

X_5 = Road density (Km per 100 sq km)

X_6 = Area under high yielding variety (Per cent)

Productivity trends in Indian agriculture

The Green Revolution has been the cornerstone of India's agricultural achievement, transforming the country from one of food deficiency to self sufficiency (Sharma, 2002). The gains from Green Revolution were further accentuated by the cumulative effect of research efforts, extension of area, development of irrigation infrastructure, enhanced use of fertilizers and plant protection measures, etc. The total foodgrain production doubled from 100 million tones to 203 million tones during the years 1970 and 2000 respectively (Table 1). This was mainly on account of increase in yield from 820 to 1652 kg per hectare during similar periods. The rice production doubled during the period 1970 to 2000, owing mainly to growth in yield. Wheat recorded 3.5 times increase in production during the period 1970 to 2000. This was more due to increase in productivity, though growth in area also played a significant role. The coarse cereals, that are grown in the rainfed regions of the country, has a stable production of about 30 million tones during the last three decades. The productivity almost doubled during the period 1970 to 2000, however, with more than a third of its area shifting to other major crops which has negated its effect on production. The pulse crop recorded very marginal increase in production. The area under the crop has remained fairly stable at 22 million hectares. A very marginal growth in productivity (0.68 per cent per annum) was observed during the 1990s. Productivity was, therefore, the paramount force for increase in production across all the food crops.

Extent of Yield variability

The yield instability of foodgrains has declined steadly from 13 per cent in 1956-65 to 8 per cent in 1986-2000. However, the yield variability during the period 1956-2000 was relatively higher for jowar, bajra, maize, ragi, Bengal gram and pigeon pea.

The critics of the Green Revolution, often criticize it on the basis that it led to increase in yield instability. A comparison of yield instability between the pre-GR phase and the Ist phase of GR (1966-75) reveals that the instability in yield of rice and wheat, the major GR crops, declined, though the other major cereals showed mixed trends (Table 2). However in the second phase of GR (1976-85) an increase in instability of yield was observed in rice and wheat crops. This was due to the susceptibility of new varieties to pest and disease and inadequate input use. The initial focus of the crop breeding programme was on developing yield enhancing technology and not resistance breeding. However, as the resistant varieties were developed and fertilizer and irrigation facilities improved, the instability declined during the period 1986-2000, which is spread across all the crops except jowar. This fact is corroborated by the findings

Table 1: Average area, production and productivity of major food crops of India.

Crop	Year				CGAR (per cent per annum)		
	TE 1970	TE 1980	TE 1990	TE 2000	1971-80	1981-90	1991-2000
Rice							
Area (mha)	37	40	42	45	0.91	0.6	0.78
Production (mt)	41	50	73	87	2.58	4.2	1.87
Yield (Kg/Ha)	1091	1247	1725	1936	1.66	3.57	1.07
Wheat							
Area (mha)	17	22	24	27	2.34	0.36	1.40
Production (mt)	21	35	53	72	4.91	3.39	3.11
Yield (Kg/Ha)	1231	1545	2216	2692	2.51	3.01	1.69
Coarse cereals							
Area (mha)	46	42	38	30	-0.65	-1.49	-1.59
Production (mt)	28	29	33	31	1.96	0.72	0.36
Yield (Kg/Ha)	595	689	878	1042	2.63	2.24	1.98
Total pulses							
Area (mha)	22	23	24	22	0.45	0.09	-0.64
Production (mt)	11	10	14	13	-0.01	1.50	0.04
Yield (Kg/Ha)	515	459	575	607	-0.47	1.41	0.68
Total Foodgrains							
Area (mha)	123	127	127	123	0.52	-0.19	-0.87
Production (mt)	101	124	172	203	2.78	2.99	0.57
Yield (Kg/Ha)	820	975	1353	1652	2.24	3.18	1.45

of Janaiah and Hossain (2002), who observed that yield instability in initial stages of technology adoption increases and it gets stabilized in the later phases due to refinement in the technology itself and spread of irrigation facilities.

Table 2: Coefficient of variation of yield of major foodgrains in India.

Crops	Sub periods				
	1956-65	1966-75	1976-85	1986-00	1956-00
	I	II	III	IV	All
Rice	9.34	6.45	8.45	3.25	6.62
Jowar	8.72	7.48	5.21	13.75	11.93
Bajra	9.69	24.89	24.23	17.56	20.65
Maize	3.80	11.88	10.04	8.32	9.41
Ragi	9.66	7.90	10.53	6.81	9.16
Small millet	6.89	8.09	9.99	5.49	8.08
Wheat	8.02	7.28	9.61	3.51	7.12
Barley	6.16	9.63	8.68	4.55	7.01
Gram	12.02	13.84	11.69	9.09	11.27
Tur	13.07	14.60	5.94	9.04	11.90
Other pulses	5.61	8.69	10.72	6.89	8.23
Total foodgrains	12.83	9.48	9.03	7.98	6.66

Yield variability across states

Agricultural performance at the regional level affects the employment, food security and income of the people dependent on it. Therefore, understanding the regional pattern of crop yield instability is very important. The aggregated view of instability may not reveal the exact picture of the magnitude of instability prevailing in the different states. Hence the yield variability was computed across different states of the country for the period 1976-85 and 1986-00 (Table 3). The states are categorised according to percentage change in the CV of yield instability of major food crops during the period 1986-00 over the period 1976-85. It is observed that the instability pattern is not the same as that revealed by the all-India picture. Wide variation in yield instability of crops has been observed across states. Some crops have recorded decrease in yield instability i.e., 80 per cent of rice area, 90 per cent of wheat area, 75 per cent of maize area and 65 per cent of Bengal gram area have recorded a decline in instability. On the other hand the larger proportion of area under jowar and pigeon pea crops have recorded increase in instability. Too much of emphasis on rice and wheat crops might be one of the causes for relative neglect of these crops. Variation in adoption of technology, infrastructure, rainfall, etc., can be other reasons for instability. The knowledge of

Table 3: Classification of states by percentage change in the coefficient of variation of major cereals during the period 1986-00 over that in period 1976-85.

Crop		% change in yield instability in 1986-00 over 1976-85			
		Decrease		Increase	
		> 50 %	< 50 %	> 50 %	< 50 %
Rice	% change*	71.79	21.26	65.87	15.32
	States	UP, WB, MP	HR, AS, OR, MH, HP, RAJ, BH, GU	KN	AP, JK, PB, TN
	% area under crop	39.00	35.44	03.06	19.65
Jowar	% change*	60.22	19.84	114.54	25.76
	States	UP, OR	KN	GU, AP, BH	RA, MH, TN, MP, HR
	% area under crop	03.88	16.87	12.30	67.07
Bajra	% change*	57.28	23.37	74.48	20.62
	States	MP, UP	AP, JK, TN, RA, KN, MH, OR, PB	HA	BH, GU
	% area under crop	09.75	72.82	06.03	11.41
Maize	% change*	61.15	11.99	64.56	11.29
	States	TN, AP	GU, MP, JK, KN, HA, UP, HP, RA	WB, PB, AS, BH, MH	OR
	% area under crop	06.62	69.43	19.18	01.63
Ragi	% change*	51.58	33.72	113.33	36.41
	States	MP	TN, KN, WB, BH, UP	MH, HP	AP, OR, GU
	% area under crop	0.75	73.46	09.41	15.79
Small millets	% change*	69.74	25.29	324.86	8.4
	States	OR	AP, WB, MP, KN, BH, MH, UP	TN, HP, JK	RA, GU
	% area under crop	03.32	83.58	08.30	03.17
Wheat	% change*	70.41	25.35	105.99	46.44
	States	PB	WB, HP, UP, BH, MP, HA, RA	OR, KN, MH, GU, AS	JK, AP
	% area under crop	13.09	78.95	06.72	01.03
Barley	% change*	58.99	29.39	132.04	-
	States	RA, MP, PB, UP	HA, HP, BH	WB	-
	% area under crop	74.89	13.87	0.87	-
Gram	% change*	-	22.79	236.39	40.58
	States	-	GU, MP, HP, OR, HR, RA	UP, KN, BH, MH, AP	WB, PB, TN
	% area under crop	-	64.70	34.17	01.05
Tur	% change*	83.28	36.08	148.29	14.91
	States	AS	UP, HR, MP	MH, BH, RA, GU	PB, AP, OR, TN, KN, WB
	% area under crop	0.21	26.79	41.64	30.97
Other pulses	% change*	-	14.17	297	47.96
	States	-	UP, GU, AS, KN, AP, RA	WB, HR, HP	MH, OR, BH, PB, TN, MP, JK
	% area under crop	-	45.82	2.45	52.11
Total foodgrains	% change*	74.23	31.19	213.94	16.76
	States	WB	MP, UP, OR, PB, KN, AS, HR, TN, HP, BH	MH	AP, GU, JK, RA
	% area under crop	5.19	62.54	11.09	19.63

'*' % change in CV is the mean weighted by crop area under the states.

Note: AP = Andhra Pradesh; AS = Assam; BH = Bihar; OR = Orissa; MH = Maharashtra; MP = Madhya Pradesh; WB = West Bengal; HP = Himachal Pradesh; HR = Haryana; RA = Rajasthan; GU = Gujarat; KN= Karnataka; TN = Tamil Nadu; PB = Punjab; UP = Uttar Pradesh; JK = Jammu & Kashmir.

Table 4: Trends in Technological and infrastructural development indicators in different states.

States	NPK (kg/ha)		Area under HYV of paddy (%)		Road density (km/100sq km)	
	Av. 1976-85	Av.1986-00	Av.1976-85	Av. 1986-00	1982-83	1996
Andhra Pradesh	50	123	75	89	487	647
Assam	3	12	32	51	411	872
Bihar	23	68	31	46	484	508
Gujarat	35	69	51	81	323	464
Haryana	44	114	79	67	555	637
Himachal Pradesh	17	33	83	100	372	542
Jammu & Kashmir	22	45	83	84	51	97
Karnataka	34	68	64	77	595	751
Madhya Pradesh	11	36	30	53	255	451
Maharashtra	23	60	63	79	595	1176
Orissa	10	27	28	56	766	1687
Punjab	110	164	93	93	955	1278
Rajasthan	8	27	28	33	222	379
Tamil Nadu	73	122	87	97	1119	1588
Uttar Pradesh	50	94	51	79	526	868
West Bengal	35	91	34	59	640	896
India	35	72	53	70	473	750

Table 5: Estimates of the coefficients of factors affecting yield instability of major cereal crops in India.

	Paddy	Wheat	Maize	Bajra	Pigeon pea	Bengal gram
Constant	40.51*** (5.73)	23.24*** (6.92)	31.51*** (6.94)	29.98*** (8.92)	57.49*** (6.88)	55.69*** (14.56)
NPK (Kg/ha)	-0.09** (0.04)	0.02 (0.04)	-0.04 (0.06)	-0.17*** (0.05)	-0.18** (0.07)	-0.53** (0.15)
HYV (%)	-	-	-0.15** (0.07)	-0.09 (0.07)	-	-
GIRR (%)	-0.09** (0.05)	-	-	-	-	-
Ln(Area)	-0.45 (0.79)	-1.877*** (0.635)	-	1.77** (0.68)	-2.08 (1.19)	-5.04** (2.25)
Nor. Rainfall (mm)	-0.012*** (0.002)	0.004 (0.003)	0.01* (0.005)	-0.01** 0.005)	0.01** (0.01)	-0.02 (0.01)
Road density (km/100 sq km)	-	-0.008** (0.003)	0.01 (0.005)	-0.02** 0.006)	-0.01 (0.008)	0.08*** (0.02)
R^2	0.82	0.70	0.62	0.76	0.57	0.79

Note: '***' significance at 1 % level; '**' significance at 5 % level; '*' significance at 10 % level.

- These variables are dropped as they did not improve the overall fit of equation as reflected by R^2

these factors will help in taking suitable policy action to minimize the same.

Determinants of yield variability

The technological and infrastructure development indicators having a bearing on the yield variability are depicted in the Table 3. Wide variation in use of NPK (kg/ha) was observed across states. States like Andhra Pradesh, Haryana, Punjab and Tamil Nadu achieved very high levels of NPK use during the post-liberalization phase. On the other hand states like Assam, Himachal Pradesh, Madhya Pradesh, Orissa and Rajasthan show very low levels of NPK (kg/ha) use. Disparity in use of

HYV of paddy was observed across states. A very high proportion of area under HYV of paddy was observed in most of the states though a few states like Assam, Bihar, Madhya Pradesh and Rajasthan had very low adoption of HYV. Wide gap in infrastructure development is observed across states. A few states have achieved road density significantly higher than the national average i.e., Maharashtra, Orissa, Punjab and Tamil Nadu. However, certain states showed very low level of infrastructure development (as revealed through road density) i.e., Gujarat, Jammu & Kashmir, Madhya Pradesh, Rajasthan. The states lagging in technological adoption and infrastructure development need special attention by the policy makers, researchers and administrators.

The estimates of the coefficients of factors affecting the variation in the instability index of various crops are presented in Table 4. The selected variables explained the variation in yield instability of crops ranging from 57 to 82 per cent. It was observed that adoption of technology as reflected through NPK (kg/ha) use had negative influence on yield instability. The proportion of HYV to the total area had significant and negative influence only in maize crop. The total area under the crop also has significant influence on yield variability as larger the area under the crop greater the probability that high yield of one region (due to good rainfall) would compensate for low yield (due to bad rainfall) of another region. Improved infrastructure captured through road density had significant bearing on yield instability. Wide network of roads influence timely availability of inputs and technical know-how. The adoption of technology by the farmers and improvement in infrastructure would assure yield stability of foodgrains, thereby reducing the risk of a large part of Indian agriculture.

Conclusion and policy implications

The new seed-fertilizer technology had initially led to increased instability but the variability has declined in recent years. Major crops like paddy and wheat have recorded of late, a very low level of instability index. This may cause a little complacency but from the point of food security of the rural masses, who depend entirely on agriculture. It is more important to understand the yield variability across states. It is shown that the yield variability has declined in most of the states. But in the same vein, increased variability has been observed in substantially large area under many of the major food crops. Knowledge of the factors having a bearing on the yield variability in certain regions and crops will help in focusing on efforts to mitigate the same. Improved technology in terms of NPK (kg/ha) and area under HYV of the crops has negative and significant influence on instability. Focused effort to develop improved varieties of food crops that are drought tolerant, resistant to pest and diseases will help in reducing the yield variability. Improved infrastructure helps in minimizing the yield variability by improving input supply, information about technology and output marketing. The multifunctional role of the infrastructure helps in mitigating the risk involved in farming. Thus, the development and dissemination of improved technology and improvement in infrastructure have great promise in minimizing yield instability achieving food security at the regional level.

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Farm Indebtedness in Punjab: A Case Study of a Village in Distress

P.S. Rangi, M.S. Sidhu & Jatinder Sachdeva

Harkishanpura village of Bathinda district is at the tail end of the canal irrigation system. Hence, it is deprived of its legitimate right over canal irrigation due to mismanagement by the Irrigation Department of Punjab Government. The underground water of the village is brackish, which is unfit for crops. The study brought out that the total amount of debt outstanding against the farmers of Harkishanpura village was about Rs. 2.88 crore during the year 2001-02. Therefore, the hype created that Punjab farmers are very rich is a myth. The economic crisis faced by the Punjab farmers can have serious social, economic and political implications for the State as well as the country.

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Punjab was perhaps among the first Indian regions to free itself from the grip of feudalism when the Moghul rule collapsed and peasant proprietorship made its advent. The struggle against poverty continued till much later. The total dependence on rain and turbulent political climate made the lot of the peasantry miserable. The then (British) government in a report in 1886 had described Punjab as the poorest province of India (Singh, 2003). Soon after, the British Government initiated certain measures that helped in ameliorating the lot of rural Punjab. They developed a canal network and certain other measures resulted in Punjab becoming agriculturally the most progressive State.

But most of the canal-irrigated land went to Pakistan during partition in 1947. The country was deficit in food and it was a pragmatic approach to hand over the tough task of attaining self-sufficiency in food to Punjab farmers. Along with other measures, fragmented and dispersed land holdings were consolidated. In the mid-1960s came another technological breakthrough when high yielding varieties (HYVs) of wheat and other cereals particularly of rice increased the yield. The Government of India provided a mechanism of a minimum support price and procurement of wheat and paddy that sustained this production by preventing price crash. The fourteen major banks of the country were nationalized in July, 1969 to facilitate credit mainly to priority sectors like agriculture. Our country, which imported about 10 million tons of foodgrains in the year 1966, became an exporter of foodgrains in the 1990s. So far, India has exported about 35 million tons of principal staples like rice and wheat earning the nation about US$4 billion (Nair, 2004). For this, the credit goes to the progressive farmers of Punjab, Haryana and some other states. The good performance of Punjab agriculture cannot be sustained in the long period. Already, the State agriculture is facing the problem of stagnation in production and productivity. On the other hand, there is decline in production and productivity for crops like cotton (American) during the last one decade

or so. This happened mainly on account of attack of American bollworm on this crop. The over-capitalization of Punjab agriculture along with stagnation/decline in production and productivity of various crops resulted in indebtedness of the farmers. The estimated total value of farm machinery in the State is worth Rs 8000 crore (Aulakh, 2004). Above all, about 45 per cent of operational holdings consist of small and marginal farmers. The average size of the operational holdings in Punjab is 3.61 hectares, which is very low as compared to developed countries like USA, Canada, etc.

The economic distress faced by the farmers in several parts of the country forced many to commit suicide. Even Prime Minister Manmohan Singh expressed concern that unfriendly weather and hard economic conditions in States like Andhra Pradesh have forced over 10,000 farmers to commit suicide during the previous regime, i.e. 1998 to 2004 (Kumar, 2004). Destitute farmers committed suicide in silence (Agnivesh and Thampu, 2004). The Movement Against State Repression (MASR), a non-government body of Punjab has claimed that in two development blocks of Lehragaga and Andana alone (Sangrur district of Punjab), nearly 200 farmers committed suicide since March 31, 2001 (TNS, 2004). Suicides had also been reported from the comparatively better off regions of Majha and Doaba (Ibid). Even the present Chief Minister of Punjab has admitted in the State Assembly that 600 farmers had committed suicide due to indebtedness from February, 1997 to February, 2002 in the State (HT Correspondent, 2004).

Keeping in view such a dismal scenario of Punjab agriculture, the present study has been conducted in Harkishanpura village of Bathinda district to estimate the indebtedness of the farmers, where all the 89 farmers of the village were under debt. A resolution, perceived to be the first of its kind in poverty-struck villages of the nation, was passed by the village panchayat in May, 2002, when four families, whose breadeamers had allegedly committed suicide over the last two years, proposed to sell themselves to clear their debts (Sharma, 2002). Astonishingly, these families were joined by the entire village, which had been reeling under heavy debt for the past decade (Ibid).

Data base

The data for this paper has been taken from the study conducted by the authors (Rangi, Sidhu and Sachdeva, 2004). This village was selected purposely because all the farming families of the village were in debt. But this does not mean that farmers of other villages of Bathinda district or elsewhere are not in debt. Another noteworthy feature of this village is its location. It is at the tail end of the canal irrigation distribution system. Hence, it was deprived of its legitimate right over canal irrigation due to mismanagement by the Irrigation Department of Punjab Government. The underground water of the village is brackish which is unfit for crops. There has been failure of cotton crop in the last one decade. Keeping in view all these considerations, this village was selected purposely.

Results and discussion

Profile of the sample farmers

The study brought out that the maximum respondents (about 34 per cent) were in the young age group of 30 to 40 years. About 27 per cent of them were between 40 to 50 years; about 18 per cent were between 50 to 60 years and about 19 per cent were 60 years and above. Only about two per cent of the respondents were less than 30 years. About 36 per cent and 64 per cent of the respondents were educated and uneducated respectively. Even among the educated respondents the majority had been educated up to VIII standard only. The study revealed that about 33 per cent of the respondents had their own tractors as a source of draft power. The rest, about 67 per cent of them, depended on custom hiring for different farming operations like ploughing, sowing, etc. The study indicated that about 81 per cent of the respondents had tubewell as well as canal irrigation whereas the rest, about 19 per cent depended on canal irrigation. The tubewell owners also sold their water for irrigation purpose to fellow farmers.

Size of operational holdings

The information regarding size of operational holdings of the respondents during the year 2001-02 is given in Table 1. There were 89 farming households in the village, out of which, about 14 per cent were marginal farmers, about 24 per cent were small farmers, about 27 per cent were semi-medium farmers, about 34 per cent were medium farmers and about two per cent were large farmers. This classification of different farm categories is based on national criteria accepted all over the country. The overall average size of operational holdings was 3.78 hectares. The average size of operational holdings of marginal farmers was 0.91 hectare, small farmers (1.51 hectares), semi-medium farmers (3.38 hectares), medium farmers (6.18 hectares) and large farmers (13.56 hectares). The average size of different categories of operational holdings of Harkishanpura village was more or less nearer to the State averages. As already stated, the average size of operational holdings in Punjab is 3.61 hectares. This size of

operational holdings is likely to decline further in the years to come because of pressure of population on land.

Table 1: Size of operational holdings of the respondents, 2001-02

Farm category	Area (in hect)	No. of respondents	%age to the total	Average size of Operational holdings (hect)
Marginal	Up to 1.0	12	13.48	0.91
Small	1.0-2.0	21	23.60	1.51
Semi-medium	2.0-4.0	24	26.97	3.38
Medium	4.0-10.0	30	33.71	6.18
Large	10.0 and above	2	2.24	13.56
Total		89	100.00	3.78

It is worthwhile to mention here that in the pre-green revolution period in the State, the bachelor farmers used to donate their share of land to their nephews (Bhatijas). This prevented the land from being further divided. It is known as the Draupati system, after the wife shared by the Pandava princes in the Mahabharta, and there is no stigma attached to it (Mishra, 1999). Due to spread of education and awareness among the farmers, this practice has almost disappeared from the rural Punjab over the last three and half decades. Hence, the size of operational holdings is becoming smaller and smaller over time.

Area, production and yield of wheat, cotton (A) and paddy

The information about area, production and yield of wheat, cotton (A) and paddy with the respondents for the year 2001-02 is given in Table 2. Wheat is the principal crop of Punjab in the rabi season. It occupied about 43 per cent of the total cropped area of the State in the year 2001-02. Punjab alone produces about 21 per cent of the country's wheat production. The State contributed about 50 to 70 per cent of wheat towards the central pool of foodgrains during the last three and half decades. Even in Harkishanpura village, wheat was the principal crop in the rabi season. The per holding area under wheat was 3.38 hectares which was about 89 per cent of the area operated by the sample farmers. The overall production (per holding) of wheat was about 101 qtls. The productivity was 2994 kgs per hectare. The data given in Table 2 clearly indicated that production and productivity had positive relationship with the farm size. As the farm size increased, the level of productivity was also high and vice-versa. This phenomenon may be attributed to poor resource base of the marginal and small category of farmers in the village.

It is worthwhile to point out that the average productivity of wheat was to the extent of 4532 kgs per hectare in the State as compared to only 2994 kgs per hectare in Harkishanpura village during the year 2001-02. In this way, the State's average productivity of wheat was higher by about 51 per cent. As already discussed, this village is located at the tail end of the canal irrigation distribution system, which adversely affected the production and productivity. A recent study conducted by the NGO Development Support Centre (DSC) on "Tail-enders and other deprived in the canal irrigation system" had revealed that productivity of head-reach farmers was 1.5 to five times that of tail-end farmers in Haryana (IANS, 2004). The nationwide study further revealed that though the head-reach farmers were taking more water than their share, this was only one of the several causes for deprivation of others (Ibid). Equally important and widespread was deprivation caused by matters related to the construction of the system. The most important of them was poor maintenance of structures, but there were cases of design fault and sub-standard construction resulting in reduced

Table 2: Per holding area, production and yield of wheat, cotton (A) and paddy of the respondents, 2001-02

Farm category	Area (hectares)			Production (qtls)			Yield (kgs per hec		
	Wheat	Cotton (A)	Paddy	Wheat	Cotton(A)*	Paddy	Wheat	Cotton(A)*	Paddy
Marginal	0.81	0.81	–	22.20	2.92	–	2741	360	–
Small	1.35	1.16	0.15	38.03	4.53	6.43	2817	391	4287
Semi-medium	3.05	2.73	0.24	89.65	12.26	6.73	2939	449	2804
Medium	5.74	4.88	0.72	173.28	22.17	28.60	3019	454	3972
Large	8.70	12.14	–	301.00	61.50	–	3460	507	–
Average	3.38	3.04	0.34	101.20	13.65	12.97	2994 (4532)	449 (1147)	3815 (5291)

* Production and yield of cotton (A) are in terms of uncleaned cotton.

Note: Figures in parentheses indicate the average yield of the Punjab State as a whole for the year 2001-02.

capacity of the system to take water to all the parts (Ibid).

It is common knowledge that there is theft of canal water in Punjab. Recently, farmers of many villages in Faridkot district of Punjab, whose fields are supplied water through Sappanwali minor, have accused the Parliamentary Secretary of the Punjab Government of "stealing" canal water through plastic pipes to irrigate his own fields (Sidhu and Gondara, 2004). The farmers of affected villages rued that peasants at the tail end of the minor were facing acute shortage of irrigation as a result (Ibid). In this way, the tail end farmers are the worst victims of such a phenomenon. The tail end farmers are treated as second class farmers by the irrigation authorities and as second class citizens by the local shopkeepers and moneylenders (Economic Times Ahmedabad Bureau, 2004). From the foregoing discussion, it can be concluded that tail end farmers suffer all over the country. The income of the farmers is directly linked with the level of productivity of various crops. The lower level of income resulted in indebtedness among the farmers. The Harkishanpura village is a typical example of all of this.

In the kharif season, cotton (A) was the principal crop in the village. This crop occupied about 80 per cent of the area operated in the kharif season. The per holding area under cotton (A) was 3.04 hectares, production was 13.65 qtls and yield was 449 kgs per hectare. The farm category wise yield of cotton (A) was 360, 391, 449, 454 and 507 kgs per hectare with the marginal, small, semi-medium, medium and large farmers. The yield of semi-medium, medium and larger farmers was high on account of better resource base and input management. The failure of cotton crop over the last one decade is one of the major reasons for indebtedness of farmers in Harkishanpura village and elsewhere in the cotton belt of the State. The yield of cotton (A) in this village was less when compared to the State average. It was 1147 kgs per hectare in Punjab during the year 2001-02. The state's yield was higher by about 155 per cent as compared to the Harkishanpura village. The reasons discussed for the low yield .of wheat crop are also applicable for cotton (A) crop in this village.

As far as paddy crop is concerned, it is not a traditional crop Bathinda district. The failure of cotton crop had forced some farmers of Harkishanpura village to cultivate paddy crop. The marginal and large farmers did not grow paddy crop at all. The per holding area under paddy was only 0.34 hectare. The per holding paddy production was about 13 qls. The average yield of paddy in Harkishanpura village was 3815 kgs per hectare, which seems to be very low as compared to the State average of 5291 kgs per hectare during the year 2001-02. The yield of small, semi-medium and medium farmers was 4287, 2804 and 3972 kgs per hectare respectively. Since paddy is a water intensive crop, therefore, its availability in time had affected the yield with different categories of farmers. Due to brackish tubewell water, the farmers of this village did not wisely opt for paddy cultivation on a large scale. The area under paddy crop was about nine per cent of the area operated by the farmers in the kharif season in Harkishanpura village. Due to economic compulsion, the farmers grew paddy crop because they did not have good experience with cotton crop.

Failure of cotton (A) in Punjab—Some recent experience

Cotton (A) has been the major crop in the south-western districts of Punjab during the kharif season. It was also known by the name of 'white gold' in Punjab. Up to the year 1992-93, this crop brought prosperity among the farmers of south-western districts because it was the only cash crop of that belt. During the year 1993-94, the American bollworm attacked this crop on a large scale and adversely affected the economy of the farmers. In spite of the best efforts of the agricultural scientists, policy makers, administrators, planners, input supplying agencies both in the public as well as private sector, the cotton (A) crop could not repeat its past performance at the level of the year, i.e. 1991-92. The failure of cotton crop during the last one decade is mainly responsible for the suicides committed by the farmers in the cotton belt in the recent years. Debts and crop failure led to these deaths of farmers even in States like Andhra Pradesh and Karnataka (Dev and Gulati, 2004).

The data regarding area, production and yield of cotton (A) crop in Punjab from 1970-71 to 2001-02 have been shown in Table 3. During the year 1970-71, the area under cotton (A) was 212,000 hectares, which increased to 502,000 hectares in 1980-81. It further increased to 636,000 hectares in 1992-93. It declined to 381,000 hectares in 1999-2000 but again picked up to hectares in 2001-02.

This fluctuation in cotton (A) area in the recent years had mainly been on account of attack of American bollworm. This resulted in failure of the crop. Hence, the farmers of cotton (A) belt shifted the cotton (A) area to paddy out of compulsion in spite of brackish underground water. The production of cotton (A) was 471,000 bales in 1970-71. It increased to 969,000 bales in 1980-81. The production further increased to 2301,000 bales in 1991-92.

Table 3: Area, production and yield of cotton (American) in Punjab, 1970-71 to 2001-02

Year	Area (000 hect)	Production (000 bales)	Yield (kgs/hect)
1970-71	212	471	399
1975-76	363 (71.23)	863 (83.23)	404 (1.25)
1980-81	502 (136.79)	969 (105.73)	329 -(17.54)
1985-86	471 (122.17)	1253 (166.03)	452 (13.28)
1990-91	637 (200.47)	1802 (282.59)	481 (20.55)
1991-92	615 (190.09)	2301 (388.54)	636 (59.40)
1992-93	636 (200.00)	2211 (369.43)	591 (48.12)
1993-94	536 (152.83)	1451 (208.07)	460 (15.29)
1994-95	538 (153.77)	1648 (249.89)	521 (30.58)
1995-96	649 (206.13)	1768 (275.37)	463 (16.04)
1996-97	626 (195.28)	1713 (263.69)	467 (17.04)
1997-98	626 (195.28)	786 (66.88)	213 -(46.62)
1998-99	457 (115.57)	489 (3.82)	179 -(55.14)
1999-2000	381 (79.72)	754 (60.08)	337 -(15.54)
2000-01	358 (68.87)	922 (95.75)	437 (9.52)
2001-02	507 (139.15)	1139 (141.83)	382 -(4.26)

Note:

(i) Figures in parentheses indicate percentage increase/decrease over 1970-71

(ii) Production figures are in terms of cleaned cotton.

(iii) One bale of cotton consists of 170 kgs cotton lint.

(iv) Yield of cotton is in terms of lint.

Source: Statistical Abstract of Punjab, Various Issues.

The cotton crisis on a large scale started from the year 1993-94. The production declined to 1451,000 bales in this year. It reached to a very low level of 489,000 bales in 1998-99. After that, there was some improvement in production but it was nowhere close to the level of 1991-92 or 1992-93. The yield of cotton (A) was 399 kgs per hectare in 1970-71. It increased by about 59 per cent to the level of 636 kgs per hectare in 1991-92. It marginally declined to 591 kgs per hectare in 1992-93. After that, the sad story of cotton (A) failure commenced in Punjab mainly on account of the attack of American bollworm. The yield of this crop was as low as 179 kgs per hectare in 1998-99. The dismal performance of cotton (A) during the last one decade or so resulted in indebtedness of the farmers. The Punjab farmers are mainly dependent on the commission agents for meeting their credit and input requirements. The commission agents charge a high rate of interest ranging from 24 to 30 per cent per annum. All this increased the debt burden of the farmers.

Cash expenses to wheat and cotton (A) crops

The farmers have to bear cash cost for growing various crops. These expenses vary from crop to crop. The cash expenses of the sample farmers for wheat and cotton (A) crops are shown in Table 4. The per holding cash expenses were Rs 17736 for wheat crop. It varied from Rs 3965 for marginal farmers to Rs 43000 for large farmers. This was on account of variation in area under wheat with different categories of farmers. The average cash expenses on per hectare basis were Rs 5249. It varied from Rs 4898 for marginal farmers to Rs 5409 for semi-medium farmers. These expenses were Rs 4942 per hectare for large farmers, Rs 5289 for medium farmers and Rs 5223 for small farmers. For wheat crop, these expenses were mainly on chemical fertilizers, weedicides, irrigation, etc. As compared to the cotton (A) crop, the cash expenses of wheat crop were less because insecticides/pesticides were not used on the latter one. Although, yield of wheat was low in Harkishanpura village but it was stable as compared to the cotton (A).

Table 4: Cash expenses of the respondents on various inputs for wheat and cotton (A) crops excluding labour*, 2001-02 Rs

Farm category	Expenses per holding		Expenses per hectare	
	Wheat	Cotton (A)	Wheat	Cotton (A)
Marginal	3 964.76	15043.70	4898.46	19031.27
Small	7173.45	24281.00	5223.00	20905.35
Semi-medium	16504.16	53590.82	5408.72	19647.32
Medium	30352.86	107656.03	5289.27	22076.19
Large	43000.00	291000.00	4942.00	23968.70
Average	17736.40	65001.23	5248.70	21415.74

*Operational expenses only.

The study brought out that per holding cash expenses of cotton (A) crop varied from about Rs 15404 for the marginal farmers to Rs 2.91 lakh for the large farmers. The variation was mainly on account of more area under cotton (A) crop with the large farmers. These figures for the small, semi-medium and medium farmers were about Rs 24281, Rs 53591 and Rs 107656 respectively. The overall average of the respondents was about Rs 65,000. The per hectare cash expenses were about

Rs 21416. It varied from Rs 19031 per hectare with the marginal farmers to Rs 23969 per hectare with large farmers. These expenses were mainly on four crucial inputs, i.e. insecticides/pesticides, chemical fertilizers, seed and irrigation. The cash expenses of small farmers were Rs 20905, semi-medium farmers (Rs 19647) and medium farmers (Rs 22076). This variation was mainly on account of variation in the number of sprays done by the farmers. The price difference was also there in different brands of these chemicals. The respondents in the sample had reported as high as 30-32 sprays on cotton (A) crop in a single season. This happened in each kharif season during the last few years. The end result was also not good. Ultimately, the farmers got very low yield of cotton (A). Hence, the failure of this crop is one of the major reasons for the problem of indebtedness in the village and elsewhere in the cotton belt.

Total amount debt

Like all other producers, the farmers also require credit. Credit supports the farmer as the hangman's rope supports the hanged (Mamoria and Tripathi, 2001). That the farmer cannot carry on his business without outside finance is a fact proved by history and evidenced by the poverty and indebtedness of the persons engaged in the business of agriculture. Agricultural credit is a problem when it cannot be obtained and it is also a problem when it can be obtained but in such a form that, on the whole, it does more harm than good (Ibid). Agricultural credit extended to the farmers is of three types: short term to purchase chemical fertilizers, insecticides, pesticides, weedicides, seeds, etc; medium-term to purchase cattle and implements and long-term finance for making permanent improvement in land for reclamation, purchase of tractors and for constructing wells and buildings (Bansil, 2002). The agricultural credit system includes commercial and private agencies and the government-owned institutions. The need for agricultural credit has become all the more important in the context of new farm technology introduced in Punjab since the mid-1960s. This technology is capital intensive and farmers have to borrow both from the institutional as well as non-institutional sources.

The story of Harkishanpura is the story of the marginal, small and medium farmers of Punjab who have fallen into a vicious debt-trap because of the indifference of the State administration to take corrective measures (Anonymous, 2002). Instead of providing meaningful guidance and assistance to the farmers for increasing output, the politicians offered them sops like free electricity and water (Ibid). The farmers got little of the promised supply of free water and electricity but the sops aggravated the economic mess (Ibid). Even the member of the outgoing Planning Commission had admitted the fact that the state governments were more interested in populist schemes than in any agenda for economic uplift (Vankatasubramanian, 2004).

Initially when the financial help came in the form of easy bank loans, the farmers thought that it was the end of their woes. With the passage of time, these loans from commercial and cooperative banks multiplied. The farmers did not examine the implications of these loans. Even small farmers opted for the purchase of tractors due to social pressure. The tractor has become a status symbol in rural Punjab. Most of these are, however, grossly underutilized with an annual average use of 264 hours as against the optimal of 1000 hours (Aulakh, 2004). It may be stated here that the number of tractors in Punjab had increased from 1.25 lakhs in 1980-81 to 4.10 lakh at present. The continuous failure of cotton crop aggravated the problem of farm indebtedness in the south-western district particularly during the last one decade or so. The economic distress faced by the farmers resulted in the emergence of markets for the sale and purchase of second hand tractors in the cotton belt. About 20,000 to 25,000 second hand tractors are sold and purchased every year in the State (Singh, Singh and Sidhu, 2003). The same study observed that slow down in agricultural growth, the overall decline in the size of operational holdings, stagnated profitability, under-utilization of the existing tractors, persistent cotton crop failures and indebtedness of the farmers in the state are the important factors for the emergence of second hand tractor markets in Punjab (Ibid).

The information regarding total amount of debt of the respondents of Harkishanpura village during the year 2001-02 is given in Table 5. A perusal of the table revealed that about 13 per cent of the respondents had debt up to Rs 1 lakh, about 20 per cent had debt between Rs 1 and Rs 2 lakh, about 24 per cent had debt between Rs 2 lakh and Rs 3 lakh and 16 per cent had debt between Rs 4 and Rs 5 lakh, about nine per cent had debt between Rs 5 and Rs 6 lakh, about four per cent had between Rs 5 and Rs 6 lakh and about 13 per cent had debt of Rs 6 lakh and above. The farm category wise data revealed that amount of debt was also linked with the farm size. As the size of the farm increased, the amount of debt also increased and vice-versa. This happened on account of higher capacity of the medium and large farmers to take credit. Their credit worthiness is more as compared to the marginal and small farmers. The commission agents and other financial institutions gave credit liberally to the medium and large farmers. At present, all the farmers of Harkishanpura village are in the vicious circle of debt. The amount of debt simply depended on the farm size.

Table 5: Total amount of debt of the respondents, 2001-02

Amount of debt (Rs in lakh)	No. of respondents					
	Marginal	Small	Semi-medium	Medium	Large	Total
Up to 0.50	3 (25.00)	2 (9.52)	–	–	–	5 (5.62)
0.50-1.00	2 (16.67)	3 (14.29)		2 (6.67)	-	7 (7.87)
1.00-1.50	-	3 (14.29)	3 (12.50)	-	-	6 (6.74)
1.50-2.00	4 (33.33)	2 (9.52)	4 (16.67)	2 (6.67)	-	-
2.00-2.50	2 (16.67)	1 (4.76)	4 (16.67)	3 (10.00)	-	10 (11.24)
2.50-3.00	1 (8.33)	7 (33.33)	3 (12.50)	-	-	11 (12.36)
3.00-3.50		2 (9.52)	1 (4.17)	3 (10.00)	-	6 (6.74)
3.50-4.00	-	1 (4.77)	2 (8.33)	5(16.67)	-	8 (8.99)
4.00-4.50	-	-	3 (12.50)			
–	4 (13.33)	-	7 (7.87)			
4.50-5.00	-	-	-	-	1 (50.00)	1 (1.12)
5.00-5.50	-	-	1 (4.17)	-	-	1 (1.12)
5.50-6.00		-	2 (8.33)	1 (3.33)	-	3 (3.37)
6.00 and above	-	-	1 (4.16)	10 (33.33)	1 (50.00)	12 (13.48)
Total	12 (100.00)	21 (100.00)	24 (100.00)	30 (100.00)	2 (100.00)	89 (100.00)

Note: Figures in parentheses indicate percentages to the total.

Per holding and per hectare amount of debt

The information about total, per holding ad per hectare debt of respondents is given in Table 6. The total amount of debt outstanding against the farmers of Harkishanpura village was about Rs 2.88 crore during the year 2001-02. Out of this total debt, the share of marginal farmers was about Rs 16.57 lakh, small farmers had debt to the extent of about Rs 38.66 lakh, and the semi-medium farmers had a sum of Rs 67.64 lakh as debt. The medium farmers had the maximum debt, i.e. Rs 1.44 crore. In the total sample, the number of medium farmers was 30 against only two large farmers. The latter category had total debt to the extent of Rs 21.20 lakh.

The data given in Table 6 indicated that per holding debt of the village was to the extent of Rs 3.23 lakh. The amount of debt was also related with the farm size. The per holding debt of marginal, small, semi-medium, medium and large farmers was about Rs 1.38, Rs 1.84, Rs 2.82, Rs 4.79 and Rs 10.60 lakh respectively. As already stated, the medium and large farmers had more capacity to take credit. Hence, the per holding amount of these farmers was more as compared to other categories of farmers. On the other hand, the amount of debt on per hectare (operated area) basis was more in case of marginal, small and semi-medium farmers. As the farm size increased, amount of debt on per acre basis declined in most of the cases. The debt per hectare was to the extent of about Rs 86,000 for all categories of farmers. This figure was about Rs 1.52 lakh for marginal farmers, Rs 1.22 lakh for small farmers, Rs 84,000 for semi-medium farmers 77,000 for medium farmers and Rs 78,000 for large farmers. The amount of debt was about Rs 706 per hectare less in case of large farmers as compared to the medium farmers. This marginal difference may be attributed to the fact that there were only two large farmers in the sample as compared to 30 medium farmers.

Table 6: Total and per holding amount of debt of the respondents, 2001-02

Farm category	Total amount of debt (Rs)	No. of respondents	Amount of debt (Rs)	
			Per holding	Per operated hectare
Marginal	16,57,000	12	1,3 8,083	1,51,645
Small	38,66,200	21	1,84,105	1,21,964
Semi-medium	67,64,000	24	2,81,833	83,503
Medium	1,43,55,000	30	4,78,500	77,481
Large	21,20,000	2	10,60,000	78,187
Total/ average	2,87,62,200	89	3,23,170	85,590

The magnitude of debt in the village needs special attention of the policy makers at the State as well as national level. The marginal and small farmers are not in a position to return the outstanding debt under any circumstances. The financial institutions may consider waiving 100 per cent interest on the amount borrowed by the marginal and small farmers. For other categories of farmers, 50 per cent interest may be waived. The marginal and small farmers may pay the principal amount of debt. In case of other categories of farmers, they may pay the principal amount plus 50 per cent interest. This is the only practical solution of the problem of indebtedness in Harkishanpura village. As a one-time settlement, the commission agents may also reduce their rate of interest by 50 per cent for the farmers of this village.

Further, arrangements may be made by the State Government, Punjab Agricultural University and other

Table 7: Per holding sources of outstanding debt of the respondents, 2001-02

Farm category Sources of credit	Marginal	Small	Semi-medium	Medium	Large	Total
Commission agents	63.33 (45.86)	89.6 (48.68)	146.46 (51.97)	233.33 (48.76)	275.00 (25.94)	154.01 (47.66)
Commercial banks	29.08 (21.06)	25.51(13. 85)	28.79 (10.22)	88.23 (18.44)	370.00 (34.91)	55.76 (17.25)
Cooperative banks	5.42 (3.93)	35.79 (19.44)	36.50 (12.96)	51.50 (10.76)	120.00 (11.32)	39.07 (12.09)
Land Mortgage Bank	22.08 (15.99)	18.00 (9.78)	37.92 (13.45)	37.17 (7.77)	160.00 (15.09)	33.57 (10.39)
Primary Agri. Service Society	12.33 (8.93)	6.73 (3.66)	24.25 (8.60)	32.67 (6.81)	105.00 (9.91)	23.13 (7.16)
Relatives	5.00 (3.62)	5.42 (2.94)	6.46 (2.29)	29.37 (6.14)	20.00 (1.89)	14.04 (4.35)
Friends	0.84 (0.61)	3.03 (1.65)	1.45 (0.51)	6.33 (1.32)	10.00 (0.94)	3.57 (1.10)
Grand total	138.08 (100.00)	184.10 (100.00)	281.83 (100.00)	478.50 (100.00)	1060.00 (100.00)	323.17 (100.00)

Note: Figures in parentheses indicate percentages to grand total.

related extension agencies for the training of farmers of Harkishanpura village for subsidiary occupations like dairy farming, poultry farming, bee-keeping, etc. The ultimate solution of indebtedness lies only in increasing income of the farmers through creating additional employment for them. Due to an increasingly modernized farming, the farmers today are left with sufficient spare time to do a side-business. Even if government help is not forthcoming due to bottlenecks, the farmers can take initiatives on their own to boost their earnings (Anonymous, 2004). Known for his enterprise and residence, the Punjab farmers will definitely emerge victorious from the pressing tough times (Ibid).

Although the problems of plenty no longer exist, the Government of India is unlikely to raise the minimum support price (MSP) of wheat and paddy significantly in the near future. Already, the food subsidy had increased from Rs 6066 crore in 1996-97 to Rs 27800 crore in 2003-04 (Shankar, 2004). Moreover, in the post-W.T.O. period, agriculture in India is faced with a new challenge: cheaper imports from the developed countries where the level of subsidies is mind-boggling. This problem is more severe in agriculturally developed states like Punjab, which are surplus ones. An analysis of the government procurement reveals that no less than 75 per cent of the total government purchases of foodgrains are made only in three states, viz., Punjab, Haryana and Andhra Pradesh (Singh, 2004). The contribution of these states to the national production of foodgrains is only about one-fourth (Ibid). Therefore, the Punjab farmers may have to face new challenges in the near future, i.e. insufficient increase in MSP of wheat and paddy and liberal imports of agricultural commodities in the W.T.O. regime. The farmers must be ready to meet this challenge.

Sources of outstanding debt

The respondents had taken credit from seven different sources. The information in detail is shown in Table 7. As already discussed, the per holding debt was to the extent of Rs 3.23 lakh. Among various sources of debt, the commission agents provided the maximum credit (about 48 per cent) followed by commercial banks (about 17 per cent), cooperative banks (about 12 per cent), Land Mortgage Bank (about 10 per cent), PASS (about seven per cent), relatives (about four cent) and friends (about one per cent). The preference for the commission agents was on account of traditional social relations of farmers with them. Moreover, no paper work was required in getting credit from the commission agents. The farm inputs like chemical fertilizers, insecticides/pesticides, seeds, etc. were also purchased by the farmers from the commission agents on credit basis. At the same time, the farm produce was sold by the farmers to the public and private agencies/traders through these commission agents. Although the rate of interest charged by the commission agents was high, i.e. 24 to 30 per cent per annum, the farmers' preference was evident from the data given in the table. It is worthwhile to point out here that an earlier study on rural credit and indebtedness in Punjab has also revealed that commission agents provided about 46 per cent credit to the farmers in the year 1997 (Shergill, 1998).

The farm categorywise data indicated that except for large farmers, the commission agents were the major source of outstanding debt for the respondents of Harkishanpura village. The large farmers in the sample had taken only about 26 per cent of their total credit from this source. Their major source of credit was commercial banks, which was 35 per cent. The share of relatives and friends was less in almost all the farm categories. This was on account of the fact that their relatives and friends in Punjab and elsewhere were also themselves facing economic hardships. It is a common phenomenon that one person's relatives and friends belong to the same strata of society in most of the cases. It is a healthy social practice that relatives and friends of the farmers of Harkishanpura village were still helping them financially in the hour of their economic distress. All categories of respondents had obtained credit from commercial, cooperative and land mortgage banks in varying degrees.

Estimates of indebtedness of Punjab farmers

The estimate indebtedness of Punjab farmers made earlier in the year 1997 is shown in Table 8. As already stated, the maximum amount of debt outstanding was of the commission agents, i.e. 46.32 per cent followed by co-operative institutions (27.14 per cent) and commercial banks (19.42 per cent). The agriculture mortgage was to the extent of about seven per cent. The per holding debt of Punjab farmers was about Rs 51 thousand in the year 1997.

Table 8: Estimates of indebtedness of Punjab farmers, 1997

(Rs in crore)

Category	Total amount of debt	Percentage share in the total debt
Commercial banks	1106.95	19.42
Cooperative institutions	1547.42	27.14
Commission agents	2640.52	46.32
Agri. mortgages	406.02	7.12
Total	5700.91	100.00

Source: Shergill (1998).

Our estimates of total debt of Punjab farmers are shown in Table 9. The data given in the table clearly indicated that the per holding outstanding debt of Punjab farmers was about Rs 1.62 lakh. There are 11.17 lakh operational holdings in the State. For all these farmers, the total outstanding debt has been worked out at Rs 18049.04 crore. We can say that Punjab farmers were under outstanding debt of about Rs 18000 crore during the year 2001-02. Therefore, the hype created by some vested interests that Punjab farmers are very rich is a myth.

Table 9: Estimates of indebtedness of Punjab farmers, 2001-02

Sr.No.	Particulars	Amount of debt (in Rs)
I	Per holding outstanding debt of the respondents of Harkishanpura village	3.23 lakh
II	No. of operational holdings in Punjab = 11.17 lakh	–
III	Per holding outstanding debt of Punjab farmers*	1,61,535
IV	Total outstanding debt of Punjab farmers (IIXIII)	18,049.04 crore

* Per holding outstanding debt of the Punjab farmers is based on the assumption that the average debt of the State farmers' was 50 per cent of the respondents' debt of Harkishanpura village during the year 2001-02. The average productivity of different crops was high in Punjab as compared to the productivity of crops raised in this village. Moreover, this village is located at the tail end of the canal irrigation distribution system. On the other hand, about 75 per cent of the State's net area sown is having assured irrigation. In majority of Punjab villages, the underground water is not brackish. This is a big problem in this village. The literacy rate in the state is much higher as compared to Harkishanpura village. Various other factors like foreign remittances, employment in the public and private sector, etc. are also unfavourable for Harkishanpura village. Above all, a small percentage of farmers may not be under any kind of debt at all in the State.

The economic crisis faced by the Punjab farmers can have serious social, economic and political implications for the State as well as the country. A delay of a few years in solving economic problems of the State farmers can be suicidal. Already, about 30 lakh youths are unemployed in Punjab. Majority of them belong to the rural areas. The concerted efforts should be made to absorb them in the non-agriculture sector also. The agriculture sector itself cannot provide employment to all of them. The empty slogans of various political parties alone cannot feed the human beings.

Summary and conclusions

In the mid-1960s came another technological breakthrough when high yielding varieties (HYVs) of wheat and other cereals particularly of rice increased the yield manifold. The Government of India provided a mechanism of a minimum support price and procurement of wheat and paddy that sustained this production by preventing price crash. The 14 major banks of the country were nationalized in July, 1969 to facilitate credit mainly to priority sectors like agriculture. Our country, which imported about 10 million tons of foodgrains in the year 1966, became an exporter of foodgrains in the 1990s. For this, the credit goes to the progressive farmers of Punjab, Haryana and some other states. The good performance of Punjab agriculture cannot be sustained in the long period. Already, the State agriculture is facing the problem of stagnation in production and

productivity. On the other hand, there is decline in production and productivity for crops like cotton (American) during the last one-decade or so.

The study brought out that cash expenses on cotton (A) crop was about Rs 21416 per hectare during the year 2001-02. It varied from Rs 19031 per hectare with the marginal farmers to Rs 23969 per hectare with the large farmers. These expenses were mainly on four crucial inputs, i.e. insecticides/pesticides, chemical fertilizers, seed and irrigation. The respondents in the sample had reported as high as 30-32 sprays on cotton (A) crop in a single season. This happened in each kharif season during the last few years. The end result was not good. Ultimately, the farmers got very low yield of cotton (A). Hence, the failure of this crop is one of the major reasons for the problem of indebtedness in this village and elsewhere in the cotton belt. For wheat crop, the cash expenses were Rs 5249 per hectare. As compared to cotton (A) crop, the cash expenses on wheat crop were less because insecticides/pesticides were not used on the latter one. Although, the yield of wheat was low in Harkishanpura village but it was stable compared to the cotton (A).

The study brought out that the total amount of debt outstanding against the farmers of Harkishanpura village was about Rs 2.88 crore during the year 2001-02. The per holding debt of the village was to the extent of Rs 3.23 lakh. The amount of debt was also related with the farm size. On the other hand, the amount of debt on per hectare (operated area) basis was more in case of marginal, small and semi-medium farmers. As the farm size increased, the amount of debt on per hectare basis declined in most of the cases. Regarding the sources of credit, the commission agents provided the maximum credit (about 48 per cent) followed by commercial banks (about 17 per cent), cooperative banks (about 12 per cent), Land Mortgage Bank (about 10 per cent), PASS (about 7 per cent and relatives and friends (about five per cent). The preference for the commission agents was on account of traditional social relation of farmers with them. Moreover, no paper work was required in getting credit from the commission agents. Based on outstanding debt of the farmers of Harkishanpura village, the total outstanding debt for 11.17 lakh operational holdings in Punjab has been worked out at Rs 18049 crore during the year 2001-02. Therefore, the hype created by some vested interests that Punjab farmers are very rich is a myth. The economic crisis faced by the Punjab farmers can have serious social, economic and political implication for the State as well as the country.

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Indebtedness of Farmers: Is Contract Farming a Solution?

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Contract farming is a system in which agricultural commodities are produced and supplied to a particular buyer under a pre-negotiated arrangement about price quality and quantity. It seems to be an ideal solution for the ills plaguing the agricultural economy, as it ensures quality inputs and stable price. However, banks need to identify a contract arrangement in order to improve the flow of credit to the agricultural sectors.

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Agriculture is still a source of livelihood for majority of people in rural areas. There is a significant change in the output mix and thereby input mix, whereby there is a shift in area from foodgrains to non-foodgrains and from coarse to finer cereals. The demand for credit has increased with progressive change in technology, exposure to international markets, promotion of exports, growth of floriculture, horticulture, agro processing, storage and marketing.

The farmers in general are dependent on banks, money lenders and traders and the last two agencies charge high rates of interest. The rural financial institutions are not advancing credit to agriculture at the rate warranted by the increased requirement of credit with the larger use of purchased inputs. The major reasons given by the Rural Financial Institution for their unsatisfactory performance are low absorption capacity, high transaction cost and greater risk. Hence the farmers have to fall back upon the non-formal sectors like input suppliers, traders and big landlords. It is easy to get credit from them but the terms and their pattern of recovery is ruthless and inhuman. Farmers are heavily indebted to them and most of the suicides of farmers are due to this reason. It is truly said that the Indian farmer is born in debt, lives in debt and dies in debt.

The recently published report of the NSSO (Report No. 498), "Indebtedness of Farmers Households in 2003" given in Table 1 shows that about half (48 per cent) of the farmer households in the country had outstanding debt; 26 per cent of the indebted farmers had outstanding loans with cooperatives and the bulk were indebted to money lenders and traders. It is worth mentioning that states like Andhra Pradesh, Rajasthan, Tamil Nadu, MP, Punjab and Karnataka have farmers indebted more to money lenders and traders than to cooperatives and banks. In Andhra Pradesh 82 per cent of the farmers that were indebted to money lenders and traders, accounted for more that 58 per cent of their total outstanding debt.

Table 1: Outstanding Loans of Farmers in India and the States in 2003

State	Percentage of Households	Percentage of Indebted Farmer Households Indebted to			Outstanding Loan per	Percentage of Loans from			Percentage of Total Loan for Agriculture (Current + Capital)
	Indebted	Cooperatives	Banks	Money-lenders and Traders	Farmer Household (Rs)	Cooperatives	Banks	Money-lenders and Traders	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	82.0	20	31	66	23,965	10.4	20.0	58.2	61.5
Assam	18.1	3	9	27	813	2.7	27.8	27.5	23.3
Bihar	33.0	4	17	49	4,476	2.5	37.0	33.9	42.4
Chhattisgad	40.2	37	27	37	4,122	20.6	50.5	17.2	70.3
Gujarat	51.9	40	23	18	15,526	41.8	27.2	10.9	70.6
Haryana	53.1	44	30	38	26,007	23.9	42.6	27.2	62.2
Himachal Pradesh	33.4	24	28	27	9,618	11.6	47.6	12.7	19.1
Jammu and Kashmir	31.8	1	4	89	1,903	0.2	54.3	16.6	29.2
Jharkhand	20.9	0	38	30	2,205	4.5	55.7	20.7	32.5
Karnataka	61.6	23	32	39	18,135	16.9	50.1	21.9	68.2
Kerala	64.4	46	42	22	33,907	28.3	49.1	9.1	21.4
Madhya Pradesh	50.8	37	23	45	14,218	16.9	38.1	31.6	68.3
Maharashtra	54.8	61	29	13	16,973	48.5	34.1	7.6	75.4
Orissa	47.8	30	36	27	5,871	18.1	43.7	15.6	53.3
Punjab	65.4	38	19	46	41,576	17.6	28.4	44.5	62.4
Rajasthan	52.4	15	21	63	18,372	5.9	27.0	55.7	57.2
Tamil Nadu	74.5	33	23	54	23,963	25.3	28.1	40.1	49.4
Uttar Pradesh	40.3	13	30	35	7,425	6.7	51.2	22.0	60.9
Uttaranchal	7.2	17	40	12	1,108	4.8	39.8	7.6	34.2
West Bengal	50.1	19	22	44	5,237	19.2	28.5	23.7	45.7
India	48.6	26	27	41	12,585	19.6	35.6	30.9	58.4

Note: The data for India includes that for the smaller states that are not included in this table.

Source: NSSO, Indebtedness of Farmer Households, Report No. 498.

Table 2: Value of Inputs, Outputs and Flow of Production Credit in Agriculture at Current Prices (Rs. crore)

Year	Value of output	Value of Input	Flow of SAO Credit
1993-94	204874	55401	9752
1994-95	236607	63654	11932
1995-96	256698	72026	15273
1996-97	302744	74415	16956
1997-98	319586	83125	18632
1998-99	387546	93005	20601
1990-00	405576	103555	23694

Source: Vyas 2004

The farmers have to take credit to a larger extent than in the past for purchase of inputs of various kinds. The flow of SAO credit has improved (as seen in Table 2) from Rs. 9752 crores to Rs. 23694 crores, which is a 2.5 times increase. The crop loan from all financial institutions to agriculture covered 17.6 per cent input cost in 1993-94 and about 23 per cent in 1999-2000. This shows that less than quarter of input cost is covered by formal sector credit. The farmers have to depend on other sources of credit to meet more than three-fourths of the cost of inputs, (Singh 1999, Singh and Sagar 2004 for informal sector credit flow to agriculture).

The suicide of farmers in Andhra Pradesh and other parts of the country such as Punjab, Maharashtra, Karnataka in the past several years brought into focus the crisis in the agrarian economy. The pundits who examined the suicides were of the opinion that the very high levels of indebtedness is the primary reason driving the farmers to despair and pushing them to take the extreme measure of killing themselves. There seems to be a combination of factors that causes the indebted-

ness. The decline in institutional finance in the 1990s, the emphasis on market lead growth rather than the government directed one, the volatility in the commodity market and crop failures due to spurious inputs and drought had precipitated the crisis.

Institutional Credit

The implementation of the Narasimhan Committee recommendations resulted in decline in commercial bank credit to the agricultural sector. The Vyas committee noted that even though the bank's agricultural advances outstanding grew nearly fourfold, from under Rs. 22,000 crores to Rs. 85,000 crores in the last decade, only five of the 27 public sector and two of the 29 private sector banks met the target of extending 18 per cent of net credit outstanding to agriculture. These banks contributed to the Rural Infrastructure Development Fund (RIDF) to make up for the shortfall in lending to the priority sector. Further, domestic commercial banks are required to extend not less than 10 per cent of the net bank credit (NBC) to weaker sections, comprising small and marginal farmers, landless labourers, artisans etc. Till March 2003 only 6.8 per cent of NBC to weaker sections was extended by these banks. This also varied from 2 to 9.4 per cent across banks (ibid).

The poor financial health of the co-operatives has constrained their ability to seize the business opportunities left by the commercial banks. The share of cooperatives in the flow of institutional credit to agriculture continued to decline. From a share of 62 per cent out of the total institutional credit flow to agriculture in 1992-93, it came down to 34 per cent.

Input Dealers

The reduction in institutional finance pushed the farmers towards private money lenders. The input dealers emerged as primary source of credit. Farmers purchased inputs such as seed, fertilizers and pesticides from the dealers on credit, on which a 24 per cent interest was charged. Lack of credit narrowed the option of the farmers in choosing the dealers. The reduction in fertilizer subsidies increased the input costs. In Andhra Pradesh the withdrawal of the government from many spheres, with emphasis on market lead growth, resulted in mushrooming of private operators. The absence of new regulations and the laxity in the implementation of the existing rules and regulations, gave room for many fly by night operators. The withdrawal of the government from the extension activities meant these dealers proffered expert advice to the farmers on the agronomic practices (Sainath 2004). Of course they gave advice about what is profitable to them rather than to the farmer. Further, the spurious seeds and pesticides supplied by these dealers resulted in crop failure, contributing in no small measure to the farmers' debt burden.

Cropping Pattern

The liberalization of the economy from the early 1990s and the WTO agreements have created a new set of challenges to the farming community in general, and small and marginal farmers in particular. Farmers have been pulled by increasing demands of the markets and the state into a nexus of a relationship that extends beyond the farm to the national and international level. The interaction between small holders and more powerful economic and political organisations in not new. What characterizes the contemporary situation is the variety of forces with which small farmers must deal. The size, complexity and impersonality of these organisations has resulted in a quantitative change in the nature of the small holders' relationship to the outside world (Glover and Kusterer 1990).

In India many farmers switched from food and subsistence farming to commercial crops for the market. These crops required costly inputs, pushing up the cost of cultivation. For example, in Andhra Pradesh many farmers including lakhs of small farmers, switched to cotton in the 1990s in the face of increasing prices due to liberalized exports. There was a quantum leap of area under the crop in a short span of three years. This was accomplished by using high cost inputs such as seeds and pesticides purchased on credit or out of borrowed funds. World cotton prices started to decline from 1996 and by 2001 it was half of the 1995 level (Patnaik 2004). The crash in prices increased the debt burden of the farmer at the beginning of the next crop cycle. The farmers went for the same crop with the hope of an increase in price so that they could recoup the losses of the previous year/s, but to no avail, and instead they accumulated heavy debt.

The Vyas committee listed some of the main factors affecting institutional credit flow to the disadvantaged, such as small and marginal farmers. They are higher transaction costs to both banks and borrowers, borrowers' inability to provide collateral securities, inadequate risk mitigation mechanism available to small borrowers in the even of micro enterprise failure and to the bank in the event of loan failure, the mindset being that banking with the poor in not profitable etc.

The committee recommended various measures to increase the flow of credit to the disadvantaged sections, one of which was for the banks to associate with

the contract farming. The committee felt that "the approach has the potential for expanding credit outreach especially to small/marginal farmers and oral lessees. Banks may increasingly consider associating with contract farming subject to availability of proper legal and regulatory framework in different states".

Contract Farming

Contract farming is a system is which agricultural commodities are produced and supplied to a particular buyer, mostly processors under a pre-negotiated arrangement about price quality and quantity. It brings producers and processors closer on mutually beneficial terms. The firm is assured of a steady supply of raw materials at a stable price. The farmers get ready market for their produce and are insulated against the volatility of price. Many times farmers get the necessary inputs such as seed, pesticides, fertilizers etc. besides expert advice from the company staff, as the firms stake is linked to the outcome at the farmers' field.

Little and Watts (1994) define contract farming as a "form of vertical coordination between growers and buyer processors that directly shape production decisions through contractually specifying market obligations such as value, volume, quality and at times price, provide specific inputs and exercise some control as the point of production".

Advocates of contract farming view it as a dynamic partnership between agribusiness firms and small farmers, that benefit both without sacrificing the right of either. It is offered as a vehicle for the transfer of technology and the modernization of peasant small holders. For the neoclassical economists and proponents of agribusiness the contract ensures a sort of mutualism between the parties. Freely entering into the contract allows growers to make better use of their specific endowments in imperfect markets and to arrive at combinations of income, effort and risk reflecting their resources and tastes (ibid).

Contract farming is explained as an institutional response to missing markets for credit, insurance, information, factors of production in an environment of pervasive risks (Key and Runstein 1999). Apart from providing credit, input and extension services, contract farming can link the farmers to international markets by organizing production of high value food crops.

Apparently contract farming is an ideal solution for the ills plaguing the agricultural economy. It ensures quality inputs and stable price. It removes the information asymmetry between the farmer and the consumer by informing the farmer about the produce, the quality requirements etc., thus prompting the Government of India to view it as an avenue for technology transfer, capital inflow and assured market for crops (GOI 2000).

There are several agricultural and horticultural crops such as tomatoes, potatoes, chillies, gherkin, baby corn, rose onions, cotton, wheat, basmati rice, groundnut, flowers, medicinal plants, culinary herbs etc. produced in some form of contractual arrangements with the farmers in the country. Big corporate houses as well as several small players are involved in contract farming (Gurdev Sing and Asokan 2005). Broiler chicken production in Tamil Nadu is entirely under contract farming. Most of the contract agreement is bilateral, that is between the farmers and the company. There are some tripartite agreements involving commercial banks to take care of the credit need of the farmers (ibid).

However, the initial enthusiasm shown by the commercial banks to contract farming seems to be waning. Commercial banks which viewed contract farming as a least risk option to fulfill their commitment to the priority sector lending, began to pull out of the arrangement.

The crux of the issue seems to be the companies' reluctance to guarantee the recovery from the proceeds of the output of the farmers. Banks are hesitant to deal directly with the farmers as they are not sure about the commitment of the firm to the farmers. Contract farming is fundamentally a way of allocating risk between the firm and the farmer. However, the distribution of risk depends heavily on factors like bargaining power, availability of alternatives and access to information. The strength of a party in any one of these factors leads to the opportunistic behaviour which is defined as unanticipated non-fulfillment of a contract, thus leading to strains in the contractual relationship and may result in failure of the contract.

In agribusiness an ex-post advantage to one party can arise in various ways such as change in weather-affecting production, prices, change in technology, changes in consumer preferences due to emergence of alternatives etc. When an agribusiness firm is not an exclusive buyer of the commodity, farmers behave opportunistically. The situation can arise when there are rivals in the market or the commodity has alternative uses. For example, tomatoes produced by farmers for a processing firm under contract were diverted to the open market when the prices were high and were supplied to the firm when the market price was lower than the contracted price. Such behaviour created havoc to the production plan of the firm. Likewise there are instances in which firms renege on the contract to buy

from the farmers. There is no legal recourse to the problem even though there may provisions for such a measure in the contract agreement. It is not prudent for the firm to drag the delinquent farmers to the court as it will put off others in dealing with the firm.

Binswanger and Rosenweig (1996) argue that technological conditions and crop characteristics combine to give rise to situations in which contract farming is the most viable option. This is specifically for crops for which important economies of scale are associated with processing, coordination and perennials. They concluded that contract farming in wheat and other foodgrains have never been able to survive. However, they ignored the crucial factor that is the availability of alternatives which determine whether a contract farming arrangement succeeds. Crops like wheat, rice, oilseeds, fruits and vegetables have alternate markets, therefore, in these crops there tends to be opportunistic behaviour of the farmers. In crops produced for specific purpose which have no alternative markets the chances of farmers behaving opportunistically is almost nil. Similarly, when the company had made specific investment in human resources, plants and machinery whose alternate uses are not available, or firms that are not cost effective, firms do not behave opportunistically.

Asset Specificity

Available evidence indicates that the relationship between the firm and the farmer in a contract would be smooth when both are locked in asset specific investments. The reason why asset specificity is critical is that once the investment has been made buyer and seller are operating in a bilateral exchange relation for a considerable period thereafter. In as much as the value of highly specific capital in other uses is much smaller than the specified uses for which it has been created, the supplier is effectively locked into the transaction. The buyer on the other hand cannot turn to alternative sources of supply and procure the item on favourable terms. The buyer is therefore committed to the transaction as well. Accordingly where asset specificity is great, buyer and seller make special efforts to design an exchange relation that has good continuing properties. As the survival of both parties is closely linked the contract is self enforcing.

For example, certified seed production has been carried out under contract for decades in India quite successfully. The seed growers are not in a position to exploit the market by diverting the produce. Similarly, gherkin has been produced in Karnataka for the past ten years quite successfully. The major reason for the success is that the crop has no local market but a huge market in Europe and North America. Farmers deliver whatever they produce to the company and the firm cannot renege on the contract as it has to fulfill its commitment to its overseas clients. Sami Labs of Bangalore produce a medicinal plant coleus through an agent in Tamil Nadu, who organized the production under contract with the farmers. The agent arranges for the loan through commercial banks to the farmers and guarantees its repayment. Sami Labs is the sole purchaser of the product and farmers have no alternative but to supply them. The agent is assured that there is no chance for diversion.

Therefore, contract farming does not offer a carte blanche for the banks to finance the activity in order to improve the flow of credit to the agricultural sectors. Banks should identify such contract arrangement in which there is high asset specificity and hence little room for opportunistic behaviour. In order to extend credit such an effort would ensure help with the flow of funds, especially to small and marginal farmers, and at the same time ensuring the recovery of such funds.

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Impact of Modern Farm Practices on Foodgrain Productivity in West Bengal

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This paper aims to examine the functional relationship between foodgrain productivity and modern farm inputs in West Bengal for the period of 1970-71 to 1999-2000. Both Cobb-Douglus and linear models are used to find out the input-productivity relationship. The results indicate that out of all the selected input factors fertilizer is the most important one in explaining the productivity growth in West Bengal.

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Modern farm practices were introduced in India mainly from the time of the Green Revolution. The Green Revolution, spreading over the period from 1967-68 to 1977-78, changed India's status from a food deficient country to one of the leading agricultural nations of the world.

Initially the Green Revolutionary effect was observed in the wheat-producing north western states of the country like Punjab, Haryana etc. West Bengal, the main important foodgrain producing eastern region state of India, ushered in the era of modern farm practices in the true sense since the late 1970s under the supervision of the left front government. In general, modern farm practices in West Bengal imply the seed-fertiliser-water technology. The high degree of correlation between these factors (fertilizer, HYV seeds, irrigation) [Table 1] indicates high complementarity among them. Balanced improvement of these factors is very much necessary for the improvement in output performance of agriculture. Though there were decade-wise ups and downs [Majumdar and Basu, 2004] in the growth rate of foodgrain production in West Bengal, in absolute amount it was almost doubled during 1970-71 to 1999-2000.

Productivity, the most important component of agricultural production in West Bengal, also registered a significant improvement during the same period. Scholars are of the opinion that both technological and institutional factors are there behind this remarkable improvement of foodgrains production in West Bengal, though debate is still on regarding the relative importance of these two factors [Saha, 1996]. In this background the present study tries to quantify the impact of different modern farm inputs to the foodgrain productivity in West Bengal for the period of 1970-71 to 1999-2000. In this connection it is important to note that since the possibility of increasing the productivity through greater use of the traditional inputs like labour, animal power etc. is very much limited in nature, the present

study concentrates mainly on the three above mentioned modern farm inputs.

Table 1: Correlation between input variables

	X_1	TF	TH	GIA
X_1	1.000	.38	.40**	.51*
TF	.38	1.000	.96*	.78*
TH	.40**	.96*	1.000	.79*
GIA	.51*	.78*	.79*	1.000
	X_1	X_2'	X_3	X_4
X_1	1.000	.33	.31	.45*
$X_2/$	.33	1.000	.96*	.62*
X_3	.31	.96*	1.000	.64*
X_4	.45**	.62*	.64*	1.000
	X_1	X_2	X_3	X_4
X_1	1.000	.14	.31	.45**
X_2	.14	1.000	.81*	.17
X_3	.31	.81*	1.000	.64*
X_4	.45**	.17	.64*	1.000

Notes: (1) * and ** indicate significant at 1% and 5% levels respectively by two-tailed test

X_1, X_2, X_3 and X_4 are specified in eqn. 2.

GIA = Gross Irrigated area

TF = Total Fertiliser

TH = Total HYV area under rice and wheat

Overview of Literature

There are so many factors which directly or indirectly influence the growth performance of agricultural output/productivity. Broadly they can be subdivided into three groups: technological, infrastructural and institutional. Technological factors include fertilisers, pesticides, high yielding variety seeds, cropping pattern etc. Irrigation, rainfall, rural market structure, soil fertility, credit facilities etc. are the important infrastructural factors. Institutional factors include the different reform practices like land reforms, tenancy reforms and the supportive roles played by Panchayat Samitis, Agro-Service Centres and Co-Operatives etc. Beside these there are some other important factors like population, literacy rate, productivity of labour, public investment, input subsidy etc. However, as mentioned earlier, in the present study the concentration is on the technological factors and in this section some of the important studies related to this field have been discussed briefly.

Sagar (1980) made an attempt to describe the relationship between yield of important cereals and strategic inputs, like fertilizers, HYV and irrigation in different agricultural regions of Rajasthan. Instead of the quantitative magnitudes of the inputs Sagar (1980) used dummy variables corresponding to each of the inputs.

Boyce (1987) tried to find out the impact of irrigation on yield in India. The percentage of gross cropped area irrigated and irrigation intensity was considered as an explanatory variable in the regression analysis. The results show that the inclusion of irrigation intensity improves the explanatory power of the model.

Singh and Chandra (2001) studied the effect of fertiliser, irrigation and farm power in increasing the foodgrain productivity in Uttar Pradesh, the largest producer of foodgrain in India. They tested both the joint and separate contributions of these inputs.

An unrestricted form of Cobb-Douglas production function was used by Bhalla and Singh (2001) with a view to examining the contribution of farm inputs to total agricultural output. The variables were entered in logarithmic form. Bhalla and Singh (2001) estimated the values of the parameters by the method of Ridge Regression, the ridge constant being determined by the iterative procedure suggested by Hoerl and Kennard (1970).

To calculate the output elasticity of modern farm inputs like HYV, fertilizer etc. by avoiding the multicollinearity problem, Saha (1996) regressed yield on each input separately. To make a comparison between the eighties and pre-eighties performance, both slope and intercept dummies were used by Saha (1996).

Methods of Analysis

Basic data and its sources

The present analysis is based on published secondary data, the sources being several issues of Statistical Abstract of West Bengal, Cost of Estimation of Area, Yield and Production of Principle Crops in West Bengal and Economic Review of West Bengal.

As mentioned earlier, the study aims to find out the impact of modern farm inputs on value foodgrain productivity in West Bengal for the period of 1970-71 to 1999-2000. Foodgrains in West Bengal mainly include rice, wheat, barley, gram and other pulses. Rice is the main food crop of the state. Basically aus, aman and boro are the main three important varieties of rice in the state. Other pulses constitute arhar, mug, maskalai etc. Total foodgrains have been calculated by adding these individual crops. As the items

are not homogeneous in nature all are expressed in value terms by their respective farm harvest prices. Three farm inputs viz. fertilizer, HYV seed and irrigation have been considered as regressors.

Methodology Used

To measure the contributions of individual modern farm inputs to foodgrains productivity, multiple regressions have been conducted. As mentioned earlier, fertiliser, irrigation and high yielding variety seeds are the three main important components of modern farm practices. However, output is not only influenced by the use of inputs, but also by the grossed cropped area (GCA), especially where the agricultural modernization has taken place in terms of double and multiple cropping also. So GCA has also been taken into consideration in the multiple regression analysis based on state level time-series data.

Due to non-availability of crop-wise input data, total fertliser and total irrigated area have been taken as the proxy variables for the present study. As foodgrains constitute more than 75% of total agricultural output as of 1999-2000, this type of approximation will not create much problem in the analysis. All the input variables except GCA have been taken in the ratio forms like fertilizer per hectare of GCA, irrigated area as a percentage of GCA, proportion of foodgrains area under HYV as a first attempt to reduce the strong multi-collinearity between the total inputs of fertilizer, irrigation and HYV seeds. However, even the pair-wise correlation remained as it is for the variables related to fertliser and irrigation (Table 1). The problem can be considerably reduced by choosing the fertiliser per hectare of gross irrigated area instead of fertiliser per unit of gross cropped area. Data on area under HYV seeds being available only for the two main important foodgrains crop in West Bengal viz., rice and wheat, the HYV seed related factor actually represents the proportion of area under HYV cultivation in the cases of these two crops alone. In view of their prominence in the production in the state, the extension of approximation is not much.

Taking gross area as one of the explanatory variables in the same equation sometimes creates a problem arising out of mean-constancy of the variable in the ratio from [Minhas, 1966]. However, the data in the present study fortunately does not depict any such near constancy.

In the present work, the functional rule between productivity and inputs has been estimated by using alternative forms. Both Cobb-Douglus and linear functions have been tried for this purpose.

Cobb-Douglus Model

The following Cobb-Douglus function is used for the present analysis

$$\ln P = \ln \eta_0 + \eta_1 \ln A + \eta_2 \ln X_2 + \eta_3 \ln X_3 + \eta_4 \ln X 4 + \theta \quad ...(1)$$

In the Cobb-Douglus models as the variables are in logarithmic form, the estimated coefficients will give the elasticities and their sum will provide the information regarding the nature of scale. With the first order differentiation of this function, the same elasticity coefficients become the coefficients of the growth equation (Equation-3).

The Linear Model

The linear model used in the present study is as follows:

$$P = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \phi \quad ...(2)$$

where

P = Value foodgrains productivity = V_t/X_1

V = Value output of foodgrains.

X_1 = Gross cropped area under foodgrains

X_2 = Fertilizer per hectare of irrigated area

X_3 = Proportion of rice wheat area under HYV seeds

X_4 = Irrigated area as a percentage of gross cropped area

η_i, α_i are the parameters, i = 0, 1, 2–4.

The time subscripts are present in all the output and input measures, however, for the sack of simplicity in the present study they have been deliberately kept understood.

An attempt has been made to tackle the residual multi-collinearity, which is not much, by using the method of Ridge regression (RR) with an iterative choice of Ridge constant [Hoerl and Kennard, 1970]. Sometimes this method provides slightly better results compared to the other popular methods of estimation with the multi-collinearity problem, like principal component analysis etc. [Hoerl et. al, 1975]. The basic idea of Ridge Regression is to augment the main diagonal elements of matrix ($X'X$) by positive constant k before the least square estimation. This method involves trading a little bias for large reduction in variance. The larger the value of k the larger is the bias but the smaller the variance.

Input output Growth Equations

An attempt has also been made here to express the relationship in terms of growth rates with the help of growth equations. The growth equations for both the Cobb-Douglus and Linear model, showing the relation between the growth rates of the modern inputs and that of foodgrains productivity, are as follows.

Growth equation in the Cobb-Douglus framework

The relation between the growth rates of modern farm inputs and that of foodgrains productivity can be seen from the following growth equation:

$$G = \eta_1 G_1 + \eta_2 G_2 + \eta_3 G_3 + \eta_4 G_4 \quad ...(3)$$

G, G_1 G_2, G_3, and G_4 are the relative growth rates of value foodgrains productivity, area under foodgrains, fertiliser per irrigated area, high yielding variety per rice and wheat area and irrigated area per gross cropped area respectively.

Growth equation in the linear framework

In equation 4, the variables are assumed to follow a linear trend. Here average elasticities are to be computed from the derivatives (marginal productivities for the output function) obtained from the linear regression of productivity on inputs. Percentage growth rate of productivity calculated as the ratio of absolute growth to the harmonic mean of that input is same as the exponential growth rate (G_i). So the growth equation in the linear framework may be presented as

$$G = \alpha_1 \frac{A_{X_1}}{A_v} G_1 + \alpha_2 \frac{A_{X_2}}{A_v} G_2 + \alpha_3 \frac{A_{X_3}}{A_v} G_3 + \alpha_4 \frac{A_{X_4}}{A_v} G_4 \quad ...(4)$$

A_{xi} s are the mean of the variables and the rest of the items carry the same meaning as before.

The equations used for the individual growth calculation are the following:

Exponential $\ln P_t = a + b_t + \mathcal{C}_t$ ...(5)

Linear $P_t = a' + b'_t + \mathcal{C}'_t$ ...(6)

Beside these analyses, partial correlation coefficient is also considered in the present analysis to indicate the individual importance of the variables keeping at constant the remaining variables at a time.

Results and Discussion

The detailed regression results for whole period production function analysis are presented in Tables- 2 and Table 3.

So far as the Cobb-Douglus functions are concerned, three elasticity coefficients out of four viz., η_1, η_2, η_4, the coefficients of gross cropped area (X_1), fertiliser per irrigated area (X_2) and the percentage of irrigated area (X_4) respectively, were found positively significantly showing favourable impact of these inputs on productivity (Table 2) in West Bengal, thus almost confirming hypothesis 1. The coefficient of the proportion of rice wheat area under HYV seeds (η_3) was found insignificant in the Cobb-Douglus framework.

Table 2: Regression results of productivity analysis in Cobb – Douglus framework

Explanatory Variables	Coefficients	Correlation of partial determination	R^2
X_1	1.66 (.33)*	.54	.92
X_2	.27 (.05)*	.47	
X_3	.108 (.089)	.002	
X_4	.228 (.109)*	.16	

Notes: (1) *and ** indicate significant at 1% and 5% levels respectively by one-tailed t test.

(2) Figures in the parentheses represent Standard Errors

X_1, X_2, X_3 and X_4 are specified in eqn. 2.

Table 3: Regression results of productivity analysis in linear framework

Explanatory Variables	Coefficients	Correlation of partial determination	R^2
X_1	.00084 (000302)*	.25	.93
X_2	.0075 (.00132)*	.42	
X_3	.0226 (.0089)*	.11	
X_4	.0544 (.0208)*	.14	

Note: The notes from 1 to 3 for Table-2 are applied here.

However, in the linear framework the elasticity coefficients of all the four factors (including HYV) were found positively significant (Table 3) and the coefficient of determinations (R^2) recorded higher values in linear models.

As mentioned in brief in section III, for the whole-period analysis the regressions were done by Ridge Regression (RR) method. But the difference of RR method and OLS method are not much in the present study because the degree of multicollinearity is not severe here. However, methodologically this RR method is more accurate.

The partial correlation of determination (r^2) shows that net variation of gross cropped area(X_1) had the most important impact on net variation of productivity in Cobb-Douglus model during the period as a whole explaining as much as 54% of net productivity variation (Table 2) after abstracting from the influences of other variables in the model. But in the linear frame work it was only 25% (Table 3). Among the non land inputs, it is the fertilizer per unit of irrigated area which had the largest effect on the net variation on output explaining as much as 47% and 42% of the net variation in output in the above mentioned two models respectively. HYV had the lowest contribution to the total productivity in both the models.

Input-output growth relation

As mention in section III, in the Cobb–Douglus production function the input coefficients (s) are nothing but the elasticities. With the first order differentiation of this function, the same elasticity coefficients become the coefficients of the growth equation (expressing rate of growth of value output as a linear function of the rate of growth of the corresponding inputs). The exponential growth rates of value productivity calculated from the productivity data is 3.05% during the period of 1970-71 to 1999-2000. The independent exponential growth rate of selected input factors X_1, X_2, X_3 and X_4 are observed 0.16%, 6.8%, 4.96% and 1.36% respectively.

Table 4: Exponential growth rates and contributions of inputs to productivity growth: Cobb-Douglus Model

	P	X_1	X_2	X_3	X_4
Exponential Growth Rate (percent per annum)	3.05	.16	6.8	4.96	1.36
Elasticity coefficient		1.66	.277	.108	.228
Percentage contribution	100	8.71	61.76	17.56	11.97

Notes: (1) P = Foodgrains productivity = V_i/X_1

It would be interesting to note that output growth rate estimated from the growth equation [Equation-3] is almost (theoretically it should be exactly) equal to the exponential growth rate of output derived independently from the productivity data. The little discrepancy between the independent estimation of productivity growth (3.05%) and the growth rate calculated from the above growth equation is because of the rounding-off error. The percentage contributions of the factors as worked out from the above growth equation are presented in Table 4. Results show the maximum portion of productivity growth was explained by the growth rate of fertilizer per GCA (X_2), around 61%. The HYV, area and irrigation related factors X_3, X_1 and X_4 explained around 17%, 8% and 11% of output growth respectively.

The independent linear productivity growth was found to be 3 per cent per annum. Here also little discrepancies are there. The percentage contributions of the four factors viz. X_1, X_2, X_3 and X_4, calculated from this equation were 4.67, 50.67, 31 and 13.66 respectively (Table 5).

Table 5: Average relative growth rates and contributions of inputs to productivity growth: linear model

	P	X_1	X_2	X_3	X_4
Average relative Growth Rate (percent per annum)	3	.16	5.24	4.64	1.68
Average Elasticity coefficient		.85	.29	.20	.23
Percentage contributions	100	4.67	50.67	31	13.66

Note: The notes from 1 to 2 for Table-4 are applied here

Conclusion

The present study tried to find out the importance of modern farm practices on the value foodgrains productivity in West Bengal for the period of 1970-71 to 1999-2000. Ridge Regression method was applied both in Cobb-Douglas and the linear frame–work to find out the impact of the modern farm inputs on the productivity. Though the Ridge Regression method gives biased estimates of the parameter, it provides low mean square error as compared to the unbiased Ordinary Least Square estimates. An attempt was also made to find out the relative contributions of the farm inputs in terms of growth rates.

The result revealed that in terms of coefficient of determination the linear model gave better fit in explaining the input-productivity relation. Though all the three inputs in linear framework and two in the Cobb-Douglus framework were found positive and significant in the regression analysis, fertilizer-related inputs was the most dominant one and its growth rate was far above the productivity growth during the period under study. The performance of gross area irrigated was very poor in terms of growth rate.

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It says something about this new global economy that USA Today now reports every morning on the day's events in Asian markets.

– Larry Summers

Basic Needs and Living Condition of People in Village Bhaganpur

B. Majumdar

Village as a unit becomes an economy by applications of social division of labour, technology, formation of market, movement and mobility of individuals. This paper focuses on basic needs and living condition of people settled in a particular village in Uttar Pradesh. The paper opines, based on primary data, that though the locally settled people are satisfied by fulfillment of basic needs, the village society needs transformation. This transformation is to be seen beyond the narrow boundary of fulfillment of basic needs.

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A village is seen in time and space. The apparently unknown geographic space becomes known by human settlements. Some regions show settled population, while some regions like hills, deserts, and forests show population not permanently settled. Village as a unit becomes an economy by applications of social division of labour, technology, formation of market, movement and mobility of individuals.

This study focuses on the basic needs and living condition of people settled in a particular village in Uttar Pradesh, located in the Karchhana block in the district of Allahabad. The name of the village is Bhaganpur. It has been selected because of its high number of tribal households.

Bhaganpur is a small village by size of population and number of households. Following the 1991 Census, the number of households in Bhaganpur village was 57 and it had a population size of 445. Of his total population, the ST (scheduled tribe) population was 73, that is, 16.4 per cent of the total village population. In Karchhana block, the percentage of ST population was 0.10. Thus, relative to the block, the village has high concentration ratio of tribal population.

Village in India: A Review

The Kautilyan analysis on (village) society, that reflects the society of a time period between 4th century BC and 150 AD, is one of the world's oldest treaties on the economic administration of the state. In his description of the economy, 'power comes from the countryside, which is the source of all activities. An ideal janapada (human settlement) was one which was easily defended and which had a lot of productive land with cultivable fields, mines, timber forests, elephant forests and pastures. Agriculture was the most important economic activity' (Rangarajan, 1992). In Kautilya's view land is the most important natural resource. Land in his

time was primarily in the public sector, with the state holding all virgin land, forest and water resources. Arable land, however, was both in the public and the private sectors. Regarding village life, Kautilya showed that a lot of responsibility fell on the 'gramika', the village headman and the gramvriddha, the village elders.

Srinivas has elaborated the experience of a village in the state of Karnataka in South India. He has shown that the life in a village in terms of animals, and plants also show the life of human beings in the village, the former providing the physical basis for the latter (Srinivas, 1976). Ramachandran also studies villages in Karnataka (Tumkur district) in South India. He has examined the process of integration of rural and urban areas based on the exchange of surplus production (Ramachandran, 1980).

The use of the term 'village' in various Indian languages denotes 'place of origin' that reinforces the silence of native locality, for which the village is paradigmatic (Lambert, 2002). With respect to a study of a village in west India, Lambert takes the assumption that 'within Indian culture, kinship is necessarily secondary to (or encompassed by) caste and ...the emphasis on jajmani-type relations in accounting for, then discrediting, the phenomenon of multicaste village 'solidarity'.

Menchel observes the socio-economic structure of a village in South India, a Tamil village. He hardly found any change in the relationships between those at the top and those at the bottom. In his study, whatever change has occurred is between castes close to one another in the hierarchy. Menchel questions the possibilities of economic development keeping caste hierarchy in tact (Menchel, 2002).

Madan explains community divisions among people settled in rural Kashmir (the state in extreme North India), in terms of their Identities. He concentrates on examining the mutual and sharp exclusion between Kashmiri Pandits and the Muslims. He shows that the Pandits do not get engaged in certain activities, which they consider as either polluting or manual. The Pandits consider the Muslims as ritually impure (Madan, 2002). As observed by Madan, Kashmiri Muslims enter into relations with Pandits, which they view as traditional economic transactions. It is a relationship of mutual dependence, but is asymmetrical. Srinivas shows that 'in contrast to the village, caste has social reality. The village is only the dwelling place of diverse and unequal castes' (Srinivas, 1996). Individual villages in India are far from self-sufficient economically. Caste ties stretched across village.

Srinivas suggests that in the past villages functioned as a unit irrespective of caste and other affiliations of individuals, perhaps because of a sense of belonging to a local community having certain common interests overriding caste, kin and factional alignments. This inclusion in village society, however, may be questioned by the revealed exclusion of Harijan castes from access to wells and temples used by the others in the same village.

In any case, caste and community were the institutions in village society that regulated the village people. These institutions by moral code (oral and often through meetings of village elders) framed by the dominant castes were also executed by the dominant castes (Srinivas, 1996). Even the mode of production gets submerged into this caste-community hierarchy, so that the system goes unquestioned and unresisted by the aid of heredity and superstition. What could be revealed as social division of labour gets revealed as caste-cum-gender division of labour.

In view of Fuller, 'villages are normally recognized as significant social units, which are defined and constituted by relationships among villagers themselves, their local deities, and the land on which they live'. In Fuller's view, villages in India are still generally recognized as local communities, rather than places in which people merely happen to live and work. Fuller examines these questions with respect to villages in both south and north India.

On the basis of a study of villages in Uttar Pradesh in north India, Dube suggests that a village in multi caste in its composition. The village itself is a part of the network of neighbouring villages. the region, and the nation. Caste is perhaps the most important single organizing principle is these communities, and it governs to a very considerable degree the organization of kinship and territorial units. The caste divisions are regarded as divinely ordained and are hierarchically graded. He also shows the patron-client relation in rural UP explained in ethnographic terms as the 'jajmani system'. Also, that caste largely determines occupational choice (Dube, 2002).

With respect to the study of Karchana tahsil in Allahabad district, UP, Jaer says that 'caste is the intersubjective fact which governs the jajmani system...caste also provides a model of the social world as well as a model for social action within it' (Jaer, 1995).

Dasgupta analyses the functioning of villages by economic parameters. He suggests that 'the propensity to migrate is high in villages characterized by land-scarcity, inequality of land distribution, moderate but not great proximity to urban centres, and a relatively high educational level. However, it is not necessarily the

poorest who migrate; given the high costs of transport to, and subsistence in towns, and then relatively low differences (and perception of differences) in earning possibilities between villages and towns among the poorest sections in the village, the propensity to migrate to towns is higher among groups other than the very poorest in a village' (Dasgupta, 1977).

Srinivas explains how the (caste-based) hierarchic mode of local production is breaking down to the emerging forces of market- based division of labour. Thus, he explains how caste division of labour centered on local production of basic needs (goods for subsistence or self-sufficiency in consumption) gives berth to impersonal (market) division of labour. The emergence of market division of labour is not only because of cash needs individuals but also because of developing techniques of production, improved communication etc. In fact, the changed and changing mode of production led to displacement of caste (status) division of labour (and social relations) to product-cum-market division of labour and economic relations. Technology played a great role in this conversion from caste relations in production to economic relations in production (Srinivas, 2003, p. 455.457).

Characteristics of Village Bhaganpur

Village Bhaganpur has 88 households at the time of study that covers a total population of 684. Thus, the size of each household on average is 7.7 (number of individuals). Of the village total population, male population is 54.68 per cent and female population 45.32 per cent (Table 1).

Table 1: Gender Composition of Population in the Village

Total Households	Total Male Population	Total Female Population	Total Population
88 (100.0%)	374 (54.68%)	310 (45.32%)	684 (100.0%)

Source: Field Survey, 2003

The caste-cum-tribe composition in the village shows percentage of ST population at 15.8 (which is 14.8 per cent for households). The castes and tribes in the village are Adivasi (tribes), Mallah (Backward caste), Brahmin and Bhumihar (General), Thakur (General). The households in general castes (Bhumihar, Brahmin, Thakur) constitute 51.14 per cent of all households. The Mallah (fishermen dependent on water-centric economic activities) constitute as high as 34.09 per cent of all households (Table 2).

In the village the Mallahs are in backward castes while Adivasi are tribes (as they claim), and Brahmins, Bhumihars, Thakurs constitute general caste. The distribution of households by size- class (number of in dividuals in households) is similar for all the caste-cum-tribe groups in the village.

Table 2: Tribes and Castes in the Village

(Percentage share in all households and population)

Castes/Tribes	Households (%)	Population (%)
Adivasi (ST)	13 (14.8)	108 (15.8)
Mallah (BC)	30 (34.09)	230 (33.6)
Brahmin and Bhumihar (General)	41 (46.6)	315 (46.1)
Thakur (General)	4 (4.5)	31 (04.5)
Total	88 (100.0)	684 (100.0)

Source: Field Survey, 2003

Agriculture is the main occupation for all the households in the village that covers 80.0 per cent of all households. There is nobody employed in the organized service sector from Adivasi (tribe) and Mallah (BC). In the service sector an insignificant percentage of households from general castes are employed. The occupations of tribes (Adivasi) and non-tribes (General castes) are similar, both being land-cum-cultivation dependent. There is nobody working as agricultural labour in the village from BC (Mallah) and general caste; only one household form ST is employed as agricultural labour. Of the households engaged as non-agriculture labour, 75.0 per cent come from STs (Adivasi) and 25.0 per cent from BCs (Mallah) Table 3).

Table 3: Households by Castes and Main Occupations

(Percentage Distribution)

Occupations	Households by Castes (%)			
	ST	BC	General	All Households
Agriculture	9 (11.3)	29 (36.3)	42 (52.5)	80 (100.0)
Agricultural labour	1 (100.0)	0	0	1 (100.0)
Non-agricultural Labour	3 (75.0)	1 (25.0)	0	4 (100.0)
Service	0	0	3 (100.0)	3 (100.0)
All Households	13 (14.8)	30 (34.1)	45 (51.1)	88 (100.0)

Source: Field Survey, 2003.

67.0 per cent of the households belong to the in-

come bracket, Rs. 1,000 - 2,500 p.m. 17.0 per cent of the households earn income p.m. below Rs. 1,000. Thus, 84.0 per cent of the households in the village earn income below Rs. 30,000 per household per year or approximately below Rs. 3,896 per capita per year, or below Rs. 324.6 per capita per month or below Rs. 10 per capital per day. 14.77 per cent of the households earn income between Rs. 2,501 and Rs. 5,000 per household per month, while only one household (in general caste) earns income per month between Rs. 5,001 and Rs. 10,000 No ST household in the village earns income per month above Rs. 2,500 (Table 4).

Table 4: Households by Castes and Income

(Percentage of Households)

Income Group (Rs. Per Month)	Households by Castes (%)			
	ST	BC	General	All Households
Below 1000	01 (6.7)	07 (46.7)	07 (46.7)	15 (100.0)
1001-2500	12 (20.3)	19 (32.2)	28 (47.5)	59 (100.0)
2501-5000	0	04 (30.8)	09 (69.2)	13 (100.0)
5001-10000	0	0	01 (100.0)	01 (100.0)
All Households	13 (14.8)	30 (34.1)	45 (51.1)	88 (100.0)

Source: Field Survey, 2003.

Basic Needs Based Living Condition of People in Village Bhaganpur

Most of the households depend on land for employment-cum-food security. Hence, we enquired into the type of agricultural land holding of the households in village Bhaganpur. This method is indirect but may show sustainability. In addition, we enquired into the ownership over income-generating productive assets of the households and also the access of people to the public distribution system that supposedly aims at ensuring food security of the people at the bottom of the economic ladder. In case of security by shelter, we looked into the type of residential landholding and the types of houses that the people have in the village. In case of security by clothing, we covered the exchange mode of clothes, collection of clothes during seasons and rituals. Thus, we covered three major items that determine fulfillment of basic needs of people, namely, food, clothing and shelter.

Agricultural Landholding

There is no landless household by ownership of agricultural landholding from general castes in village Bhaganpur. The 'landless' are very few from BCs (Mallahs) and ST (Adivasi). More than 50.0 per cent of all the households have agricultural landholding between 1 acre and 5 acre. There is no household from ST and BC who own agricultural land above 10 acres. There are very few households (5.7%) who own agricultural land more than 10 acres and that is cultivated by the households in general castes. 69.3 per cent of all ST households own agricultural land between 0.5 acre and 2 acres. Two-thirds of BC households own agricultural land between 1 acre and 5 acres. Around two thirds of the households in general castes own agricultural land between 2 acres and 5 acres per household. Thus, small size of agricultural land is generally owned by households in STs (Adivasi), while medium size is owned by BCs (Mallah) and large size is owned by households in general castes (Table 5).

Table 5: Agricultural Landholding of Households by Castes

Agricultural Landholding (in Acre)	Households by Castes (%)			
	ST	BC	General	All Households
Land less	01 (07.7)	01 (03.3)	0	02 (02.3)
Below 0.5 Acre	02 (15.4)	06 (20.0)	01 (02.2)	09 (10.2)
0.5 to 1.0 Acre	06 (46.2)	02 (06.7)	03 (06.7)	11 (12.5)
1.0 to 2.0 Acre	03 (23.1)	17 (56.7)	07 (15.6)	27 (30.7)
2.0 to 5.0 Acre	01 (07.7)	03 (10.0)	15 (33.3)	19 (21.6)
5.0 to 10.0 Acre	0	01 (03.3)	14 (31.1)	15 (17.0)
10.0 Acre above	0	0	05 (11.1)	05 (05.7)
All Households	13 (100.0)	30 (100.0)	45 (100.0)	88 (100.0)

Source: Field Survey, 2003

There is no one-to-one link between households in income brackets and agriculture landholding. For example, agricultural landholding over 10 acres per household is owned only by the households in income bracket Rs. 1,001 - Rs. 2,500. However, 52.5 per cent of households in the low-income bracket own mostly agricultural land between 1 acre and 2 acres. These households do not own agricultural land above 5 acres. For households in medium income bracket (Rs. 2,501 - Rs. 5,000 per month), ownership over agricultural land is evenly distributed between 1 acre and 10 acres. 77.0 per cent of the households in this income bracket come under this range of agricultural land ownership. The single household in the village within the high income

bracket own agricultural land between 5 acre and 10 acre (Table 6).

Table 6: Agricultural Landholding of Households by Income

Landholding (in Acre)	Households by Castes (%)				
	Below 1000	1001-2500	2501-5000	5001-10000	All Households
Land less	01 (06.7)	01 (01.7)	0	0	02 (02.3)
Below 0.5	03 (20.0)	04 (06.8)	02 (15.4)	0	09 (10.2)
0.5 to 1.0	02 (13.3)	08 (13.6)	01 (07.7)	0	11 (12.5)
1.0 to 2.0	08 (53.3)	16 (27.1)	03 (23.1)	0	27 (30.7)
2.0 to 5.0	01 (06.7)	15 (25.4)	03 (23.1)	0	19 (21.6)
5.0 to 10.0	0	10 (16.9)	04 (30.8)	01 (100.0)	15 (17.0)
Above 10.0	0	05 (08.5)	0	0	05 (05.7)
All Households	15 (100.0)	59 (100.0)	13 (100.0)	01 (100.0)	88 (100.0)

Source: Field Survey, 2003

Productive (Income Generating) Assets of Households

The productive assets that we covered include domestic animals like cows, bulls, buffaloes, goats, and pigs that yield milk, meat, skin, and work as draught animals. The productive assets also include ploughs, pump sets, thresher, tractor, sewing machine, non-residential building etc.

The households, in general, have some combination of domestic animals like cows, bulls, and buffaloes. The rare productive assets are non-residential building, pump set, tractor, sewing machine, Jeep/Tempo. None of the households from STs (Adivasis) and BCs (Mallahs) owns non-residential building, pump set, thresher, tractor, sewing machine, Jeep/Tempo. While 80 per cent of the households are cultivators, more than 80 per cent do not have even a plough per household. All the tractors in the village are owned by high caste households. The machines and equipments (capital goods) as productive assets are owned by high caste households, while the domestic animals as capital goods and trees/garden/plantations are owned by all the caste/tribe groups in the village (Table 7).

Table 7: Income Generating (Productive) Assets of Households

Assets by Types	Households by Castes (%)							
	ST		BC		General		All Households	
	Owning Assets	Asset less	Owning Assets	Asset less	Owning Assets	Asset less	Owning Assets	Asset less
Cow	02 (15.4)	11 (84.6)	09 (30.0)	21 (70.0)	28 (62.2)	17 (37.8)	39 (44.3)	49 (55.7)
Bulls	03 (23.1)	10 (76.9)	14 (46.7)	16 (53.3)	07 (15.6)	38 (84.4)	24 (27.3)	64 (72.7)
Buffalo	04 (30.8)	09 (69.2)	24 (80.0)	06 (20.0)	31 (68.9)	14 (31.1)	59 (67.0)	29 (32.9)
Goat	01 (07.7)	12 (92.3)	10 (33.3)	20 (66.7)	02 (04.4)	43 (95.6)	13 (14.8)	75 (85.2)
Non Res. Building	0	13 (100.0)	0	30 (100.0)	01 (02.2)	44 (97.8)	01 (01.1)	87 (98.9)
Plough	03 (23.1)	10 (76.9)	07 (23.3)	23 (76.7)	06 (13.3)	39 (86.7)	16 (18.2)	72 (81.8)
Pump Set	0	13 (100.0)	0	30 (100.0)	03 (06.7)	42 (93.3)	03 (03.4)	85 (96.6)
Thresher	0	13 (100.0)	0	30 (100.0)	04 (08.9)	41 (91.1)	04 (04.5)	84 (95.5)
Tractor	0	13 (100.0)	0	30 (100.0)	04 (08.9)	41 (91.1)	04 (04.5)	84 (95.5)
Sewing Machine	0	13 (100.0)	0	30 (100.0)	05 (11.1)	40 (88.9)	05 (05.7)	83 (94.3)
Jeep/Tempo	0	13 (100.0)	0	30 (100.0)	01 (02.2)	44 (97.8)	01 (01.1)	87 (98.9)
Trees/Garden	09 (69.2)	04 (30.8)	24 (80.0)	06 (20.0)	42 (93.3)	03 (06.7)	75 (85.2)	13 (14.8)
All HHs	13 (100.0)	13 (100.0)	30 (100.0)	30 (100.0)	45 (100.0)	45 (100.0)	88 (100.0)	88 (100.0)

Source: Field survey, 2003

Table 8: Income Generating (Productive) Assets of Households (By number of assets and income per year from use of assets)

Assets by Types	Households by Castes											
	ST			BC			General			All Households		
	No. of HHS	No. of Assets	Annual Income	No. of HHS	No. of Assets	Annual Income	No. of HHS	No. of Assets	Annual Income	No. of house-holds	No. of Assets	Annual Income
Cow	2	2	10000	9	9	36000	28	43	184000	39	54	230000
Bulls	3	5	5000	14	26	24000	7	13	10400	24	44	39400
Buffalo	4	5	25000	24	30	150000	31	48	240000	59	83	415000
Goat	1	1	300	10	16	4500	2	20	5000	13	37	9800
Non-Res. Building	0	0	0	0	0	0	1	1	0	1	1	0
Plough	3	3	0	7	7	0	6	6	0	16	16	0
Pump set	0	0	0	0	0	0	3	3	7000	3	3	7000
Thresher	0	0	0	0	0	0	4	4	9000	4	4	9000
Tractor	0	0	0	0	0	0	4	5	17000	4	5	17000
Sewing Machine	0	0	0	0	0	0	5	5	0	5	5	0
Jeep	0	0	0	0	0	0	1	1	0	1	1	0
Trees	9	34	10200	24	74	22200	42	278	83400	75	386	115800

Source: Field Survey, 2003

One direct corollary of this pattern of ownership over productive assets is that no household within STs and BCs earns anything from material capital goods like ploughs, pump sets, thresher, tractor, sewing machine, Jeep/Tempo, and non-residential building. This is because either they do not own these and/or these do not yield any direct income (like ownership/use of plough). The households in STs and BCs earn most from ownership/use of buffaloes, per buffalo this annual income is Rs. 5,000 (net income over and above costs for maintenance of a buffalo at current prices). Owning/maintaining cow shows differential income for households in STs, BCs, and general (high) caste. Bulls are used in drawing ploughs, carts, and for breeding. Thus, unless the net income from bulls falls drastically and unless tractors substitute bulls partially in some uses, bulls continue to be maintained as a productive asset in village Bhaganpur by the households.

While ownership of plough does not reportedly yield any income to the household, tractors by use yield income to the owners in general caste, one tractor generating net income more than Rs. 5,000 per year. Households in general castes own sewing machines non-commercially, hence, not accounted by households as earning income. The similar is the case for non-residential building reported to be owned by high caste households that yields no income. So is the Jeep/Tempo owned non-commercially, and hence reporting no income (Table 8).

Peoples' Access to Food distributed by PDS

In village Bhaganpur as in 2003 there were 39.8 per cent of the households in BPL and 63.6 per cent in APL, implying some households owning more than one type of cards and/or owning more cards than fixed per household/family. Almost all the households in STs are in BPL while most of the households in general caste are in APL. Mallahs are evenly distributed between APL and BPL.

The household in the highest income bracket is in APL by cardholding, while some high-income households (Rs. 2,501 - Rs. 5,000) also enjoy BPL cards. The households in income bracket less than Rs. 1,000 have also been allotted APL cards. The implication is, if price-differential for rice and wheat really works at the village Fair Price Shop (FPS) level, then this section of income-poor households will be deprived of the basic food needs of life (Tables 9A and 9B).

Basic Needs by Shelter

We focus not only on the residential house but also on the landholding for residential purposes. There is no landless in the village by residential landholding. There is also no household owning more than 20 biswa of land per household for residential purposes. 69.3 per cent of all households in the ST (Adivasi) and BC (Mallah) own land less than 2 biswa

Table 9A: Ration Cards Owned by Households by Castes

Households	% of Households by castes			
	ST	BC	General	All Households
BPL	13 (100.0)	14 (46.66)	08 (17.77)	35 (39.77)
APL	01 (07.69)	16 (53.33)	39 (86.66)	56 (63.63)
All Households	13 (100.0)	30 (100.0)	45 (100.0)	88 (100.0)

Source: Field Survey, 2003

Table 9B: Ration Cards Owned by Households by Income

Households	Households by Income (%)				
	Below 1000	1001-2500	2501-5000	5001-10000	All Households
BPL	04 (26.66)	27 (45.76)	04 (30.76)	0	35 (39.77)
APL	11 (73.33)	34 (57.62)	10 (76.92)	01 (100.0)	56 (63.63)
All Households	15 (100.0)	59 (100.0)	13 (100.0)	01 (100.0)	88 (100.0)

Source: Field Survey, 2003

per household for residential purposes. Only the households in general caste have residential land per household more than 5 biswa. The category that is 'land poor' most is the ST (Adivasi). In general, 72.0 per cent of the households by residential and ownership are bracketed between 1 biswa and 2 biswa that show the modal class of residential landholding (Table 10).

Table 10: Residential Landholding of Households by Castes

Landholding in Biswa	ST	BC	General	All Households
Land less	0	0	0	0
Less than 1 Biswa	08 (61.5)	10 (33.3)	01 (2.2)	19 (21.6)
1-2 Biswa	03 (23.1)	17 (56.7)	22 (48.9)	42 (47.7)
2-5 Biswa	02 (15.4)	03 (10.0)	17 (37.8)	22 (25.0)
5-20 Biswa	0	0	05 (11.1)	05 (5.7)
More than 20 Biswa	0	0	0	0
All Households	13 (100.0)	30 (100.0)	45 (100.0)	88 (100.0)

Source: Field Survey, 2003.

There is no one-to-one link between households in income brackets and residential landholding. The households in the modal class by income bracket between Rs. 1,001 and Rs. 2,500 own mainly residential land between 1 biswa and 2 biswa. The households with income less than Rs. 1,000 per month mostly own residential land between 2 biswa and 5 biswa. In general, 72.7 per cent of the households own residential land between 1 biswa and 5 biswa. Residential landholding below 1 biswa is covered mostly by households in income bracket between Rs. 1,001 and Rs. 2,500 (Table 11).

Table 11: Residential Landholding of Households by Income

Residential Landholding (in Biswa)	Households by Income (%)				
	Below 1,000	1,001-2,500	2,501-5,000	5,001-10,000	All Households
Land less	0	0	0	0	0
Less than 1 Biswa	04 (26.7)	13 (22.0)	02 (15.4)	0	19 (21.6)
1-2 Biswa	14 (93.3)	22 (37.3)	06 (46.2)	0	42 (47.7)
2-5 Biswa	06 (40.0)	11 (18.6)	04 (30.8)	01 (100.0)	22 (25.0)
5-20 Biswa	01 (06.7)	03 (05.1)	01 (07.7)	0	05 (05.7)
More than 20 Biswa	0	0	0	0	0
All Households	15 (100.0)	59 (100.0)	13 (100.0)	01 (100.0)	88 (100.0)

Source: Field Survey, 2003

Residential Houses by Types

In village Bhaganpur in 2003 more than half of the residential houses were katcha, while nearly one-fourth was pakka. The rest were semi-pakka (one-sixth) and 'jopri' (one-tenth).

Table 12: Types of Residential Houses of Households by Castes

Houses by Types	Residential houses of Households by Castes (%)			
	ST	BC	General	All Households
Katcha	07 (53.8)	13 (43.3)	25 (55.6)	45 (51.1)
Pakka	0	06 (20.0)	15 (33.3)	21 (23.9)
Semi-Pakka	0	09 (30.0)	05 (11.1)	14 (15.9)
Jhopari	06 (46.2)	02 (06.7)	0	08 (09.1)
All Households	13 (100.0)	30 (100.0)	45 (100.0)	88 (100.0)

Source: Field Survey, 2003

The households in STs reside either in Katcha houses or jhopris, the former type for a little more than half of all ST households. The households in general caste do not live in jhopris. The pakka houses are

generally one-storey building made of bricks, stone, iron, sand, and cement. The katcha houses are generally made of clay/mud, tiles, leaves etc. The jhopris are mostly dilapidated. Half of the households in BCs (Mallahs) have semi-pakka and pakka houses (Table 12).Nearly three-fourth of the households that own katcha residential houses belong to low income brackets. More than half of all households who own pakka houses, half belong to the low income bracket, i.e., Rs. 1,001 - Rs. 2,500. The reason why most of the households in both katcha and pakka houses come from this low income bracket (Rs. 1,000 - Rs. 2,500) is that this income bracket covers most (two-thirds) of the households in the village. No households in income bracket above Rs. 2,500 reside in jhopris and no household in income bracket above Rs. 5,000 p.m. reside in Katcha or semi-pakka houses. In fact, there is only one household in the village in this income bracket that reside in pakka house. Of the middle income bracket households (Rs. 2,501 - Rs. 5,000), more than half reside in pakka houses. 84.0 per cent of households in the village have income per month less than Rs. 2,500 and most of them are settled in katcha houses (Table 13).

Table 13: Types of Residential Houses of Households by Income

Types by Houses	Residential Houses of Households by Income (%)				
	Below 1000	1001-2500	2501-5000	5001-10000	All Households
Katcha	10 (66.6)	32 (54.2)	03 (23.1)	0	45 (51.1)
Pakka	02 (13.3)	11 (18.6)	07 (53.8)	01 (100.0)	21 (23.9)
Semi-Pakka	01 (06.7)	10 (16.9)	03 (23.1)	0	14 (15.9)
Jhopari	02 (13.3)	06 (10.2)	0	0	08 (09.1)
All Households	15 (100.0)	59 (100.0)	13 (100.0)	01 (100.0)	88 (100.0)

Source: Field Survey, 2003

All the households by castes/tribes have bedrooms in the residential houses for stay. However, other components for comfortable living are not always available for households, like kitchen, bathroom, and toilet. In fact, bathroom and toilet are not available for households in STs and BCs. Only one-sixth of the STs have separate space available within residential house at kitchen, which is 40.0 per cent for Mallahs. Nearly three-fifths of the households in general castes have kitchens. Bathroom is available for less than one-fifth of the households in general caste, while only one household in this caste has separate toilet in the residential house. Of all households, thus, toilet is not available as a separate space in the residential houses of the households, while separate bathroom is available for less than one-tenth of all the households.

The concept of separate bathroom is also rare in the mindset of most of the households in village Bhaganpur, water for bathing being a natural source outside the residential house, like public pond, public well, canal, nearby river etc. Toilet as an urban concept is yet to enter the mindset of people settled in the village.

Only the households in general castes have got legal electricity connections in the village. The households in STs and BCs have no legal electricity connection. As reported by all the households in STs, BCs and general caste, electricity supply per day remains operational for seven hours on average. Among all households, only 15.9 per cent have legal electricity connection, while 44.3 per cent use/avail electricity illegally.

Basic Needs by Clothing

The households buy/use both old and new clothes depending on the necessity and festivals/rituals etc. They buy/use clothes depending on the season (climatic conditions) and also gifts (and return gifts). In all these senses, the village life remains accommodative by voluntary participation of individuals/households in social non-monetary transactions and mutual dependence.

More than half of the households in the village can afford to buy new clothes. Those who buy new clothes also use old clothes. The STs are exceptions who can not depend only on new clothes. The households in general castes do not buy old clothes. The general caste households also do not take any gift (clothes) from others in the village. The time then the high caste households accept gifts (clothes) from others in the village. The time when the high caste households accept gifts also imply that they offer gifts within their relatives, which are occasion-specific. The households in general caste, thus, essentially buy new clothes and use both old and new clothes (they do not buy old clothes). The BCs buy new clothes, buy and use old clothes, very rarely get clothes as gifts. The STs depend more on 'gift clothes' relative to the BCs.

The single household in the highest income bracket (Rs. 5,001 - Rs. 10,000) buys new clothes. The households in the medium income bracket (Rs. 2,501 - Rs.5,000) buy new clothes and use both new and old clothes, and do not depend on clothes as gifts from others. The households in the middle income bracket (Rs. 2,501 - Rs. 5,000) depend on new clothes but use both new and old clothes. These households do not buy

old/second hand clothes and do not depend on or search for any possibility of 'cloth gifts' from others. The dependence of households on both old and new clothes (second hand purchase, new purchase, receiving after being used by elders within the household) is more for households in low income bracket (below Rs. 2,500 p.m.). These are the households also who depend on 'cloth gifts'. Thus, mutual dependence (via purchase/use/exchange) of clothes is more glaring for low-income households.

'Necessity' is the single most important reason for all the households behind purchasing clothes. The STs depend more on windfall earning to buy new clothes. Marriage is one of the reasons when the households buy new clothes.

Living Condition of People in village Bhaganpur: Lessons and Possibilities

As we understand, the locally settled people do not aspire for more. They remain satisfied with what they have. The fulfillment of basic needs is their local boundary. No one likes to leave the village Bhaganpur for ever. By being a small village by size of population, and visibility of activities of all, the village life remains accommodative. The bribes (Adivasis as they claim to be in village Bhaganpur) have been merged into mainstream life in the village. Thus, operationally, the Adivasis in the village, settled over generations, are accommodated in Hindu rituals and practices. The economic activities differ. However, most of the people in the village are land/agriculture dependent. The ownership and use of land, in addition to other productive assets, make the economic life of people in the village comfortable.

The village is yet far from having adequate infrastructural facilities like motorable road (all seasons), electrification (regular supply), communications (private and public), and irrigation (by durable and assured water supply by public methods). The village is far from development of economic bases of life, like money-based production (market-oriented) and exchange of goods, leasing-in and leasing-out of private assets (like tractors, pump sets) for public purposes. The village is yet to be exposed to mobility-led improved awareness of individuals. The village women are far from literacy and participation in public places without fear and shame.

The business and commercial activities in the locality adjacent to the village show a break from caste-dependent activities in rigid-hierarchic frame to freedom of individuals in acquired skill-specific jobs. The occupation pattern, thus, is linked more with economic parameters and less with social (caste) parameters. The introduction of economic forces in the village life may offer a comparative scenario and hence a choice to people: the choice between mechanical (by birth-caste) solidarity to organic (economic mode) solidarity. The conversion of the social/non- economic individuals to social-economic individuals shows a path in social progress.

We believe that even within a village society, the life of people may be transformed. This transformation has to ensure improved physical infrastructure, by connectivity of the village through motorable/durable roads, railways (subject to constraints of national railway network), river/water transport (for which the village is most suitable), irrigation, communication and electricity. In all these cases, the state has to be interventionist so that it can promote public space for private operations.

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Focus

Planning Suitable Sites for Water Harvesting Structures in Bandal Watershed – RS & GIS Approach

I. Sekar, J.P. Singh & K.H.V. Durga Rao

Water harvesting structures are essential to conserve water and soil. In this study potential sites for constructing different water harvesting structures are identified in the Bandal watershed, through remote sensing and Geographic Information.

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Water is essential for all life and is used in many different ways – for food production, drinking and domestic uses and industrial use. It is the most abundant liquid on Earth and is almost universally present, but often not in the right amount for the optimum growth of plants and animals or to meet human needs. As perceived across the globe, water is at risk in many places. A shortage of water is the most common limiting factor for plant growth, but an excess of water is also a common limiting factor.

Lack of water is caused by low water storage capacity, low infiltration capacity, large inter-annual and annual fluctuations of precipitation and high evaporative demand. Watershed concept has become more popular in the sense that during good rainy years, excess rainwater could be stored in the soil using suitable soil moisture conservation measures and water harvesting structures on a watershed basis. A watershed is an area from which runoff resulting from precipitation flows past a single point into a large stream, river, lake or pond. Each watershed is an independent hydrological unit. It has become an acceptable unit of planning for optimum use and conservation of soil and water resources. Watershed development and management implies an integration of technologies within the boundary of a drainage area for optimum development of land, water and plant resources, to meet the people's basic needs in a sustained manner.

The concept of integrated watershed development refers to the development and management of the resources in the watershed to achieve higher sustainable production without deterioration in the resource base and any ecological imbalances. This concept requires the formulation and implementation of a package of programmes with activities for optimum resource use in the watershed without adversely affecting the soil and

water base or life supporting system. The concept assumes more importance in the context of planning for sustained development.

Water harvesting structure is one of the important components of watershed development. There are always strong links between soil conservation and water conservation measures. Many actions are directed primarily to one or the other, but most contain an element of both. Reduction of surface runoff can be achieved by constructing suitable structures or by changes in land management. Further, this reduction of surface runoff will increase infiltration and help in water conservation. Appropriate structures are needed to avoid excessive run off, help in improving soil moisture availability and to increase the watertable in the watershed. These structures may differ with different parameters viz. location, slope of the land, soil type, intensity of rainfall, land cover and settlement. Depending on these parameters, the construction of check dams, gully plugging structures, percolation ponds, and farm ponds are to be decided. Each structure has its own requirement. For example farm ponds can be constructed for every 4-5 ha in the watershed to provide protective/supplemental irrigation. Planning about the required type and number of water harvesting structured and making decisions is extremely important in watershed development to avoid mammoth investments on unproductive structures. It is highly imperative that scientific planning of installation of harvesting structures at suitable places be done utilizing modern technologies at hand. The present study envisages the potential suitability for different water harvesting structures in the watershed study area. For the present investigation, Bandal watershed, which is located in Uttaranchal state, is considered as the universe of study with the help of space technology viz. remote sensing and information technology viz. Geographic Information System. The study was conducted with the following objectives.

(i) To generate thematic maps required for site selection of water harvesting structures,

(ii) To suggest suitable sites for water harvesting structures in the watershed.

Water harvesting structures – Decision Rules

Check dams may be temporary structure constructed with locally available materials. The various types are: Brushwood dam, loose rock dam and woven wire dam. The main function of the check dam is to impede the soil and water removed from the watershed. This structure is cheap, but lasts about 2 to 5 years. A permanent check dam can be constructed using stones, bricks and cement. Small earthwork is also needed on both sides. This is constructed across rivulets and gullies to control erosion, prevent gully formation and to arrest the flow of water to allow it to go underground. A number of such obstructions will be useful for soil and moisture conservation measures. Inexpensive, temporary structures can be constructed using vegetation, stone or brushwood, available at the site. Large numbers can be provided to reduce erosion and formation of gullies. Permanent check dams can be located at the junction of one or two streams or gullies using masonry structures.

For our study, the following criteria were considered to determine the suitability of sites for construction of check dam:–

(i) The slope should be less than 15 per cent.

(ii) The land use may be barren, shrub land and riverbed.

(iii) The infiltration rate of the soil should be less.

The farm pond is a multipurpose conservation structure depending on its location and size. It stores water for livestock and recharges the groundwater. It is constructed by excavating a depression, forming a small reservoir or by constructing an embankment in a natural ravine or gully to form an impounded type of reservoir. Normally 2 or 3 fillings are expected in a year (season). The following factors may be considered for farm ponds. It should not be located in heavy soils or soils with impervious strata, otherwise the top should be porous. Suitable and adequate soil should be available for forming embankments. The ideal location of the pond will be on a narrow stream with high ground on either side of the stream. Simple, economic and efficient surplus arrangement should be possible. Pond size should be decided on the basis of the catchment area and the number of fillings possible for the pond in the area. In the present study, the ensuring criteria were followed for finding locations for farm ponds:

(i) The slope should be less than 10 per cent

(ii) The infiltration rate of the soil should be moderate.

(iii) The land use may be either barren land or shrub land.

The criteria, which were considered for groundwater recharges, are:

(i) The slope should be less than 10 per cent.

(ii) The infiltration rate of the soil should be more.

(iii) The land use/cover may be barren or shrub land.

3. Methodology

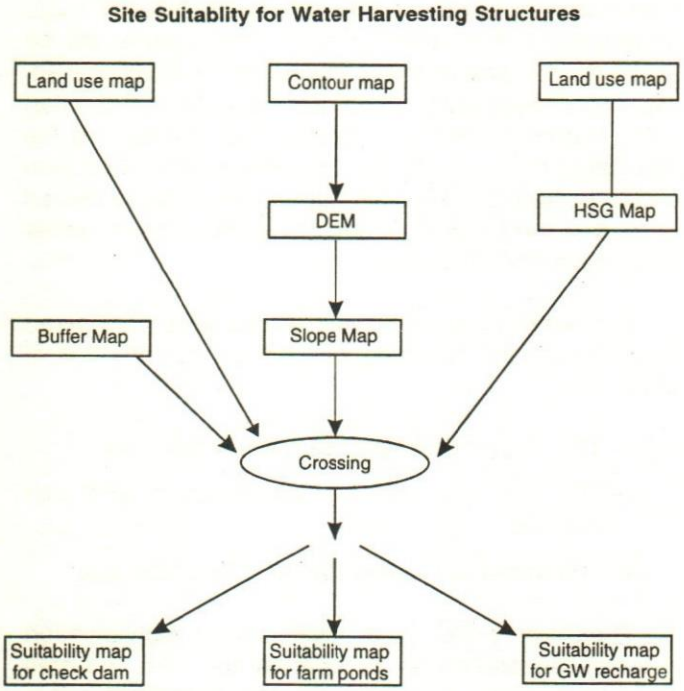


Fig. 1. Site Suitablity for Water Harvesting Structures

Data used

1. IRS-IC-LISSIII imagery

   Type: FCC geocoded
   Bands: 1,2,3
   Scale: 1:50,000
   Projection: UTM

2. Survey of India Topographical sheet

   Sheet No: 53J/3
   Scale: 1:50,000

3. Window-based Integrated Land and Water Information System (ILWIS), a GIS and Image processing software (raster based) version 3.1 developed by the International Institute of Aerospace and Earth Sciences (ITC), the Netherlands, was used.

Geo referencing and creation of coordinate system

Using tie points, geo reference was carried out with the creation of a coordinate system. The Universal Transverse Mercator (UTM) coordinate projection system was used. To convert from latitude-longitude coordinates to UTM coordinates, ERDAS IMAGINE software was used. The ellipsoid was taken as Everest India and datum as India Nepal. The file was imported to ILWIS software through the conversion of LAN type format.

In ILWIS, segment maps were prepared initially and then transformed to polygon map. The segments were checked for intersection, dead end points, overlapping and consistency. All raster maps were prepared using the same geo reference: Furthermore the thematic maps like land use map, soil map were polygonosed and rasterized for further operation.

Thematic Maps

1. Land use map

Land use map was prepared with seven different classes of land use. (i) Agriculture (ii) Dense forest (iii) Open forest (iv) Shrub forest (v) Barren land and (vi) River bed.

2. Classified land use map

Land use map was further classified based on the suitability for different water harvesting structures. For example, to establish check dam three land categories viz. riverbed, barren and shrub land were considered. For farm ponds and ground water recharges, land classes of barren and shrub forest were only considered.

3. Slope map

Slope map was prepared from contour map. The contour map was first converted to a Digital Elevation Model (DEM) map, and then slope map. Using filtering technique, the slope map, which was designated in value domain, was prepared.

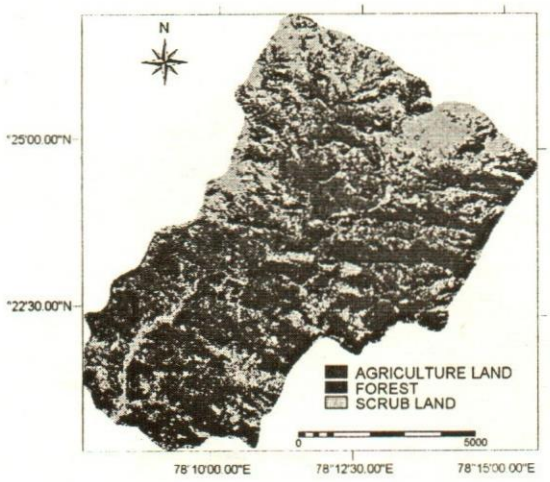
4. Classified slope map

The slope map was further classified for exploring potential suitable sites for several water harvesting structures. For check dam, the criteria was fixed as less than 15 per cent and for farm ponds and ground water recharges, it was less than 10 per cent.

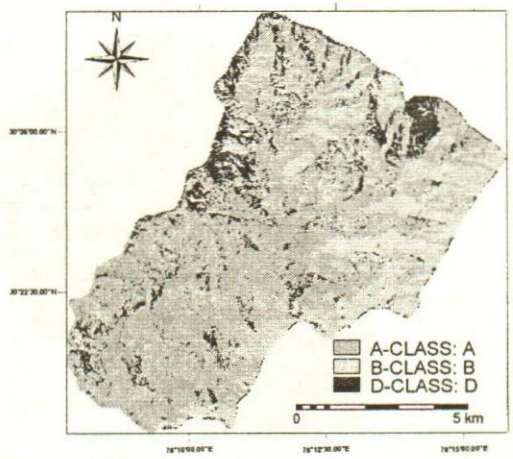
5. Soil map

The soil map consists of three different classes viz. fine sandy soil, silty loam and clay loam. From this soil map, hydrologic soil group (hsg) map was prepared taking into account the infiltration rate of various soil textures. Accordingly, the above soil classes fell under the categories viz. A, B, and D. Classifies HSG map was further grouped for the suitability of check dam, farm ponds and water harvesting structures.

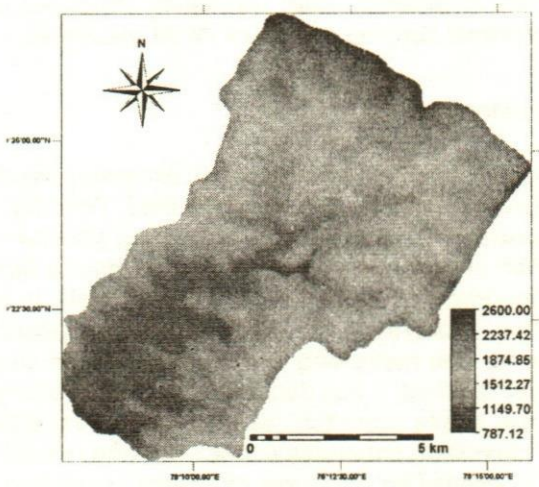
Land Use Map



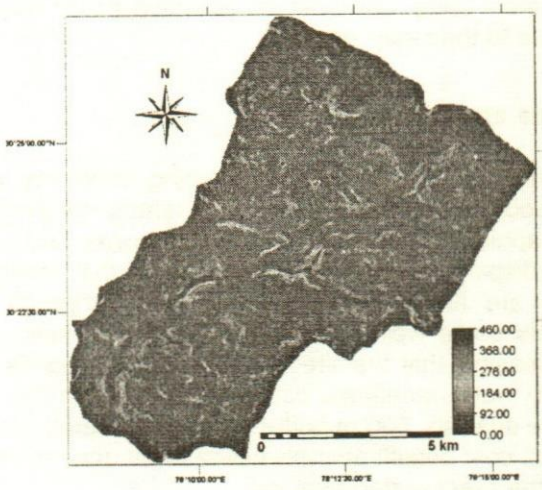
Hydrological Soil Group Map



Digital Elevation Model Map



Slope Map



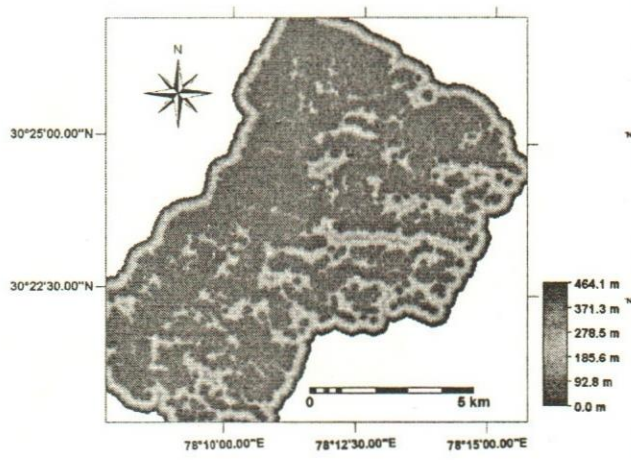
6. Cross operation

For overlaying different thematic maps, cross operation was performed using classified land use map and classified slope map. In the next iteration, crossing was performed with the input map of crossed map and classified HSG map. The process was then terminated for locating suitable sites for farm ponds and ground water recharges. But for assessing feasible zones for locating check dams, the crossed map so obtained was again crossed with the buffer map agricultural land use. The buffer map was prepared using the land use map with 500 meters from the agricultural land vicinity. Finally, three maps, which portray suitable locations for all water harvesting structures were obtained.

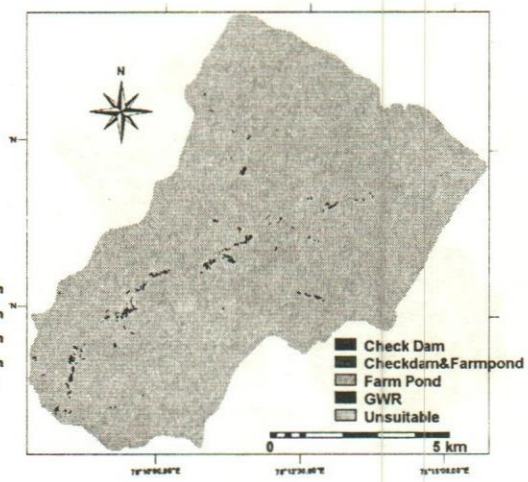
Study Area

The study area is a watershed of the Song river at Bandal, Uttaranchal state of India. The aerial extent (area) of the watershed is 8,202 hectares. Geologically, the area comprises of phyllites, shales and alluvium. The drainage pattern is dendritic (branching tributaries from the main drain) with local variations at some places. Physiographically, the area is composed of mountains (steep to very steep slopes), hills, piedmont plains, river terraces and flood plains. The average slope of the watershed is approximately 52.7 per cent. The watershed comprises of soils falling in the order of entisols, inceptisols, alfisols and mollisols and is well drained. In most cases, the depth of soils varies from deep to very deep underlain by stones, boulders, sand and silty

Buffer Map of Agricultural Land



Site Suitability Map for Water Harvesting Structures



strata. Average annual rainfall of the study area is 2500 millimeters (mm), but most of the time the river remains dry due to the steep slope.

Results and Discussion

Suitable sites for water harvesting structures were identified through the application of remote sensing and geographic information system technologies. The buffer zone displayed in figure 5 has shown that locations which are finally found to be suitable through the analysis come well within the buffer zone. Hence it is quite feasible that the sites suitable for farm ponds and ground water recharges can be developed in the site. For the analysis, 500 m buffer zone was created. Nevertheless, cost benefit analysis needs to be done to determine the exact buffer distance.

There were eight check dams suitable to construct the check dams in the study area of Bandal watershed. The area, which was covered by the check dams, was found to be around 86 in the watershed region. The area covered by the ground water recharges was computed and presented in the following table.

Table: Water Harvesting Structures

Water Harvesting Structures	Number	Area (sq. m)
Check dam	8	449531
Groundwater recharges	86	449531
Farm pond & Check dam	15	36448

Nearly 15 places were found suitable for constructing both ponds and check dams. The area coverage under both these structures are around 36448 sq. meters. The suitability of different water harvesting structures could be confirmed keeping in view of IMSD guidelines.

Conclusion

Water harvesting structures are extremely important to conserve water and soil in watershed. Potential sites for constructing different water harvesting structures are identified in Bandal watershed through Remote Sensing and Geographic Information Systems analysis. in some locations, more than one alternative is proposed. To decide for one harvesting structure, a detailed study is however required. It was deduced through this study that there are ample opportunities for constructing different water harvesting structures and for carrying out soil and water conservation measures of Bandal Watershed.

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Role of Women in Dairy Development: A Study in Krishna District (Andhra Pradesh)

V. Omkara Rao

India, which has emerged as the largest milk producer in the world, has a dairy industry centered around dairy cooperatives. A micro study was conducted in Krishna district of Andhra Pradesh, which revealed that members of Women Dairy Cooperative Societies (WDCS) enjoyed a better socio-economic status than non-members.

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The contribution of agriculture in the country's GDP is about 25 per cent, of which the share of livestock is about 6.5 per cent (over 25% of overall agriculture). Further, dairy farming accounts for 65 per cent of livestock sector indicating a significant role in the socio-economic situation, (Balaraman, 2003). India has emerged as the largest milk producer in the world with a record production of 90 million tonnes in 2004. Uttar Pradesh, Rajasthan, Gujarat, Haryana, and Karnataka are the leading milk producing states in the country.

The Indian dairy industry is centered around Anand pattern dairy cooperatives initiated way back in 1946. These cooperatives got impetus through operation flood programme, and over time spread throughout the length and breadth of the country. There are 1.10 lakh dairy cooperative societies (DCSs) with a membership of 12.19 million farmers and procuring 17.42 million kgs milk/day (2004). These DCSs have a processing capacity of 29.66 million litres/day (http.//dahd.nic. in/stat.htm).

As per the 2001 census, Andhra Pradesh has 8.4 per cent area, and 7.37 per cent population of the country. Of the state's total population, the rural population constitutes 73 per cent. As per the 2003 livestock census, the state had 5 per cent of cattle, 10.9 per cent of buffaloes, 34.8 per cent of sheep, 5 per cent of goats and 4.2 per cent of pig population of the country. The state contributed 7.90 per cent (6.96 million tonnes) of the country's total milk production. Of the total milk production, 75 per cent is contributed by buffaloes milk and the rest by cows (http://mospi.nic.in/mag_rept_pubn.htm).

In terms of the dairy scenario, Andhra Pradesh is one of the fast progressing states in India. The total livestock in the state has increased from 36.01 million to 48.20 million between 1999-03, showing an overall in-

crement of 34 per cent. Further, the state experienced tremendous increase in crossbred cattle (47.4%) and buffalo population (10.06%) during the inter-censal period. As on 31st March, 2004 the state had 5590 DCSs with 0.78 million farmer members and procuring 0.95 million kgs of milk/day.

Women dairy cooperatives

Women constitute about half of the total population of country but suffer from many disadvantages in terms of literacy, labour participation, participation in the decision-making process and earnings. Social, economic and political empowerment is the need of the day, as it is the only surest way of making women 'equal partners in development'. The process of women empowerment is conceptualized in terms of personal assertions, self-esteem and confidence, ability to protect themselves as women, attaining socio-political participation and economic independence, ownership of productive assets, ability to handle capital and assets, and provide leadership in both women and community-related issues at all levels. In order to fulfill the vision of expanding women's horizons, participation in decision making and control over resources, and making them equal partners, Government of India launched several programmes and schemes. Support to training and employment programme (STEP) is one such programme (Rao 2004, 2005). A number of women dairy cooperative societies (WDCSs) have been launched under STEP, and there are 300 WDCSs in Andhra Pradesh. However, women constitute less than 3 per cent of total board members (www.indiadairy.com/info-women.html)

Need for the study

WDCSs have emerged as an effective instrument for the successful development of women. The benefits obtained from WDCSs are numerous in income and employment generation, assured market round the year, remunerative milk prices, better veterinary services, leadership development, education and training, sobriety in decision making, promoting entrepreneurship, creating awareness, etc, On the other hand, though women play a significant role in livestock management and production, women's control over livestock and its products are negligible. The contributions of rural women, though not less than that of men in terms of time and efforts, are invisible because they are largely unpaid and home-based. Taking into consideration these facts, NDDB in its 'strategy zolo' emphasized the need for recruiting, training and motivating women to work for cooperatives to achieve significant improvements in dairy husbandry (Anonymous, 2000). Keeping these aspects in mind, the present study is an attempt to assess the role of women in dairy development at the micro level (Krishna district of Andhra Pradesh).

Objectives of the study

The specific objectives of the study are to examine the socio-economic status of members vis-à-vis non-members, to study the pattern of animal feeding, production, consumption, and marketing of milk in both the categories, and to assess participation and time spent by women in dairy activities. The study was conducted in Kuchipudi village in Krishna district of Andhra Pradesh, and a moderate sample of 25 each members and non-members were interviewed. Data was collected during June-July 2005.

Results and discussion

Socio-economic profiles of member vis-à-vis non-members are presented in Table 1. The table indicated that average age of respondents was 38 years having marginal land holding (ha. 0.71), and nuclear family (2.8 children). Average literacy rate was worked out to be 60

Table 1: Socio-economics background of sample respondent

S.No.	Particulars	Members	Non-members	Average
1.	Sample	25	25	50
2.	Age	32.5	43.7	38.0
3.	Educational status			
	* Illiterate	3 (12.0)	6 (24.0)	5 (20.0)
	* Can sign	5 (20.0)	5 (20.0)	5 (20.0)
	* Primary	S (36.0)	9 (36.0)	9 (36.0)
	* Secondary	6 (24.0)	5 (20.0)	5 (20.0)
	* Others	2 (8.0)	0 (0.0)	1 (4.0)
	* Total	25 (1000.0)	25 (100.0)	25 (100.0)
4.	Land Holding (ha)	0.85	0.58	0.71
5.	Children	2.6	3.1	2.8
6.	Income (Rs/annum)			
	* Agriculture	18062 (21.3)	11310 (28.4)	14686 (23.6)
	* Dairying	56248 (66.3)	22462 (56.5)	39356 (63.2)
	* Other	10500 (12.4)	6000 (15.1)	8250 (13.2)
	* Total	84810 (100.0)	39772 (100.0)	62292 (100.0)

Source: Field survey

per cent. Annual income from various sources was calculated as Rs. 62292 of which dairying contributed the highest share (63.2%) followed by agriculture (23.6%), and others (13.2%).

Across respondents, members were found younger (32.5 years), better educated (68%) with higher land holding (ha. 0.85), and fewer children per family (2.6) compared to non-members. Average annual income from various sources was found to be double in case of members (Rs. 84810) compared to non-members (Rs. 39772). Among both the categories, dairying contributed the highest share to the total annual income followed by agriculture and others. However, income from dairying was found to be 2.5 times more in case of members compared to non-members. On the whole, results indicated that members had better socio-economic status than non-members.

Ownership of milch animals

Average animal holding/respondent was 3.5 animals (Table 2). Livestock possession of the respondents was found to be buffalo dominated (71%). Further, improved buffaloes contributed the highest share (43%) to total livestock possession. Among the respondents, members possessed more animals (4) than non-members (3). It is interesting to note that 100 per cent replacement of local breed by improved breeds was achieved by members compared to local-breed-only in case of non-members.

Table 2: Category-wise animal holding

S.No.	Particulars		Members	Non-members	Average
	Animal holding				
1.	(a)	Local buffaloes	0	2	1
2.	(b)	Improved buffaloes	3	0	1.5
3.	(c)	Local cows	0	1	0.5
4.	(d)	CBS	1	0	0.5
5.	(e)	Total	4	3	3.5

Source: Field survey

Average daily milk production was worked out to be 13.65 litres of which 88 per cent was marketed by respondents after meeting family consumption needs (Table 3). Respondents, on an average, realized prices ranging between Rs. 7.75 to Rs. 9.75/litre of milk. Category-wise, milk production/day was found to be double in case of members (18.5 litres) compared to non-members (8.8 litres). As much as 90 per cent of milk produced was marketed by members compared to 82 per cent in case of non-members. Members realized better prices (Rs. 8 to Rs. 10/litre) than non-members (Rs. 7.50 to Rs. 9.5/litre).

Table 3: Production, consumption, and marketing of milk

S.No.	Particular	Members	Non-members	Average
1.	Production (litres/day)	18.5	8.8	13.65
2.	Consumption (litres/day)	1.84	1.56	1.70
3.	Marketing (litres/day)	16.66	7.24	11.95
4.	Rate/litre (Rs)	8.00-10.0	7.50-9.50	7.75-9.75

Source: Field survey

Quantity and quality of milk is determined by breed and feed. Milch animals in general, and cross-breds in particular, require better feeding during lactation. Results provided in Table 4 clearly reflect this concern among the respondents. Animal feeding pattern in case of members lead by green fodder (11.4 kgs/day), dry fodder (9.8 kgs/day), rice bran (3.25 kgs/day), and concentrates (2.75 kgs/day). While that of in case of non-members lead by dry fodder (8.6 kgs/day), green fodder (7.8 kgs/day), and rice bran (1.56 kgs/day). Non-members preferred own agricultural byproducts (groundnut and sesame cake) as concentrates over branded ones to check cost. In addition to the above, animal feeding was supplemented by salt in case of members.

Table 4: Animal feeding pattern (kgs/day/animal) among respondents

S.No.	Feed	Members	Non-Members	Average
1.	Dry fodder	9.8	8.6	9.20
2.	Green fodder	11.4	7.8	9.6
3.	Concentrates Vijaya cattle feed	2.75	0.00	1.38
4.	Groundnut cake	0.50	1.30	0.9
5.	Coconut cake	0.25	0.00	0.13
6.	Sesame cake	0.10	0.10	0.10
7.	Rice bran	3.25	1.56	2.41
8.	Salt (grams/day/animal)	0.10	0.00	0.5

Source: Field survey

Participation of women in dairy farming

Dairy farming demands hard labour from dawn to dusk. The work ranges from cleaning of animal-sheds to marketing of milk mainly by women. An attempt is made here to assess the participation of women in dairy activities and the results are presented in Table 5.

Across respondents, members participation was found to be highest in milking and preparation of dung cakes (100%) following by cleaning of animals, shed, and dairy equipment, bringing fodder from fields, and feeding (90%), and the least in breeding (20%), and selection of animals (32%). As of non-members, it was highest in milking, preparation of dung cakes, and cleaning of animals, shed and dairy equipment (100%) followed by bringing fodder from fields, and feeding (90%), and the least in selection of concentrates (4%), breeding (8%), and selection of animals (12%). From the above results in can be concluded that women participated mostly in laborious dairy activities rather than decision-making activities. Comparatively higher percentage of members participated in activities like collection of money, selection of concentrates and animals, and breeding than non-members, indicating the marginally better off position of member women.

Table 5: Participation of women in dairy activities

S.No.	Activity	Members	Non-Members	Average
1.	Selection of animals	8 (32.0)	3 (12.0)	5.5 (22.0)
2.	Breeding	5 (20.0)	2 (8.0)	3.5 (14.0)
3.	Bringing fodder from fields	22 (88.0)	24 (96.0)	23 (92.0)
4.	Selection of concentrates	15 (60.0)	10 (4.0)	12.5 (50.0)
5.	Feeding	24 (96.0)	23 (92.0)	23.5 (94.0)
6.	Cleaning animal & shed	23 (92.0)	25 (100.0)	24 (96.0)
7.	Cleaning dairy equipments	22 (88.0)	25 (100.0)	23.5 (94.0)
8.	Health care	18 (72.0)	17 (68.0)	17.5 (70.0)
9.	Milking	25 (100.0)	25 (100.0)	25 (100.0)
10.	Marketing	19 (76.0)	21 (84.0)	20 (80.0)
11.	Preparation of dung cakes	25 (100.0)	25 (100.0)	25 (100.0)
12.	Collection of money	18 (72.0)	12 (48.0)	15 (60.0)

Source: Field survey

Efforts are also made to assess time spent per day on various dairy activities by respondents, and results are presented in Table 6. The results reveal that the respondents spent about 6 hours/day on various activities among which feeding and general management contributed the highest share (16% each) followed by cleaning of animals and shed (10%), and marketing of milk and milk products (7%).

Across respondents, members spent 6.43 hours compared to 5.11 hours in case of non-members on various dairy activities. Further, it is observed that because of more animals, members spent relatively more time on all included activities especially in feeding, general management, milking, and marketing of milk and milk products. Among both the categories, least time was spent on health care.

Table 6: Time spent (minutes/day) on various dairy activities by respondents

S.No.	Activity	Members	Non-Members	Average
1.	Cutting & bringing fodder from fields	125	105	115
2.	Feeding	65	48	56.5
3.	Cleaning animals & shed	36	35	35.5
4.	Health care	15	10	12.5
5.	Milking	30	20	25
6.	Marketing of milk and milk products	45	25	35
7.	Preparation of dung cakes	22	20	21
8.	General management	65	48	56.5
9.	Total (minutes)	403	311	357
10.	Time (hours and minutes)	6 hrs 43 min	5 hrs 11 min	5 hrs 57 min

Source: Field survey

Conclusion

A micro study conducted in Krishna district of Andhra Pradesh revealed that members of a WDCS had better socio-economic status than non-members. Quantity and quality of animals maintained by members is superior to animals held by non-members. Thus, adoption of improved breeds by members is a positive step for modernizing dairying. Better feeding and breeding techniques fetched better milk yield and better prices to members over non-members. More animals per member respondents also demanded more time, which is mostly contributed by women. Women from both categories participated more in laborious dairy activities than in the decision making process. Time spent on health care by both the categories is the bare minimal, which needs to be improved upon.

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There are two kinds of companies, those that work to try to charge more and those that work to charge less. We will be the second.

– Jeff Bezos

Feature

State-of-Art of Knowledge Management Strategy in Indian Organizations

Rajesh K. Pillania

Knowledge has emerged as a critical resource. How firms create, disseminate and use knowledge makes or mars them. This paper sets out to study the knowledge management strategy of Indian organisations. It was found that this strategy is lacking more in the public sector than the private sector, which could have serious implications for India in a global setting.

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Today, knowledge has emerged and is accepted as the most critical resource available to an organization [Bartlett and Ghosal, 1993, Davenport and Prusak, 1997, Drucker,1997). The productivity of knowledge is increasingly going to be the determining factor in the competitive position of a company, an industry, a country [Drucker,1993]. Further, the only way to have a competitive advantage is through innovation and upgrading [Porter, 1997].

Research was conducted to understand the current state of knowledge management strategy in the Indian Industry. To have a macro view of the situation experts from industry, academia and policy makers were asked about the attitude of Indian companies towards knowledge management strategy. To have the micro view, five firms each were selected from two industries namely Software, Pharmaceutical and four firms from the Petroleum Marketing Sector, thus, covering both the private and public sector.

Theoretical Background

Definition

Though there is general agreement and acceptance over the importance and relevance of knowledge and knowledge management, there exists a number of perceptions and definitions. Almost every individual and organisation has got his own definition.

Knowledge is a whole set of intuition, reasoning, insights, experiences related to customers, products, processes, markets, competition and so on that enable effective action.

Knowledge Management (Km) is a systematic, organised, explicit and deliberate ongoing process of creating, disseminating, applying, renewing and updating the knowledge for achieving organisational objectives (Pillania, 2005b).

Literature Review

Here is the abstract of selected literature arranged in descending order by year.

McCann and Buckner (2004) identify two barriers – conceptual and cultural - making it difficult for KM to deliver its full potential. For overcoming these barriers they propose an integrative model that focuses on how knowledge is assessed and valued, externally acquired, and/or internally built, shared and retained, and applied. Further they undertake a survey of 222 organisations and ten industries showing that KM initiatives, while promising, do require significant further developments to maximize their potential impact.

Smith (2004) feels that the goal of every organization is to manage their knowledge successfully. A firm's KM strategy should reflect its internal competitive strategy and the strategy chosen should create value for the firm's customers, profit for the firm and focus on how the employees deliver on the value, differentiation and speed. He inspects the KM practices of three organizations and discusses the commonalities based on a grounded theory approach to identify some of the tools and methods successful organizations have used.

Snyman and Kruger (2004) stress that due to a shift in the strategic importance of information and knowledge, in the last 5-10 years the manner in which strategy was formulated 5-10 years ago has changed. They analyse the different perspectives with regard to strategy formulation from a business point of view and KM view and propose a generic model incorporating KM strategy formulation within business strategy formulation.

Tallman, Jenkins, Henry and Pinch (2004), taking a clue from increasing focus on regional clusters studies in international strategy, study knowledge development at the firm level and the cluster level and examine the role of knowledge in establishing competitive advantage of firms and clusters.

Wenger (2004) stresses that "communities of practice" are the cornerstones of knowledge management (KM). He proposes a doughnut model of KM from strategy to performance and back. He claims that true KM is the process by which communities of practice are supported in completing this full cycle. He suggests that as long as we adopt a good model for managing knowledge, its practice can give a company a decided advantage.

Wong and Aspinwall (2004) emphatically say that many organizations are still struggling with KM and failing in their endeavours to realize its full potential because of lack of a solid theoretical foundation. They review the existing KM implementation frameworks and propose a set of guidelines for constructing them for facilitating the accomplishment of KM.

Akhter (2003) observes that traditionally strategic planning was pursued with a decision-making orientation in which action takes precedence over knowledge creation, but in the present hyper-competitive market it is time to put knowledge at the beginning. Using two elements of strategic planning-scenario building and internal situation analysis--managers can map and integrate knowledge to gain a sustainable competitive advantage.

De Souza and Evaristo (2003) study eleven firms across three continents to find out knowledge management strategies in firms operating in multiple countries. They found three KM strategies namely-headquarter commissioned and executed; headquarter commissioned and regionally executed; and, regionally commissioned and locally executed.

Maier and Remus (2003) review the current state of KM initiatives and find organizations on KM starter stage. They suggest a process-oriented KM approach based on four current scenarios of KM to bridge the gap between human - and technology-oriented KM.

Rao (2003) discusses the findings of Eighth Annual KM Conference of American Productivity and Quality Council (APQC) in Houston 2003. Successful KM initiatives aligns KM strategy with business strategy and transformation.

Satyadas (2003) programme director of On Demand Workplace Industry Solution at IBM emphasizes that KM strategy should map back to organizational business strategy; help solve business issues; and, highlight and interlink three areas people, process and technology.

Shankar, Singh, Gupta and Narain (2003) find that a major reason for the failure of many KM projects is the absence of a well-defined strategic plan to guide implementation. They recommend strategic planning of organizational knowledge into value proposition and the reengineering of operating models to leverage knowledge relating to the value proposition.

Zack (2003), based on his work with more than thirty companies over eight years, finds that companies that succeed over the long term align their KM processes with their strategy. The knowledge based organization recognizes that knowledge is a key strategic

resource, identifies its knowledge gaps and seeks to close those gaps faster and more effectively than its competitors do.

April (2002) stresses the need to understand the role of KM as it pertains to sustainable competitive advantage. Drawing on resource-based theory he introduces a chain of sustainability and highlights complementary resource combination, strategic architecture and pool of resources to explain the requirements of a knowledge strategy for organizations to attain and sustain competitive advantage.

Kamara, Anumba and Carrillo (2002) based on CLEVER (cross-cultural learning in the virtual enterprise) project on current KM processes in the construction and manufacturing sectors describe a framework for selecting a knowledge management strategy that is appropriate for the organisational and cultural context of the organoisation. They stress that KM is not an end in itself, but a means towards the solution of business problems of an organization.

Maier and Remus (2002) based on literature survey and empirical study show that current KM activities in organizations are linked neither to a well-defined KM strategy nor directly to a business strategy. They propose a process-oriented KM strategy providing an integration of the resource-based view and the market-based view of the organization.

Pablos (2002) studies organisational knowledge strategies in the Spanish manufacturing industry. He finds that knowledge strategies determine stocks and flows of organizational knowledge and thus, the competitive advantage of the firm. Results show organizational performance varies across clusters and he suggests that knowledge strategy should be formally integrated among strategic decisions to get good organizational fit.

Skyrme (2002) offers a five-step process of information gathering, analysis and diagnosis, planning the approach, documenting the detail, and communicating and gaining acceptance, for developing a successful KM strategy followed by a set of guidelines and pitfalls to avoid and some case studies.

Turner, Bettis and Burton (2002) using a computer-simulated product development process, compare the performance of generalist or eastern and specialist or western KM strategies under conditions of market turbulence. The generalist KM strategy emphasizes breadth of knowledge in product development teams, while the specialist KM strategy focuses on depth of knowledge. They find that specialist team outperforms generalist team in almost all cases, irrespective of market turbulence or learning decision rule. They infer that specialist KM strategies are appropriate for teams that develop modular products and cross-learning can be beneficial or detrimental contingent upon the mode of learning.

Dyer and McDonough (2001), based on a survey in 2001 with IDC consisting of 556 respondents, find that a pivotal issue in migrating to a knowledge strategy is the creation of a culture of trust and collaboration. KM is migrating from a discrete understanding to a strategic component of business solution. A KM strategy represents a long term commitment involving not only technology integration but also significant investment in change management and business process design.

Knight (2001) describes how the department of health has attempted to integrate its KM programme with the core objectives of the organization.

Skyrme (2001) explains why and how knowledge can be used as an element of business strategy. Seven specific levers of strategy are identified and illustrated with examples of good practice. Knowledge–enhanced business strategy are built on two broad thrust–managing, what you already know and innovation, creation and commercialization of new knowledge. Effective knowledge management requires attention to both explicit and tacit knowledge as well as to both hard i.e. technology and soft i.e. people issues. There is a need to shift from a custodial view of knowledge to one that is innovative and dynamic i.e. a shift from knowledge management to knowledge leadership.

Teece (2001) argues that competitive advantage flows from the creation, ownership, protection and the use of knowledge assets that are difficult to imitate. So, superior performance depends on the ability of firms to be good at innovation, protecting intangible knowledge assets and using them. Using knowledge assets conceals complicated processes that require management to refocus priorities, build organizations that are highly flexible to accommodate such activity and display a high level of entrepreneurial drive.

Zack (2001) observes that there is a lack of focus in knowledge management literature on the strategic aspect of knowledge, as knowledge management has become an issue of information technology first, followed by organizational behaviour as a distant second. The collection of articles in the volume is aimed at filling this void. The articles in part one provide background on the resource-based view of the firm, in part two, use the resources-based view of the firm as a jumping-off point to explicitly consider

knowledge as a strategic resource, in part three, examine characteristics of knowledge that enable it to function as a strategic resource and the implication for its management; and in the last part, explicitly relate knowledge and strategy. The articles in the book offer some of the intellectual foundation for developing the concept of knowledge strategy by addressing several themes and perspectives.

APQC (2000) study the KM efforts at 49 companies. It stresses on aligning KM strategy with business strategy and leadership role and support needed to sustain a KM strategy. The study finds that at every successful large scale KM-initiative it has examined, an important senior champion or group saw the strategic value of KM and endorsed what became a significant investment in it.

KPMG (2000) survey focuses on the various aspects of KM. It finds that only a third of those companies with a KM-initiative had created a strategy and a further one-third were planning to develop one. Two key indicators of a strategic approach-responsibility allocation and budget allocation-were largely absent. Forty per cent said that there was no one at board level responsible for it. The funds come mostly from MIS department.

Nielsen (2000) based on literature study identifies main strategic management perspectives as content view and process view; combines them with current knowledge management perspectives; and, provides an overview the evolution of strategic KM research. The research agenda has grown from a rather static, content-based focus on categorization and projection of knowledge and knowledge-related capabilities in the 1960s and 70s; via a preoccupation with transferability of knowledge to a more dynamic and process-oriented emphasis on internalization through organizational learning in the 80s and 90s. Lately, some strategic management scholars have attempted to integrate content and process view parts to facilitate a more dynamic and synergistic understanding of the existence and capabilities of collaborative, strategic arrangements.

Soliman and Spooner (2000) discuss the strategic role of the human resource department in identifying strategic and knowledge gaps and assisting in filling these gaps using knowledge mapping. The process of forward knowledge mapping serves as the exploration of strategic opportunities while the backward knowledge mapping acts as the alarm-bell for strategic deficiencies of the organizations.

Thompsen (1999) examines how an enterprise can identify and measure a key resource capability or Critical Knowledge Area, to enhance competitive advantage in the context of the emerging field of knowledge management. The measures of this Critical Knowledge Area include the consistency and completeness of its deployment, as well as its impact on established measures of competitive differentiation and customer satisfaction. A Critical Knowledge Area is another critical success factor for knowledge-intensive enterprises.

Teece (1998) in a summary of KM research questions raises the most basic question involving knowledge and strategy. He suggests that researchers should "assemble evidence to test the proposition that firm-level competitive advantage in open economies flows fundamentally from difficult to replicate knowledge assets" i.e. does knowledge yield competitive advantage?

Zack (1998) says that knowledge is a source for sustainable competitive advantage. Firms need to perform a knowledge–based SWOT analysis and go for mapping knowledge to perform a gap analysis. To give knowledge management a strategic focus the firm's knowledge management initiative must be directed towards closing this strategic knowledge gap. He puts forward a framework – A Knowledge Strategy Framework – for describing and evaluating an organisation's knowledge strategy using examples from five companies representing the spectrum of physical and knowledge–based products and services.

Davenport, Delong and Beers (1997), in a study of more than 30 knowledge management projects, conclude that less than ten per cent were likely to have an important impact on the overall business. The projects improved the efficiency or effectiveness of individual departments or business process, but strategist or stockholders would have little about which to get excited. There are very few examples of companies where the product itself isn't knowledge and KM really matters to long-term success.

Manasco (1997) spoke with Strassmann, Paul about the need to effectively measure knowledge and productivity in this interview. Strassmann defines knowledge capital as the value that a customer assigns on top of cost of sales and cost of capital i.e. surplus value on top of traditional value. He laments that traditional accounting principles fail to recognize the value of knowledge capital and tangible things gets disproportionate attention. He favours a top-down approach i.e. what the customer/market recognize for knowledge assets valuation. Capital is now a small fraction of total input and information is the dominant input.

APQC (1996) study identifies strategy and leadership as one of the KM enablers. It identifies the

strategies for KM in practice by companies. The most widely used strategy among the participants was 'the transfer of knowledge and best practices' in order to improve operations or to embed them in products/services. Further it observes several approaches and solutions being used for implementing KM initiative. KM tends to be decentralized management responsibility and funding usually comes from MIS department.

Bierly and Chakrabarti (1996) studied and analyzed knowledge strategies of 21 U.S pharmaceutical firms from 1977 to 1991 and identified four generic knowledge strategy groups, namely, explorers, exploiters, loners, and innovators. Most firms remain in the same knowledge group over time. The firms in the innovator and explorer groups tend to be more profitable than the firms in the exploiters and loners group. The generalisation of these preliminary findings to other industries must be made cautiously until further research of other industries is completed.

Liebeskind (1996) argues that firms, as institutions, play a critical role of protecting valuable knowledge by using an array of organizational arrangements that are not available in market. Firms can differentially prevent expropriation of knowledge and differentially reduce the observability of knowledge and its products thereby protecting against imitation. This argument has a number of important implication for strategy theory and research, like it suggests that the condition of uniqueness depends critically upon the deployment of protective organizational arrangement by the firms; expect to observe a long-run correlation between a firm's rate of innovation and its success at protecting knowledge; and lastly, it provides some correctness to theories of the scope of the firm that are based on knowledge–protection arguments.

Collis and Montgomery (1995) say that superior performance will be based on developing a competitively distinct set of resources and deploying them in a well–conceived strategy. The resource-based view (RBV) of the firm inextricably links a company's internal resources and its external industry environment. A resource need to qualify a number of tests, namely, tests of inimitability, durability, appropriability, substitutability and competitive suitability for being the basis for an effective strategy. The strategic implications for the manager is to continually invest, upgrade and leverage these resources with effective strategies into attractive industries in which they can contribute to a competitive advantage.

Earl (1994) makes the case for 'knowledge as strategy' focusing on the value of information technologies in exploiting organizational knowledge. He classifies information systems from the perspective of knowledge and uses the case studies to develop a model for managing knowledge as a strategic resource. He concludes that any knowledge–based strategy requires a combination of organizational and technological capabilities.

This literature review brings out five important points:

1. KM strategy is still in the evolution phase as many of the KM initiatives are in the initial stage.
2. Some researchers have tried to align KM strategy with the developments in the strategy literature. KM strategy started with content view (1960s & 70s) to process view (1980s & 90s) and now (late 1990s & 2000s) integrative/synergetic views are emerging.
3. There is a lack of well-defined KM strategy as found in a number of surveys. Many KM initiatives are linked neither to a well defined KM strategy or a business strategy. The major reason for the failure of many KM initiatives is a lack of a well defined KM strategy to guide implementation.
4. Successful KM strategy is aligned with overall business strategy.
5. There is a lack of studies on KM strategy of Indian organizations.

Research methodology

Data Sources: This research work was based mainly on primary data collected from companies under study and a number of experts from industry, academics, government bodies, etc.

Research Approach: A survey method was adopted to gather primary data.

Research Instrument: Two sets of questionnaires were prepared. The questionnaires were discussed with experts to check for any bias. One questionnaire was administered to experts in the field of knowledge management to study information technology for knowledge management in Indian industry. The experts consisted of academicians, industry consultants and government officers/policy makers. The second questionnaire was administered to the executives in the firms under study. This questionnaire was first pre-tested on a sample of twenty respondents and necessary improvements were made.

Contact Method: To collect the primary data, the

questionnaires were distributed by mail or in person; depending on the distance to the concerned person and after that a few personal interviews were taken.

Sampling Plan: The universe for the industry study consisted of three sectors of Indian economy, namely: software, pharmaceutical and the petroleum marketing sector. From the pharmaceutical sector the firms taken, namely, Ranbaxy, Cipla, Glaxo and Dr. Reddy's Lab were leading firms in BT 500 (Business Today, 2000) survey of India's most valuable companies for the year 2000. The firms in BT 500 were ranked based on their market capitalisation. Though Novartis was ranked fourth in the survey, there was no response and so Dabur, which was ranked sixth in the pharmaceutical sector, was the fifth firm for study.

From the software sector, the firms taken, namely Wipro, HCL Technologies and Infosys, were leading firms in the BT 500 survey. Tata Consultancy Services (TCS), the biggest software firm in India, was not a publicly listed company. It was not listed on the stock exchange and was privately owned by the Tata Group and so falls out of the BT 500 survey, but was taken for study because it was the biggest software firm in terms of annual turnover. Lastly, though Satyam Computer Services was ranked fourth in BT 500, there was no response and so CMC, though lower in rank in BT 500 survey, was the fifth company of the study.

From the petroleum marketing sector, all the four major players, namely, Indian Oil Corporation (IOC), Bharat Petroleum (BP), Hindustan Petroleum (HP) and IBP Ltd. (IBP) were included in the study. Incidentally, all four of these were in the public sector. From each firm, ten people were selected on a random basis for the study.

For expert opinion, thirty responses were gathered from industry, academics and government servants/policy makers. This was more of a judgmental/convenience sampling and discussion groups at a Yahoo website were also used.

Data Analysis: The data so collected was tabulated and was checked for bias. Finally, percentages were calculated to find out the practices prevailing in the industry. In the final presentation, figures were used.

Limitations of the Study

The study has two limitations. Firstly, it is limited to only three sectors and only five firms from software and pharmaceutical sector and four from petroleum marketing sector. Secondly, the sample size is not very big i.e. fifty people from software sector and pharmaceutical sector and forty people from petroleum marketing sector.

Empirical Findings in Indian Industry

Expert Opinion: Majority of the respondents (63.33 per cent) say Indian organizations recognize knowledge as part of their assets base, 23.33 per cent do not think so and 13.33 per cent have no idea.

The strategies used for KM by Indian organizations in descending order are: personal responsibility for knowledge (30 per cent), innovation and knowledge creation (23.33 per cent), customer focused knowledge (13.33 per cent), transfer of knowledge and best practices (6.66 per cent), intellectual property rights management (6.66 per cent) and KM as a business strategy (3.33 per cent). The rest i.e. 6.66 per cent have no idea about it. This clearly highlights the emphasis put on personal responsibility for knowledge.

There is need for more interest into and more support to KM by the senior management in the organizations. 53.33 per cent of the respondents say that senior management sees KM as very important and provides full support; 23.33 per cent say that senior management sees it very important but hardly supports it; 13.33 per cent say senior management sees it as a waste and hardly bothers; and 10 per cent say senior management was very supportive in the beginning but has lost interest.

Software Sector

A very high majority of the respondents (92 per cent) think that their products/services deliver higher value as a result of the knowledge component they contain whereas a thin minority (4 per cent) thinks other way and 4 per cent of the respondents have no idea about it. The companies under study show almost similar response except in case of CMC where a large number of respondents i.e. 30%, show a negative or are not aware of response.

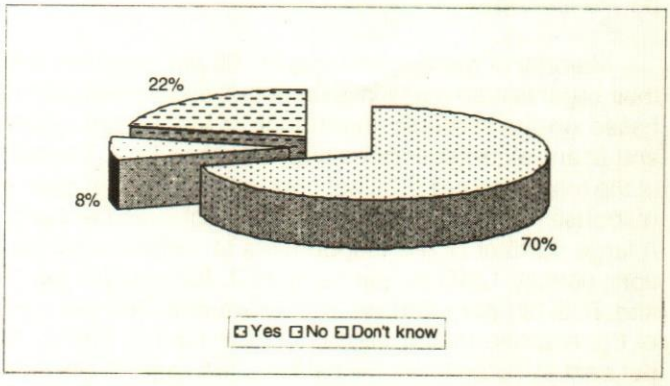

Fig. 1. Do you recognise knowledge as a part of your asset base?

Knowledge is recognised as part of their assets base by a high majority of respondent as depicted in the Fig. 1. People at Infosys are the most positive (100 per cent) about it whereas those at CMC (70 per cent) are the least positive.

Twenty six per cent of the respondents say that they have some sort of knowledge management strategy, 18 per cent have no idea about it and 56 per cent say they have a well defined knowledge management strategy as shown in the table1. This clearly indicates that there is a lack of well-defined knowledge management strategy in the organisations under study. A large number of the respondents at CMC (40 per cent) and HCL Tech (20 per cent) have no idea about KM strategy in their organisation; 50 per cent of the respondents at HCL Tech and 40% at CMC think their organisation has some sort of KM strategy; and at Infosys (90 per cent), Wipro (80 per cent) and TCS (70 per cent), majority of the respondents think that their organisation has a well defined KM strategy.

Table 1: Presence of KM Strategy

Does your organization have a KM strategy?	Percentage
We have a well defined KM strategy	56
Don't know	18
We have some sort of KM strategy	26

Seventy four per cent of the respondents say that their KM strategy is aligned with the overall corporate strategy, 4 per cent do not think so and a good number of respondents i.e. 22 per cent have no idea about it. Whereas the majority of the respondents at Infosys (90 per cent), Wipro (90 per cent), TCS (80 per cent), HCL Tech (70 per cent) and CMC (40 per cent) say their KM strategy is aligned to overall corporate strategy, a large number of respondents at CMC (40 per cent), HCL Tech (30 per cent), and TCS (20 per cent) have no idea about it; and a good number of people at CMC (20 per cent) think their KM strategy is not aligned with overall corporate strategy.

Majority of the respondents i.e. 68 per cent, say that their organisation make investment/divestment decisions based on the strategic importance of knowledge assets and financial projections as shown in the Fig. 2. The rest of the respondents i.e. 32 per cent, either show a negative response (6 per cent) or are not aware of it (26 per cent). A large number of the respondents at various organisations namely, CMC (50 per cent), HCL Tech (40 per cent), and TCS (30 per cent) are not aware of it. 100 per cent of the respondents at Infosys, 90 per cent at Wipro, 70 per cent at TCS, 60 per cent at HCL Tech and 20 per cent at CMC a show positive response.

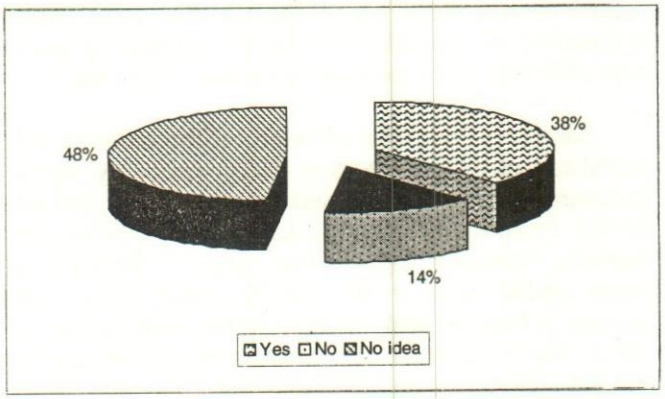

Fig. 2. Does your organisation make investment/disinvestment decisions based on both the strategic importance of knowledge assets and financial projections?

Table 2 displays the strategy used by the organisations under study for knowledge management. It can be gleaned from table 2 that there is a focus on transfer of knowledge and best practices and customer focused knowledge as a knowledge management strategy. Also, a good number i.e. 10 per cent have no idea about it. Customer-focused knowledge is the major (40 per cent) strategy at Wipro while 30 per cent opt for intellectual assets management; Learn once use anywhere is the major (60 per cent) strategy at Infosys while 30 per cent opt for transfer of knowledge and best practices; 30 per cent of the respondents at TCS opt for innovation and knowledge creation; 30 per cent of the respondents at HCL Tech. go for transfer of knowledge and best practices; and 30 per cent of the respondents at CMC go for personal responsibility for knowledge and a same number i.e. 30 per cent have no idea about the KM strategy their organisation is following.

Table 2: KM Strategy in Practice

KM Strategy	Percentage
KM as a business strategy	4
Transfer of knowledge and best practices	20
Customer-focused knowledge	18
Personal responsibility for knowledge	8
Intellectual property rights management	12
Innovation & knowledge creation	16
Any other (Learn once use anywhere strategy at Infosys)	12
No Idea	10

Pharmaceutical Sector

Majority of the respondents (78 per cent) think that

their products/services deliver higher value as a result of the knowledge component they contain, whereas ten per cent think otherwise and twelve per cent of the respondents have no idea. The companies under study show almost a similar response.

Knowledge is recognised as part of their assets base by the majority of the respondents, whereas a good number of people have no idea about it as depicted in the Fig. 3. People at Ranbaxy are the most positive (80 per cent) about it, whereas those at Cipla are the least positive.

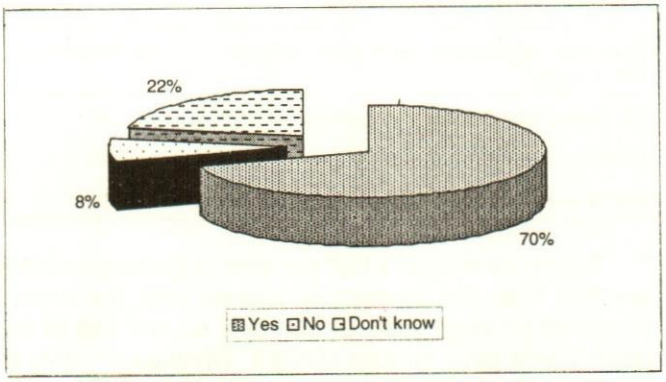

Fig. 3. Do you recognise knowledge as a part of your asset base?

Forty six per cent of the respondents say that they have some sort of knowledge management strategy, 34 per cent have no idea about it and only 20 per cent say they have a well defined knowledge management strategy as shown in the table 3. This clearly indicates that there is lack of a well-defined knowledge management strategy in the organisations under study. A large number of the respondents at Cipla (50 per cent) and Glaxo (40 per cent) have no idea about KM strategy in their organisation; 60 per cent of the respondents at Dabur and 50 per cent at Ranbaxy think their organisation has some sort of KM strategy; and only at Reddy's Lab a significant number of the respondents i.e. 40 per cent think that their organisation has a well defined KM strategy.

Table 3: Presence of KM Strategy

Does your organization have a KM strategy?	Percentage
We have a well defined KM strategy	20
Don't know	34
We have some sort of KM strategy	46

Sixty per cent of the respondents say that their KM strategy is aligned with the overall corporate strategy, 8 per cent do not think so and a large number of the respondents i.e. 32 per cent have no idea about it. Whereas majority of the respondents at Reddy's Lab (70 per cent), Ranbaxy (60 per cent), Cipla (60 per cent), Glaxo (60 per cent) and Dabur (50 per cent) say their KM strategy is aligned with the overall corporate strategy, a large number of respondents at Cipla (40 per cent), Glaxo (40 per cent), Dabur (30 per cent) and Reddy's Lab (30 per cent) have no idea about it; and a good number of people at Dabur (25 per cent) and Ranbaxy (25 per cent) think their KM strategy is not aligned with overall corporate strategy.

Only thirty eight per cent of the respondents say that their organisations make investment/divestment decisions based both on the strategic importance of knowledge assets and financial projections as shown in the Fig. 4. Majority of the respondents i.e. 62 per cent either show a negative response (14 per cent) or are not aware of it (48 per cent). Nearly half of the respondents at various organisations, namely, Reddy Labs (40 per cent), Ranbaxy (40 per cent), Glaxo (50 per cent), Cipla (60 per cent) and Dabur (50 per cent) are not aware of it. Only 50 per cent of the respondents at Reddy's Lab, 40 per cent at Ranbaxy, 30 per cent at Glaxo, 30 per cent at Cipla and 40 per cent at Dabur show positive response.

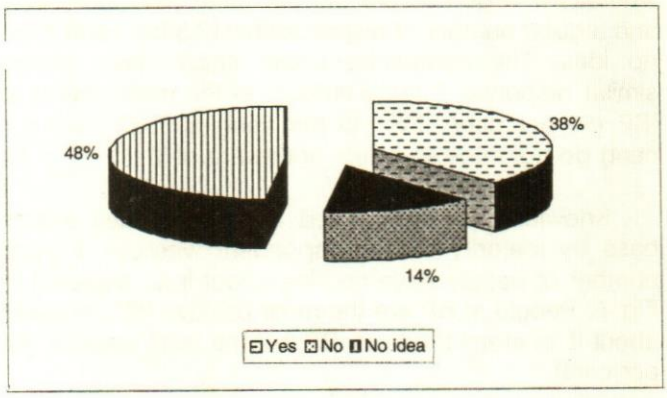

Fig. 4. Does your organisation make investment/disinvestment decisions based on both the strategic importance of knowledge assets and financial projections?

Table 4 displays the strategy used by the organisation under study for knowledge management. It can be gleaned from the table 4 that there is focus on innovation and knowledge creation and personal responsibility for knowledge as a knowledge management strategy. Also, a good number i.e. 12 per cent have no idea about it. Innovation and knowledge creation is the major (60 per cent) strategy at Reddy's Lab; transfer of best practices and KM as a business strategy gets equal (30 per cent) response at Ranbaxy, 40 per cent of the respondents at Glaxo opt for innovation and knowledge creation; 40 per cent of the respondents at Dabur go for personal

responsibility for knowledge, and 30 per cent of respondents at Cipla go for personal responsibility for knowledge and an equal no. i.e. 30 per cent have no idea about the KM strategy their organisation is following.

Table 4: KM Strategy in Practice

KM Strategy	Percentage
KM as a business strategy	16
Transfer of knowledge and best practices	8
Customer focused knowledge	6
Personal responsibility for knowledge	22
Intellectual property rights management	2
Innovation & knowledge creation	32
Any other	2
No Idea	12

Petroleum Marketing Sector

Majority of the respondents (62.5 per cent) think that their products/services deliver higher value as a result of the knowledge component they contain whereas a large number (20 per cent) think otherwise and a good number of respondents (17.5 per cent) have no idea. The companies under study show almost similar response. A large number of the respondents at IBP (50 per cent), HP (40 per cent) and IOC (40 per cent) do not think so or are not aware of it.

Knowledge is recognised as part of their assets base by majority of the respondent whereas a good number of people have no idea about it as depicted in Fig. 5. People at BP are the most positive (80 per cent) about it whereas those at IBP are the least positive (50 per cent).

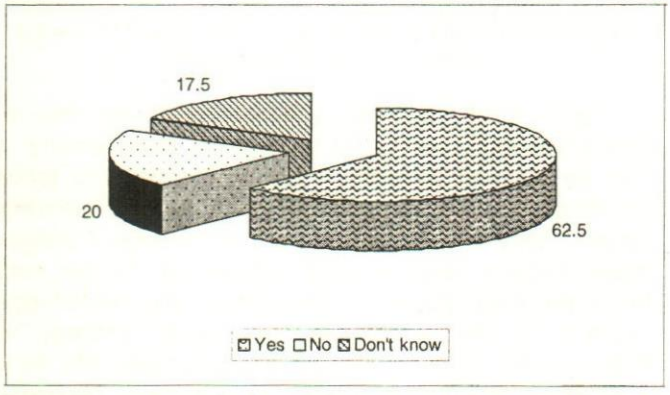

Fig. 5. Do you recognise knowledge as a part of your assets base?

Thirty per cent of the respondents say that they have some sort of knowledge management strategy, 45 per cent have no idea about it and only 25 per cent say they have a well defined knowledge management strategy as shown in the Table 5. This clearly indicates that there is lack of a well-defined knowledge management strategy in the organisations under study. A large number of respondents at IBP (70 per cent), HP (50 per cent) and IOC (40 per cent) have no idea about KM strategy in their organisation; 40 per cent of the respondents at IOC and 30 per cent at HP think their organisation has some sort of KM strategy; and only at BP half of the respondents i.e. 50 per cent, think that their organisation has a well defined KM strategy.

Table 5: Presence of KM Strategy

Does your organization have a well defined KM strategy?	%age Response
We have a well defined KM strategy	25
Don't know	45
We have some sort of KM strategy	30

Twenty seven and a half per cent of the respondents say that their KM strategy is aligned with the overall corporate strategy, 20% do not think so and half of the respondents have no idea about it. Whereas majority of the respondents at HP (60 per cent), IOC (60 per cent), and BP (50 per cent) and IBP (50 per cent) show ignorance, a large number of the respondents at BP (40 per cent), IOC (30 per cent), HP (20 per cent) and IBP (20 per cent) think their KM strategy is aligned with overall corporate strategy and a good number of people at IBP (30 per cent) and HP (20 per cent) think their KM strategy is not aligned with overall corporate strategy.

Only twelve and a half per cent of the respondents say that their organisation make investment/divestment decisions based on the strategic importance of knowledge assets and financial projections as shown in the Fig. 6. Majority of the respondents i.e. 87.5 per cent

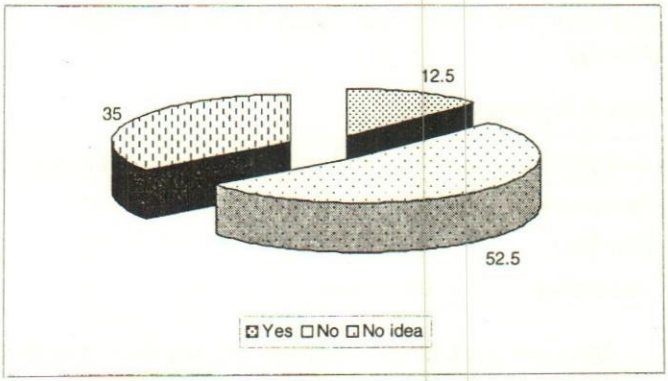

Fig. 6. Does your organisation make investment/disinvestment decisions based on both the strategic importance of knowledge assets and financial projections?

either show negative response (52.5 per cent) or are not aware of it (35 per cent). A large number of the respondents at various organizations, namely, BP (50 per cent), IOC (40 per cent), HP (30 per cent) and IBP (20 per cent) are not aware of it. Only 20 per cent of the respondents at BP, 10 per cent at IOC, 10 per cent at HP and 10 per cent at IBP show positive response.

Table 6 displays the strategy used by organizations under study for knowledge management. It can be gleaned from the bar chart that there is focus on innovation and knowledge creation and personal responsibility for knowledge as a knowledge management strategy. Also, a good number i.e. 17.5 per cent have no idea about it. Innovation and knowledge creation is the major (30 per cent) strategy at BP and personal responsibility for knowledge is the major strategy at HP (40 per cent), IBP (40 per cent) and IOC (30 per cent). At IBP 30 per cent of the respondents have no idea about the KM strategy their organisation is following.

Table 6: KM Strategy in Practice

KM Strategy	Percentage
KM as a business strategy	5
Transfer of knowledge and best practices	10
Customer focused knowledge	12.5
Personal responsibility for knowledge	32.5
Intellectual property rights management	2.5
Innovation & knowledge creation	20
Any other	0
No Idea	17.5

Sectoral Comparison

The number of respondents thinking that their products/services deliver higher value as a result of knowledge component they contain is highest for the software sector (92 per cent), followed by the pharmaceutical sector (78 per cent) and petroleum marketing sector (62.5 per cent).

The number of the respondents recognising knowledge as a part of their assets base is highest for the software sector (86 per cent), followed by the pharmaceutical sector (70 per cent) and petroleum marketing sector (62.5 per cent).

Majority of the respondents in the software sector (56 per cent) say they have a well-defined KM strategy, whereas only 25 per cent of the respondents in the petroleum marketing sector and 20 per cent in the pharmaceutical sector are of the same opinion. A large number of the respondents in the pharmaceutical sector (34 per cent) and petroleum marketing sector (45 per cent) have no idea about it.

Majority of the respondents in the software sector (74 per cent) and pharmaceutical sector (60 per cent) say that their KM strategy is aligned with the overall corporate strategy, whereas only 27.5 per cent of the respondents in the petroleum marketing sector think so. Half of the respondents in the petroleum marketing sector and a large number (32 per cent) in pharmaceutical sector have no idea about it.

There is a focus on transfer of knowledge and best practices as a KM strategy in the software sector; innovation and knowledge creation in the pharmaceutical sector; and personal responsibility for knowledge in the petroleum marketing sector.

Overall the scenario is worst in the Petroleum marketing sector i.e. public sector as compared to software or pharmaceutical sectors i.e. private sector. Within the private sector, the software sector is far ahead as compared to the pharmaceutical sector in KM strategy development and alignment of this strategy with the overall business strategy.

Implications

These findings have serious implications for the organisations under study as well as the industry and the country. In this knowledge-driven, services-led global economy knowledge is the most critical resource and if the organizations are not able to create, manage and exploit it well, then the competitiveness of the industry and the country is at stake. As Drucker (1993) has rightly said, the productivity of knowledge is increasingly going to be the determining factor in the competitive position of a company, an industry, a country. Though majority of the respondents realise the importance of knowledge, a good number of them are not aware of KM in their organizations. This is just against the very spirit of KM. Literature review findings are reflected in the empirical research as there is a lack of well-defined KM strategy and the KM strategy is not aligned with the overall business strategy. And this may lead to failure of the KM initiatives, as suggested in the literature review, that successful KM initiatives have a well-defined KM strategy aligned with the overall business strategy. From the software and pharmaceutical sectors India has great expectations, but these findings are raising questions on those expectations. The Indian public sector, in particular, needs to redefine its orientation and direction to be able to survive and compete in the present knowledge economy.

We are in the knowledge economy, where knowledge is the most critical resource. A well-defined Knowledge Management strategy and its alignment with the overall business strategy is the prerequisite for a successful Knowledge Management initiative. Indian organizations in general and in the three selected sectors in particular are lacking in a well–defined KM strategy. The overall scenario is worse in the petroleum marketing sector i.e. public sector as compared to software or pharmaceutical sector i.e. private sector.

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Feature

The R&D Investment Pattern, its Determinants and Effects on Profitability: An Empirical Analysis of Indian Companies

Bibek Prasad Mishra

In today's world of competition, technology as a strategic variable can create competitive advantage. Since purchasing of existing technology available elsewhere requires extensive adaptations, many times firms prefer to invest in internal R&D, which may lead to technology innovations. In this paper, it has been hypothesized and tested that business groups spend more money in R&D activities among all listed companies doing business in India. Finally, through an econometric model, it has been tested that the Indian market as a whole is still not valuing investment in R&D and many of the high R&D investors have less price-earning ratios.

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In a Schumpeterian world of innovation-based competition, price and performance rivalry, increasing returns and the 'creative destruction', it is very difficult for any company to remain in the forefront without having any competitive advantage. Technology as a strategic variable can change the competitive 'rules of the game' by impacting all the forces driving competition and can create competitive advantage. Technology can be employed successfully to implement a firm's chosen strategy—whether it is cost leadership, differentiation or focus (Porter, 1980; Porter, 1985).

Past research has demonstrated that there is a direct, robust relationship between organisational innovation and performance (Vincent et al., 2005). Product innovation can be the source of competitive advantage to the innovator and at the same time can lead to a sustainable increase in firm profits (Geroski et al., 1993). Firms faced with intense competition and turbulent environments often rely upon innovation as the primary driver of organisational performance (Gronhaug and Kaufman, 1988). Technology innovation can happen through in-house Research and Development (R&D) investment or through technology purchase (TP) or through foreign/domestic R&D spill over. One study conducted by Basant & Fikkert (1996) reveals that return to TP is much higher compared to return to R&D, but that R&D and TP are substitutes for one another in the production of knowledge.

One study carried out by McGahan & Porter (1997) indicates that year, industry, corporate-parent, and business-specific effects account for 2 per cent, 19 per cent, 4 per cent and 32 per cent, respectively, of the aggregate variance in profitability. Another study carried out by Khanna and Palepu (1997) concludes business groups have greater chance of success in emerging markets than in developed countries. Combining these

two studies, the pattern and impact of R&D investments on various ownership groups and industry sectors has been studied in this paper. Also regression models have been developed to find the determinants of R&D intensity and effects of R&D on profitability.

Incentives to invest in R&D

Companies can directly buy the existing technology available elsewhere. But, more often the transfer of technology to another context requires extensive adaptations because of the sticky nature of innovation which is firm specific. Further such imported technologies are accessible to other fellow competitors and therefore do not give the buyer any competitive advantage (Krishnan & Prabhu, 1999). In-house R&D based technology, being proprietary, is not easily imitated by other firms, and may provide the firm with a first-mover advantage. Moreover, being indigenous, such technology is inherently adapted to local conditions with simultaneous learning and development of tacit knowledge within the firm (Gambardella, 1992). This facilitates the assimilation and application of technology more easily, compared to imported technology. The technology developed in this way, being firm specific, creates faster competitive advantage.

Another reason why firms invest in R&D is to get fiscal incentives. Most of the emerging economies have promoted technology development through a variety of policy instruments, the most common being subsidies and tax credits. In India, the government announces from time to time fiscal incentives and support measures to encourage R&D in industry and increase utilization of locally available R&D options for industrial development.

But, investments in R&D involve temporary tradeoffs as R&D expenditures are incurred immediately but payoffs come after many years. The year lag between investment and payoff can be as high as 12 years for pharmaceutical industries involved in new drug development, and an average of 2-3 years for most of the other sectors. However, stakeholders can differ in their temporal preferences and performance evaluation criteria. Corporate managers favour short-term payoffs, but stockholders favour long-term investments (Mank and Nystrom, 2001).

Hypotheses Development

Khanna and Palepu (1997) provide the theoretical rationale as to why big business groups may be more successful in emerging markets than in developed countries. They argue that diversification can be valuable in emerging markets because diversified firms can mimic the beneficial functions of various institutions that the present in developed markets. Developing countries suffer from a large number of market deficiencies and they have incomplete or missing economic, social and legal institutional framework within which advanced country markets are embedded. In the absence of such a framework in emerging markets, business groups help filling this institutional void (Khanna and Palepu, 1997).

Efforts at innovation almost always involve a large element of trial and error and repetitive learning (Nelson, 1993), and therefore, involve huge sums of long-term investment. Amsden (1989) regards Korean chaebols (business groups) as the engines of Korea's industrial development and the reason for its enormous success in international markets. Nelson & Winter (1982) predicts that larger firms are more innovative than smaller firms because:

- A large firm can finance a larger research and development staff;
- A large diversified firm is better able to exploit unforeseen innovation; and
- High sunk cost involved in innovations makes large firms more profitable

Smaller firms, on other hand, depend more on external financing to carry out R&D activities. Developmental financial institutions (DFIs) can help these firms in encouraging indigenous technology development in emerging economies. Currently major DFIs in India are SIDBI (Small Industries Development Bank of India), IIBI (Industrial Investment Bank of India), IFCI (Industrial Finance Corporation of India), and IDFC (Infrastructure Development Finance Company). However, in India, DFIs are becoming insignificant, as more and more banks are coming forward to provide long-term developmental finance; and at the same time many DFIs are converting themselves to banks. ICICI ceased to be a development bank from May, 2002 when it reversed merged with its banking subsidiary. Similarly, IDBI, an erstwhile development bank, metamorphosed into a banking company from October, 2004.

In less developed countries financial institutions are not equipped to provide risky project-financing services, with fears of non-performing assets (NPAs). This deters them from funding innovative projects with a high rate of uncertainty. As per the study done by Lall & Streeten (1980), the larger firms have high bargaining powers. Business groups, usually being large organisations, might negotiate well with financial institutes and manage to get funding most of the time. Even some of these business groups often have in-house non-banking

financial institutions which can be used to undertake risky debt financed projects. Given the low investment capacity and a lack of financing options in many emerging economies (Khanna & Palepu, 2000), it is difficult for small and independent firms to engage in innovative activities. Hence the diversified business houses play a major role in technology innovation in emerging markets. Based on the above discussion, the first hypothesis is defined below:

Hypothesis 1: Indian Business Groups invest larger amounts in R&D than other ownership groups

A number of studies have been done before to develop models for determining firm's R&D intensity, but none of them have been validated for Indian companies. Cohen et al. (1987) have empirically tested that business unit size has no effect on the R&D intensity of business units that perform R&D, but it affects the probability of conducting R&D. Business Unit size explains less than one per cent of the variance in R&D intensity; industry effects explain nearly half the variance. Scherer (1967) has explained that technological opportunities (based on industry types and nature of their technology) significantly affect R&D intensity and reduces the effect of market concentration. R&D intensity also differs with technological appropriability which depends on the inherent ease of imitation, the strength of patent protection and average time to duplicate a patented innovation. Another study conducted by Lee (2003) suggests that both demand-side factors and technology-side factors jointly determine firm R&D effort. Firm age can be used as a proxy variable for the stock of previously accumulated technological knowledge, since old firms are more likely to have accumulated a large stock of technological knowledge through R&D and manufacturing experiences (Lee, 2003).

Keeping in mind the above factors, the second hypothesis has been developed on an econometric model to determine R&D intensity. R&D intensity (RDI) is taken as ratio of Total R&D to Net Sales. The factors in independent variables include industry effect (in terms of industry dummies); ownership effects (in terms of ownership dummies); Sales revenue as proxy for demand-side factor and age of the firm as technology-side factor. Regarding sales, literature is divided as to whether to include this as a factor for RDI determinants. However, we felt that sales should be included as demand side factor and in our model we have taken logarithm of sales in order to avoid large variation across the companies. Finally we have included price-earning (PE) ratio as one of the independent variables as a market feedback to a firm's R&D effort. Hence, our second hypothesis is as follow:

Hypothesis 2: R&D Intensity of a firm is a function of its age, sales, price-earning ratio, ownership, and sectoral effects

After knowing the determinants of R&D, it is important to know whether investment in R&D transforms into improving profitability of a firm. The measures of profitability are taken as Return on Capital Employed (ROCE) and Price Earnings Ratio (PE ratio). The reason for taking these two measures are mentioned below:

- The ROCE is a fundamental and the most important measure of the profitability of any specific company. The ratio is a popular indicator of management efficiency because it contrasts the net profit by the company with the total value of fixed and current assets, which are presumed to be under management control. Therefore, the ROCE demonstrates how well the management has utilized total assets.
- The PE ratio is a measure of market confidence in the shares of a company. Also the PE ratio plays a significant role not only in the company itself, but on the industry in which it operates and, of course, on the level of the stock market, which tends to rise more than reported profits when the business cycle swings up and to fall more than profits in a downturn. Arithmetically, the ratio measures the number of years it would take to repay the share's current value in earnings. Based on the logic for hypothesis 2, we have developed our third hypothesis as below.

Hypothesis 3: Profitability of a firm depends on its age, its sales, and R&D investment

Data Set

All these hypotheses have been tested with the data from Indian companies. For this purpose, data has been taken from Prowess data base of CMIE (Centre for Monitoring Indian Economy) last accessed on 28th April, 2005. There were 9302 companies listed in the Prowess data base. Since some companies' data has not been available, we have analyzed only those companies whose financial data are available in Prowess. Our study was done from 1988 till 2004, spanning a period of 16 years. As far as R&D expenses are concerned, there are two types of R&D expenses that companies are involved in. R&D expenses on capital account are the capital expenses incurred by a company on research and development. R&D expenses on revenue account are the revenue expenses incurred by company on research and development. Many a times, being a relatively small amount, companies do not disclose revenue expenditure on research and development separately.

Table 1: Comparative analysis of R&D share of various ownerships groups

S.No.	Year	Total R&D in Rs. Crore	R&D share of Indian Business Groups in %	R&D share of Govt. Sector in %	R&D share of Private Indian Cos. in %	R&D share of Foreign Business Groups in %	R&D share of Private Foreign Cos. in %	R&D share of NRIs in %	R&D share of Joint Sector in %
1.	1988-89	38.2	34.1	60.8	0.0	4.5	0.7	0.0	0.0
2.	1989-90	63.8	42.8	39.5	0.0	5.5	12.2	0.0	0.0
3.	1990-91	119.3	20.4	56.5	2.4	3.0	11.9	5.8	0.0
4.	1991-92	275.8	37.1	50.3	1.8	3.7	7.2	0.0	0.0
5.	1992-93	477.9	45.4	26.6	4.1	10.1	11.3	1.2	1.4
6.	1993-94	593.1	53.8	22.1	5.1	7.2	10.0	1.4	0.3
7.	1994-95	940.2	57.8	18.8	6.1	7.5	7.3	2.2	0.3
8.	1995-96	1436.6	57.1	18.3	5.5	7.3	6.2	5.3	0.3
9.	1996-97	1957.7	50.6	17.8	4.5	5.6	6.8	14.3	0.4
10.	1997-98	1796.0	54.2	18.7	5.0	7.8	12.2	1.5	0.7
11.	1998-99	2703.9	68.2	15.2	3.7	4.3	7.6	0.6	0.5
12.	1999-00	2014.8	55.4	23.7	5.9	5.9	8.4	0.1	0.7
13.	2000-01	2431.5	54.1	22.4	7.1	4.3	10.5	1.5	0.3
14.	2001-02	2820.5	58.3	20.7	7.9	1.8	9.9	1.0	0.5
15.	2002-03	3647.9	51.8	29.7	7.3	2.2	7.7	0.9	0.4
16.	2003-04	4441.1	53.6	26.7	7.6	3.1	7.5	1.1	0.4

But, as a mandatory requirement (Companies Act, 1988), companies are required to disclose this information as part of the report of the Board of Directors. Money spent in the head of current account is taken as expenditure as per Indian accounting standard and hence companies do not pay any tax for that. Money spent in capital account is taken as investment like other assets and are depreciated over the life span of that asset.

In our analysis we have included only those companies in a particular year, if their details are available in Prowess data base. All these companies were segregated on the basis of ownership into eight categories. They are Government sectors, Indian Business Groups, Private Indians, NRIs, Foreign Business Groups, Private Foreign, Joint Sector, and Cooperatives. Since, cooperatives have very few companies; we have removed them from our analysis. As per NIC, there are 92 two digit codes (from 01 to 99) for industry segregation based on product classification. However some of the product classes do not have any companies. In fact there are only 65 product classes where at least one company has been listed. Out of these 65 categories, many of them do not have even ten companies in their list. So to avoid insignificant product categories, we have taken the company classifications based on Prowess grouping. Prowess has divided all the companies into 23 product classes. To get a more realistic figure, we have averaged last five years data available in Prowess. Appendix-4 gives a detail list of different sectors and R&D investment as a percentage of net sales.

Data Analysis and Hypotheses testing

In order to test our hypothesis, let us now look at the year-wise total R&D spent and the percentage share of different ownership groups as mentioned in Table 1, by the listed companies. It is obvious that the last twelve years investment of Indian Business Groups are more than all other ownership groups as far as R&D spending is concerned. In fact the R&D spending of Indian business groups alone is more than that of all other ownership groups put together. One may think business groups are of bigger size so they spend more money. In order to get a feel of the size of companies belonging to different ownerships, and have calculated the minimum, maximum, mean and standard deviation of net sales for all the seven ownership groups. As in the year 2002-03, details of maximum number of companies are available, and we have taken the sales figure for that year. It is clear from Appendix-2 that the government sector has the highest average sales as well as highest standard deviation. Indian business groups have highest co-efficient of variation, which means there are huge disparities among the companies belonging to this group. We have made com-

Table 2: Comparative analysis of R&D intensity of various ownerships groups

S.No.	Year	R&D Intensity of Indian Business Groups in %	R&D Intensity of Govt. Sector in %	R&D Intensity of Private Indian Cos. in %	R&D Intensity of Foreign Business Groups in %	R&D Intensity of Private Foreign Cos. in %	R&D Intensity of NRIs in %	R&D Intensity of Joint Sector in %
1.	1988-89	0.02	0.03	0	0.03	0.005	0	0
2.	1989-90	0.04	0.02	0	0.06	0.10	0	0
3.	1990-91	0.03	0.05	0.03	0.05	0.15	0.24	0
4.	1991-92	0.10	0.09	0.04	0.11	0.17	0	0
5.	1992-93	0.18	0.07	0.10	0.41	0.35	0.18	0.31
6.	1993-94	0.22	0.07	0.11	0.32	0.33	0.20	0.09
7.	1994-95	0.28	0.07	0.14	0.44	0.30	0.46	0.09
8.	1995-96	0.34	0.09	0.14	0.56	0.29	0.95	0.11
9.	1996-97	0.36	0.11	0.14	0.50	0.37	3.18	0.19
10.	1997-98	0.33	0.10	0.12	0.57	0.53	0.30	0.28
11.	1998-99	0.57	0.10	0.11	0.41	0.45	0.18	0.28
12.	1999-00	0.31	0.10	0.11	0.39	0.31	0.01	0.26
13.	2000-01	0.30	0.09	0.13	0.32	0.41	0.33	0.11
14.	2001-02	0.38	0.09	0.16	0.14	0.43	0.23	0.20
15.	2002-03	0.39	0.16	0.17	0.23	0.41	0.24	0.19
16.	2003-04	0.44	0.17	0.22	0.38	0.43	0.32	0.18

parative analysis of R&D intensity (Total R&D/Total Net Sales) in the Table-2.

We have now tested pair-wise for significant difference of R&D intensity of Indian Business Groups with all other ownership groups. Table-3 shows one of the paired t-Test result. It indicates R&D intensity for Indian business group is significantly higher than that of Govt. sector. Barring Private Foreign Companies, Indian Business Groups have significantly higher RDI compared to all other ownership groups. But in absolute R&D value, Indian Business Groups have very highest R&D spending.

Table 3: t-Test: Two-sample assuming unequal variances

	Variable 1	Variable 2
Mean	0.268125	0.088125
Variance	0.025136	0.00155
Observations	16	16
Hypothesized Mean Difference	0	
Degree of Freedom	17	
t Stat	4.407498	
P(T < =t) one-tail	0.000192	
t Critical one-tail	1.739606	
P(T < =t) two-tail	0.000385	
t Critical two-tail	2.109819	

Hence, based on the above analysis we conclude that our first hypothesis is true, which means business groups spend higher amount of money than all other ownership groups in R&D.

In order to test our second and third hypotheses, we have run regressions with the data from year 1997 onwards (as in prowess, stock prices are available from year 1997 onwards). We have developed panel data by including only those companies whose RDI is greater than zero, and in this way the total number of companies comes to 1063. In our model, we have kept the slope constant over all the dummies and the constant term alone varies for a firm depending upon the ownership and sector it represents. Age of firm is calculated by subtracting the year of incorporation from 2004. We have included six dummies to accommodate ownership effects and 21 dummies to include industry effect (Sector number 23 has been excluded since this sector has only 2 companies). PE ratio is calculated by dividing 365 days average closing stock price of a firm with the earning per share (EPS). Since we are including intercept term in our regression model, we have introduced one dummy less in order to avoid perfect collinearity (dummy variable trap).

The summary statistic of regression has been shown in Appendix-1. Let us make a few important observations about regression result.

- First, even though the F-test shows overall significance of the model is very high, yet the goodness of fit (R^2) value is poor. This means the model is not able to fully describe the R&D determinants over panel data. The factors like government tax incentives, which are not included in our explanatory variables, may be playing a bigger role in determining RDI.
- Second, sales has a negative and statistically significant coefficient that is quite robust to the choice of model specification. This means bigger companies spend lower percentage of their sales in R&D investment. Yet, the absolute value of their R&D will be higher than that of smaller companies.
- Third, PE ratio also has a negative and statistically significant coefficient. This indicates market in emerging market is still not incentivising R&D investment and price-earning ratio is negatively related with RDI. In fact market is penalizing the companies engaged in R&D which means market expects short term investment by the companies to increase profits.
- Fourth, firm age (AGE) is not statistically significant in determining RDI and it has very less impact on R&D investment. However, the positive coefficient indicates old firms are tending to invest little more in R&D than new firms.
- Finally, the most surprising result is that ownership and sector specific dummies are mostly insignificant. We suspected that since panel data contains data for 8 years, the effect of one year might have nullified in other years.

Based on the above results, it is proved that our second hypothesis is not true. This means R&D intensity of a firm depends on many other factors than those mentioned in the hypothesis.

Appendix-3 shows the average sales and profitable growth of all the ownership groups up to year 2003-04 which show a steady growth both in sales and profit. Indian business groups, Govt. sector, foreign business groups, and private foreign companies are more or less growing in a similar fashion (9% CAGR in Sales and 14% CAGR in PBIT). NRIs have done far better in sales growth (11%) than all other groups even though they spend the least on R&D. This indicates that they follow vigorous marketing strategies to compensate for low R&D investment. Growth Rate in R&D investment is highest among private Indian companies which is nearly 40 per cent. This means small companies think R&D investment will give them a competitive advantage. As shown in Appendix-4, we have calculated the R&D intensity for different sectors. As expected, the chemical sector is the highest R&D spender among all the sectors belonging to Indian business groups and R&D accounts for approx. 2 per cent of net sales. Among government owned companies, transport equipment sector commands highest R&D. Private Indian have no significant presence in any of the sectors.

It was observed that profitability models (ROCE and PE ratio) have failed to establish any relationship with R&D. The negative coefficient of R&D in determining PE indicates market penalizes companies who invest in R&D. But, as expected, sales are highly significant in determining PE. The positive coefficient indicates market rewards positively if a company has higher sales revenue. Age and even ownership and sectors have no effect on determining PE. As expected, sales are highly significant in determining ROCE and the positive coefficient indicates higher sales lead to higher ROCE. Age and R&D are not significant. Among the ownership dummies, Indian Business Groups and NRI have higher significance, but negative coefficient indicates the group affiliation does not improve ROCE. Many sector specific dummies are significant and this indicates some sectors are getting higher return than others for similar investments. These high return sectors are Transport Equipment, Chemical, Plastic, and Food; which are also R&D intensive sectors.

Based on the above discussion we conclude that hypothesis 3 is not true and the profitability of a firm does not depend on its R&D investment.

Managerial Implications

As far as regression results are concerned, we found sales and price-earning ratios of a company are highly significant in determining R&D intensity, but are inversely proportional. This means the Indian market is still not valuing investment in R&D, in general, as the right way of investment. Instead, the market is penalizing the companies and these companies have lower PE ratio (barring a few companies in specific sectors). The reason behind such an anomaly may be due to the poor patent regimes in India and market thinks companies engaged in R&D may not appropriate their investments due to rampant initiations by competing firms. Yet, a few sectors like Chemical, Transport equipment, Food, Rubber & Plastic market think R&D investment is mandatory as they are technology-intensive sectors and market penalizes them if they do not invest in R&D. But, the gestation period being very high (as high as 12 years for Pharmaceutical products), the reward for R&D investment comes with a time lag. Managers must understand this market behaviour.

Conclusions

We have concluded that Indian Business Groups are the maximum spenders of R&D among all the ownerships groups. These groups are also present in almost all the sectors and they are engaged in R&D in most of the sectors. The reason for their presence could be attributed to the lack of financing sources for R&D projects in India, as the innovative projects are inherently high risk. Indian Business Groups are able to fund their projects properly as they have high profits and even a small percentage of that money will be enough to feed R&D activities. Since Indian Business Groups have a presence in many sectors, the risk of failures can be evened out.

The Indian market is still not valuing investment in R&D as the right way of investment; instead, the market is penalizing the companies. This can be seen from investment of NRIs who are not big R&D spenders. Yet, they have achieved higher CAGR in sales as well as in profits. This also indicates that R&D investment is not the only way to run a successful business. Other types of innovation in terms of marketing, business models etc. can help companies to grow faster.

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Appendix 1: Empirical result of panel data (for 8 years) Sample: 1997 2004

Dependent Variable: RDI
Method: Panel Least Squares Cross-sections included: 1063

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.098013	0.029106	3.367392	0.0008
AGE	0.000102	0.00012	0.848116	0.3964
LOGSALES	–0.01748	0.001779	–9.82828	0
PE	–4.06E-05	5.40E-06	–7.52499	0
ODUMGOVT (Govt. Sectors)	0.034677	0.026498	1.308658	0.1907
ODUMINDBG (Ind. Business Groups)	0.003617	0.023349	0.154912	0.8769
ODUMPVTIND (Private Indians)	–0.00568	0.02382	–0.23835	0.8116
ODUMFORBG (Foreign Business Groups)	0.009149	0.027226	0.336027	0.7369
ODUMPVTFOR (Private Foreign)	–8.43E-05	0.024263	–0.00347	0.9972
ODUMNRI (NRI companies)	–0.00061	0.031592	–0.01917	0.9847
IDUMANIMP (Animal products)	–0.01674	0.041481	–0.40354	0.6866
IDUMAGRIP (Agri products)	–0.01237	0.02358	–0.52441.	0.6
IDUMMINEP (Mineral products)	0.011564	0.020612	0.561011	0.5748
IDUMFATS (Fats & oil)	–0.00835	0.028566	–0.29224	0.7701
IDUMFOOD (Food beverage & Tobacco)	–0.01314	0.017053	–0.77027	0.4412
IDUMTEXT (Textiles)	–0.01296	0.015924	–0.81354	0.4159
IDUMLEATH (Leather products)	–0.00983	0.037193	–0.26426	0.7916
IDUMWOODP (Wood products)	–0.02293	0.043591	–0.52596	0.5989
IDUMPULP (Pulp & paper products)	–0.01644	0.020409	–0.8055	0.4206
IDUMCHEM (Chemical sector)	0.001935	0.014502	0.133413	0.8939
IDUMPLAST (Plastic & Rubber)	0.019042	0.016456	1.157164	0.2473
IDUMNONMET (Non-metallic products)	–0.01424	0.017236	–0.82587	0.4089
IDUMBASEMET (Base metals)	0.000435	0.0168	0.025871	0.9794
IDUMNONEM (Non-electrical machinery)	–0.00925	0.016069	–0.57558	0.5649
IDUMELECM (Electrical machinery)	–0.01398	0.016294	–0.85766	0.3911
IDUMELECT (Electronics)	0.017834	0.016253	1.097289	0.2726
IDUMTRANSP (Transport equipments)	–0.00282	0.015894	–0.17734	0.8593
IDUMMISCMFG (Misc. manufacturing)	–0.01907	0.029111	–0.6551	0.5124
IDUMCONST (Construction)	–0.00458	0.03353	–0.13672	0.8913
IDUMENERGY (Electricity & energy)	0.002052	0.028817	0.071222	0.9432
IDUMSERVICE (Service)	–0.00314	0.020673	–0.15165	0.8795
R-squared	0.037565	Durbin-Watso stat		0.659482
Adjusted R-squared	0.031978	Akaike info criterion		–0.75585
S.E. of regression	0.165326	Schwarz criterion		–0.71676
Sum squared resid	141.2556	F-statistic		6.723719
Log likelihood	1995.827	Prob (F-statistic)		0

Appendix 2: Mean, Max, Min Sales, Standard Deviation and co-efficient of variation of Sales different ownership groups in the year 2002-03

S.No.	Ownership Type	Maximum Net Sales in Rs. Crore	Minimum Net Sales in Rs. Crore	Mean Net Sales (m) in Rs. Crore	Std Deviation (s) of net sales in Rs. Crore	Co-efficient of Variation (s/m)
1.	Indian Business Group	60088.7	–0.32	223.1	1434.6	6.44
2.	Government Sector	110784.8	–0.12	1848.7	7426.5	4.02
3.	Private Indians	3617.3	–0.85	38.5	118.1	3.07
4.	Foreign Business Group	10148.5	0	486.6	1402.6	2.88
5.	Private Foreign	7263.5	0	211.6	552.2	2.61
6.	NRIs	4338.9	0	295.2	788.3	2.67
7.	Joint Sector	2562.6	0	314.2	632.5	2.01

Appendix 3: Comparative analysis of Average Net Sales and Average PBIT (in brackets) of various ownership groups in Rs. Crore

S.No.	Year	Indian Business Groups	Govt. Sector	Private Indian Cos.	Foreign Business Groups	Private Foreign Cos.	NRIs	Joint Sector
1.	1988-89	70 (4)	533 (73)	18 (1.4)	132 (12)	59 (7)	64 (5)	117 (16)
2.	1989-90	82 (10)	515 (85)	21 (1.8)	131 (14)	66 (9)	98 (8)	145 (22)
3.	1990-91	79 (11)	565 (118)	19 (1.8)	146 (17)	70 (11)	98 (9)	134 (23)
4.	1991-92	87 (13)	681 (154)	19 (2.1)	174 (21)	82 (14)	87 (11)	176 (32)
5.	1992-93	88 (13)	711 (162)	18 (2.4)	203 (32)	88 (17)	96 (10)	176 (29)
6.	1993-94	96 (15)	716 (162)	16 (2.2)	215 (32)	93 (21)	120 (14)	138 (24)
7.	1994-95	112 (19)	876 (213)	16 (2.5)	242 (37)	107 (23)	100 (14)	157 (28)
8.	1995-96	132 (24)	973 (235)	20 (3.0)	262 (43)	138 (32)	158 (29)	180 (39)
9.	1996-97	143 (24)	1099 (286)	21 (3.2)	305 (51)	150 (35)	157 (30)	193 (35)
10.	1997-98	151 (24)	1164 (326)	24 (3.4)	304 (50)	156 (35)	145 (25)	187 (27)
11.	1998-99	153 (24)	1319 (359)	27 (3.5)	318 (52)	155 (32)	171 (24)	190 (23)
12.	1999-00	170 (26)	1510 (384)	30 (4.1)	356 (62)	171 (33)	183 (25)	222 (19)
13.	2000-01	198 (28)	1761 (404)	35 (4.1)	370 (75)	185 (35)	202 (23)	231 (25)
14.	2001-02	194 (24)	1739 (445)	33 (4.3)	411 (91)	197 (36)	225 (22)	248 (14)
15.	2002-03	223 (30)	1849 (498)	38 (4.7)	487 (114)	212 (39)	295 (33)	314 (22)
16.	2003-04	298 (43)	2647 (687)	50 (7.2)	608 (156)	286 (54)	382 (44)	568 (75)
CAGR - up to 2002-03 in %		8 (14)	9 (14)	5 (8)	9 (16)	9 (12)	11 (13)	7 (2)

Appendix 4: Total Number of Companies and Total R&D as a percentage (%) of Net Sales (figure inside the bracket)-Average figure of last five year data

Sector Ownership	Indian Business Groups	Govt. Sector	Private Indian Co.	Foreign Business Groups	Private Foreign Co.	NRI Co.	Joint Sector
Animal products	3 (0.2)		7 (0.03)				
Agri Products	48 (0.24)	3 (0.03)	123 (0.02)	5 (0.29)	5 (0)	2 (0.08)	
Mineral Products	30 (0.12)	34 (0.08)	63 (0.05)		9 (0.31)	1 (0.32)	1 (0)
Fats & oil and derived products	21 (0.01)	2(0)	92 (0.03)	2 (0)	2 (0.03)		1 (0)
Food beverages & tobacco	91 (0.11)	4 (0)	146 (0.10)	5 (0.35)	10 (0.1)	10 (0)	2 (0)
Textiles	190 (0.1)	15 (0.15)	369 (0.03)		6 (0.32)	4 (0.01)	1 (0)
Leather Products	8 (0.05)	1 (0)	28 (0.02)	1 (0)	1 (0.45)		
Wood Products	5 (0.09)		13 (0)				
Pulp & paper products	44 (0.07)	7 (0.15)	98 (0.07)	2 (0.04)	3 (0)		
Chemicals	210 (1.5)	21 (0.06)	347 (0.95)	17 (0.33)	45 (0.83)	4 (0.16)	7 (0.22)
Plastic & Rubber	83 (0.31)	3 (0.08)	182 (0.05)	1 (0)	13	(0.19)	2 (0.03)
Non metallic mineral products	84 (0.16)	5 (0.02)	110 (0.01)	1 (0)	9 (0.18)	2 (0.11)	1 (0)
Base Metals	150 (0.09)	13 (0.58)	278 (0.02)		12 (0.05)	3 (0.05)	2 (0)
Non-electrical Machinery	83 (0.56)	13 (0.01)	82 (0.35)	4 (0.05)	35 (0.67)	4 (0.17)	2(0)
Electrical machinery	69 (0.20)	5 (0.23)	92 (0.17)	7 (0.61)	15 (0.26)		
Electronics	133 (0.49)	10 (3.3)	261 (0.52)	7 (0.44)	37 (0.5)	2 (0)	1 (0)
Transport Equipment	118 (1.02)	14 (2.74)	78	(0.28)		15 (0.64)	3 (0.91)
Misc. manufg. articles	7 (0.40)	1 (0.59)	29 (0.55)		3 (0.03)		
Construction & allied activities	58 (0.009)	7 (0.003)	105 (.002)		2 (0.06)		2 (0)
Electricity & non-conv. energy	27 (0.03)	16 (0.03)	7 (0)		2 (0)	2 (0)	
Services	639 (0.02)	162 (0.002)	1351 (0.006)	27 (0.004)	95 (0.01)	11 (0)	4 (0)
Diversified	40 (0.12)	2 (0.29)	8 (0.04)	1 (0.28)	2 (0.63)		
Irrigation		2 (0)					

Feature

Production Structure in the Indian Manufacturing: A Translog Approach

S. Venkata Seshaiah & I.R.S. Sarma

In this paper an attempt is made to analyze the production structure of the Indian manufacturing sector. This is done by estimating a translog production function in which capital, labour, energy, materials and liberalization index (a proxy for technology, reduced trade restrictions, technology penetration) are the input determinants. The results reveal that the post-liberalization growth in productivity is less than that of pre-liberalization productivity growth.

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Much work has been done by researchers to analyze productivity trends. The productivity growth in the Indian manufacturing sector in the post-reform period became a debatable issue. Some recent studies for example Unil (2003), Tata Service Limited (TSL) (2003), concluded that the post-reform period of productivity growth is greater than that of the pre-liberalization period. Bishwanath Goldar (2004) concluded that the post-liberalization period of growth in total productivity was less than in the pre-liberalization period. Most of the researchers used time variable as the factor that captures the technology.

In this paper liberalization is regarded to be the right proxy that captures technology transfer, knowledge transfer, R&D expenditure, reduction in trade barriers and reductions in capital controls or other barriers. The proxy used is the import penetration ratio of imports to GDP as a more direct measure of own-country economic liberalization. This reflects the degree to which trading barriers in the country have fallen (Mansori, 2001). Thus a higher import penetration should be an indicator of the degree of economic liberalization in a country. As the country reduces trade restrictions, it is expected that the import penetration ratio rises, which would help the manufacturing sector import new technology or lead to innovations. In this paper the liberalization index has been used as one of the independent variables and factors have been identified that have influenced the productivity before liberalization, after liberalization and overall. Keeping in view the above studies and research gaps especially after liberalization, the first objective of the study is to examine the Divisia Productivity trends before and after liberalization in the Indian manufacturing sector; the second objective is to identify the factors that influence the Total Factor Productivity before and after liberalization; the third objective is to estimate the Translog Production Function and to find the substitutability between factor inputs.

The required data for the period 1970-2003 on the variable gross output, capital, labour, energy and material consumed have been collected from Annual Survey of Industries (ASI) 1993-94 as the base period. The data on imports and GDP was collected from RBI. Using appropriate deflation techniques the data is transformed to constant prices.

Review of Literature

Traditionally, the estimation of an economy's production function has allowed for the influence of the technological change using time as one of the independent variables. The studies were mainly aimed at analyzing the contributory factors of output growth, returns to scale, partial and total factor productivity indices, technical progress, elasticity of substitution etc.

Sengupta (1963) using ordinary least squares fitted a fist degree homogeneous CES production function to seven industries for the period 1948-1958 to test for two hypotheses:

1. Elasticity of substitution equals to zero and
2. Elasticity of substitution equals to one, separately

Sankar (1970), observed evidence of economies of scale estimating the constant elasticity of substitution Kazi (1980) using cross section data for the years 1773, 1974 and 1975 estimated CES function. The estimates are obtained VES and CES suggested that it varies between industries. Ragbendra Jha, et. al. (1991) have analyzed cement, electricity, iron and steel and cotton textiles and have found evidence of substitution possibilities among factors of production in these industries. Their estimates of elasticity of substitution reveal that capital can be easily substituted by labour and/or EM in all the industries except cotton textiles, implying that capital cannot be said to be the factor constraining growth of output, except in cotton textiles. Unel (2003) has observed an accelerated total factor productivity (TFP) growth in the Indian manufacturing sector and Tata Service Limited (TSL) (2003), observed a faster growth in TFP in Indian manufacturing sector. Bishwanath (2004), contradicting the studies of Unel (2003) and Tata service Limited (2003), concluded that the TFP growth in the post-reform period has come down compared to the pre-reform period. The author has analyzed the growth in employment and output in India's organized manufacturing sector since the mid-nineties and observed growth in employment in this period.

Methodology

Several methods have been suggested for the measurement of total factor productivity such as Kendrick, Solow and Divisia. Most of the studies in India on total factor productivity have used Kendrick's, Solow's and CES indices. In our study we have used the Divisia index to measure the total factor productivity. We followed the procedure adopted by Dorgenson and Griliches (1967) and Christensen and Dorgenson (1969). However, their analysis contained only two factors of production only. Even though further studies used three inputs or four inputs such as capital, labour, energy and material consumed, to our knowledge nobody has used liberalization of the economy as one of the inputs that captures the technology, Knowledge transfer, market expansion, R&D etc. Hence in our study we have used liberalization of the economy as one of the inputs apart from capital, labour, energy and materials.

The Divisia index of total factor productivity (D) is given by

$$D = Y/X \qquad ...(1)$$

Where Y is the Divisia quantity index of output and X denotes Divisia index of total factor input. This is obtained by aggregating the Divisia indices of labour, capital, energy, materials and liberalization of the economy. From the above we get

$$D \cdot /D = (Y \cdot /Y) - (X \cdot /X) \qquad ...(2)$$

The rate of growth of total factor productivity is, therefore, derived as the difference between the rate of growth of output and the rate of growth of total factor input.

We can compute the Divisia index of total factor productivity by the following procedure:

$$\Delta A_t / A_t = (\Delta Q_t / Q_t) - [M_k (\Delta K_t / K_t) + M_L (\Delta L_t / L_t) + M_E (\Delta E_t / E_t) + M_M (\Delta K_t / K_t) + M_0 (\Delta K_t / K_t)] \qquad ...(3)$$

$$\overline{M}k = \tfrac{1}{2} [M_{k,t+1} + M_{k,t}]$$

$$\overline{M}_L = \tfrac{1}{2} [M_{L,t+1} + M_{L,t}]$$

$$\overline{M}_E = \tfrac{1}{2} [M_{E,t+1} + M_{E,t}]$$

$$\overline{M}_M = \tfrac{1}{2} [M_{M,t+1} + M_{M,t}]$$

$$\overline{M}_0 = \tfrac{1}{2} [M_{0,t+1} + M_{0,t}]$$

Where M_K M_L, M_E, M_M and M_{LI} are the shares of Capital, Labour, Energy, Materials and liberalization of the economy. The total productivity, A_{t+1} is, then derived by the following relationships.

$A_{t+1} = A_t (1+[\Delta A_t/A_t])$ where base year $A_t = 1$

Translog Production Function

The majority of studies on production function estimation for Indian industries have used the Cobb-Douglas (CD) functional form, Constant Elasticity of Substitution (CES), the Variable Elasticity of Substitution (VES). The Cobb-Douglas and Constant Elasticity of Substitution (CES) place a restriction on elasticity of substitution, whereas the Translog function allows for variability of Allen partial elasticities of substitution and allows any number of inputs.

Consider the general case of a production function with five inputs

$$Q = F(K, L, E, M, O) \quad ...(4)$$

Where

K = Capital, L = Labour, E = Energy, M = Materials and O = liberalization of the economy, then Translog Production Function becomes,

$$\begin{aligned} ln\, Q = {} & \alpha+\alpha_\kappa\, ln\, K+\alpha_L ln\, L+\alpha_E\, ln\, E+\alpha_M\, ln\, M+\alpha_0\, ln\, O \\ & +\tfrac{1}{2}\beta_{KK}\,(ln\, K)^2+\beta_{KL}\,(ln\, K)(ln\, L)+\beta_{KE}\,(ln\, K)(ln\, E) \\ & +\beta_{KM}\,(ln\, K)(ln\, M)+\beta_{KO}\,(ln\, K)(ln\, O)+\tfrac{1}{2}\beta_{LL}\,(ln\, L)^2 \\ & +\beta_{LE}\,(ln\, L)(ln\, E)+\beta_{LM}\,(ln\, L)(ln\, M)+\beta_{LO}\,(ln\, L)(ln\, O) \\ & +\tfrac{1}{2}\beta_{EE}\,(ln\, E)^2+\beta_{EM}\,(ln\, E)(ln\, M)+\beta_{EO}\,(ln\, E)(ln\, O) \\ & +\tfrac{1}{2}\beta_{MM}\,(ln\, M)^2+\beta_{MO}\,(ln\, M)(ln\, O)+\tfrac{1}{2}\beta_{OO}\,(ln\, O)^2 \end{aligned} \quad ...(5)$$

Under perfect competition assumption, output elasticity with respect to input equals to factor share of that input. Thus, we can get a system of equations from differentiating the translog production function with respect to each factor input,

$$M_K = \alpha_K+\beta_{KK} ln\, K+\beta_{KL} ln\, L+\beta_{KE} ln\, E+\beta_{KM}\, ln\, M+\beta_{KO}\, ln\, O$$

$$M_L = \alpha_L+\beta_{LK} ln\, K+\beta_{LL} ln\, L+\beta_{LE}\, ln\, E+\beta_{LM}\, ln\, M+\beta_{LO}\, ln\, O$$

$$M_E = \alpha_E+\beta_{EK}\, ln\, K+\beta_{EL}\, ln\, L+\beta_{EE}\, lnE+\beta_{EM}\, lnM+\beta_{EO}\, ln\, O$$

$$M_M = \alpha_M+\beta_{MK} lnK+\beta_{ML} lnL+\beta_{ME}\, lnE+\beta_{MM}\, lnM+\beta_{MO}\, lnO$$

$$M_O = \alpha_O+\beta_{OK} lnK+\beta_{OL} lnL+\beta_{OE}\, lnE+\beta_{OM}\, lnM+\beta_{OO}\, lnO$$

The liberalization of the economy which is permitted not only alters the existing shares, but also adds additional equations to the system. After adding an error term to the translog production function (5) given the above, it can be estimated by the OLS technique. But, as the sum of five factor shares is sum to unity, a non zero contemporaneous covariance between the disturbances of the two share equations can be expected. Due to the presence of contemporaneous correlation the Ordinary Least Squares (OLS) estimates are not efficient. The more efficient estimates of the parameters would be obtained by estimating jointly with the share equations by imposing symmetry restrictions on parameters as

$$\beta_{ij} = \beta_{ji}$$

For Constant Returns to Scale we impose the following restrictions

$$\sum \alpha_i = 1 \text{ and } \sum \beta_{ji} = 0$$

We can measure the curvature of isoquant by estimating Allen Partial Elasticities of Substitution for pair factor of inputs. It will be estimated from the above translog cost function by the formula

$$C = AES_{ij} = \sigma_{ij} = |C_{ij}|/|C|$$

where i and j represent inputs, |C| is the determinant of bordered Hessian of the estimates and $|C_{ij}|$ is the cofactor of C_{ij} is the Matrix C. By Shephard duality, we can get ASE from estimated parameters of cost function and fitted estimated cost share of inputs as follows

$$\sigma_{ij}=(a_{ij}+S_i\, S_j)/(S_i\, S_j)$$

$$\sigma_{ij}=(a_{ii}+S_i^{\,2} - S_i)/(S_i^{\,2})$$

Where a_{ii} represent the estimated second order derivatives on the diagonal of Hessian Matrix. a_{ij} represent parameter estimated of elasticities of output share with respect to price of factor input service. S_i and S_j are the fitted output share of inputs substitutability among factor of production.

Results and Discussion

The Divisia total factor productivity, Labour productivity, Capital productivity indices and the capital intensity are reported in Table 1. The growth rates of Labour productivity, capital probability, capital intensity and Divisia indices of Indian manufacturing sector before and after liberalization and the overall growth of labour productivity, capital productivity and total productivity are reported in Table 2. The factors that have influenced the productivity results are reported in Table 3.

Table 1: Divisia Total Productivity and Partial Factor Productivity of Labour, Capital and Capital Intensity

Year	Divisia Index	Labour	Capital	Capital Intensity
1971	100	19	46	41
1972	104	19	51	38
1974	112	21	59	36
1975	142	27	88	31
1976	145	28	89	31
1977	139	28	79	35
1978	142	28	73	39
1979	147	30	72	41
1980	161	33	88	37
1981	176	38	105	36
1982	183	41	103	40
1983	192	45	101	45
1984	180	47	92	51
1985	182	49	93	52
1986	185	54	94	57
1987	187	55	89	62
1988	187	56	90	63
1989	202	62	97	64
1990	206	68	102	67
1991	214	74	99	75
1992	233	81	103	79
1993	267	92	100	92
1994	284	100	100	100
1995	282	107	97	110
1996	287	111	96	116
1997	290	112	89	125
1998	317	122	95	129
1999	342	129	96	134
2000	348	145	103	141
2001	343	146	105	139
2002	342	151	100	150
2003	493	161	106	152

It may be observed from Table 2 that the growth rate of labour productivity, capital productivity, capital intensity in the pre-liberalization period are greater than that of the post-liberalization period. All the pre-liberalization growth rates of partial factor productivity are significant whereas in post-liberalization the labour productivity and capital intensity are significant. In general growth in labour productivity, capital intensity has increased whereas the capital productivity and total productivity decreased. All the overall growth rates are significant at 5% level.

Table 2: Growth Rates

	Pre-Liberalization	Post-Liberalization	Overall
Labour Productivity	7.05 (28.63)	6.15 (20.5)	7.05 (66.6)
Capital Productivity	3.12 (4.55)	0.2828^{NS} (0.73)	1.48 (5.125)
Capital Intensity	3.92 (7.48)	5.83 (12.54)	5.56 (22.41)
Divisia Indices	5.20 (10.013)	4.95 (8.080)	4.10 (14.794)
	Coefficient of Variation		
	Pre-Liberalization	Post-Liberalization	Overall
Labour Productivity	0.3727	0.2246	0.6112
Capital Productivity	0.1985	0.0449	0.1659
Capital Intensity	0.2537	0.2093	0.5343
Divisia Indices	0.1966	0.2139	0.3964

Figures in parenthesis are t-values
'NS' Indicates not significant

Table 3: Regression Coefficients of independent variables with Divisia Productivity as dependent variable

	X1	X2	X3	X4
	Pre-Liberalization			
X4 Dropped	4.590^{NS} (1.554)	0.483 (1.993)	0.236^{NS} (1.100)	
X3 Dropped	4.161 (2.025)	0.572 (4.322)		–0.195 (2.741)
	Post-Liberalization			
X4 Dropped	2.157^{NS} (0.445)	0.109^{NS} (0.3)	-0.499^{NS} (1.830)	
X3 Dropped	2.267^{NS} (0.343)	0.177^{NS} (0.301)		0.409^{NS} (0.770)
	Overall			
X4 Dropped	5.375^{NS} (1.513)	0.129^{NS} (0.506)	-0.334^{NS} (1.924)	
X3 Dropped	9.037 (2.792)	0.719 (3.301)		-0.213^{NS} (1.204)

Figures in parenthesis are t-values
'NS' indicates Not Significant

Though the total productivity growth in the pre-liberalization period is greater than the post-liberalization growth, there is a negligible difference. Hence an attempt was made to identify the factors that have in-

fluenced total productivity, decomposing the entire period into pre-liberalization (Since the required data was not available for the period 1970-1990, we considered 1980- 1990 as pre-liberalization period) and 1991-2003 as the post-liberalization period, and overall 1980-2003. The following function in log-linear form has been estimated for all the three periods.

$$Productivity = F(X_1, X_2, X_3, X_4)$$

The divisia index of productivity is used as the dependent variable. Where,

X_1 = is output

X_2 = is the salaried employees as percentage of total work force.

X_3 = is the average wage rate of productivity workers and

X_4 = is the average wage rate of all employees.

And also X_2, represents the level of entrepreneurial skills, X_3, the average skill level of productivity workers and X_4 the average skill level of all workers. As the two variables X_3 and X_4 are highly correlated, they are used alternatively. The results are presented in Table III.

The co-efficient of output has a positive sign in all the periods; however it is significant only in the pre-liberalization period and overall period when X_3 is dropped.

The coefficient of entrepreneurial skill ratio has a positive sign. It is low in all the periods and is significant only in the pre-liberalization period. The contribution of the skill ratio is positive and insignificant in the pre-liberalization period whereas it is negative and significant in the post-liberalization as well as in the overall period. This indicates that in the Indian manufacturing sector the skill of the managerial staff engaged as a result of modernization of the industries is poor in quality. That is, the managerial staff may not be having much required skill for running the industries especially after liberalization, or because of higher salaries in the service sector the talented managerial staff shifted to the service sector and in turn the low level skill managerial staff must have continued in industries, or the post-liberalization policies would have not helped the Indian manufacturing sector. These could be the some of reasons for low level skills of the managerial staff.

The contribution of average skill levels of workers on productivity was negative before liberalization as well as in the overall period, whereas it is positive and insignificant in the post-liberalization period. This indicates that the supply of the industrial skill has not kept pace with the increased demand.

The parameter estimates of the translog production function with symmetry CRTS imposed for pre-liberalization and post-liberalization are presented in Table 4. It may be observed from the table that the marginal productivity of Capital and Labour are positive and significant in both pre-liberalization as well in post-liberalization period. In fact the marginal productivity of capital and labour in post-liberalization period is less than that of the pre-liberalization period. This might be due to the low level skills of managerial staff.

Table 4: Parameter Estimates of Translog Production Function with Symmetry-CRTS imposed

	Pre-Liberalization		Post-Liberalization	
	Parameter Value	t-value	Parameter Value	t-value
β_{kk}	0.1688	2.58	0.1595	77.25
β_{kl}	0.0448	2.16	0.003^{NS}	1.48
β_{ke}	–0.1068	3.16	–0.0699	48.79
β_{km}	–0.0997	3.64	–0.0589	33.31
α_k	0.2924	3.4	0.1850	14.27
β_{ll}	0.0274	2.66	0.0229	7.78
β_{le}	–0.0413	3.22	–0.0066	3.57
β_{lm}	–0.0277	2.46	–0.0049	2.24
α_l	0.1474	3.29	0.0827	4.28
β_{ee}	-0.031^{NS}	1.29	–0.0908	51.57
B_{em}	0.2069	11.17	0.1900	121.03
α_e	0.1789	2.23	0.2323	19.89
β_{mm}	–0.0711	3.87	–0.1028	29.16
α_m	0.2196	2.93	0.2486	16.48
β_{oo}	0.0141^{NS}	0.29	0.0636	16.64

'NS' indicates Not Significant

The contribution of average skill levels of workers on productivity was negative before liberalization as well as in the overall period, whereas it is positive and insignificant in the post-liberalization period. This indicates that the supply of the industrial skill has not kept pace with the increased demand.

The parameter estimates of the translog production function with symmetry CRTS imposed for pre-liberalization and post-liberalization are presented in Table 4. It may be observed from the table that the marginal productivity of Capital and labour are positive and significant in both pre-liberalization as well in post-liberalization period. In fact the marginal productivity of

capital and labour in post-liberalization period is less than that of the pre-liberalization period. This might be due to the low level skills of managerial staff. Surprisingly the marginal productivity of energy and material consumed are negative in both the pre-liberalization and post-liberalization period, except the marginal productivity of energy in the pre-liberalization period remaining are significant. This might be due to the fact that the power supply could not match the demand for energy in the manufacturing sector. The negative marginal productivity of material consumed might be due to the over-utilization of fixed input or due to the depreciation policies. It is observed that the influence of liberalization of the economy in pre-liberalization period is not statistically significant whereas it is statistically significant in the post-liberalization period, but the influence is negligible.

Elasticities of Substitution

In order to measure the possibilities of substitution among the factor inputs, we have computed the Allen partial elasticities of substitution σ_{ij} and price elasticities σ_{ij} . The estimates of the elasticities of substitution and price elasticities are reported in Table 5. It is observed from the table that the capital and labour are substitutable in pre-liberalization period as well as in the post-liberalization period whereas capital and energy, capital and materials are substitutes in both the periods. It is observed that the labour and energy, and labour and materials are complements in pre-liberalization period and they are substitutes in the post-liberalization period. The energy and materials are substitutes in both the periods. The own price elasticity of capital is elastic in both periods. However it is highly elastic in the post-liberalization period compared to the pre-liberalization period. The own price elasticities of energy, material consumed are inelastic in both the periods and in the post-liberalization period they are highly inelastic compared to the pre-liberalization period. The own price elasticities of energy, material consumed are inelastic in both the periods and in the post-liberalization period they are highly inelastic compared to the pre-liberalization period. Though the own price elasticity of capital is highly elastic and price sensitive, the total factor productivity and labour productivity is low in the post-liberalization period. This might be due to the highly inelastic nature of energy, materials consumed. The own price elasticities of labour is negative in both the periods, indicating that the demand curve for energy is downward slopping. Further the price elasticities of labour demand is inelastic in pre-liberalization period and it is highly elastic in the post-liberalization period indicting price sensitiveness of the labour.

Table 5: Estimates of Allen Elasticities of Substitution between pairs of inputs at the sample mean level

	Pre-Liberalization	Post-Liberalization
σ_{kl}	5.89	4.59
σ_{ke}	–3.99	–8.93
σ_{km}	–4.08	–8.71
σ_{le}	–1.32	1.05
σ_{lm}	–1.47	1.03
σ_{em}	–2.67	5.22
Own Price Elasticities between pairs of Inputs		
	Pre-Liberalization	Post-Liberalization
σ_{kk}	1.3022	3.1667
σ_{ll}	–0.6444	–1.2735
σ_{ee}	0.2650	0.6766
σ_{mm}	0.2270	0.5491

Summary and Conclusion

In this paper we made an attempt to analyze the productivity trends before and after liberalization using Divisia index methodology. We also calculated the labour productivity, capital productivity and capital intensity. We also identified the factors that have influence the productivity before and after liberalization. Most of the studies used time variable as factor that captures the technology. In our study we have used liberalization of the economy as one of the independent inputs that captures technology, knowledge transfer, R&D expenditure. The liberalization of the economy is calculated as the ration of imports to GDP. Using symmetry CRTS restrictions we have estimated the translog production function and then we have estimated the Allen elasticities of substitution. The results revealed that the post-liberalization growth in productivity is less than that of pre-liberalization productivity growth. The results are consistent with the results of Biswanath Goldar (2004) and inconsistent with Unel (2003) and Tata service limited (2003). The growth in labour productivity and capital productivity is lower in the post-liberalization period compared to the post-liberalization period, whereas the capital intensity growth in the post-liberalization period is greater than that of the pre-liberalization period. The contribution of the skill ratio is positive and insignificant in the pre-liberalization period whereas it is negative and significant in the post-liberalization as well as in the overall period. This indicates that in the Indian manufacturing sector the skill of the managerial staff engaged as a result of modernization of the industries is poor in quality. Here our intuition has directed us to conclude that liberalization policies have not helped the manufacturing sector

much. The own price elasticities of labour is negative in both the periods, indicating that the demand curve for energy is downward slopping. Further the price elasticities of labour demand is inelastic in the pre-liberalization period and it is highly elastic in the post-liberalization period indicating price sensitiveness of the labour.

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The common idea that success spoils people by making them vain, egotistic, and self-complacent is erroneous; on the contrary, it makes them, for the most part, humble, tolerant, and kind.

– Somerset Maugham

Feature

Improving the Quality and Productivity Using Six Sigma Methodology: A Case Study

N. Gunasekaran, V.P. Arunachalam, M. Shanmugaraja & S.R. Devadasan

Six Sigma quality is the focus of various industries to be globally competitive. This paper discusses the quality and productivity improvement in small and medium enterprises (SMEs) through a case study. The sigma quality level has been improved to 3.65 σ using Taguchi's DOE technique in the second phase of its implementation.

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The manufacturing scenario has started changing all over the world with the concept of globalization. Third world countries like India are suffering due to the inefficiencies that dog their industries. The companies in India began their quality race with the ISO 9000 standards, which provide a framework for showing how to conduct business, train employees, keep records and fix defects. The true success of the companies does not lie only with ISO 9000 certification but also with the way they adopt the concepts like TQM, JIT, TPM and many other tools. Although these standards look good there are gaps as well. The companies started closing the gaps by using the concept of SIX SIGMA which was implemented with varied degrees of success in Indian units of Closer Home, Motorola and GE (Lulla, 2000). Six Sigma demands a cultural renaissance. One cannot implement Six Sigma in an organization where there is a culture of fear or where there are too many hierarchies. Basu (2004) stressed that there is a need for tools and techniques to achieve operational excellence in organizations. The issues of implementing Six S'igma in an industry have been focused in this paper.

Six Sigma – an overview

Sigma (σ) is a Greek alphabet which represents standard deviation of processes. Normally, 3σ limits are followed and it includes 99.73% of area in a normal curve for product/process quality control. The product/process quality could be improved by reducing the value of 'σ' and limits could be set at 6σ which accounts for only 3.4 defects out of one million products even with a mean shift of 1.5σ. Robert Galvin, in 1987, introduced the concept of Six Sigma. And success in his company 'Motorola', led to implementation of Six Sigma in IBM, DEC and Texas instruments. Six Sigma is viewed as a Systematic, Scientific, Statistical and Smarter (4S) approach for management innovation, which is quite

suitable for use in knowledge-based information society (Breyfogle, 1999). Harry (1998) says that it is a strategic initiative to boost profitability, increase market share and improve customer satisfaction through statistical tools. Park et al. (1999) believes that six sigma is a new paradigm of management innovation for company survival in this 21st century, which implies three things: Statistical Measurement, Management Strategy and Quality Culture. Park (2003) states that a rapid dissemination took place in non-electronic industries all over the world after 1995. Lulla (2000) described that Samsung SDI made cost savings up to US $150 million by implementing Six Sigma projects. The competition in quality and productivity has been ever increasing and the customer has all-mighty power in e-business environment (De et al., 2001 & Pant and Hsu, 1996).

Normal Curve

The probability density function (PDF), f(x) of a normal distribution is

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}\left[\frac{x-\mu}{\sigma}\right]^2}$$

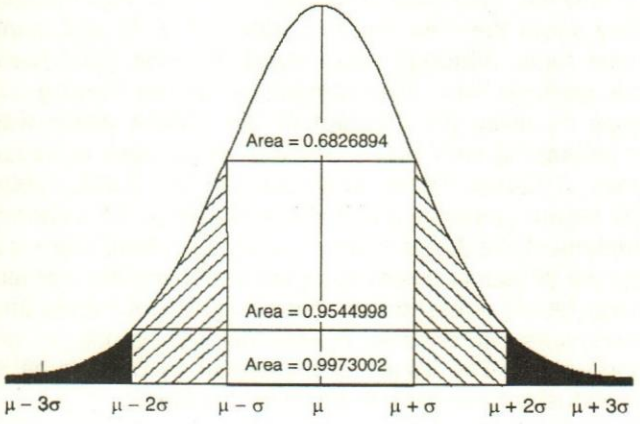

Fig. 1. Normal Curve

where we usually denote X~N ($\mu\sigma^2$) and it can be converted into a standard normal variable Z ~ N (0,1) using the relationship of variable transformation, whose probability density function is

$$f(z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}z^2}$$

Defect Rate, ppm and DPMO

The defect rate is denoted by 'p' and it is the ratio of number of defectives to the total number of pieces processed. The 'ppm' stands for parts per million pieces processed. But ppm measure may not be useful in certain service-oriented industries and hence DPMO shall be used in such cases (Breyfogle, 1999). DPMO stands for defect per million opportunities i.e. defects occurred out of possible million defective opportunities.

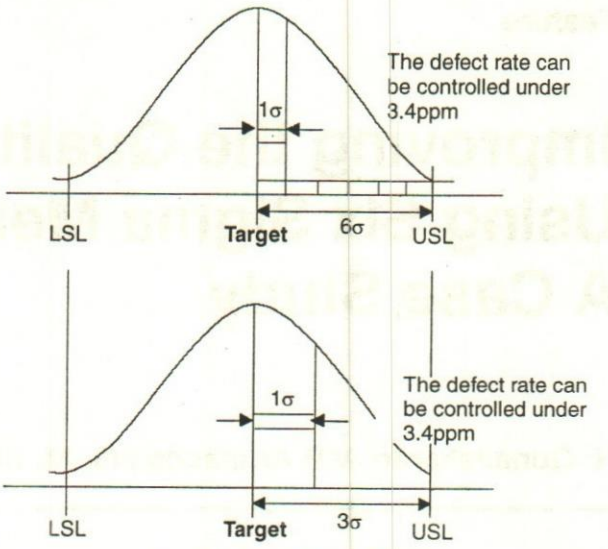

Fig. 2. Sigma Quality Levels

Sigma level

Specification limits are the tolerances or performance ranges that customers demand of the products or processes they are purchasing. The specification limits are shown in Figure 2. as the two major vertical lines. The sigma quality level (in short, sigma level) is the distance from the process mean (μ) to the closer specification limit. In practice, we desirable that the process mean to be kept at the target value. However, the process mean during one time period is usually different from that of another time period for various reasons. This means that the process mean is being constantly shifted around the target value. To address typical maximum shifts of the process mean, Motorola

Table 1: ppm changes when sigma quality level changes

Sigma Quality Level	Process Mean, Fixed		Process Mean, with 1.5 σ shift	
	Non-Defect rate (%)	Defect rate (ppm)	Non-Defect rate (%)	Defect rate (ppm)
1σ	68.26894	317,311	30.2328	697,672
2σ	95.44998	45,500	69.1230	308,770
3σ	99.73002	2,700	93.3189	66,811
4σ	99.99366	63,4	99.3790	6,210
5σ	99.999943	0.57	99.97674	233
6σ	99.9999998	0.002	99.99966	3.4

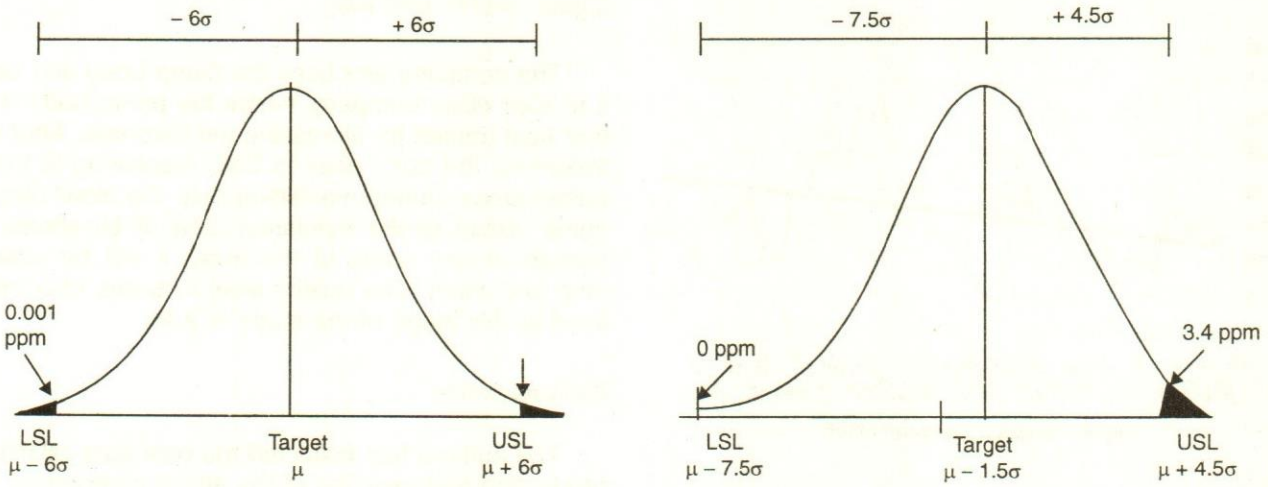

Fig. 3. Effect of 1.5 Sigma Shift of Process Mean When 6 Sigma Quality Levels is Achieved

added the shift value $\pm 1.5\ \sigma$ to the process mean (Breyfogle, 1999). This shift of the mean is used when computing a process sigma level as shown in Figure 3. Table 1. illustrates how sigma quality levels would equate to other defect rates and organizational performances.

Why This Case Study on Six Sigma?

The company A taken for the case study is situated in Coimbatore city of Tamil Nadu state in India. The company expanded its operations in the late 80s to manufacture High Pressure Die Cast Aluminium and Zinc components to suit the needs of various customers in the Automobile and Textile Industries, with high degree of quality and perfection. Now the company has established itself and plays a pivotal role in the die cast component manufacturing thanks to the expertise built in the core activities like tool design, tool making and pressure die cast component manufacturing. The company produces 70 to 80 varieties of components and supplies machined castings and sub-assemblies as per the needs of the customer. The company was one of the first few companies in India, which adopted ISO 9000 and QS 90 standards for improving the quality of products. The top management wants to be globally competitive by providing world class quality auto components. And also the management wishes to have a single measure of quality throughout the company.

Case Study Problem

A project committee consisting of a Managing Director, Managers, a Professor with Six Sigma background, and a research scholar, was formed to discuss and to identify the strategy which the company can adopt in future. The success stories of Six Sigma led the committee to experience the same in the company. For this purpose, it was decided to do project in the line of DMAIC methodology involving the employees but without formal belt structure.

Define phase

In the first phase, the project committee decided to exploit the knowledge of employees in statistical quality control (SQC) for improving the quality. An oil pump body was chosen for implementing sigma-based improvements after analysing the project priorities in the following line.

(i) Better return on capital employed by reducing the waste/rejections.

(ii) Producing the components with fit and forget quality

(iii) Higher product value from the customer point of view and

(iv) Better service for customers.

The oil pump body is used as lubricating oil pump housing in two stroke engines, exclusively used in PIAGGIO scooters.

Measure phase

The company produces the pump body using aluminium material of grade AC 8A, [JIS H 5202] as prescribed by the customer. The basic material composition of AC 8A aluminium material contains the following base metals.

The essential operating characteristics of the pump body are:

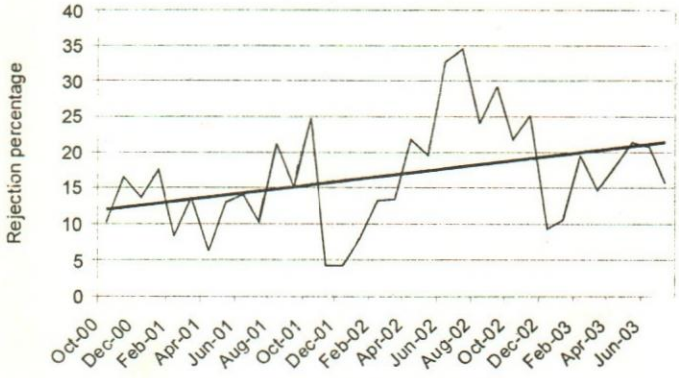

Fig. 4. Rejection trend-run chart

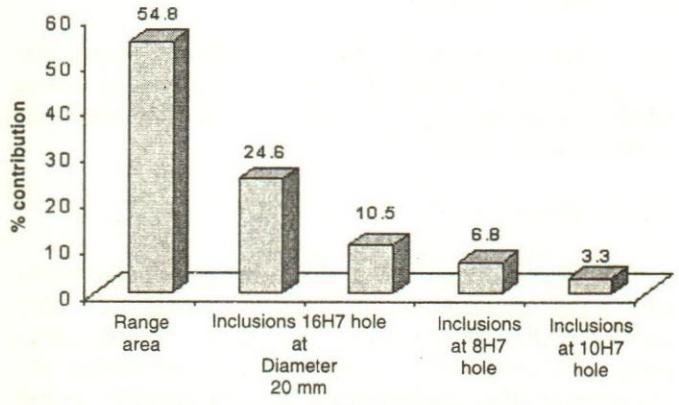

Fig. 5. Area-wise distribution of blow holes

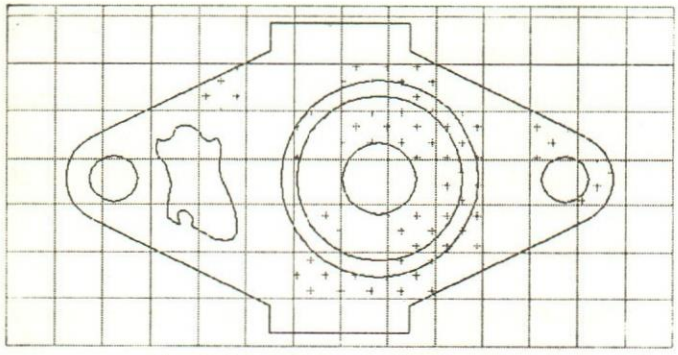

Fig. 6. Defect Concentration diagram

Operating temperature	:	80 °C.
Operating speed	:	12,000 RPM.
Delivery capacity	:	2.5 ± 0.5 CC

Table 2: Chemical composition of AC8A Aluminum metal

Copper [Cu]	0.8 %– 1.3 %	Manganese [Mn]	0.1%
Magnesium [Mg]	0.7% – 1.3%	Nickel [Ni]	1% – 2.5%
Silicon [Si]	11% – 13%	Zinc [Zn]	0.1%
Iron [Fe]	0.8%	Titanium [Ti]	0.2%

Sigma level to start with

The company produces the pump body and sends it to their client company, where the pump body is further heat treated for increasing the hardness. After heat treatment, the body goes to CNC machining at the required areas. During machining only, the blowholes become visible at the machined area. If blowholes are noticed at any areas of the body, it will be rejected then and there. The quality level in terms of σ calculated at this stage of the study is 2.44.

Analysis phase

The authors had collected the past data relating to production and rejection of the above component. The Figure 4 shows the rejection trend of the component that it is on the rise.

Data Analysis

The project committee decided to analyse the presence of blowholes in various segments of the oil pump body which was divided into flange area, 20mm diameter, 16H7 hole, 8H7 hole and 10 H7 hole. The data were plotted as a Pareto chart as shown in Fig. 5. Out of 1000 defective components, nearly 548 components were rejected due to the presence of blowholes at the flange section of the components. When compared to other potential areas, the flange section constitutes more rejection by blowholes. The result of the analysis after segregating the components according to the cavity 1 and 2 of the die indicated that there were more rejections from the cavity 1 than cavity 2.

Defect Concentration Diagram

An attempt was made to know the area where the blow holes are present by analysing their locations. A defect concentration diagram was drawn as shown in Figure 6. from the pieces rejected due to the presence of blow holes in flange area.

Die Design Analysis

The data analysis and defect concentration diagrams had led to the die design analysis. The following Figure 7 shows that the die design has two different gating arrangements for producing two components using cavity 1 & 2 in one single shot. The gate section of cavity No: 1 was given at the bottom side of the flange section while the same was given at the topside of the flange section for cavity No: 2.

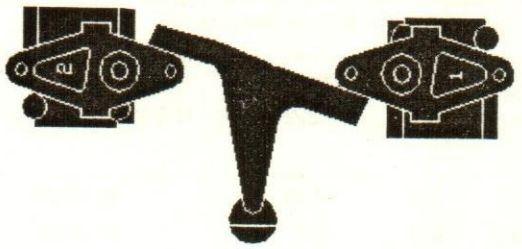

Fig. 7. Existing gating design

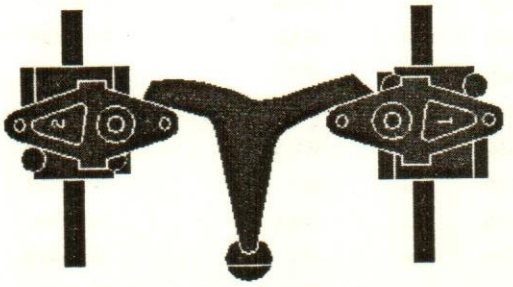

Fig. 8. Modified gating design

Improvement phase

The project committee has decided to modify the gating design as shown in Figure 8 and it was implemented with the approval of top management. A pilot production was run and the rejections were analysed.

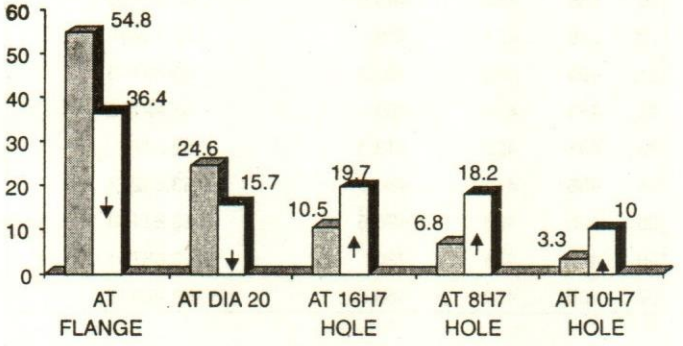

Fig. 9. Effects of die design modification

Because of die design modification, nearly 18.4% of defectives were saved at the flange section as shown in Figure 9. Where as the defectives rate at other sections like diameter 10H7, 16H7 and 8H7 holes were found to be on the increase as an adverse effect of gating modification.

Control phase

The employees have experienced that the rate of defectives was controlled and brought down by providing suitable vent holes near the holes section. The managers has demonstrated the benefits from the first cycle of implementation of DMAIC methodology and got approval for the second cycle of implementation from the management. The following sections explain the application of Taguchi's DOE for obtaining the optimum parameters for improving the process quality.

Taguchi's DOE approach

Define phase

Step 1: Objective of the Experiment

The primary objective for conducting Taguchi's experimentation methodology was to study the contribution of each factor causing more blowholes during the solidification of hot liquid metal and to reduce the rejections (Ross, 1996; Palanikumar et al., 2003; Davim, 2002 and Rowlands et al., 2003).

Step 2: Parameter Identification

A brainstorming session was conducted and with the help of Ishikawa diagram, all parameters, that were considered to be contributing to more blowholes, are listed below.

1. Component design complexity
2. Process capability of machine being used
3. Machine plunger limit switch position
4. II Phase turns
5. Intensifier pressure
6. System pressure
7. Die temperature
8. Metal mixing ratio
9. Metal degassing frequency
10. Metal degassing agent
11. Die coat agent and frequency of usage
12. Metal temperature
13. Worn out short sleeve
14. Chemical composition of material being used (Alu. grade AC 8 A – JIS STD)

Measure phase

Out of the above stated parameters, five process parameters had been selected for further analysis. The rest were distinguished as constant parameters and kept steady throughout the experimentation. This selection of parameters of interest and their working

ranges were based on practice and earlier studies by the company experts.

Step 3: Determination of levels of factors

The Table 3 shows the factors and their levels for conducting the experiments.

Table 3: Factors and their levels

Notation	Controllable factors	Metric	Present values	Level 1	Level 2	Level 3
P	Metal temperature.	Centigrade	690	665	690	715
Q	Intensifier pressure.	Kg/cm^2	220	220	240	260
R	Metal degassing frequency.	Shots per degassing	320	320	240	160
S	II phase turns.	Nos.	3.25	3	3.25	3.5
T	Metal mixing ratio.	Ratio	60:40	80:20	70:30	60:40

Step 4: Selection of Orthogonal Array

L_{27} array had been selected on basis of the theory of orthogonality for five factors at three levels.

Analysing phase

Step 5: Arranging factors and interactions to the columns

Five columns are required for assigning five factors. Since each interaction has 4 DOF, total six columns (2 columns for each interaction) were needed for assigning the interactions. The process parameters can be assigned to the remaining seven columns. Using Taguchi's triangular table for three levels OA, the interacting columns in L_{27} OA were identified and parameters were assigned to specific columns accordingly. The assignment of process parameter and interactions to columns is given in Table 4.

Table 4: L27 Orthogonal array and factor assignment

Column no.												
1	2	3	4	5	6	7	8	9	10	11	12	13
P	Q	PQ	PQ	R	PR	PR	QR	S	T	QR		

Step 6: Preparing the trail data sheet

The trial data sheet had been prepared using the trial combinations. The trial data sheet helps to conduct the experiments and record the results for further analysis.

Table 5: Resultant trial data sheet with response (No. of good components out of 500 per Replication)

Trial No.	Replications 1	Replications 2	Mean (1+2)/2	S/N Ratio [lb] $db = -10 \log \left[1/r \sum_{i=1}^{r} (1/y_i^2)\right]$
1	401	452	426.5	52.55178
2	462	450	456	53.17704
3	421	436	428.5	52.63502
4	390	401	395.5	51.94041
5	369	354	361.5	51.15656
6	469	476	472.5	53.48732
7	485	468	476.5	53.55711
8	359	346	352.5	50.93875
9	310	264	287	49.07387
10	418	431	424.5	52.5545
11	479	469	474	53.51412
12	352	378	365	51.22933
13	301	320	310.5	49.82903
14	329	365	347	50.77152
15	458	478	468	53.39897
16	490	486	488	53.76818
17	369	389	379	51.56371
18	385	368	376.5	51.50866
19	436	455	445.5	52.97103
20	395	421	408	52.19997
21	459	462	460.5	53.26445
22	463	475	469	53.42132
23	401	426	413.5	52.3176
24	485	476	480.5	53.63273
25	495	486	490.5	53.81168
26	425	435	430	52.66761
27	465	452	458.5	53.22417

Step 7: Execution of experiments

The experiments had been conducted based on the settings of trial data sheet and 500 units were produced for each trial. Two replications were conducted for each trial and they are reported as shown in Table 5. The number of good components was considered as the output response of the experiment and the experiments were conducted for seven days with three shifts per day.

Step 8: ANOVA Analysis

An ANOVA analysis was performed to determine the influential parameters and their optimum levels. The mean responses and mean S/N ratios were calculated and they are shown in Table 6 and 7.

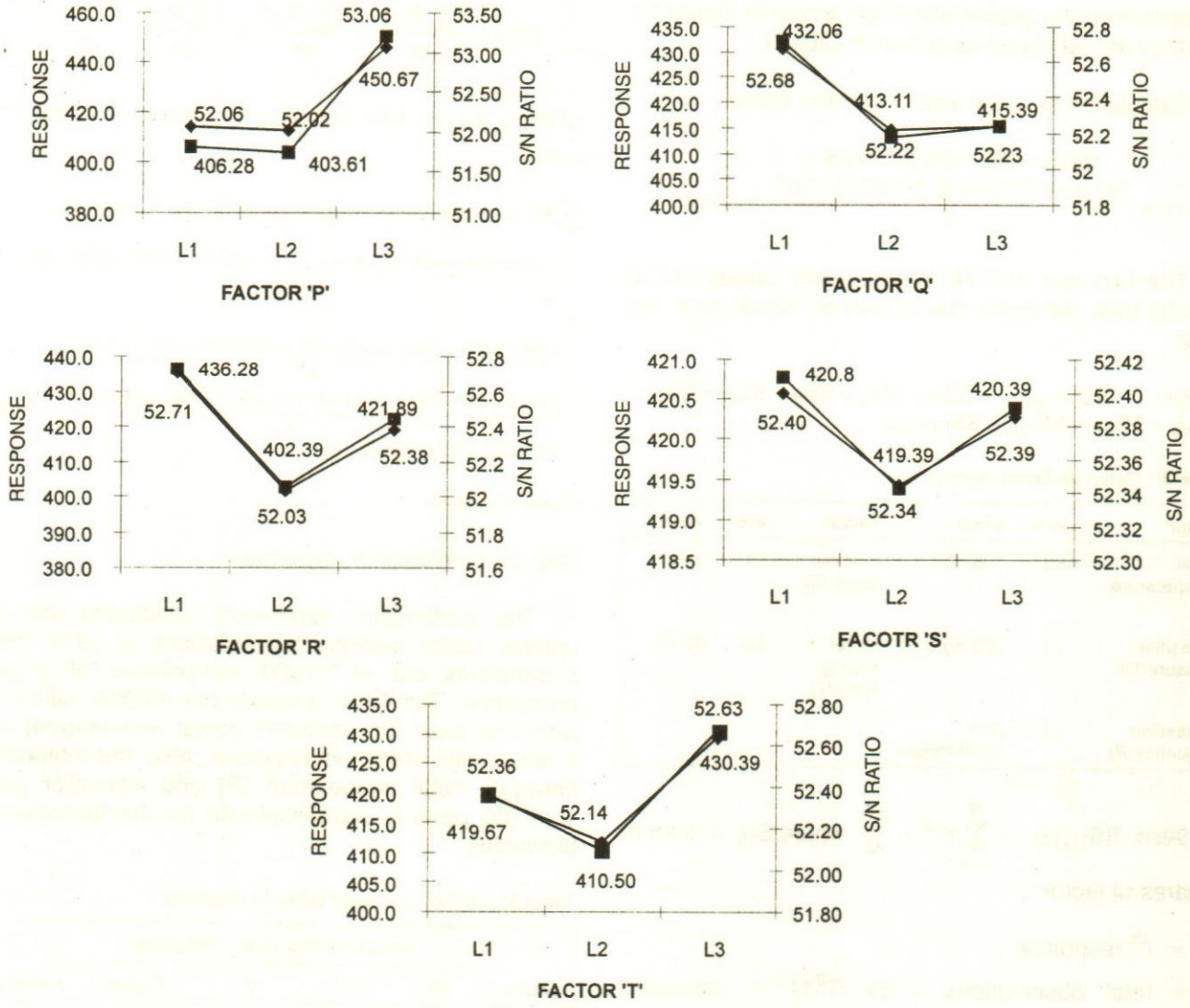

Fig. 10. Graphs showing the response and S/N ratio of factors

Table 6: Mean Response

Factors	L1	L2	L3
P	406.3	403.6	450.7
Q	432.1	413.1	415.4
R	436.3	402.4	421.9
S	420.8	419.4	420.4
T	419.7	410.5	430.4
PxQ	442.4	425.5	405.4
QxR	412.2	436.1	412.3
PxR	425.4	420.9	414.2
D			

Improvement phase

Step 9: Optimum factor settings

The optimum factor settings were then obtained by plotting the mean response values and mean Signal-to Noise ratio values in a graph and the optimum values were identified based on the "Larger the Best" S/N ratio characteristic. The optimum factor settings were

Table 7: Mean S/N ratio

Factors	L1	L2	L3
P	52.06	52.02	53.06
Q	52.7	52.22	52.23
R	52.7	52.03	52.38
S	52.40	52.34	52.39
T	52.36	52.14	52.63
PxQ	52.60	52.50	52.00
QxR	52.20	52.70	52.20
PxR	52.60	52.40	52.20

selected from the graphs which are shown in Figure 10. and they are tabulated as shown in Table 8.

Calculation to show mean response value:

$$P(L_1) = \frac{426.5+456+428.5+395.5+361.5+472.5+476.5+352.5+287}{9} = 406.3$$

The two-way ANOVA analysis was carried out to find the total variations due to factors, interactions and error.

Hence, $SS_{TOTAL} = SS_P + SS_Q + SS_R + SS_S + SS_T + SS_{PQ} + SS_{PR} + SS_{QR} + SS_{ERROR}$

Table 8: Optimum factor settings

Factor	Level	Value	Factor	Level	Value
Metal Temperature (P)	L3	715º C	II phase turns (S)	L1	3 no.
Intensifier pressure(Q)	L1	220 Kg/cm^2	Metal Mixing Ratio(T)	L3	60:40
Degassing frequency(R)	L1	320 shots/degas			

Also, $SS_{TOTAL} = \sum_{i=1}^{N} Y_i^2 - \frac{T^2}{N}$ where SS_i = sum of squares of factor I;

Y_i = i^{th} response;

N = total observations = 54; T^2/N = correction factor; $T = \sum_{i=1}^{N} Y_i$

we can calculate Correction Factor as

$$CF = T^2/N = \frac{(401+452+462+450+.....465+452)^2}{54} = 9534001.852$$

Therefore total sum of squares SS_{TOTAL} would be

$$= \sum_{1}^{54} 401^2+452^2+462^2+450^2+.....465^2+452^2 - 9534001.852 = 170942.148$$

The total variations due to main factors can be calculated by using the general formula for any number of levels of each factor as:

$$SS_P = \frac{(\sum P_1)^2}{n_{P_1}} + \frac{(\sum P_2)^2}{n_{P_2}} + \frac{(\sum P_3)^2}{n_{P_3}} - \frac{T^2}{N}$$

where , n_{p_i} = Number of observations of factor P at level I;

$\sum P_i$ = sums of all response of factor P at level i

$$= \frac{(426.5+456+428.5+395.5+361.5+472.5+476.5+352.5+287)^2}{9} + \frac{(424.5+474+365+310.5+347+468+488+379+376.5)^2}{9} + \frac{(445.5+408+460.5+469+413.5+480.5+490.5+430+458.5)^2}{9} - 9534001.852 = 25150.259$$

Control phase

Step 10: Confirmation experiment

The confirmation experiment conducted with the optimal factor settings had resulted in 9782 good components out of 10,000 components of a pilot production. The Table 9 shows the ANOVA values on response data. The factor P [metal temperature] has a substantial effect on response. Also the interaction between metal temperature [P] and intensifier pressure [Q] plays a substantial role for the formation of blowholes.

Table 9: ANOVA Summary table on response

	Anova on Raw Data - Response				
Factors	SS	DOF	V	F ratio	F-critical
P	25150.26	2	12575.13	5.55326	3.3
Factors	SS	DOF	V	F ratio	F-Critical
Q	3851.148	2	1925.574	0.850346	3.3
R	13790.48	2	6895.241	3.044984	3.3
S	18.481	2	9.2405	0.004081	3.3
T	3567.37	2	1783.685	0.787687	3.3
PxQ	25456.07	4	6364.018	2.810392	2.68
PxR	21483.74	4	5370.935	2.37184	2.68
QxR	7426.37	4	1856.593	0.819883	2.68
Error	70198.23	31	2264.459		
Total	170942.1	53			
					Significant at 95% confident level

Results and discussions

The rejection was brought down to a lower mini-

mum possible in two stages via die design modification and by Taguchi's process experimentation approach. In a nutshell the following results were achieved

- Die gating design modification shows a positive result as 18.4% savings. It has helped to save US $36,056 foreign exchange per annum for the company.
- By applying Taguchi technique, out of selected five factors, the metal temperature plays significant role in affecting the response.
- Also the interaction between metal temperature and intensifier pressure plays significant role in affecting the response.
- The optimum factor setting was P3-Q1-R1-S1-T3.
- The predicted range of optimal response is 483.85 $< \mu_{Good} <$ 493.32 and defect rate got reduced to 2.18% at the optimal condition. The savings went up to US $39,896 per year after the application of Taguchi technique.

Results of quality improvement in terms of Sigma

The sigma level is calculated as follows.

The defects per unit (DPU) may be calculated as:

$$DPU = \frac{\text{Total number of defectives observed}}{\text{Total units inspected/produced.}}$$

$$DPU = \frac{158010}{910491} = 0.17352$$

then defects per opportunities may be calculated as

$$DPO = DPU/\text{opportunities (m)}$$

Since here the opportunities for a pump body to be defective is only because of blowholes, the opportunity is one.

Therefore $DPO = DPU$

$= 0.17352$

Then defect per million opportunities may be calculated as

$DPMO = DPO \times 1000{,}000$

$= 0.17352 \times 1000{,}000$

$= 173{,}520$

From the standard sigma to DPMO conversion table (Park, 2003b), the corresponding sigma value can be obtained.

for DPMO = 173,520 the sigma value is = 2.44

Similarly the sigma values for the subsequent stages can be calculated as shown in

Table 10 and the improvement in sigma level is shown in Figure 11.

Table 10: Sigma calculation table

	DPU	Opportunity	DPO	DPMO	Sigma*
Before study	0.17352	1	0.17352	173,520	2.44
After die design modification	364 / 10000 = 0.0364	1	0.0364	36,400	3.30
After Taguchi's DOE Application	218 / 10000 = 0.0218	1	0.0218	21,800	3.62

* Please refer sigma conversion table

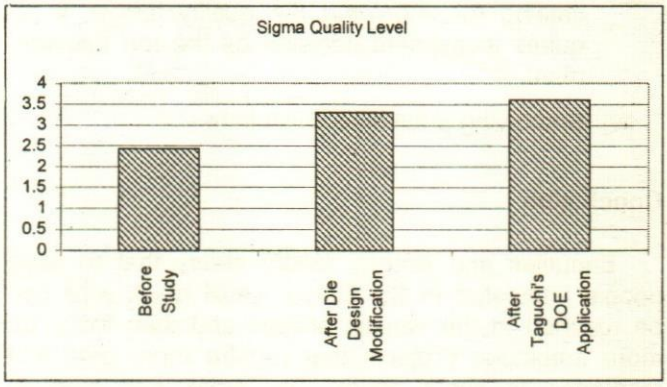

Fig. 11. Results in terms of sigma quality level

Managers' implications

The strategy was to introduce the six sigma approach without much resistance from employees. The case conducted has helped the project committee and managers to demonstrate the benefits with the support of top management. The top management was convinced with the outcome first cycle of DMAIC methodology as the rejections of fast moving oil pump body was reduced. However, the management was not ready to take a decision to implement the six sigma company-wide due to the following reasons:–

(i) The investment to be made for infrastructure and facilities required for implementing Six Sigma

(ii) Training of employees and its related issues

(iii) Fear of employee resistance

Hence, the project committee has decided to implement the second cycle of DMAIC methodology to further demonstrate the quality improvement. The Taguchi's DOE approach was chosen as it was one of the cost-effective experimental approach for optimizing the process parameters. The managers could demonstrate the capabilities of the employees to adopt the statistical tools such as DOE to improve the quality. The top management was happy with the improvement in the sigma level of the company pertaining to the oil pump body. However, the managers should study the following issues before taking it company-wide.

(i) Cultural changes if the company adopts belt structure

(ii) The cost of training and its related issues

(iii) Return on investment in case of huge investments required. Say, for example in this study, the project committee recommended the purchase of "PROCAST" software to analyse the casting for improving the quality further. It requires investment decision by the top management.

(iv) Employing a full-time consultant

Conclusion

Banuelas and Antony (2002) states that to keep people interested in Six Sigma, small quick wins can be reached in the earliest phases and then focus on more ambitious projects that require more time and resources to reach them. The small and medium scale enterprises are engaging themselves to be competitive in the global market. The concepts like Six Sigma are also implemented by them to improve their quality of products while they are not particular in following the belt structure. The sigma level was found to be approaching 4 sigma level while the rejections were minimized to 2.18% from 17.35%. The foremen, supervisors, managers and CEOs have the responsibilities of green belt, block belt, master black belt and champions and sponsors respectively. The benefits of Six Sigma were reaped even with this kind of implementation and there could be much more benefits if the belt structure is introduced among the employees. The die design analysis shall be carried out using software and Taguchi's design of experiments with noise factors to take forward the quality improvement and the sigma level in this Aluminium die casting industry.

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Feature

JIT Purchasing Attributes and Supplier Evaluation in Indian Industries: A Survey

Sultan Singh & Dixit Garg

Recently just-in-time (JIT) practices have been recognised as a cornerstone of Japan's success in improving product quality and productivity. Purchasing has been found to be an important area of JIT application due to its potential for quality improvement and cost savings. This paper attempts to analyze the importance of JIT purchasing attributes and supplier evaluation criteria on the basis of a survey of 41 Indian industries.

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JIT is a globally accepted approach of continuous improvement is purchasing, processing, inventory control and sales for quality improvement and cost savings. It is a technique for excellence in a system by eliminating waste at each stage of manufacturing to produce high quality goods and creating a manufacturing system responding to the market needs. The ultimate aim of JIT philosophy in a variety of industries is to achieve "perfection" in manufacturing through continuous improvement and elimination of waste. It has true potential to become a universal manufacturing philosophy of the future. The achievement of high quality level is a prerequisite of successful JIT. Its area of application includes total quality management, product development, purchasing, inventory reduction at each stage, lead time reduction, engineering design, marketing, kanban system etc.

JIT purchasing attributes

Global competition has forced the manufacturer to seek methods that produce products at a reasonable price and also improve productivity. The JIT philosophy implementation is seen as an effective tool to achieve these objectives (Golhar and Stamm, 1993). To implement the JIT successfully (O'Neal, 1987) a close buyer-supplier relationship is necessary, which is strengthened by buyer actions, supplier actions and joint buyer-supplier actions (Stamm and Golhar, 1991). To achieve benefits of JIT purchasing like frequent and reliable delivery of high quality, reduced inventory and improved productivity (Burton T.T. 1988, Hahn C.K. et al., 1990, Higginson et al., 1990) a buyer must make fundamental changes in the purchasing policies. The JIT purchasing literature focuses on the changes. The JIT purchasing is an uninterrupted flow of 100 per cent acceptable material delivered on due dates at optimal cost 100 per cent of the time (Grieco, 1988).

JIT purchasing functions often conflict with traditional

practices of purchasing, which is characterized by competitive buyer-supplier relations with minimum communication and infrequent deliveries. The buyer carries large inventory (Lee and Ansari 1985, Bartholomew 1984) to compensate for long lead-times and poor quality of incoming parts. In contrast a fundamental element of JIT purchasing is cooperative and long-term (Stamm, C.L. and Golhar D.M. 1993] buyer-supplier relationship. In addition to price the supplier selection is based on quality, technical expertise, and effective buyer-supplier communication, which result in frequent and reliable deliveries, high quality of incoming parts, small shipment size and parts delivered in exact quantity. As a result JIT purchasing helps to reduce inventory and increased productivity, benefiting both the buyer and supplier (Schonberger, R.J. et al. 1993, Gupta Y.P. 1990, Manoochehri, G.H. 1984).

Survey

A questionnaire of JIT purchasing attributes and supplier evaluation criteria was prepared and sent to 80 different companies situated in various parts of Haryana, Punjab, Chandigarh, Delhi and Orissa. Forty-one responses were received. The response rate was 41.25 per cent. The general profiles of the companies are shown in Table 1.

Earlier the literature on JIT purchasing identified 34 attributes of JIT purchasing (Stamm, C.L. and Golhar, D.Y. 1993) and 15 attributes of supplier evaluation criteria. Ten more attributes of JIT purchasing are identified and have been included in this paper. The two newly identified attributes are added in supplier action attributes, which are:

1. Ability of supplier
2. Supplier attitude

The eight newly identified attributes are added in joint buyer-supplier action attributes, which are:

1. Motivation
2. Transportation reliability
3. Coordination of work centers
4. Teamwork spirit
5. Workforce flexibility
6. History and background
7. Managing skills
8. Reputation in market

Table 1: General Profile of Companies

- **Type of Company:**
  Automobile-11
  Processing Industries-4
  Textile-4
  Heavy Mills-5
  Electronics-4
  Electricals-8
  Others-5
- **Annual Turnover (crores)**
  Maximum-35,000
  Average-2800
  Minimum-0.1
- **Number of employees**
  Maximum-37,000
  Average-1465
  Minimum-6
- **Number of suppliers**
  Maximum-10,000
  Average-700
  Minimum-2
- **Percentage of material cost to total cost**
  Maximum-94%
  Average-56
  Minimum-20%
- **Number of industrialists who have heard about JIT-27**
- **Number of industrialists who have not heard about JIT-14**
- **Scope of JIT implementation in India:**
  Very good-8
  Good-18
  Fair-3
  Little-1
  No response-11
- **Name of states surveyed:**
  Haryana, Punjab, Chandigarh, Delhi, and Orissa

Now the total attributes of JIT purchasing have become 44.

The 35 attributes belong in *input attributes,* in which,

- 13 attributes belong to buyer action
- 8 attributes belong to supplier action
- 14 attributes belong to joint buyer-supplier action categories.

The nine attributes belong to *output attributes.*

The relative importance of all these 44 attributes is determined on the basis of frequency of their citation in the literature pertaining to JIT purchasing as shown in Table 2.

Table 2: The degree of importance given to following purchasing attributes

	< Scale >						
	Very good 4	Good 3	Fair 2	Little 1	Not at all 0	No response	Aggregate score
1. Buyer action attributes							
Fewer suppliers	13	17	6	3	–	2	75.64
Long term contracts	12	19	5	2	2	1	73.12
Buyer responsible for inbound freight	5	16	13	2	5	–	58.53
Increase volume to supplier	7	19	12	1	1	1	68.75
Supplier evaluation	13	20	6	1	–	1	78.12
Supplier certification	12	21	5	–	–	3	79.60
Supplier training and development	10	2	12	3	1	3	67.76
Supplier plant audit	6	16	8	1	3	7	65.44
Freight consolidation	6	21	12	–	1	1	69.37
Contract carrier	9	17	12	–	2	1	69.37
Stable production schedule	9	20	10	–	–	2	74.35
Emphasize performance not specs	8	15	14	1	1	2	67.94
Reliable network of supplier	15	18	5	–	2	1	77.50
2. Supplier action attributes							
Ability of supplier	16	19	6	–	–	–	81.09
Supplier attitude	13	19	7	–	1	1	76.87
Statistical process control	11	19	9	1	1	–	73.17
Close proximity	10	13	15	–	3	–	66.46
Quality circle	20	15	4	1	1	–	81.70
Flexible supplier	8	17	10	3	1	2	67.94
Reduced set-up	2	12	17	5	2	3	54.60
Increase customer support	17	12	6	1	1	4	79.05
3. Join buyer supplier action attributes							
Mutual trust and co-op. Relationship	17	7	13	3	–	1	73.75
Increased information sharing	11	17	7	3	2	1	70.00
Supplier involvement in designing	11	17	9	3	–	1	72.50
Continues improvement	18	13	7	2	–	1	79.37
Join value analysis programming	11	15	10	3	1	1	70.00
Standardized packaging	10	20	11	–	–	–	74.39
Motivation	16	14	5	2	2	2	75.64
Transportation reliability	7	21	3	–	1	9	75.78
Coordination of work centers	13	19	9	–	–	–	77.43
Team work spirit	22	12	6	–	–	1	85.00
Work force flexibility	10	14	14	1	–	2	71.15
History and background	11	15	8	4	1	2	69.87
Managing skills	10	22	7	1	–	1	75.62
Reputation in market	17	18	4	2	–	–	80.48
4. Outcome attributes							
Frequent delivery	8	20	8	1	3	1	68.12
Reliable delivery (on time)	14	20	7	–	–	–	79.26
Small shipment size	5	15	16	4	–	1	63.12
Exact quantity	16	17	7	–	–	1	80.62
Reduced delivery lead times	11	14	13	2	–	1	71.25
High quality	22	18	1	–	–	–	87.80
Elimination of receiving inspection	14	13	11	2	1	–	72.56
Fair price	11	15	11	1	2	1	70.00
Reduced paperwork	12	18	5	3	3	–	70.12

Analysis

The data collected from 41 companies was analyzed with the help of factor analysis on a scale (0-100) as shown in Tables 2, 3 and 4. Scope of JIT implementation is found 77.5 on the scale (0-100), which is "fairly good" scope of JIT implementation in India. As per the *Delphi study* (Prem Vrat et al., 1993) which indicated the JIT index to be 23.28 on a 40 point scale (0.40), the implication is that though quite difficult JIT implementation in India is possible. Garg et al. (1996) have found the JIT index as 2.23 on a scale of 0 to 4. The study indicated that the professionals of Indian companies are not very optimistic about the scope of JIT implementation in India. Garg et al. have also found the JIT implementation to be 70 on a scale of 0 to 100 in India which is fairly good.

Table 3: Importance of JIT purchasing attributes of different categories

Attribute type	Mean score
Buyer actions	71.19
Supplier actions	72.61
Joint buyer-supplier actions	75.07
Outcome attributes	73.65
Grand mean score	**73.13**

However, as per the current study there is better scope of JIT implementation in India as compared to earlier studies. Table 2 shows the importance of JIT purchasing attributes perceived by the respondents. The mean score of these attributes on the scale (0-100) has been arranged in decreasing order as shown in table 4. It is found that high quality, team work spirit, quality circle, ability of supplier, exact quantity, reputation in market, supplier certification, continuous improvement, reliable delivery (on time), increased customer support, supplier evaluation, reliable network of supplier, coordination of work centres, supplier attitude, transportation reliability, fewer suppliers, motivation, managing skills, standardized packaging, stable production schedule, mutual trust and cooperative relationship, statistical process control, long term contract, elimination of receiving inspection, supplier involvement in design, reduced delivery lead time, work force flexibility, reduced paper work, increased information sharing joint value analysis programme, fair price, history and background, freight consolidation, have been given high degree of importance by the surveyed companies.

Supplier plant audit, small shipment size, buyer responsible for inbound freight, reduced set up have been given less importance. However, Indian companies have

Table 4: Importance of JIT Purchasing Attributes (in decreasing order)

High quality	87.80
Team work spirit	85.00
Quality circle	81.70
Ability of supplier	81.09
Exact quantity	80.62
Reputation in market	80.48
Supplier certification	79.60
Continuous improvement	79.37
Reliable delivery (on time)	79.26
Increased customer support	79.05
Supplier evolution	78.12
Reliable network of supplier	77.50
Coordination of work centre	77.43
Supplier attitude	76.87
Transportation reliability	75.78
Fewer supplier	75.64
Motivation	75.64
Managing skills	75.62
Standardized packaging	74.39
Stable production schedule	74.35
Mutual trust and co-operative relationship	73.75
Statistical process control	73.17
Long-term contract	73.12
Elimination of receiving inspection	72.56
Supplier involvement in design	72.50
Reduced delivery lead times	71.25
Workforce flexibility	71.15
Reduced paper work	70.12
Increased information sharing	70.00
Joint value analysis Programming	70.00
Fair price	70.00
History and background	69.87
Freight consolidation	69.73
Contract carrier	69.37
Increased volume to supplier	68.75
Frequent delivery	68.12
Flexible supplier	67.94
Emphasize performance not specialisations	67.94
Supplier training and development	67.76
Close proximity	66.46
Supplier plant audit	65.44
Small shipment size	63.12
Buyer responsible for inbound freight	58.53
Reduced setup	54.60

Table 5: The degree of importance given to following supplier evaluation criteria

	Score						
	Very high 4	High 3	Average 2	Below average 1	Not at all 0	No response	Aggregate score
Quality	28	9	2	–	–	2	91.66
Reliable delivery	12	22	7	–	–	–	78.04
Frequent delivery	5	18	14	2	2	–	63.41
Exact quantity	13	22	6	–	–	–	79.26
Small quantity	3	9	21	4	4	–	51.82
Technical expertise	10	24	7	–	–	–	76.82
Price	9	10	21	–	–	1	67.5
Statistical process control	11	15	8	–	–	7	77.2
Communication	11	23	1	–	–	6	82.14
Product design development	9	21	5	–	–	6	77.85
Cooperative relationship	10	16	9	–	–	6	75.71
Proximity	5	16	11	2	–	7	67.64
Flexibility	6	17	12	1	–	5	69.44
Capital investment	5	15	13	1	–	7	67.64
Financial stability	6	20	8	1	–	6	72.14
						Grand mean score	73.21

given fairly good importance to JIT purchasing attributes. The importance given by surveyed companies to attributes pertaining to supplier evaluation criteria is shown in Table 5. The mean score of all these attributes is also determined on a scale (0-100) and arranged in decreasing order as shown in table 6. Quality, communication, exact quantity, reliable delivery, product design development, statistical process control, technical expertise, cooperative relationship, financial stability and flexibility are the important supplier evaluation criteria attributes as perceived by the Indian companies, whereas price, frequent delivery and small quantity have been accorded less priority.

Conclusion

JIT as a manufacturing strategy has the potential to compete globally. This paper has surveyed the different Indian industries in terms of JIT purchasing attributes. The types of industries included are automobiles, processing, textiles, electronics, electricals and heavy mills. Out of 41 industries, 27 have heard about JIT. Eight industries reported that scope of JIT implementation in India is "very good" and 18 industries reported that it is "good". In the degree of importance of buyer action attributes the aggregate score for fewer suppliers is 75.64 and for long-term contract is 73.12. In the supplier action attributes the aggregate score of ability of supplier is 81.09 and of supplier attitude is 76.87. In joint buyer-supplier action attributes for mutual trust and cooperative relationship the aggregate score is 73.75 and of increased information sharing is 70.

Table 6: Importance of supplier evaluation criteria attributes (In decreasing order)

Attribute	Mean score
Quality	91.66
Communication	82.14
Exact quantity	79.26
Reliable delivery	78.04
Product design development	77.85
Statistical process control	77.20
Technical expertise	76.82
Co-operative relationship	75.71
Financial stability	72.14
Flexibility	69.44
Proximity	67.64
Capital investment	67.64
Price	67.5
Frequent delivery	63.41
Small quantity	51.82

In outcome attributes for frequent delivery the aggregate score is 68.12 and of reliable delivery (on time) is 79.26. The mean score, of buyer action attributes is 71.79, of supplier action attributes is 72.61, of joint buyer-supplier action attributes is 75.07 and of outcome attributes is 73.65. The importance of JIT purchasing attributes for high quality is 87.80 and for teamwork spirit is 85. In the degree of importance to supplier evaluation criteria, the aggregate score for quality is 91.66 and for communication it is 82.14 on a scale (0-100). The attributes found important should be given due weightage.

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Quality isn't something that can be argued into an article or promised into it. It must be put there. If it isn't put there, the finest sales talk in the world won't act as a substitute.

– C.G. Campbell

Feature

Meta-heuristics to Hybrid: A Short Journey for Job Shop Scheduling

Pankaj Chandna and S.K. Sharma

Scheduling in job shop is an important aspect of a shop floor management system, which has a significant impact on the performance of the shop floor. In this paper a review of all meta heuristics and hybrid approaches used for job shop scheduling has been presented. It has been concluded that by reasonably combining the perspective advantages of any two different paradigms, researchers are able to obtain high quality solutions within reasonable computational time.

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Sequencing and scheduling is a form of decision-making that plays a crucial role in manufacturing and service industries. In the current competitive environment effective sequencing and scheduling has become a necessity for survival in the market place. Also it has been concluded from the literature survey that scheduling improves productivity, increases throughput rate, maximizes machine utilization, meets overdue rates, satisfies production constraints and achieves further business objectives. Traditionally many scheduling problems are considered as problems in optimization subjected to constraints. Theoretically scheduling problems which are concerned with searching for optimal schedules subjected to a limited number of constraints, suffer from excessive combinatorial complexity and are mostly NP-hard (Garey & Johnson, 1979). Much research has been carried out in the scheduling area where approaches have ranged from the use of Gantt chart to optimization methods such as dynamic programming, integer programming and Branch & Bound methods. However most scheduling problems are classified as NP complete and optimum seeking methods have been found to be impractical for a real size manufacturing shop.

Production scheduling deals with the allocation of limited resources for tasks in the discrete production system. Scheduling in job shop is an important aspect of a shop floor management system, which has a significant impact on the performance of shop floor (Holthaus & Rajenderan, 1997). The job shop-scheduling problem is among the hardest combinatorial optimization problems. Not only is it hard, but even among the members of the latter class it appears to belong to the more difficult ones (Van Laarhoven et al., 1992). As in the case of job shop scheduling, combinations of goals and resources exponentially increases the search space and the generation of. consistent and satisfying schedules becomes difficult. With the growing uncertainty and complexity in manufacturing environment most job shop scheduling problems have been proven

to be NP-hard i.e. computational requirement grows exponentially as a function of the problem size and this degrades the performance of conventional OR techniques. The approximation algorithms produce solutions that are guaranteed to be within a fixed percentage of the actual optimum and are considered as urgent and useful tools for solving discrete optimization problems (Brucker, 1995). Heuristic algorithms are conspicuously preferable in practical applications. As an extension to these, a large number of local search approaches have been developed to improve these feasible solutions. The main drawback of these approaches is that their inability to continue the search upon becoming trapped in a local optimum, leads to consideration of techniques for guiding known heuristics to overcome local optimally. Following this theme one started the application of intelligent search methods like meta heuristics. To enhance the performance of the meta heuristics and to overcome the disadvantages of these, researchers tried to hybridize wherever possible to compensate their shortcomings.

In this paper a review of all meta heuristics and hybrid approaches used for job shop scheduling has been presented.

Recently much attention has been devoted to four general heuristics: simulated annealing (SA), genetic algorithms (GAs), Tabu search (TS) and Ant colony system (ACS). They are applicable, in particular, for solving combinatorial optimization problems. These are capable of providing high quality solutions with reasonable computational effort. Job shop scheduling provides one of the most fruitful areas for these meta heuristics and hybrid approaches.

Job shop scheduling

The Job shop problem is a well-known NP-hard scheduling problem of combinatorial optimization and has a very wide engineering background. A general job shop-scheduling problem considered in this paper is described as follows. A set of n jobs (J_1, J_2, J_3..... J_n) must be processed on m machines (M_1, M_2, M_3..... M_n) and each job consists of exactly m operations. Each operation uses one of the m machines for fixed duration. The sequence of these operations processed on the machines is restricted by a pre-set job routing. Each machine can process at most one operation at a time and once an operation initiates processing on a given machine, it must complete on that machine without interruption. The operations of a given job have to be processed in a given order. The problem consists in finding a schedule of the operations on the machines.

As compared to the single machine model, which on its own yields complex combinatorial problems, the job shop has the added features of several machines and logical constraints. Deterministic methods hardly solve the problem satisfactorily except when the size of the problem is very small. Instead many priority rules and heuristic approaches have been developed to find feasible solutions. Complexity grows remarkably fast as problem size increases but for small problems, enumerative procedures such as Branch and Bound can be applied to obtain the optimal schedule (Baker, 1974). Branch and Bound techniques have been often applied to minimize the makespan in job shops (Carlier & Pirson, 1989; Applegate & Cook, 1991 and Brucker et al., 1994).

Also in the case of enumerative procedures, the effort, time and the mathematical sophistication for finding and understanding a suitable method may be judged not worth the possible return. There may be no method which is suitable for the complex constraints of the real situation. As a consequence, optimization methods may be ignored and some rules known as heuristics may be implemented. These are capable of obtaining good solutions very quickly but not necessarily yield optimal solutions (Pirlot, 1996). Tasgetiren et al., (1995) stated that not only priority rule but also due date arrangement method affect the job shop performance. Therefore to produce better results, specific due date assignments methods for specific performance measures must be used.

Blazewicz et al., (1996) presented an overview of solution techniques for solving job shop problems. After a brief round up of all the trends and techniques, they concentrated on branching strategies and approximation algorithm belonging to a class of opportunistic and local search scheduling. They also deducted that local search methods are the most powerful tools to schedule job shops. The monograph by Ovacik and Uzsoy (1997) presented an excellent treatise of the application of decomposition methods and shifting bottleneck techniques to large-scale job shops with several objectives. Also shifting bottleneck heuristics method is one of the successful heuristics methods for minimizing makespan in large job shop problems (Pinedo, 2001).

Meta Heuristics

Basically meta heuristics is top-level strategy that guides an underlying heuristic solving a problem. Following Glover (1993) "It refers to a master strategy that guides and modifies other heuristics to produce solutions beyond those that are normally generated in a quest for local optimality", we may also consider the following definition, "A meta heuristic is an iterative

generation process which guides a subordinate heuristic by combining intelligently different concepts for exploring the search spaces using learning strategies to structure information in order to find efficiently near optimal solutions" (Osman, 1996). Vob (2001) stated that meta heuristics support managers in decision-making with robust tools that provide high-quality solutions to important applications in business, engineering, economics and science in reasonable time horizons.

Meta heuristics algorithm shares the basic idea of neighbourhoods. A neighbouring solution is derived from its originator solution by a predefined partial modification which is called MOVE. A MOVE results in a neighbouring solution, which differs from its originator slightly. Because the chance of finding an improved solution within a neighbourhood is much lighter than in less correlated areas of the search space, local search methods are capable of providing near optimal solutions (Mattfeld, 1997). For instance, Lee and Dicesare (1994) used petri net to model the scheduling problems in the job shop. They proposed a heuristic search algorithm that generates and searches for an optimal or near-optimal feasible schedule with the firing sequence of the transition of the petri net model. But their search mechanisms are an iterative procedure that takes much time. Much attention and much paper have been devoted to these meta heuristics that are applicable in particularly solving these NP-hard combinatorial job shop optimization problems.

Genetic algorithm

Since the 1980s much interest has been devoted to the development and application of the meta heuristic algorithm, the Genetic Algorithm (GA), inspired by the process of Darwinian evolution which has been recognized as a general search energy and also as an optimization method which is useful for attacking combinatorial optimization problems. As opposed to other optimization methods, GA works with a population of solutions instead of just a single solution. It assigns a value to each individual in the population according to a problem specific objective function. A survival of the fittest step selects individual from the old population. A reproduction step applies operators such as crossover or mutation to these individuals to produce a new population that is fitter than the previous one. GA is an optimization method of searching based on evolutionary process. In applying it, we have to analyze specific properties of problem and decide on a proper representation, an objective function, a construction method of initial population a genetic operator and genetic parameters. Davis (1985) proposed first GA-based technique to solve job shop scheduling problems.

There are two important issues related to use GA to job shop problems:

(i) how to decode a solution of the problem into a chromosome so as to ensure that a chromosome will correspond to a feasible solution and

(ii) how to enhance the performance of genetic search by incorporating traditional heuristic methods.

A classical GA uses a binary string to represent a potential solution to a problem, but such a representation is not naturally suited for ordering problems like JSSP as classical GA representation using simple crossover or mutation strings always produces infeasible solutions. Thus to overcome this problem Syswerda (1991) and Bierwort et al., (1995) proposed a new chromosome representation. Yamada & Nakano (1992) and Dorndorf & Pesch (1993) used some variations in standard genetic operators and the hybridization of some existing algorithms. Bagchi et al., (1991) and Uckun et al., (1993) used a decoder or a schedule builder, which performed the transaction from a chromosome representation to a feasible schedule when a representation did not represent a schedule directly. Nakano and Yamada (1991) used repair procedure to find feasible schedules from an infeasible string and a treatment called forcing. In contrast to other local search methods such as SA & Tabu search which are based on handling one feasible solution, the GA utilizes a population of solutions in its search, giving it more resistance to premature convergence on local optima. GA exhibits its parallelism and can retain useful, redundant and historical information from previous searches by its representation in individuals in the population.

Obviously one of the advantages of the GA is its robustness over a wide range of problems with no requirement of domain specific adaptations. Hence genetic operators deal with genotype, which is domain independent, and are separated from domain specific decoding process from genotype to phenotype. Yamada and Nakano (1992) felt that from the performance viewpoint, it is often more efficient to directly incorporate domain specific features into the genetic operators and skip wasteful intermediate decoding steps. Thus the GT (Giffler & Thompson's) crossover and the genetic algorithm based on GT crossover, denoted as GT-GA improved the performance.

Wang and Brunn (2000) presented an effective genetic algorithm for job shop scheduling particular through the development of unique and meaningful encoding schemes and genetic operators of sequence-extracted crossover and neighbour swap

mutation. The addition of heuristic rules to the GA not only improved the quality of solutions but also the efficiency of the method by preventing generations of unfeasible schedules and thus increasing the rate of convergence. GA may be very useful for Job shop scheduling problems because of simplification based on hybridization of GA and existing algorithm and creative evolution procedure.

Tabu Search

Tabu Search is a meta heuristic designed for finding a near optimal solution of combinatorial optimization problems. It consists of several elements called move, neighbourhood, initial solution, memory, aspiration function and stopping rules. The basic paradigm of TS is to use information about the search history to guide local search approaches to overcome local optimality (Glover, 1997). In general this is done by dynamic transformation of the local neighbourhood. Based on some sort of memory certain moves may be forbidden. We say they are set Tabu. The remarkable success of TS in the 1980s has nowhere been marked more than in the areas of machine scheduling and sequencing with ever-growing importance in real world manufacturing (Anderson et al., 1997).

Barnes et al., (1995) stated that Tabu Search is a remarkably effective method in solving difficult scheduling problems. They presented an effective Tabu Search approach to Job shop scheduling problems. The procedure starts from an initial solution and selects the schedule with minimal solution and the algorithm then makes use of the classical distinctive network representation of the problem and iteratively moves to another feasible solution by reversing the other of the two adjacent critical path operations performed by the machine.

In another research, Karabga & Kalini (1997) stated that the converging speed of the standard Tabu search to the global optimal depends on the initial solution since it is a form of iterative search and presented a new Tabu search model. According to them the model based on the crossover operations of genetic algorithm overcomes this drawback of the standard Tabu search and the new model is more robust than standard Tabu search algorithm. Ponnambalam et al., (2000) considered the same technique and used adjacent pairwise interchange method to generate neighbourhoods. They compared results with simulated annealing and genetic algorithm and concluded that the performance of Tabu search is comparable to these two and also proposed the possibility of development of hybrid technique by combining the feature of TS, GA and SA.

Simulated Annealing

Simulated Annealing is a search process that has its origin in the fields of material science and physics. It was first developed as simulation model for describing the physical annealing process of condensed matter. The effectiveness of this depends on the design of neighbourhood as well as on the search conducted within its neighbourhood. Over the last two decades SA has been applied to many scheduling problems in research as well as in industry with considerable success. Many of the practical applications of SA, however, have been in complicated problem domains where previous algorithms either did not exist or performed quite poorly (Johnson et al., 1989b).

SA algorithms are very sensitive to parameters and their performances are largely dependent on fine-tuning of the parameter (Inger 1992). Van laarhoven et al., (1992) developed an approximation algorithm for the problem of finding the make span in a job shop. Based on Simulated Annealing, a generalization of well-known iterative improvement approach to combinatorial optimization problems, computational experiments showed that their algorithm could find shorter make span than two recent approximation approaches that are more tailored to the job shop scheduling problems. The SA algorithm technique randomizes the local optimization procedure in a way to attempt to reduce the probability of getting stuck in a poor but locally optimal solution. Like local search methods, the SA algorithm can be adapted readily to new problems and because of its ability to avoid poor local optimal it offers hopes of obtaining significantly better solutions (Parthasarthy, 1997).

He et al., (1996) considered a generalized Job shop scheduling problem with due dates. With the objective of minimizing tardiness an effective heuristics algorithm referred to as the enhanced heuristics algorithm was presented. This algorithm integrated simulated annealing and the exchange heuristic algorithm by employing an insertion technique. Morikawa et al., (1999) proposed a simulated annealing method based on the rescheduling activity of the human schedule in order to avoid local search solution for job shop scheduling. Steinhofel, et al., (1999) have presented two simulated annealing methods for solving job shop scheduling and used new neighbourhood reaction characterized by a large number of arcs. Ponnabalam et al., (1999) used the same for scheduling in the job shop for minimizing the makespan. To create neighbourhood three perturbation schemes viz. pair wise exchange, insertion and random insertions were used and the effect of them on the final schedule was compared. On a comparative evaluation with existing genetic algorithm the proposed algo-

rithm was found to perform well for scheduling of the jobs.

In contrast to GA, SA is naturally a serial algorithm and currently possesses a formal proof of convergence, and its behaviour can be controlled by the cooling schedule (Mahfoud, 1995).

Ant colony

One of the recent concepts within intelligent search used for Job shop scheduling is the ant colony system, a dynamic optimization process reflecting the natural interactions between ants searching for food (Taillrad, 2000). The ant's ways are influenced by two different kinds of search criteria. The first one is the local visibility of food i.e., the attractiveness of food in each ant's neighbourhood. Additionally each ant's way through its food space is affected by the others ant's trails as indicators for possibly good directions. This meta heuristics has got less attention from the researchers handling Job shop scheduling problems, so very less work has been reported in the literature, but it is reported that to achieve enhanced performance of the ant colony optimization it is useful to hybridize it with a local search component. With the rapid increase in creating hybrid methods, Boryczka (2004) focused on development of the Ant Colony Optimization, which incorporated various forms of repairing methods. He presented modified version of ACS with two techniques: FIND HOLE procedure and by using different priority rules. They concluded that ACS-JSP is the most interesting among modern meta heuristics in term of using it in such difficult problems as the JSP is. Also the experiments conducted illustrated the difficulty of creating an appropriate version of ACS for Job shop scheduling problems.

Hybrid approaches

In recent years, by reasonably combining the perspective advantages of any of the two different paradigms discussed above, researchers have been investigating hybrid algorithm because they are able to obtain high quality solutions within reasonable computational time, and also presented several different hybrid parameters for job shop scheduling. In this section we have examined the studies which hybridize two or more meta heuristics all together.

Sim et al., (1994) proposed an expert neural network approach for dynamic job shop scheduling problem. They noted that SPT gives better tardiness performance at more congested shop while EDD is better at lighter loads. As a result it is emphasized that the expert neural network system act like a ceiling over the best performance of its component factors across different arrival rates and scheduling criteria. Lee et al., (1997) proposed to combine capabilities of genetic algorithms and machine learning techniques in order to develop a job shop scheduling system.

Kopfer and Mattfeld (1997) proposed a hybrid GA that applies a local search operator in an evolutionary framework and evaluates with the results obtained for a well-known test suite of particularly hard, but medium-sized job shop problems (including the famous mt 10 problems). The presented results encouraged the use of the GA framework for future research. The superior performance of the proposed hybrid GA was obtained by the successful incorporation of the chromosome representation, the generating method of initial population, genetic operators and selection method, which are better designed to transmit the temporal relationships in the chromosome. Candido et al., (1998) presented a robust procedure to solve job shop scheduling problem with a large number of realistic constraints. The system uses a modified schedule generation algorithm to obtain an initial solution. Each initial solution was enhanced by a local improvement procedure, then a hybrid genetic algorithm which incorporated a local hill climbing procedure was applied to the set of local optimum schedules. Rahmati (1998) also proposed a hybrid genetic algorithm for non-classical job shop scheduling problems.

K. Mesghovni (1999) coupled three approaches in order to contributed to the solving to the job shop problem: genetic algorthrim, constraint logic programming (CLP) and multi-criterion decision making (MCDM). The GAs are searching algorithms based on the mechanics of natural selection, CLP provide a set of solutions expressed in the form of constraints. MCDM aimed at providing an analysis of a set of possible alternatives according to the set up of the conflicting criteria in order to help the user. A larger-sized example illustrated clearly the advantages of this hybridization. Yu and Liang (2001) have presented a hybrid approach combining neural networks and genetic algorithms to solve the extended job shop scheduling problem. In this case genetic algorithm is used for the optimization of the sequence and neural network produce is used for optimization of the operation start times with a fixed sequence.

Wang (2002) proposed an enhanced genetic algorithm with an effective crossover operation for operation-based representation used to guarantee the feasibility of the solutions, which are decoded into active schedules during the search process. The classical mutation operator was replaced by the metropolis sample process of simulated annealing such a prob-

abilistic jumping property to enhance the neighbourhood search and to avoid premature convergence with controllable deteriorating probability as well as avoiding the difficulty of choosing the mutation rate. Park et al., (2003) designed a scheduling method based on Single Genetic Algorithm (SGA) and Parallel Genetic Algorithm (PGA). In this method the representation, which encodes the job number, is to be made always feasible, and the initial population is generated through integrating representation and GT algorithm. The new genetic operators and selection method are designed better to transmit the temporal relationships in the chromosome, and the proposed island model PGA yielded significant improvement in solution quality.

Among the modern heuristics methods simulated annealing and genetic algorithms represent powerful combinatorial optimization methods with complementary strengths and weaknesses. By properly combining these global probabilistic search algorithms, Chaoyong et al., (2005) represented GASA (Genetic Simulated algorithm) for solving job shop problems. They incorporated metropolis acceptance criterion into crossover operator, which could maintain the good characteristic of the previous generation and reduce the disruptive effects of genetic operators. They also proposed a new crossover operator, named Precedence Operation Crossover (POX), for the operation-based representation. Computational results showed the effectiveness and robustness of the algorithm.

Conclusions

1. Over the last decade meta-heuristics have become a substantial part of the heuristic stock room with applications in job shop scheduling. From a theoretical point of view the use of most meta heuristics has not yet been fully justified but most papers on meta heuristics used for job shop scheduling claim to provide high quality results based on conventional regular and non-regular performance measures.
2. Compared to other meta heuristics such Genetic algorithm, SA and Tabu search relatively few attempts have been made to solve job shop scheduling problems using ant colony algorithms. Results of the various applications encourage the development of ant colony algorithm for the job shop-scheduling problem with different objectives.
3. The basic difference between Tabu search and simulated annealing lies in the mechanism that is used for approving a candidate schedule. By reasonably combining the two advantage aspects of these global heuristics the hybrid framework of GA and SA can achieve more efficient optimization results. However, to reduce the computational times integration of TS into the algorithm is required.
4. Classical GA creates initial population randomly and greatly influence the results, but it is not possible for the job shop scheduling problems, as we must satisfy a set of constraints. For this reason some other approaches should be used to create initial population and then results can be improved by using genetic algorithm. It means that joining to or more approaches i.e. hybridization can be beneficial for the user, leading both to an efficient aid (i.e. efficient integration of the wishes of the user) and to the management of a large-sized real world job shop scheduling problem. GA may be very useful for Job shop scheduling problems because of simplification based on hybridization of GA and existing algorithm and creative evolution procedure.
5. The number of paper introducing hybrid systems in growing, hybrid optimization technology is still topical. In order to achieve better quality, time performance and robustness other advance operators e.g. global search mechanisms and problem-specific information can be introduced. Because of generality and ease of implementation of the hybrid heuristic, it can be applied to real world job shop problems.

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When a man is no longer anxious to do better than well, he is done for.

– Benjamin Haydon

Feature

Emerging Issues in Supply Chain Management

Harman Preet Singh & M.L. Singla

No enterprise can gain a competitive edge unless it integrates its strategies with supply chain management. One of the leading emerging trends in this context is that IT applications have led to e-SCM becoming a potent market force today.

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Over the past decade, companies constituting a wide spectrum of industries have been focusing on leveraging the competencies and innovative capabilities to be found in clusters of customers and suppliers constituting their business supply chains. In today's competitive environment, no enterprise can expect to build a product, process or competitive advantage without integrating their strategies with those of supply chain systems. In the past, what occurred inside the four walls of the business was of primary importance. In contrast, today a company's ability to look outward to their channel alliances, to gain access to sources of unique competencies and physical resources is the measure of success. In fact, the ultimate core competency an enterprise may hold today is not found in a temporary advantage it may hold, for example, in an area of product design or market brand but rather in the ability to continuously assemble and implement market winning capabilities arising from collaborative alliances with their supply chain partners. Enterprises have increasingly come to recognise that their performance depends, to a large extent, on their role in supply chain ecologies and competitiveness of supply chains they participate in (Gosain, Malhotra et al 2004).

Supply chain management (SCM) involves procuring the right inputs (raw materials, components & capital equipment); converting them efficiently into finished products; and despatching them to final destinations. Handfield and Nicholas (1999) define SCM by breaking the concept into two terms: supply chain and supply chain management. Supply chain is defined as:

"All activities associated with the flow and transformation of goods from the raw material stage (extraction), through the end user, as well as associated information flows. Material and information flow both up and down the value chain".

Supply chain management is defined as

"The integration of all these activities through improved supply chain relationships to achieve a sustainable competitive advantage".

So, SCM consists of four key value-enhancing activities. Channel supplier management, channel customer management, product & service processing and channel support activities. At strategic level, the mission of SCM is to propel channel trading partners beyond a concern with purely logistics to the establishment of collaborative partnerships which create value by unifying the resources, capabilities & competencies of the entire network, and not just an individual company. Since the late 1990s, companies have increasingly turned to internet and web-based technologies to accomplish this. According to one estimate, web based applications permit a wide range of transactions at roughly 20 per cent of private network cost (Costello, Daniel, 2001).

This application of internet is a radical enhancement to the SCM concept and is termed as e-Supply Chain Management (e-SCM). e-SCM extends beyond traditional boundaries to integrate, in real time the customer/product information and productive competencies to be found in customer's customers and supplier's suppliers systems. The synergy created enables companies to dramatically improve revenues, costs and asset utilisation beyond dependence on internal capabilities and resources. e-SCM is defined by David F. Ross as:

"e-SCM is a tactical and strategic management philosophy that seeks to network the collective productive capacities and resources of intersecting supply chain systems through the application of internet technologies in search of innovative solutions and synchronisation of channel capabilities dedicated to the creation of unique, individualised sources of customer value" (Ross, David F., 2003).

This definition throws light on three key features of e-SCM. First, e-SCM enables real time connectivity of all channel- trading partners and provides for the instantaneous visibility of events and decision-making across the global supply chain. Second, it enables companies to leverage digital technology to structure close, collaborative partnerships with their supply chain partners. Finally, it enables supply chain to synchronise information arising from all network nodes.

Evolution of E-Supply Chain Management

Critical business requirements of the modern enterprises have given rise to the focus on e-supply chain management. Up until the late 1980s, limitations in computer architecture and communications devices forced the companies to remain concentrated on streamlining and integrating internal business functions. Even simple data components like inventory balances or forecasts, were communicated with great difficulty to sister warehouses or divisions. In the late 1990s, the marketplace had become aware of definite acceleration in the speed of change shaping the business environment. Management buzzwords, such as agile enterprises, virtual organisations, total quality management (TQM), business process reengineering (BPR) and lean manufacturing, all focused to eliminate time and costs from the entire supply chain process while providing new levels of customer satisfaction. As this movement toward internal cost reduction and process optimisation has moved to its ultimate conclusion, today best companies have sought to apply the same management and technology paradigms outwards to their supply chains. Todays leading market organisations have realised that by closely collaborating with their supply chain partners in cross-channel areas such as product development, forecasting, inventory management, logistics etc., new avenues of competitive advantage can be uncovered.

The explosion in global trade has opened up new markets and new forms of competition. Companies are no longer limited to selling in their own national boundaries. Global enterprises have been on a continuous search for business partners that will provide them not only with cost reductions but also access to resources and markets previously beyond their reach. E-business technologies have the capability to enable even the smallest companies to work closely with networked global supply chains.

The application of breakthrough information technology tools centered on the internet has enabled companies to look at their supply chains as a revolutionary source of competitive advantage. Before the internet, businesses used their supply chain partners to realise tactical advantages, such as passing documents through electronic data interchange (EDI) and integrated logistics functions. With the advent of e-commerce, these advantages have been dramatically enhanced. Enterprises are recognising that transferring the functions of SCM to the web will provide the integration of customer value-enhancing capacities found among allied channel partners.

Stages of E-Supply Chain Management Development

For customers, logistics functions have traditionally provided for the efficient and speedy movement of goods and services from the point of manufacture the point of need. But, over the past 30 years logistics had progressed from a purely operational function to a key strategic component. Since then, synchronising the

supply chain has occupied a central position in the management of enterprise, linking business marketing and sales strategies with manufacturing, inventory and service execution.

The evolution of e-SCM could be said to consist of five distinct management stages as under:

First stage (up to 1960s) can be described as an era of internal logistics departmentalisation. Logistics was a decentralized function with little management authority, having weak internal linkages between logistics functions. Management focus towards logistics was support for sales/marketing, warehousing, inventory control, transportation efficiencies, etc.

In the second stage (1960s to 1980s), logistics started migrating from organisational decentralization to centralization driven by new attitudes of cost optimisation and customer services. Logistics was seen as a source of competitive advantage. This stage can be described as the stage of total cost management.

In the third stage (1980s to 1990s), the scope of logistics expanded dramatically to embrace new concepts calling for the linkage of internal operations with functions performed by channel trading partners. Management focus shifted towards logistics planning and its integration with enterprise & channel operation functions. This stage can be described as the stage of internal logistics management.

The fourth stage (1990s - 2000s), can be called the stage of full supply chain management. In order to have new capabilities to realize continuous breakthroughs in product design, manufacturing, delivery, customer service, cost management and value added services; companies began striving to identify the best core competencies and collaborative relationships among their trading partners. Management focus moved towards the use of extranet technologies, channel alliances and collaboration to leverage channel competencies.

The fifth stage (2000 till now continuing) can be called stage of e-Supply Chain Management. e-SCM enables networked, multi-enterprise supply chain having organisational agility and scalability. The management focus is towards internet technologies enabling e-information, low cost instantaneous sharing of all databases and SCM synchronisation. e-SCM enables product and process design, collaborative planning, e-procurement, e-marketplaces, internet exchanges etc. One of the greatest advantages of e-SCM is towards enabling fulfilment management. The collapse of dotcom era in 2000 revealed through e-commerce, customers can have instantaneous access to product information and place orders but actual fulfilment is a complex and time consuming affair. e-SCM solves this problem by enabling the highest form of supply chain collaboration and substitutes, as much as possible, information for physical flows of inventory.

An example would be the strategic partnership between the Ford Motor Company and UPS Logistics Auto-gistics (specialized group of UPS Logistics group that will assume the lead role in reengineering finished vehicle delivery networks) announced on Feb 2, 2000 http://www.autointell-news.com/news-2000/March-14-0 0- p8.htm. Using real-time web based technologies; the alliance is designed to reduce by up to 40 per cent of the time required to deliver vehicles from Ford plants to dealers and customers. The systems provide pinpoint network operations capability through real time reporting by Auto-gistics people at every node in the delivery channel.

Changing Business Scenario

Doing business in today's marketplace is becoming increasingly complex. With the advent of the new technologies, customer's expectations are rapidly changing. The immense power of e-business has given customers a powerful tool in their search for unique value and a solution for their buying needs. The migration of marketplace power from producers and sellers to buyers and consumers is being accelerated and amplified by the internet revolution. Along with empowerment of customers, e-business also presents opportunities for the marketers. They can engage in a wide variety of cross-selling and up-selling opportunities, while reaching each customer in real life, one to one.

Liberalisation and globalisation have made the market increasingly competitive. Increasing competition has lead to rapid development of new products and consequently, shortening of product life cycles. In the past companies competed by selling standardized, mass-based products based on lowest cost and possessing standards of average quality and availability. Today customers expect rapid availability of products and services along with other characteristics like cost, quality etc. Materialising internet-driven expectations about this new view of products and services is e-collaborative product lifecycle management (PLM). Such collaborations offer the benefits of reduced product design time and faster time to market.

In order to continuously produce and deliver products and services capable of rapid development,

deployment and configurability, companies are integrating Collaborative Planning, Forecasting and Replenishment (CPFR) technologies with e-collaborative Product Data Management (PDM) systems. Real time collaboration with channel trading partners down the supply chain provides access to valuable customer information. For example, Cook & Tyndall (2001) relate how Dell was able to steal time, cost and leadership from competitors. Because of its real-time demand management channel connectiveness, when a sudden surge in two-gigabyte disk drives called for a switch from one-gigabyte drives, it quickly changed its ordering with the supplier. Because of conventional 6-week demand forecast, Dell competitors missed the trend and continued to build the one-gigabyte PC.

In recent times, severe supply chain disruptions have created a new appreciation for supply chain flexibility. Today, businesses have to cope with global recessions, incidents like September 11, terrorist threats etc. After the events of September 11, 2001, supply chains of large manufacturers struggled to cope with production changes of their partners. Ford Motor Company, for example, had to close five plants in North America due to parts shortages.

There has been a tremendous explosion in international trade. The word is rapidly becoming a global trading community. As an effective solution to emerging issues, e-business is rapidly changing the way business is done. For example, Covisint, a giant automotive exchange being built by General Motors, Ford and Daimler Chrysler, has already been the site for the purchase of million of dollars worth of direct materials via the online markets http://www.businessweek.com/2000/00_23/b3684044.htm. Together the exchange expects to be transacting billions of dollars worth of goods each year. There is a tremendous scope for formation of such alliances across boundaries. According to Gartner Group estimates (May 2001), the global B2B Internet commerce is expected to reach $8.5 trillion by 2005.

The pace of change driven by the expectations of the customers, the speed of product and service innovation and the emergence of global marketplaces have dramatically altered the structure and mission of logistics. In the past, logistics was perceived as operations function concerned with warehousing, transportation and finished goods management. Today, it is perceived as competitive weapons that can not only deliver products and services at lowest cost but can also enable enterprises to synchronise materials and information from one end of the supply chain to the other. With the application of internet, e-logistics acts as a critical enabler of e-business and e-commerce.

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The Rise of Internet Commerce

The changing business scenario has led to the rapid development of web-enabled e-business. The web-enabled e-business development can be said to consist of four definite phases as under:

i. **The Phase of I-Marketing:** Modern era is forcing companies to inform and communicate with customers, both beyond local markets and across vertical and horizontal industries. Also, the customers have increasingly shown the desire to move beyond the passive approach of searching and learning about new companies and their product/service mixes. The advent of internet and World Wide Web enabled companies to finally escape from the limitations of traditional marketing, by providing a revolutionary medium to communicate to the customers around the world. According to Forester Research, by the end of 1995 about 34 per cent of Forture 500 companies had established a website. A year later, this figure skyrocketed to nearly 80 per cent. Today it would be difficult to find a corporation that does not have a website informing browsers about information ranging from company goals to daily product categories.

ii. **The Phase of E-Commerce:** While I-marketing did provide the companies with the capability to open existing new channels of communication with the marketplace, it was realised that a platform to transactions and permit interactions between companies and the consumers over the internet was needed. During the second half of the 1990s, companies like Amazon.com, e-Bay and Priceline.com were offering web-based storefronts that combined I-Marketing online catalogues and advertising techniques with new technology tools such as Website personalisation, self service, interactive shopping cards, bid boards, credit card payment, and online communities that permitted actual on-line shopping. According to Hoque (2000), the new e-commerce tools gave rise to new e-application categories like e-tailing and consumer portals, bidding and auctioning, consumer care and electronic bill payment.

iii. **The Phase of E-Business:** While the e-commerce storefronts offered transactions between consumers and various types of e-tailors, e-business is concerned with the transactions of products and services between businesses. Trading exchanges are becoming key success factors for business collaboration. They provide for the creation of internet portals combining transactions, content and services focussed on optimising, synchronising and automating selling, buying and fulfilment. Three types of trading exchanges are used. Independent, public exchanges are websites where buyers congregate to seek out the best deals for the specific industry from a wide range of suppliers. Private exchanges perform the same functions as public, with the exception that they are proprietary, driven by a single host or "hub" and membership is usually restricted to trading partners. Third types are the consortium exchanges. In consortium exchanges, groups of large companies and their trading partners organise themselves. They are private in the sense that only members can participate but public in the sense that members can freely trade with each other inside the exchange. It has been observed that the companies are reluctant to share vital information with the trading partners by the way of trading exchanges. The strength of the security systems and trust among trading partners hold the key to e-business success.

iv. **The Phase of E-Collaboration:** The power of e-business marketplaces to increase demand visibility, operational efficiencies, and customer segmentation, while simultaneously decreasing procurement costs, replenishment time, and geographical barries, has dramatically changed the nature of supply chain management. B2B e-marketplaces are evolving from transaction based to e-supply chain collaborative and synchronised systems. Driven by internet, Collaborative–Commerce (c-commerce, a term coined by Gartner) is on the rise. C-commerce is seeking to utilise internet technologies to enable closer collaboration of channel network partners. It enables closer and timelier contact with the customer, better channel inventory management, faster time to market, better synchronisation and increased revenues; as have already been realised by early adopters like Dell, Wall-Mart & Hewlett Packard. The experience of the successful players shows that security, trust and branding are keys to c-commerce success.

Internet provides an example of what Downes and Mui (2000) term a "disruptive technology". According to the Law of Disruption, changes in social, political and economic environment occur incrementally, while changes in technology are exponential in nature and cause order of magnitude shifts in the environment. For example, the enabling power of the internet inaugurated a change in the way business is conducted that was another level in comparison to incrementalist strategies of process management tools such as business process re-engineering (BPR), enterprise resource planning (ERP), total quality management (TQM) and just- in-time (JIT). The bottomline is that internet offered the enterprises the capability to fundamentally transform themselves.

The Information Revolution

The 21st century is the age of information. It is information rather than productive assets, materials or labour that constitutes the fundamental source of wealth. Information sharing is fundamental to learning required for deliberate change, particularly in dynamic environments Mendelson (2000). Merely sharing a broad range of information is detrimental to the supply chain flexibility, and organisations should instead focus on improving the quality of information shared. Enterprises that engage in broader and higher-quality information exchanges with current partners are likely to be better aware of new opportunities and more ready for potential partners, whereas those without this information may not be able to sense and adopt to key industry events (Kota; 1998).

The Internet has propelled the effective management of the information to a new dimension. Internet enables the companies to transform not just internal processes but whole industries–companies, suppliers and trading partners. According to Raisch (2001) the emerging knowledge began "first with the foundation of a standardised global communication network, followed by universal data and rich media network that is provided via global Internet, and finally via communication, collaboration and enterprise application integration (EAI) solutions". According to AMR Research, the traditional linear, sequential supply channel will give way to the evolution of real time, electronically connected networks, composed of traditional players joined by a number of non-traditional intermediaries. In contrast to traditional supply chains, where inventory flows down through the pipeline, node by node, and information from each node moves back to the channel, the internet-enabled cybermediaries may never own or physically inventory the product. Their role will be to leverage the internet, to perform matching of products and buyers or coordinating marketing or transaction processes among network trading partners, e.g. the partner-

ship announced between mid-August 2001 between Amazon.com and Circuit City http://www.ecommercetimes.com/story/1299. The partnership was designed to provide the shoppers with the option of buying electronics from Amazon website and then picking them up at one of 600 circuit city stores or, by early 2002, having them sent directly to customers homes. Amazon, who never touched the products, increased its electronics inventories considerably and received a percentage of sale originating from the website.

According to AMR research (Lapide; 2001), at least four new e-Supply Chain Management business Cybermediary Models are emerging today:

i. *Virtual Manufacturers:* They does not physically manufacture products. Their role is to control the product development, marketing & sales, as well as coordinate customer services, e.g., Sun Microelectronics.

ii. *Virtual distributors:* They neither own any warehouse nor physically distribute products. Their role is to control marketing & sales and to coordinate order management, e.g., Contract manufacturers, 3rd party logistics etc.

iii. *Virtual Retailers:* They use the internet to customise products displayed in online catalogues & other web mediums, e.g., e-tailors like Barnes and Noble.com

iv. *Virtual Service Providers:* They provide channel services without possessing any physical assets, e.g., Lead Logistics Providers (LLP's) & Logistics Exchanges (LX).

This information revolution has lead to continued migration from vertically to virtually integrated enterprises, e-business expansion, expanding customer relationship management and increased emphasis on business collaboration.

Emerging Trends

We are now at interesting cross-roads where IT applications for inter-enterprise information exchange can take advantage of the new breed of interaction capabilities derived from flexible mark- up formats and low-cost connectivity. There has been a proliferation of technology platforms, using lighter weight protocols for creating electronic bonds, such as e-marketplaces (e.g., E-Steel) or hubs (e.g., Covisint), as well as tools for inter-enterprise integration (e.g., Webmethods) (Bischoff; 2000). What has made e-SCM such a potent market force today is its ability to leverage digital technology to provide a seamless channel structure, which is physically dispersed and consists of different competencies. The more tightly information is synchronized among network business partners, the more the entire channel is enabled to act as if it were a single company. For example, Cisco Systems e- planning applications automatically alert suppliers when actual customer demand deviates from forecasts, thereby reducing inventory imbalances throughout the entire supply channel. As Cisco is able to include more suppliers in the planning system, their ability to be more flexible to meet any customer order exponentially grows. The validity of this proposition is based on the e-business postulate known as "Metcalf's Law" http://www.during.com/mme.html. So, e-SCM has revolutionised the activities in almost all business areas such as Customer Relationship Management (CRM), Supplier Relationship Management (SRM), Manufacturing, Logistics Resource Management (LRM) etc. Certain noticeable developments in these areas are mentioned below:

Customer Relationship Management (CRM)

These days, customers have become value driven and look to build strong relationships with the suppliers. Unsatisfied customers can be a significant negative force in today's internet-empowered business environment. So, it has become essential for suppliers to move beyond past transactions to a position of understanding the personal needs, wants and preferences that constitute value for each customer. With the use of real time technologies such as Online catalogues, Online service processing & configurability, e-mail marketing etc., companies are able to improve effectiveness and better utilise resources.

One of the important applications of e-CRM is in the fields of Partner relationship Management (PRM). This phenomenon has made re-intermediation of the supply channel simple. For example, Amazon.com and Yahoo have succeeded because instead of bypassing channel intermediaries, these companies stressed on closely structured relationships with the channel partners, dealers and resellers with the help of IT (Laffey, 2004). Similarly, the e-choupal initiative of ITC is another significant example. PRM started as a means to facilitate channel sales and gather metrics based on marketing and sales efforts of channel partners. Today, applications of PRM can be felt in many vital areas like partner recruitment, development and profiling; marketing development; sales management; services management; business collaborations etc.

Another rapidly developing area in the field of e-CRM is Electronic Bill Presentment and Payment (EBPP). The initiatives in this area can be seen from software suppliers, financial service providers (like

banks), portals and exchanges (like Quicken.com, Yahoo.com etc). As e-billing applications grow, many companies have begun the process of integrating EBPP into their CRM toolsets. In India, applications in this field are noticeable in the areas like online banking, railway reservation etc.

According to AMR research, (Scott; 2001) investment in CRM analytics is expected to grow from $560M in 2000, or about 8 per cent of total CRM spending, to about double the rate of operational systems. The market will expand to nearly $4.4B by 2005, which represents about 19 per cent of total market by 2005. This shows the potential which e-CRM has to offer.

Supplier Relationship Management (SRM)

For several decades companies have known that it is not the cost- effective purchasing of inventories, but rather the existing relationship between the buyer and the seller, that adds the real value added component of procurement. As the demands of the customer and capacities of suppliers are increasingly synchronized, the essential components of procurement are made more efficient, costs decline, the flow of channel inventories are accelerated, and cooperative alliances to improve planning and product information exchange and deepened. Supplier partnering in today's global business environment is no longer an option but has become a strategic requirement to maintain competitive advantage. E-SRM in the changing business environment enables cost control, quality and innovation of products and services; enhances risk-sharing capabilities by collaborative partnerships using supporting concepts like supply chain planning (SCP) and collaborative planning, forecasting & replenishment (CPFR) and focuses on continuous improvement. With the application of internet, purchasers have been able to leverage new forms of procurement functions, such as online catalogs, interactive auction sites, radically new opportunities for sourcing and supplier management.

E-procurement and e-sourcing have emerged as two most important applications of e-SRM and has enabled strategic sourcing. According to AMR, strategic sourcing can be defined as a systematic, cross-functional, and cross-enterprise process that seeks to optimise the performance of purchased goods and services through reductions in total cost, sourcing cycle time, and assets. E-procurement focuses on leveraging web applications to reduce tactical costs and increase efficiencies and is primarily focussed on non-strategic, indirect materials by covering activities such as purchase order generation, order management, procurement statistics. E-sourcing is focused on the more effective management of vendor sourcing, contract, request for quotation (RFQ) and supplier management during the early stages of strategic, production materials life cycle management. It helps to develop long term supplier relationships that will assist in the growth of collaborative approaches to joint product development, negotiation, contract management and CPFR.

According to Foster, (2002) e-SRM expands the scope of procurement functions, provides for deep integration of business processes, facilitates direct collaboration between manufacturers and their suppliers and enables increased speed and flexibility. E-SRM is currently at a transition stage from its early buy side focus on commodities sourcing to fully collaborate marketplace commodities. In order to accomplish this, e-SRM must, first of all, respond to the individual company's requirements and secondly, must enable true collaboration across the supply chain.

Manufacturing

The traditional objectives and methodologies of manufacturing have undergone tremendous change, in response to migration of once large, vertical organisations to increased outsourcing, the dramatic shortening of product lifecycles and growing requirements for rapid product design. According to Jordan and Michael, (2000) todays typical manufacturing company's fate changes in four directions such as technological, structural, managerial and human. Today, manufacturing firms are trying to engage in design for supply chain, signifying that the ability to build and distribute products is the focus of not just individual firms but of whole supply networks. The focus of such a structure is on developing product and service mixes that corresponds to the needs and desires of a majority of firm's customers. The goal is to utilise lean manufacturing principles to develop processes that minimise the impact of product design changes, maintain or shrink production costs, permit the recycling of marketing and advertising, and utilize the existing distribution infrastructure.

Manufacturers over a period of time have tried to use the power of IT in manufacturing. By the 1970s, advances in computer hardware and manufacturing theory assisted basic Material Requirement Planning (MRP) to evolve from being purely an ordering system to a set of applications used to integrate company's demand with the material plan calculation. MRP I (closed loop MRP) started a trend in this direction. Just-in-Time (JIT) appeared as a new manufacturing philosophy from Japan. MRP II enclosed the function of business planning into closed loop system. Subsequently, new computerized tools like manufacturing execution systems (MES), computer integrated

manufacturing (CIM) and high-powered tools for shop floor optimisation and finite loading emerged. Despite a tremendous degree of planning and control afforded by MRP, todays requirements for often minute-by- minute update of data and reformulation of plans have rendered the labour intensive planning and recalculation processes of MRP too cumbersome for real-time shop floor information and execution. These deficiencies of MRP have been overcome by the rise of Advanced Planning Systems (APS) and Supply Chain Management (SCM) systems. These new technologies have been able to tap into the enabling power of internet to create real time linkages with the suppliers, thereby enabling collaborative planning, forecasting & replenishment (CPFR). CPFR has enabled timely communication of forecasts and inventory replenishment data to support the synchronisation of activities necessary to effectively respond to supply chain demand.

These tools are designed to utilise the internet and existing technologies to link the demand and supply capabilities of manufacturers, distributors, retailers and suppliers in order to integrate channel demand with total network resources, reduce channel inventories and improve productivities. These e-business applications to manufacturing have provided the ability to receive real time information from a variety of systems thereby enabling manufacturing process synchronisation, business collaboration with suppliers and internet-driven design collaboration. This increased focus on integrating and synchronizing the entire supply chain in the pursuit of faster product development, speed to market and shortened time-to-profit has resulted in collaborative product commerce (CPC) development.

Logistics Resource Management (LRM)

The key to logistics competitiveness is to utilise the best service partners and technologies to ensure that the most timely information and efficient business systems can be leveraged in the pursuit of value-added processes driving the cycle of supply chain procurement, manufacturing and delivery. Logistics Resource Management (LRM) focuses on trading partner collaboration, removal of channel barriers and the creation of agile, responsive organisations linked together in a single-minded pursuit of superior customer service. LRM creates competitive value by ensuring the optimization of logistics operations costs and productivity, better capacity and resource utilization, inventory reduction, and closer integration with customers and suppliers.

According to Hintlian and Churchman, (2001) today's LRM environment requires logistics service relationships characterized by increased collaboration, establishment of contractual and operations arrangements, catalogue of core competencies that can be outsourced and design support systems that can assist both individual companies and supply chains. Of increasing importance to logistics managers is visibility to information about inventories and fulfilment capabilities found not just between immediate buyer and supplier, but also among trading partners constituting the entire supply chain. Powered by the emerging technologies inside the organisation, companies can leverage ERP suites, warehouse management systems (WMS), and transportation management systems (TMS) to view shipment-order linkages and in-transit shipment information. Externally companies can leverage supply chain planning, management and execution applications that provide CPFR and supply chain event management (SCEM). They provide LRM planners with visibility to the entire supply channel, enabling them to execute more effective strategic logistics solutions and help them provide superior service to the customer.

According to Langley, (2001) the range of today's e-LRM solutions span the categories like: independent transportation exchanges designed to match shippers and providers; transportation network infrastructures providing hosting web-based applications to shippers and carriers; transportation management software vendors providing Web-enabled logistics solutions; 3rd Party Logistics providers (3PLs) offering transportation and and warehousing services to clients; and collaborative logistics networks using Web-based tools to enable community of shippers and buyers to connect with each other and trade logistics functions. Today, e- logistics marketplaces have closely followed the experience of other area of e-business as they migrate from independent to private exchanges and move their focus from cost economies and spot buys to developing collaborative communities. E-LRM has enabled whole supplychains to make better decisions, trim costs, increase logistics efficiencies and architect effective collaborative relations between all supply channel trading partners.

Creating Value Networks

All the above applications and trends noticed in the field of e-business must not be seen as a component of a company's technology suite, but rather as a new business chain model that requires entire supply channels to be transformed into value networks. These networks seek to utilize e-business architectures to achieve superior customer satisfaction as well as company's profitability. They provide collaborative links matching customer demand with flexible, agile manufacturing product design and delivery. They provide for real time transfer and synchronization of plans and information enabling channels to bypass costly distribution inter-

mediaries. In creation of these networks, it is essential for the trading partners to determine the intensity of collaboration. According to Prahalad and Ramaswamy, there are four levels of collaboration intensity that can be pursued by the companies such as, arms length relationship which utilises a web portal site but will not require any greater level of sophistication; information sharing to improve business processes through real time work flows; sharing and creating knowledge by utilising the competencies of network partners and sharing and creating new insights leading to creation of common vision. It is this fourth level of collaborative intensity by which the companies can realize the true benefits of e-SCM. In this business environment the information supply chain will replace the physical supply chain.

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Management works in the system. Leadership works on the system.

– Stephen R. Covey

Feature

Measuring Productivity in the Supply Chain: Use of the Balanced Scorecard

Siddharth Varma, Subhash Wadhwa and S.G. Deshmukh

The petroleum supply chain, being a process industry supply chain, presents a unique set of attributes. This paper develops a framework for applying the balanced scorecard to determining the productivity of the supply chain in the petroleum industry. Quantification has been made possible by assigning weights using the AHP method. Finally, a generalized framework has been developed which can even be used for benchmarking a supply chain with other supply chains in the petroleum industry.

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The subject of productivity and how it could be improved has evoked interest among academicians and practitioners alike. Conventionally, productivity has been defined as the ratio of output to input. Measurement of productivity has often been a subject of controversy and differing views exist on this subject.

The objectives of this paper are:

- To discuss the importance of measuring productivity/performance in the supply chain and the challenges faced in doing this
- To look at the pros and cons of using Balanced Scorecard (BSC) for measuring supply chain productivity
- To formulate a generalized framework for using BSC for measuring productivity in the petroleum industry supply chain

The approach to productivity followed in this paper is justified for the following reasons:

(a) The conventional approach to productivity is not feasible for the supply chain as a supply chain brings diverse processes together.

(b) Conventional metrics only focus on financial measures. The current approach also covers non-financial measures.

(c) The strategic objectives have been derived from the issues that plague the petroleum industry supply chain instead of being derived from the strategy of a firm. By doing this, we have assumed that a strategy for supply chain management (SCM) in the petroleum industry must be a function of the issues that the industry faces. Thus, a generalized framework for determining performance of supply chains has been proposed, which will make it possible to benchmark one petroleum supply chain against other.

Defining Productivity

In broadest terms, productivity is the change in results obtained for the resources expanded (Davis, 1955). Productivity is the fundamental economic measure of a technology's contribution (Brynjolfsson, 1993). It is a measure of how efficiently and effectively a variety of resources is used as inputs to produce outputs needed by society (Mohanty & Deshmukh, 1998). Historically, productivity was related to just two measures: labour and capital. Total productivity presents a more suitable way to measure productivity of a firm. It is the relationship between outputs and sacrificed different input items to create those outputs (Hilmola, 2005). The idea behind total productivity measurement can be expressed in the following equation (Craig & Harris, 1973):

$$P = O/(L + C + R + Q)$$

Where L is the labour input factor, C is the capital input factor, R is the raw material factor and purchased parts input factor and Q is the collection of other smaller input factors which are not included in the previous items and O is the total output. Total productivity can also be expressed as the ratio of total tangible output to total tangible input (Sumanth, 1979):

$$\text{Total productivity} = \frac{\text{Total tangible output}}{\text{Total tangible input}}$$

Even though high total productivity performance and its improvement is an important objective for any organisation, but in reality it does not take into consideration all stakeholders sufficiently (Hilmola, 2005). Focus should not only be on economic value adding process, but also the environmental and social aspects should be taken into consideration (Mohanty & Deshmukh, 1999). Productivity and quality are closely related. The only way to improve productivity is to improve quality (Deming, 1994). Measures of quality can be expressed in productivity terms (Midas, 1982).

The view of various authors on productivity have been tabulated in Table 1.

Total productivity is in some sort of crisis - even the definition of output differs between different researchers and approaches (Hilmola, 2005). A supply chain is made up of diverse processes and application of the simple output-input formula may not be feasible. For example, defining productivity of the purchasing process as output/input would not be possible since it would be tough to identify what the output and input for a purchase process are. Thus, measuring productivity in the supply chain is not such a straightforward task. E.M. Goldratt in his famous book "The Goal" relates productivity to throughput, operating expenses and total inventory in the system. However, even this approach does not cover various non-financial aspects related to productivity. What is required is a performance measuring system which can combine the contributions of different entities in the supply chain into a single measure of performance.

Table 1: Differing views on productivity

Author	View on productivity
Davis, 1955	Productivity is the change in results obtained for the resources expanded
Craig & Harris, 1973	Total productivity P = O/(L+C+R+Q) where L = labour input, C = capital input, R = raw material/purchased parts input, Q = other smaller input and O = output
Sumanth, 1979	Total productivity is the ratio of total tangible output to total tangible input.
Midas, 1982	Quality and productivity are interrelated and measures of quality can be expressed in productivity terms.
Brynjolfsson, 1993	Productivity is the fundamental economic measure of a technology's contribution.
Deming, 1994	The only way to improve productivity is to develop total quality better
Mohanty & Deshmukh, 1998	It is a measure of how efficiently and effectively a variety of resources is used as inputs to produce outputs needed by society.
Brynjolfsson & Hitt, 1998	Productivity is the value created for consumers.
Mohanty & Deshmukh, 1999	Focus of productivity should not only be on economic value adding process, but also the environmental and social aspects should be taken into consideration
Hilmola, 2005	Total productivity is the relationship between outputs and sacrificed different input items to create those outputs

Performance Measurement of Supply Chain: The Importance

One of the most significant paradigm shifts of modern business management is that individual businesses no longer compete as solely autonomous entities, but rather as supply chains (Lambert & Cooper, 2000). SCM is being heralded as a value driver because it has such wide ranging effect on business success or failure (Farris II & Hutchison, 2002). Measuring its performance then, becomes critically important.

You can't improve what you can't measure. This adage is also true for SCM. For an improvement to take place, it is essential that a firm use performance measures appropriate to its business (Shah & Singh,

2001). The main reason for poor performance of supply chains is the lack of a measurement system (Morphy, 1999). Measures and metrics are needed to test and reveal the viability of strategies without which a clear direction for improvement and realization of goals would be highly difficult (Gunasekaran et al., 2001). Performance measurement is related to strategic intent, and the broad set of metrics used by managers to monitor and guide an organisation within acceptable and desirable parameters (Morgan, 2004). Management gurus have long argued that a key to continuous improvement is to measure, measure and measure (Lapide, 2000). The purpose of measurement and control in the supply chain is to provide management with a set of actions that can be taken in improving performance and planning competitiveness enhancing efforts (Hoek, 1998). Firms need to carry out performance measurement for various reasons (Parker, 2000).

1. Identify success;
2. Identify whether they are meeting customer requirements;
3. Help them understand their processes
4. Identify where problems bottlenecks, waste, etc., exist
5. Ensure decisions are based on fact, not on supposition, emotion, intuition
6. Show if improvement planned, actually happened.

Organisations need to ensure achievement of their goals and objectives, therefore, the purpose of performance measurement is to evaluate, control, and improve operation processes (Ghalayini & Noble, 1996). Performance measures have two main effects. First of all they can be used to set performance goals (Myer, 2000).

Firms need to measure not only the final output but also the processes involved to identify the causes of variance from target specification. To understand value drivers, managers must have in place a performance measurement system designed to capture information on all aspects of business not just the final results (Bryant et al., 2004).

It is clear that measuring performance of the supply chain becomes an important activity for any organisation to achieve supply chain excellence.

Performance Measurement of Supply Chain: The Challenge

Several factors make it challenging to measure performance of the supply chain today.

- The global focus of most companies makes hands-on management and measurement more difficult than ever (Dreyer, 2000).
- The internet has added to the measurement challenge as well. In today's dot com world, changes to the supply chain are taking place faster than our ability to comprehend them (Dreyer, 2000).
- As the business environment has changed, operations-based definitions of logistics service have evolved. The basic concept of utility creation has become inadequate to fully express the value created by logistics (Mentzer et al., 1999). One of the most challenging parts of measuring logistics is attaching a quantifiable value to the services that organisation provides (Hannon, 2004).
- Identifying the parameters that drive supply chain success may not be a straightforward task because customers have different perceptions about value.
- The problem of measuring supply chain performance extends to the service supply chain also. There is no single metric that defines the service supply chain's performance. Simply measuring delivery performance against service level agreements (SLAs), for example, does not appropriately measure overall asset performance (de Waart & Kemper, 2004).
- The difficulty of developing appropriate performance measures also includes issues of scope such as whether the measurement system should include a single or many organisations; one product line or many (Beamon, 1999).

The challenge of performance measurement of a supply chain has been schematically shown in Fig. 1.

Measuring performance: Pros and Cons of Using the Balanced Scorecard (BSC)

Different types of systems require specific measurement system characteristics, and therein lies the difficult in creating a general approach to performance measurement (Beamon, 1999). Traditionally, firms have focused on financial indices for measuring performance. However, survival of the company does not depend on profitability alone and managers have learnt that unequalled focus on financial health can result in adverse consequences (Pandey, 2005). Financial accounting measures are insufficient to measure supply chain per-

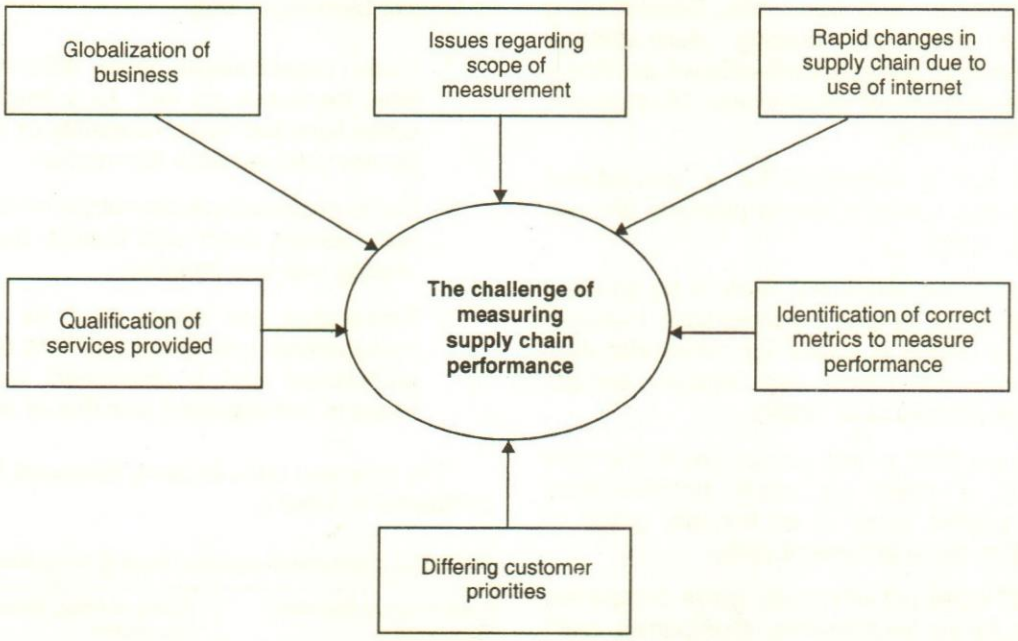

Fig. 1. The challenge of measuring supply chain performance

formance for the following reasons (Lapiede, 2000):

- They tend to be historically oriented, lacking a forward looking perspective
- They do not relate to strategic performance
- The measures are not directly tied to operational effectiveness/efficiency

The BSC suggested by Kaplan and Norton in 1992 takes care of many deficiencies of the traditional performance measurement systems and has the following advantages:

- It takes care of financial and non-financial measures.
- Traditional logistics measures neither adequately assess supply chain performance nor embody measures to motivate employees to behave with a supply chain orientation (Brewer & Speh, 2000). The BSC overcomes this deficiency.
- Implementing BSC starts by applying it at a high level and letting the strategic objectives and themes cascade down to lower levels. Thus, decentralized units become aligned with each other and to the corporate strategy (Kaplan, 2005).
- A good measurement system must measure parameters affecting all its stakeholders. The balanced scorecard tries to do this by measuring performance across different perspectives: financial perspective affects sharecard tries to do this by measuring performance across different perspectives: financial perspective affects shareholders, customer perspective affects external customers, business processes affect shareholders and customers, innovation and learning affects employees.
- It includes both function-wise performance measures and specific activity-focused measures which are important in tracking and controlling how well the system is performing and how effective managers are in executing their key functional responsibilities (Brewer & Speh, 2001).
- The BSC enables management reports to focus on measures specifically selected to represent the organisation strategy (Kaplan, 2005).
- It also takes care of soft and intangible parameters. By defining the specific, measurable behaviours desired in leaders, it forces previously implicit choices to become explicit, actionable and accountable (Kaplan, 2005).

Inspite of the various advantages of the BSC, the concept has certain shortcomings:

- Though the BSC includes a variety of performance metrics, it does not weigh the relative importance of these metrics nor acknowledges

their interaction and trade offs. Developing a balanced scorecard utilizing multi-attribute utility theory to address trade-offs will provide a better evaluation of alternatives (Youngblood and Collins, 2003).

- BSC is not a substitute for a well-defined strategy or a formal business planning process (Pandya, 2002).
- Balanced scorecard is less likely to be adopted by small firms as it is an integrative management tool which is useful for co-coordinating cross function and cross level decisions and activities (Hendricks et al., 2004)
- Though the BSC points a company in the right direction, it does not allow benchmarking results against those of an industry group or competitor (www.accenture.com).
- The BSC does not effectively guide companies in their future investments. Companies can't answer the critical question: Where do we invest our dollars to get maximum return (www.accenture.com)?
- Though the BSC incorporates multiple performance measures, it lacks long term perspective, the distinction between cause and effect is blurred; and it lacks empirical validation (Maltz et al., 2003).
- Critics of the balanced BSC argue that it is difficult to achieve a balance between financial and non-financial measures and that the firms do not adhere to this balancing act because of implementation problems (Anand et al, 2005).
- It does not tell us how to combine dissimilar measures into an overall appraisal of performance (Meyer, 2002).
- In the services sector, the role of motivated employees is critical to success but the balanced scorecard fails to consider it (Smith, 1998).
- As stakeholders, suppliers are left out of the model. Also left out is the general public as the scorecard does not address environmental related issues like greening of supply chain.

Difficulties also exist in implementing the scorecard as follows (www.aqpc.org):

1. Many organisations have difficulty identifying what measures are key. As a result, scorecards either have too many measures or measures that do not yield valuable information.
2. Some organisations do not define their measures well, leaving them with metrics that are unconvincing and unsupported.
3. Scorecards are often used as a high level management tool to run business units within organisations and a disconnect exists between focus of management and that of employees.

The pros and cons of using Balanced Scorecard are compared in Table 2.

Table 2: Comparison of pros and cons of using Balanced Scorecard

Pros of using Balanced Scorecard	Cons of using Balanced Scorecard
It takes care of financial as well as non-financial measures of performance.	(a) It neither weighs relative importance of metrics nor acknowledges their trade offs. (b) Does not tell us how to combine dissimilar measures. (c) It is difficult to achieve balance between financial and non-financial measures.
The process of implementing BSC starts with defining strategy and letting strategic objectives cascade down to lower levels.	It is still not a substitute for a well-defined strategy or a formal business planning process.
It uses channel spanning performance measures to gauge collective success in reaching the end user.	Though it does point a company in the right direction, it does not allow benchmarking results against competitors.
It includes factors affecting several stakeholders: shareholders, employees and customers.	Though it does measure parameters that affect different stakeholders, suppliers as a stakeholder are left out of the model.
It includes both function wise performance measures and specific activity focused measures.	The distinction between cause and effect is blurred and it lacks empirical validation.
Helps in designing a customized performance management system.	Identifying the correct metrics is often a problem.
By defining specific, measurable behaviors, it makes implicit choices explicit and accountable.	It still fails to consider the role of a motivated employees which is very important in services.

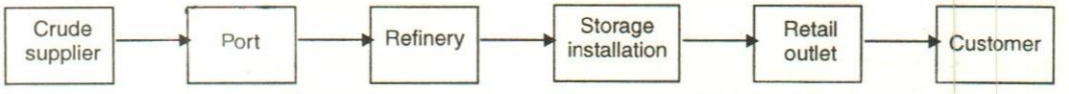

Fig. 2. Schematic representation of the petroleum supply chain

A framework of Using Balanced Scorecard for Petroleum Industry

The supply chain in the petroleum industry commences with the crude supplier and ends with the customer who buys the product from the retail outlet. This is schematically depicted in Figure 2.

The concept of balanced scorecard can help in measuring performance of the supply chain in the following ways (Brewer & Speh, 2001):

- The goals of SCM, eg, unit cost reduction, can be measured via the business process perspective.
- The outcomes of SCM, eg, customer satisfaction, can be measured via the customer and financial perspectives.
- The rate of improvement in SCM, eg, information flows, can be measured by the innovation and learning perspective.

Since the petroleum industry is a process industry, it has certain unique characteristics which differentiate it from the discrete manufacturing supply chain. This uniqueness has to reflect in the measures chosen for measuring the performance of this supply chain.

In order to develop a framework for applying the balanced scorecard to the petroleum industry, we have used the following steps:

1. Identifying strategic objectives
2. Mapping the strategic objectives to various perspectives in the BSC.
3. Selecting suitable measures for the strategic objectives
4. Applying AHP in order to determine weights of various perspectives and of the measures used for the strategic objectives under each perspective.
5. Evaluating performance of a particular supply chain by using above weights and scoring the particular supply chain on the chosen measures.

Step 1: Identification of strategic objectives

The strategic objectives of a typical organisation with respect to the supply chain in the petroleum industry can be derived from the unique features of the petroleum industry supply chain. Since most of these unique features also lead to inefficiencies in the system, it is logical that any firm in the petroleum industry should have strategic objectives revolving around these issues. In this manner, we can bypass individual strategies of firms for SCM and arrive at a generalized set of strategic objectives which will address the issues in the petroleum industry supply chain. Table 3 gives the possible strategic objectives against the attributes of the petroleum supply chain.

Table 3: Deriving possible strategic objectives for the petroleum supply chain

S.No.	Attributes of Petroleum industry	Related strategic objectives
1.	Raw material prices: Unstable and often affected by fluctuating international prices.	Have stable raw material prices
2.	Stability and predictability of raw material supplies: Low due to international pressures, OPEC pressures etc.	Have steady flow of raw material
3.	Transportation costs: High	Reduce transportation costs
4.	Inventory carrying costs: High	Reduce inventory costs
5.	Postponement: Extremely difficult	Introduce postponement if possible
6.	Level of integration of supply chain partners: Low	Enhance integration with supply chain partners
7.	Risk contamination/adulteration: High	Maintain purity of product
8.	Length of supply chain: Long	Try to reduce length of supply chain
9.	Flexibility: Very difficult to achieve	Improve flexibility in terms of volumes transported or delivered
10.	IT usage: Laggards in usage	Enhance use of IT
11.	Physical risks (fire etc): High	Reduce risks
12.	Type of supply chain required: Adaptive supply chain (ASC)	Use software for optimizing the enterprise
13.	Criticality of supply (due to government pressures, demanding customers): High	Maintain steady supply of finished product
14.	Switching costs for customer: Low	Try to retain customers and increase market share

Step 2: Mapping strategic objectives w.r.t BSC perspectives

Once the strategic objectives have been derived keeping in mind the issues in the petroleum industry supply chain, the strategic objectives need to be mapped to the perspectives in the balanced scorecard. This has been shown in Table 4.

Table 4: Mapping strategic objectives to BSC perspectives

S.No.	Strategic objectives	Relevant BSC perspective
1.	Have stable raw material prices	Financial
2.	Have steady flow of raw material	Internal business process
3.	Reduce transportation costs	Internal business process
4.	Reduce inventory costs	Internal business process
5.	Introduce postponement if possible	Customer
6.	Enhance integration with supply chain partners	Internal business process
7.	Maintain purity of product	Customer
8.	Try to reduce length of supply chain	Financial
9.	Improve flexibility in terms of volumes transported or delivered	Internal business process
10.	Enhance use of IT	Innovation and learning
11.	Reduce physical risks in the supply chain	Financial
12.	Use software to optimize the enterprise	Internal business process
13.	Maintain steady supply of finished product	Customer
14.	Try to retain customers and increase customer base	Financial

Step 3: Identifying measures for the strategic objectives

The next step is to find out measures for the strategic objectives which have been identified in step 1. These have been enumerated in Table 5.

Finally, each measure shall correspond to either of the three categories: poor, average, very good. These categories shall carry predetermined weights. Thus, dissimilar metrics can be combined together.

Role of innovation and learning

Most performance measurement systems ignore the aspect of innovation and learning in the firm. However, the balanced scorecard gives due importance to innovation and learning. Innovations can bring in both continuous improvement for any organisation in order to increase productivity. The framework discussed above has two strategic objectives related to this perspective. The first one is the use of IT.

It is a well known fact that information sharing in vital for SCM. Otherwise it would be difficult to eliminate duplication, reduce waste, cut costs and respond flexibly to customers (Brewer & Speh, 2000). This naturally brings about more efficient utilization of resources and increases productivity. The second strategic objective is postponement. The product finalization point measure addresses the increasingly important issue of postponement (Bovet and Sheffi, 1998). The way to manage postponement is to create product or process innovations that enable a supply chain to reduce the time elapsed between finalization and customer delivery (Brewer & Speh, 2000). Again, postponement can help in providing a product that satisfies customer requirement in a better way without increasing inventories in the supply chain. This again enhances productivity in the supply chain.

Step 4: Applying AHP to determine weights of objectives/measures

First of all, we need to determine the weights of the various perspectives in the balanced scorecard. This is done by carrying out pair wise comparison using a three point scale having values for "least significant", "most significant" and "equally important". By pair wise comparison we get a matrix which can be used to arrive at relative weights of the various perspectives. This gives weights for level 1 in the AHP. This can be either done manually or by using Expert Choice software. Once the weights have been determined the consistency index is calculated to check whether inconsistency is within acceptable limits.

$$C I = (\lambda(max) - n)/(n - 1)$$

Where $\lambda(max)$ = maximum eigen value and

n = no. of rows or columns

Consistency ratio CR = CI/RI where RI is the average random index

A consistency ratio of less than 0.1 is acceptable.

After the weights of the perspectives have been determined the same procedure can be used to arrive at weights for level 2, i.e., weights for the strategic objectives in each perspective.

Table 5: Identifying measures for strategic objectives

Perspective	Strategic objectives	Relevant measures	Measuring unit
Financial	Have stable raw material prices	Variation in price over the year	Ratio of standard deviation to average price
	Try to reduce length of supply chain	No. of days elapsed from dispatch of crude to delivery of finished product at retail outlet	Number of days
	Reduce physical risks	Extent of coverage through insurance	Ratio of assets insured to total supply chain assets.
	Increasing market share	Change in market share annually	Percentage
Internal Business Process	Have steady flow of raw material	Variation in flow of raw material	Ratio of std deviation to total requirement/month
	Reduce transportation costs	Transportation cost	Rs per MT
	Reduce inventory costs	Inventory value	Inventory value to annual sale ratio
	Enhance integration with supply chain partners	Suppliers and customers networked electronically	Percentage suppliers or customers networked
	Use software to optimize the enterprise.	Extent of optimization done for efficient use of resources using software	Likert scale
	Improve flexibility in volumes transported or delivered	Minimum no. of litres delivered or transported	Litres
Customer	Maintain purity of product	Customer complaints regarding purity of product	Percentage complaints
	Maintain steady supply of finished product	No. of days of dry out at in the supply chain within an year	Number
Innovation and learning	Enhance use of IT	No. of employees using IT	Percentage
		Expenditure on training employees for use of IT	Percentage of total budget.
	Introduce postponement if possible	Distance between market and location where differentiation occurs	Kilometres

Step 5: Evaluating performance of a supply chain

Once the weights at level 1 and 2 have been determined, we need to determine the weights at level 3, i.e., weights for the measures used. This is done by determining the values for each of the measures for the given. The values of these measures will correspond to one of the categories: poor, average, good; as mentioned in the preceding paragraph which shall in turn correspond to a certain weight. In order to obtain final measure of the supply chain we first multiply weights at level 1 with weights at level 2 and then with the weight for a particular measure. The values thus obtained for each perspective are added together to get the final measure of performance.

Conclusion

In this paper we have tried to formulate a method of measuring the performance/productivity of a petroleum industry supply chain. The strength of the method lies in the fact that it considers a wide range of issues both financial and non-financial. But the greatest advantage of the model is that strategic objectives are based on the issues that plague firms in the petroleum industry. This helps in generalizing the model giving a set of strategic objectives which must be logically addressed by firms in the petroleum industry. Also, dissimilar metrics are combined together so as to arrive at a single quantitative measure of productivity in the supply chain. By using generalized objectives, the model can be used to benchmark against other firms in the industry. Application of AHP allows assigning of weights to criteria at various levels and allows tradeoffs among perspectives and among the measures for each perspective.

Whereas the model gives a logical way to arrive at performance of petroleum industry supply chains it does not look at strategy of a firm as the basis for deriving the strategic objectives which is what the conventional BSC aims at. The framework also does not address issues which are related to environment like greening of supply chain even though these can have substantial effect on the long term profitability of a firm. Moreover, the AHP model fails to recognize interaction among the criteria at a particular level.

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Feature

Supply Chain Issues in the Indian Poultry-Meat Industry: The Case of a Vertically-Integrated Farm

Subrata Mitra & Dipankar Bose

In this paper the supply chain issues specific to the Indian poultry-meat industry are discussed and the case study of a vertically-integrated farm is presented. The poultry-meat industry in India is a success story, gradually transforming from unorganized backyard farming into large-scale, organized farming. However, the supply chains are still characterized by inefficiencies, diseconomies of scale, lack of investments and inadequate infrastructure. Policies and procedures need to be eased to facilitate investments and exports. The focus should be on consolidation through mergers and acquisitions, and creating vertically-integrated farms such as the one presented in the case study.

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The world poultry-meat industry derives its significance from the fact that among all the meat categories, poultry meat is the fastest growing. According to an estimate made by Food and Agriculture Organisation (2003), world bovine and ovine meat productions are expected to increase by 15.3 and 4.5 million tonnes, respectively, during the period 1997/1999 - 2015, compared with an increase of 38.8 million tonnes for poultry meat during the same period. Consumer are increasingly preferring poultry meat to bovine and ovine meat. In fact, in the US, beef consumption has decreased significantly over the last two decades, losing about 25 per cent of the market share to pork and poultry (Katz and Boland, 2000). Increasing consumer preference for poultry meat can be attributed to growing concerns related to health, hygiene, quality, safety, consistency, convenience and variety, concerns over growing red meat-borne illnesses (e.g., "mad cow" disease), and price-competitiveness vis-à-vis red meat (Viaene and Verbeke, 1998).

Poultry meat is a perishable product. Hence, it cannot be made to stock like other non-perishable products by full capacity utilization (to reduce the cost per unit). Neither can it be made to order as the lead time for production of poultry meat (from hatching of eggs to rearing of fully-grown broilers) is about 10-12 weeks. The problem is compounded by uncertainties in demand that is seasonal in nature, fluctuates with promotional activities, and is not balanced (different quantities of chicken legs and chicken breasts, for example, may be demanded), resulting in over-production. The challenge is to create a lean, agile and flexible supply chain that not only leverages scale efficiency, but also meets delivery requirements in 18 to 48 hours with 99 per cent reliability by identifying the right point of differentiation of product varieties in the supply chain (Van der Vorst et al., 2001). Success will depend on the

ability of vertical integration and development of cold chains.

Two important issues related to poultry-meat supply chains are environmental regulations and globalization. Due to the growing awareness towards protection of the environment, poultry farms today are increasingly required to adhere to the environmental regulations stipulated by the governments, particularly with regard to water purity, manure removal and dead carcass disposal (Katz and Boland, 2000). Poultry-meat supply chains are increasingly becoming globalized as consolidation and evolution of transnational companies, either by vertical or by horizontal integration, are taking place around the world. Global poultry-meat supply chains enjoy the benefits of other global supply chains in terms of economies of scale, better sourcing options, and access to intellectual and technological resources. The benefits to the consumers are in terms of lower prices, higher varieties, higher qualities, and the advent of "convenience" foods. Factors influencing the globalization of poultry-meat supply chains would include, among others, the relative strength of currencies, speed of technology transfer to developing countries, tax and regulatory issues, cost of labour and capital, concerns over production methods, food safety and hygiene standards, development and implementation of bio-security protocols, availability of land to grow crops for feed ingredients, and fee costs. Globalization has also led to the risk of spreading bird-borne diseases in different countries, as the world has recently witnessed the outbreak of avian influenza, commonly-called "bird flu" in China and some south-east Asian nations, highlighting the importance of keeping strict control and maintaining security of the meat supply chain (Manning and Baines, 2004). This paper addresses the issues related to poultry-meat supply chains in India, accompanied by a case study.

Indian Poultry Industry

India is the third largest egg producer and fifth largest poultry meat producer in the world. The Indian poultry industry employs about 2 million people, and contributes 1.1 per cent to the national income (*Source: http://www.ciionline.org/news/newsMain.asp?news_id = 1262004 125333PM*). Among all the meat categories, poultry meat is witnessing the highest growth rate, at over 15 per cent per annum, compared to the overall meat industry growth rate of 5 per annum (Ali et al., 2004). Currently, poultry meat constitutes approximately 25 per cent of the total meat production in the country (*Source: http://www.vethelplineindia.com/art_poultryind.htm*).

The poultry industry has made a rapid progress in the last three decades. Several breakthroughs in poultry science and technology have led to the development of genetically superior birds capable of high production, even under an adverse hot climate. Manufacture of high-tech poultry equipment, quality poultry feed, pharmaceuticals and health care products including vaccines are some of the important factors contributing to higher productivity. The industry is dominated by the private sector and majority of the poultry producers still belong to the unorganized sector with backyard rearing of birds numbering anywhere between 25 and 250. Furthermore, the contribution of processed meat to the total value of meat production is negligible.

Threats and Opportunities

Though India is one of the largest producers of poultry products in the world, per capita consumption of eggs and poultry meat are among the lowest. The annual per capita consumption of eggs and poultry meat in the country are around 40 and 1 kg, respectively, well below 180 and 10.8 kg, respectively, recommended by the Nutritional Advisory Committee (*Source: http://www.poultrysolutions.com/knowledge/about/product.htm*). Poor consumption of poultry products are attributed to socio-cultural and religious factors (about 40 per cent of the Indian population in vegetarian), high prices and low per capita income (~USD 500). High prices are caused by high feed costs, low meat yield, inefficiencies, diseconomies of scale and lack of modern processing facilities. Feed costs, which form 70-75 per cent of the total cost, are almost four times as high as those of other countries, e.g., Brazil. A principal cause of these high costs is low yields of feed ingredients such as maize. Another reason why feed costs have remained high is the reservation of this sector for small-scale units. These units suffer from poor economies of scale and typically lack the resources to invest in modern technologies (*Source: www.aponline.gov.in/ quick%20links/vision2020/cl2.pdf*).

Indian breeds have lower Feed Conversion Ratios (FCR) compared to the breeds used in developed countries, resulting in lower meat yield. The FCR in India is typically 1:2, meaning thereby to put on a weight of 1 kg by a broiler, 2 kg of feed have to be administered. In most of the developed countries, the FCR is 1:1. Obviously, low FCRs result in high overall costs. Poor meat yield is also caused by the lack of research on genetics to produce high-yielding varieties, nutrition and ambience for healthy growth of broilers, and the lack of modern poultry rearing technologies. Moreover, since most poultry producers are backyard farmers belonging to the unorganized sector, as mentioned before, they suffer from inefficiencies and diseconomies of scale,

and lack funds to invest in technologies due to their small size.

The processed meat industry in India is growing at a very slow pace. In developed countries, almost 100% of broilers produced are processed and sold as value-added products in the form of portions, boneless and further processed products. Even in countries like Thailand, Indonesia and Malaysia, most chicken sold is processed and branded. In India, however, poultry meat is a commodity product, and only about 2-3 per cent of the total poultry meat produced is sold in the processed and branded form. Two main reasons for this are consumers' preference for live chicken and skepticism about processed chicken, and inadequate infrastructure like lack of cold chains etc. To Indian consumers, chicken is fresh if it is live and cut before their eyes, even in a very unhygienic manner. Since live birds are available in plenty in the markets, consumers prefer live birds over processed chicken, which they perceive to be "not as fresh". Also, as processed chicken is costlier than live chicken, buying of processed chicken has so far been confined to the upper income group. the change in consumer mindset in favour of processed chicken would gradually evolve with promotion and awareness. The absence of cold chains from the processors to the retailers and the lack of adequate refrigeration facilities at the retail outlets result in deterioration of the quality of processed meat, ultimately affecting consumer health.

Most of the poultry meat produced in India is consumed domestically. Only a very small amount of this is exported. High costs of production of Indian poultry products make them uncompetitive in the international market. Indian poultry meat is over 50 per cent costlier than the average world price. Exports have also suffered due to the lack of adequate infrastructure (cold storage etc.) at the seaports and airports.

However, the opportunities for the Indian poultry sector are immense. Not only does India have a huge live bird population, but also the poultry sector is the fastest growing among all the meat categories since it is one of the quickest and most efficient converters of plant products into food of high biological value (Ali et al., 2004). Demand for poultry meat is expected to rise faster due to India's sustained economic growth, increasing per capita income, rising non-vegetarian population (about 60% of the total population) and increasing awareness about healthier poultry meat. Demand for processed meat is also expected to rise with increase in health awareness and rise in living standards. Processed meat was introduced in the Indian market in 1986 by Venkateshwara Hatcheries, the largest vertically-integrated poultry farm in India, under the brand name "Venky's". Later, many regional poultry farms have started selling processed chicken on smaller scales.

Processed meat was introduced in the Indian market in 1986 by Venkateshwara Hatcheries, the largest vertically-integrated poultry farm in India, under the brand name "Venky's". Later, many regional poultry farms have started selling processed chicken on smaller scales.

To boost the growth of the Indian poultry sector, the government has an important role to play. The government should formulate policies and simplify procedures to encourage private investments in the poultry sector. Existing infrastructure such as roads and power conditions should be improved and new infrastructure such as warehouses, refrigerated transportation and cold storage facilities should be created with adequate capacity. Poor road conditions not only delay and transit time for processed chicken, thus severely affecting its quality, but also reduce the weight of live birds before they reach the markets. Chilled and frozen chicken also need a steady power supply to maintain the chilling and freezing temperature, respectively. The government should itself invest, and also encourage private investments, in research on genetics, nutrition, automation, ambience and food safety to increase yield and food value, shorten lead times for production of broilers and ensure preservation of the quality of meat products for longer periods. The government should also ease the policies for the poultry farms to enter into contract farming of corn, maize etc. required for processing of feed for chicks and broilers. The private sector poultry farms can work with the contract farmers to increase the yield of crops, that will not only ensure a steady supply of ingredients of chicken feed, but also smooth out price fluctuations. This is exactly what happened in Thailand, where the poultry industry, once relatively fragmented and unorganized, has transformed itself into an organized sector consisting of large integrated farms such as Charoen Pokphand. These farms work in close association with the crop farmers, feed producers, growers, hatchers, processors, fast food retailers and the government, and supplement meagre government investments in R&D to improve breeds of layers and broilers, look for alternative feed sources and develop better disease control methods and vaccines. They take an active role in stimulating domestic demand and developing the export market (*Source: www.aponline.gov.in/quick%20links/vision2020/c12.pdf*).

To stimulate demand for processed chicken, the government should launch awareness campaigns (which it is already doing in various media for processed and canned foods). The value-added tax (VAT) imposed on processed meat could also be reduced to make its price at par with the price of live chicken. Export of chicken meat can be facilitated by simplifying customs procedures and building adequate infrastructure (cold storage and warehousing facilities) at seaports and airports. Phasing out of subsidies on agricultural products internationally under WTO agreements is likely to open up new markets like Russia and Eastern Europe for the Indian poultry exporters.

The thrust should be on consolidation in the Indian poultry industry through mergers, acquisitions and strategic alliances, and creating vertically-integrated poultry supply chains. Vertical integration not only allows a farm to have complete control over all the elements of the supply chain, but also enables it to be lean, efficient and price-competitive. Because of scale of economies enjoyed by the integrated farms, the price and quality of processed chicken would also become competitive in the international market.

Case Study: Bengal Hatcheries Ltd.

Bengal Hatcheries Ltd. (BHL)[1], located in Kolkata, capital of West Bengal, an eastern state of India, started its business in 1974 with the selling of hatching eggs, day-old chicks and feed for chicks and broilers. It also started exporting hatching eggs to Bangladesh and U.A.E. However, with increase in competition from new entrants, BHL started losing market share. Also, it had to stop exporting hatching eggs because this was no more profitable. BHL then thought of forward integration, and accordingly set up its first commercial farm in early 1980s for production of broilers. In early 1990s, BHL set up its dressing unit for production of processed meat. In 1995, with the development of its own cold chain, BHL opened its first outlet in Kolkata, followed by more outlets in different parts of the state. To expand the retail business more rapidly, BHL started franchising in 1998. These outlets sell both processed meat and ready-to-eat chicken items cooked at "kitchens" set up by BHL at certain strategic locations. Today, BHL is a reputed name in the chicken business in eastern India, occupying more than 50 per cent of the market share in this region. Besides selling processed meat and live birds, BHL continues its original business of selling hatching eggs, day-old chicks and feed for chicks and broilers. In 2000, BHL achieved yet another milestone by opening "Food Mart", a chain of convenience stores to sell groceries, confectionaries, toiletries, and chilled and frozen items.

BHL achieved a turnover of Rs. 1.93 billion[2] in 2004-2005. It earned Rs. 1.34 billion from processed meat and live birds, Rs. 230 million from selling day-old chicks, Rs. 180 million from its business is poultry feed, Rs. 150 million from retail groceries (Food Mart) and Rs. 30 million from selling hatching eggs. The scare of bird flu all over the country led to a 40.4 per cent drop in its net profit at Rs. 31 million. To maintain a steady growth of 25 per cent from sales, BHL plans to raise the share of processed meat and live birds (currently about 70%) in the total turnover by opening more retail outlets in the next couple of years. Though the share of day-old chicks in the total turnover has come down gradually from an earlier level of 50 per cent, BHL still is the largest breeder of day-old chicks, breeding 1.2 million chicks a week.

Chicken Supply Chain

BHL has a vertically-integrated chicken supply chain from hatching of eggs, breeding of day-old chicks, production of broilers, processing of feed for chicks and broilers to selling of live birds, processed meat and ready-to-eat chicken items through distributors and own or franchisee outlets. The supply chain broadly consists of the following 6 units:

1. Breeding farm for hatching of eggs and production of day-old chicks
2. Commercial farm for production of broilers
3. Feed processing unit
4. Dressing unit for production of processed meat
5. Kitchen for preparing ready-to-eat chicken items, and
6. Own or franchisee outlets for selling processed and ready-to-eat chicken items

The supply chain is shown in Fig. 1, followed by brief descriptions of the units

Breeding firm

This is the first unit of the supply chain that produces day-old chicks. At present, BHL owns 5 breeding units in eastern India. The hatching eggs produced by parent birds are hatched for about 3

1. The real name of the company has been suppressed for confidentiality.

2. USD 1 ≈ Indian Rupees (Rs.) 45

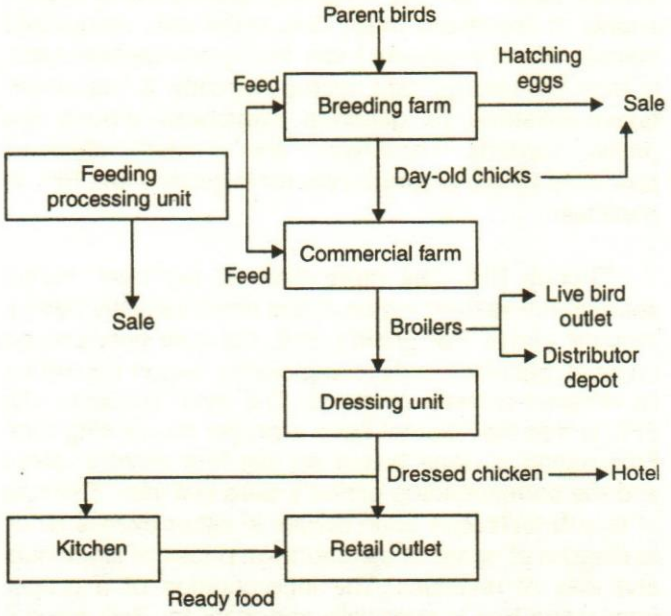

Fig. 1. Chicken supply chain of Bengal Hatcheries Ltd.

weeks in a hatching machine called the "incubator". The normal temperature for production of chicks is about 95° F. Hence hot summer is not a problem for chick production. However, in winter some mechanism like the use of electric heater is required to increase the temperature. Chicks not sold to farmers are transferred to the commercial farms. Normally, this transfer takes place at night.

Commercial farm

At commercial farms, day-old chicks are reared and developed into fully-grown broilers in about 6-7 weeks of time. The average capacity of the farmers is 30,000 birds. Depending on the requirements, birds are grown to 1200 to 2500 gm. However, for production of processed meat at the dressing unit, birds are normally grown to 1400 to 1500 gm.

Feed processing unit

At this unit, feed is produced for day-old chicks, broilers and parent birds. The main ingredients of feed are cereals (mainly maize), oil cakes, fish and animal protein. However, the composition varies for chicks and broilers. For example, animal protein content is more in the feed for broilers. Most of the ingredients are supplied from the wholesale market, which basically come from farmers of different states. For example, maize is not produced in West Bengal. Hence, it is bought from the farmers of Bihar, another eastern state of India. Availability of these ingredients is a matter of concern. BHL has made long-term contracts with most of the wholesalers.

Dressing unit

Based on the demands for dressed and ready-to-eat chicken, the Kolkata office decides on the order quantity of live birds to be supplied to the dressing unit from the commercial farms, which area located within 20 km from the dressing unit. The transfer is done by some vans owned by BHL. The capacities of the vans vary from 3,000 to 10,000 birds. The processing capacity of the unit is 40,000 birds per shift, the average being about 16,000-20,000 birds per shift. BHL now produces 6,000 tonnes of processed chicken meat per month. Dressing is done mainly at night. Day time is used for cleaning of the semi-automated dressing machine. Dressed chickens (some of which are made boneless) are then directly transported to the outlets located in Kolkata and other parts of eastern India. Part of the dressed chickens is also supplied to the kitchens for preparation of ready foods. The transportation is taken care of by 7 refrigerated vans owned by BHL. The inside temperature of the vans is maintained between 0 and 4° C, required for chilled chicken. In festive seasons, when there is a huge demand for chickens, some amount of the dressed chicken is blasted at –20° C to prepare frozen chicken, which lasts more than the chilled chicken. The frozen chickens are stored in the warehouse of the dressing unit for meeting seasonal demands.

Kitchen

To supply ready-to-eat chicken items to different outlets, BHL has set up a number of kitchens in Kolkata and other parts of the eastern region. Orders for ready foods are received from the outlets, aggregated and the requirements of raw chickens are forecasted based on the actual orders and past experience. The forecasted requirements are then sent to the dressing unit from where the raw chickens are supplied to the kitchens in the same vans used for supply to the outlets.

Outlets

BHl has its own and franchisee outlets to sell processed and ready-to-eat chicken items. The normal requirement is to have a floor space of 150 to 200 sq. ft. to open an outlet. Each outlet is equipped with a refrigerator that maintains a temperature around –5 °C to –8° C. For ready foods and boneless items, 15 per cent margin is given to the franchisees. For other dressed items, 10 per cent margin is given. Stock taking is done once at night. However, during heavy-demand periods, stock taking is done twice, once being in the afternoon. Within BHL-owned outlets, if there is any imbalance in stocks, that is taken care of

by adjusting the supply and inter-outlet transfers. However, for franchisees no such return or exchange policies exist.

Apart from selling through permanent outlets, BHL also sells dressed and ready-to-eat chicken items from temporary stalls put up at the sites of special fairs like book fairs, industrial fairs etc. BHL supplies dressed chickens to hotels also with whom they enter into long-term agreements. The average credit period offered to hotels is about one week. Live birds are sold through either live bird retail outlets or distributors at wholesale prices.

Strengths and Weaknesses

The vertical integration enables BHL to have complete control over the entire supply chain. The problems of availability and fluctuating wholesale prices of ingredients of feed for chicks and broilers are overcome by BHL by entering into long-term contracts with the farmers so that the supply of the same is not affected by market dynamics. BHL also enters into long-term agreements with hotels and restaurants for an assured supply of dressed chicken. The vertically-integrated supply chain makes BHL lean and cost-efficient, and allows it to pass on part of the benefits to customers in terms of promotional and discount offers and provide high margins to franchisee outlets on value-added products.

BHL adheres to strict quality control in terms of maintaining high sanitary standards at all its units and assuring safety of processed foods for consumption. In India, every ready-to-eat food item is required to be certified by the government's Meat Food Products Order (MPFO). For quality assurance of dressed chicken, BHL obtained the international Hazard Analysis and Critical Control Point (HACCP) certification about two years ago. The processes of hatching, breeding, rearing, dressing, transporting and storing all conform to the international norms. The dressing unit is so located that overnight delivery in refrigerated vans to all the outlets is possible, thereby minimizing the transit time and maintaining freshness of the processed meat. To enable overnight delivery of the processed meat without storing at the dressing unit, dressing is normally done at night, as mentioned before. Once dressing is over, the waste is collected and is used as one of the ingredients of feed for chicks and broilers.

The cold chain, i.e. refrigerated transportation and storage of processed meat at the dressing unit and the outlets is well-developed and fail-safe procedures are adhered to, to maintain quality. For BHL-owned outlets, the excess demand at one outlet is met by transferring the required items from another outlet where there is excess stock, thereby reducing spoilage and excess supply of processed meat. BHL is the only recognized chicken brand in eastern India, facing competition mainly from the unorganized sector. Recently, it has undertaken initiatives to generate awareness among the public towards "healthier" and "safer" chickens produced by the organized sector in general and BHL in particular.

Though BHL has more than 50 per cent market share in the eastern region, it has predominantly been a regional player. For growth, BHL not only needs to go national, but also needs to explore the export market for its dressed chicken products. The main problem with BHL is that they do not have a proper forecasting tool. Forecasting is done based on last four months' sales and the corresponding period's sales last year. This rule of thumb technique often results in either excess stock to dispose of or sell at market-down prices or stock-outs and loss of revenues. The incorporation of a proper forecasting tool is especially important for BHL since it deals with a perishable product that cannot be stored for more than 3 days. BHL is yet to interconnect its outlets, warehouses, supply chain units and offices through computer networks. The items sold through its outlets are not bar-coded. Hence, they do not have a proper accounting method for capturing the point-of-sale (POS) data and transmitting the same on a real-time basis to their local office and dressing unit for better planning and forecasting. Ideally, BHL should go for Radio Frequency Identification (RFID) that not only captures the POS data, but also stores the purchasing behaviour and enables tracking even in transit. Bar coding or RFID is essential in the unfortunate event of a product recall (Smola and Bear, 1999).

For growth, BHL needs to increase capacity and open more outlets. Indeed, it plans to open 100 more outlets in the next couple of years, many of which will be franchisee outlets. BHL needs to relook its franchisee policy. Currently, there is no return or exchange policy for the franchisees. If items are not sold in 3 days, they are not taken back by BHL. Hence, franchisees would want to order less than the actual requirement in order to minimize spoilage. BHL, on the other hand, would like the franchisees to order more. This conflict of interest can be avoided if BHL implements the same policy of inter-outlet transfers to reduce imbalance in stocks for franchisee outlets also, as it does for its own outlets. This would be a win-win situation for both BHL and its franchisees, and would pave the way for a long-term, sustained relationship. BHL may also consider extending the one-day credit period for the franchisees, especially when the credit period it offers to hotels and restaurants is one week.

Future Prospects

The prospects of selling dressed chicken in India are very high due to the changing perception of the people towards safer and healthier processed meat and the increasing tendency to buy chilled and frozen items from supermarkets for convenience. Currently, India is experiencing a retail boom, and once FDI is permitted, many large retailers such as Wal-Mart will open outlets in India is various formats to woo the middle and upper class that constitute about 60 per cent of the population. These retailers will source, at least initially, their requirements of chilled and frozen items from local suppliers only, thus stimulating demand for processed meat. BHL cannot afford to miss this opportunity; efforts must immediately by put in to augment capacity and promote the brand from a regional level to the national level. Simultaneously, efforts should also be put in to explore the export market. There has been some progress in this front as BHL has recently entered into an agreement with Marubeni Corporation and Itochu of Japan to supply 200 tonnes of dressed chicken legs per month, subject to the compliance of WTO-approved norms on sanitation and food safety. As per company sources, this export contract would fetch the company Rs. 300 million and raise the turnover by 27 per cent to Rs. 2.45 billion in 2005-2006. The company sources also said that Marubeni and Itochu are willing to import about 1000 tonnes of processed chicken meat per month from BHL. To meet the export orders, BHL is setting up another fully-automated dressing unit (currently they have one) at an investment of Rs. 2 billion that will have a capacity of processing 120,000 birds per shift on a three-shift basis. Earning potential from such exports are estimated at Rs. 10 billion.

Being vertically-integrated, BHL already has complete control over the supply chain. It should now focus on shortening the lead time (i.e. from hatching of eggs to selling of live birds and dressed chicken) and increasing the yield (i.e. lower mortality rates and higher FCR). Investments should be made in research on genetics, automation, nutrition and ambience to reduce the hatching, breeding and rearing time and mortality rates of chicks and broilers and increase the population of genetically superior varieties of chickens and FCR. Simultaneously, BHL has to put more emphasis on sanitation, quality and safety of processed chicken, especially since now it has to serve the export market. As far as the supply of ingredients of chicken feed is concerned, BHL has entered into long-term agreements with many wholesalers, as mentioned before. However, at times there may be problems in sourcing these ingredients due to natural calamities, lower crop production yields etc. To hedge these risks, BHL may consider contract farming of corn, maize etc., which will not only ensure a steady supply of feed ingredients, but also probably enable BHL to leverage better prices. However, all these efforts would go in vain unless BHL expedites the companywide IT integration process.

Concluding Remarks

Production and consumption of poultry meat are growing at a faster rate than any other meat category around the world. India is no exception. The Indian poultry-meat industry has been growing at a very rapid rate in the last three decades, transforming gradually from unorganized, small-scale backyard farming into large-scale, organized farming. However, the poultry-meat supply chain is still characterized by inefficiencies, diseconomies of scale, lack of investments and inadequate infrastructure, resulting in high prices, poor yields (of crops for feed and meat) and inadequate preservation of processed meat. The immediate need is to facilitate public and private investments in research on genetics, nutrition, automation and bio-securities, and infrastructure in terms of improvement of roads, development of cold chains and ensuring steady power supplies. The policies and procedures have to be eased to facilitate investments and exports. Awareness campaigns for increased consumption of processed meat also need to be launched in a more concerted way. The thrust should be on consolidation and creating more vertically-integrated supply chains, such as the one in the case study presented in this paper.

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Feature

Facility Location in a Supply Chain Network Using Microsoft Excel

S. Kumanan, J. Prasanna Kumar & K. Kumar

Logistics/supply chain mainly tackles four major problem areas: customer service levels, facility location, inventory decisions and transportation decisions. Each has an important impact on system design. In this paper a facility location model is formulated and is solved using Microsoft Excel's solver.

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The impact of global competition has forced suppliers, manufacturers and distributors to collaborate efficiently with each other on the entire supply network. The planning activities of all participants become very important in doing so. Ballou (1992) divided the planning problem into strategic, tactical and operational problems based on time horizon. Ereng Simpson and Vakharia (1999) referred to network design as one of the strategic decision problems. The network design determines the number and location of the suppliers, plants and warehouses. Dynamic multi-commodity capacitated facility location model for strategic supply chain planning was proposed by Melo et al. (2005). A multi-commodity multi plant capacitated facility location problem using the heuristic approach was proposed by Prikul and Jayaraman (1998). The dynamic relocation and phase-out of a hybrid, two-echelon plant/warehousing facility model was proposed by Emanuel Melachrinoudis, Hokey Min (2000).

Facility location decisions have a long-term impact on a supply chain's performance because it is very expensive to shut down a facility or move it to a different location [Sunil Chopra, 2000]. Admi Syarif et al. (2002) studied the choice of facilities to be opened and the distribution network design to satisfy the customer demand with minimum cost using a spanning tree based GA. A good location decision can help a supply chain be responsive while keeping its costs low. A manager must identify potential locations in each region where a company has decided to locate a plant. As a preliminary step, the manager needs to identify the geographical location where the potential sites may be considered. In general, the problem of locating manufacturing (or warehousing) facilities is concerned with the determination of the optimal number, size, and geographic configuration of the facilities in such a way that it minimizes the total cost associated with supply chain operations, while satisfying customer demand requirements. The location decision usually entails the

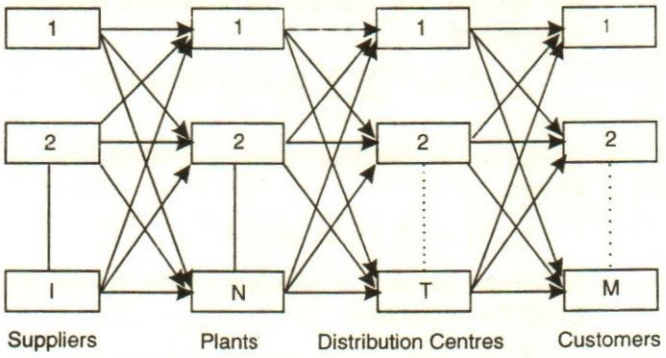

Fig. 1. Multi stage logistics Network Model

firm's long-term commitment to the established facility and thus is not intended for a quick change.

Factors such as proximity to competition, population make-up, customer traffic patterns, nearness to retailers, good transportation routes are few of the many factors that can influence retail or service location. In this paper we propose a multi plant, multi warehouse capacitated facility location problem using Excel's Solver. Long-term commitment/costs are a major factor in the facility location decisions.

Excel's Solver

Microsoft Excel has a solver as an add in. Excel's solver is used to determine the maximum or minimum value of one cell by changing other cells. Solver is a powerful tool that can be used for solving analytical models. Solver uses the Generalized Reduced Gradient (GRG2) non-linear optimization code developed by Leon Lasdon and Allan Waren Bloch S.C., (2000). For linear and integer problems, Solver uses the simplex method with bounds on the variables, and the branch and bound method, implemented by John Watson and Dan Fylstra of Frontline Systems, Inc.

Mathematical Modeling

Supply chain logistics network problems received much attention among organisations. A company with multiple plants serving geographically dispersed markets seeks to allocate demand for its products to the plants. Its objective is to minimize the sum of sourcing, manufacturing and distribution cost associated with satisfying demand. The allocation of markets to facilities affects production, inventory and distribution costs incurred by the supply chain.

Figure 1 shows the model of the company with multiple plants and distribution centres serving geographically dispersed customers. The problem involves determining not only how much each customer is to receive from each facility but also the number of facilities along with their locations and capacities.

The assumptions of the model are:

1. Single product, multi-echelon system
2. The number of customers and their demands are deterministic and hence remain the same throughout the period of study
3. The capacity for suppliers, plants and distribution centres are known in advance.
4. Transportation lead-time and handling time are fixed and for simplicity they are not included.
5. The variable costs associated with production and distribution grows linearly with quantity produced.

Problem formulation

A mixed integer linear programming model is developed to solve the multi plant, multi warehouse capacitated location problem. The objective is to choose the subset of plants and distribution centres to be opened and to design the distribution network strategy; that can satisfy all capacities and demand requirements imposed by customers with minimum cost.

Indices

- M Number of Markets or Customers, $m \in \{1, 2, ...M\}$
- t Number of Distribution Centres, $t \in \{1, 2, ...T\}$
- n Number of Plants, $n \in \{1, 2, ...N\}$
- l Number of Suppliers, $l \in \{1, 2, ...L\}$

Parameters

- a_m Demand of Customer m
- b_t Capacity of Distribution centre t
- c_n Capacity of Plant n
- d_l Capacity of Supplier l
- F_n Fixed cost of operating Plant n
- F_t Fixed cost of operating Distribution centre t
- C_{ln} Cost of shipping one unit from Supplier l to Plant n
- C_{nt} Cost of shipping one unit from Plant n to Distribution centre t

C_{tm} Cost of shipping one unit Distribution centre t Customer m

U_t Upper Limit on total number of Distribution centres that can be opened

U_n Upper Limit on total number of Plants that can be opened Variables

X_{ln} Amount that is to be shipped from Supplier 1 to Plant n

X_{nt} Amount that is to be shipped from Plant n to Distribution centre t

X_{tm} Amount that is to be shipped from Distribution centre t to Market m

Y_n I, if Plant n is opened, 0 otherwise

Y_t I, If Distribution centre t is opened, 0 otherwise

Objective Function

The objective is to

$$\text{Minimize} \sum_{l}\sum_{n} C_{ln}\, C_{ln} + \sum_{n}\sum_{t} C_{nt}\, X_{nt} + \sum_{t}\sum_{m} C_{tm}\, X_{tm} + \sum_{n} F_n\, Y_n + \sum_{t} F_t\, Y_t$$

Subject to:

1. Quantity shipped from supplier cannot exceed the supplier's capacity

$$\sum_{n} X_{ln} \le d_l \text{ , for all l}$$

2. Quantity transported from any plant to all distribution centres should be less than or equal to the capacity of that plant

$$\sum_{t} X_{nt} \le c_n \text{ , for all n}$$

3. Quantity shipped through distribution centre cannot exceed its capacity.

$$\sum_{m} X_{tm} \le b_t \text{ , for all t}$$

4. Quantity shipped to customer must satisfy the demand of the customer

$$\sum_{t} X_{tm} \ge a_m \text{ , for all m}$$

5. Amount shipped out of Plant cannot exceed the quantity of material received from supplier.

$$\sum_{l}\sum_{n} X_{ln} - \sum_{n}\sum_{t} X_{nt} \ge 0, \text{ for all l, n}$$

6. Amount shipped out of Distribution centres cannot exceed the quantity of Products received from plants

$$\sum_{n}\sum_{t} X_{nt} - \sum_{t}\sum_{m} X_{tm} \ge 0 \text{ for all t, m}$$

7. Each plant or distribution centre is either open or closed.

$$Y_n, Y_t = \{0, 1\}, \text{ for all n, t}$$

8. Maximum Number of Opened Plants do not exceed the upper limit

$$\sum_{n} Y_n \le U_n$$

9. Maximum Number of opened Distribution centres do not exceed the upper limit

$$\sum_{t} Y_t \le U_t$$

10. All decision variables are non negative

$$X_{ln}, X_{nt}, X_{tm}, \ge 0 \text{ for all l, n, t, m}$$

Numerical Example

The proposed multi plant, multi warehouse capacitated facility location problem is solved using excel solver. This model aims to locate a given number of plants and warehouses and assign quota and distribution quantity to the plants subject to the capacity of the plants. The input data for the case example is shown in tables 1 to 5. The screen shot of the solver model is shown in figure 2.

Table 1: Parameters of the test problems

Number of Suppliers	3
Number of Plants	4
Number of Distribution Centres	4
Number of Customers	3
Upper Limit on opened Plants	3
Upper Limit on Opened DC	3

Table 2: Capacity, demand and fixed cost Details

Supplier Capacity	Plant		Distribution Centre		Customer Demand
	Capacity	Fixed Cost (Rs)	Capacity	Fixed Cost (Rs)	
500	400	1800	530	1000	460
350	550	900	590	900	330
390	490	2100	400	1600	450
–	300	1100	370	1500	–

1	PSO Problem														
2				Cost of Shipping									Plant	1	
3	No. of Customers		Demand			Plant	1	2	3	4		Supplier	1	200	
4		1	460	Supplier		1	5	6	4	7			2	0	
5		2	330			2	6	5	6	6			3	0	
6		3	450			3	7	8	3	9			DC	1	
7											Plant	1	1	52	
8				SHI+PRO		DCs	1	2	3	4		2	1	240	
9	No. of Suppliers		Capacity	Plant		1	5	8	5	8		3	1	239	
10		1	500			2	8	7	8	6		4	0	0	
11		2	350			3	4	7	4	5					
12		3	390			4	3	5	3	5	CUS		3	1	
13											DC	1	1	150	
14												2	1	310	
15	No. of Plants		Capacity	F. Cost	Dcs	Custom	1	2	3			3	1	0	
16		1	400	1800	1		7	4	5			4	0	0	
17		2	550	900	2		5	4	6						
18		3	490	2100	3		7	5	3				3		
19		4	300	1100	4		3	5	6					460	
20														0	
21															
22	No. of Dcs		Capacity	F. Cost									Plant	0	
23		1	530	1000											
24		2	590	900									DC	0	
25		3	400	1600											
26		4	370	1500											
27															
28															
29			Total Cost	26240											
30															
31															
32															

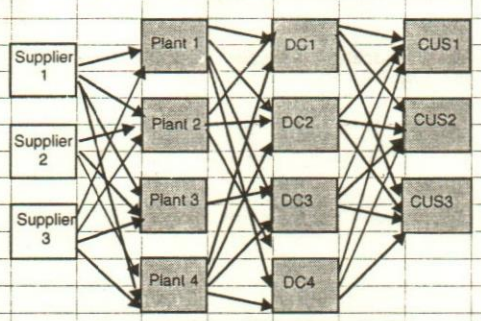

Fig. 2. Screen shot of the solver model

Table 3: Shipping Cost in rupees from Supplier to Plants

Supplier	Plants			
	1	2	3	4
1	5	6	4	7
2	6	5	6	6
3	7	6	3	9

Table 4: Production and Shipping cost in rupees from Plant to DC

Plants	Distribution Centre			
	1	2	3	4
1	5	8	5	8
2	8	7	8	6
3	4	7	4	5
4	3	5	3	5

Table 5: Shipping Cost in rupees from DC to Customer

DC	Customers		
	1	2	3
1	7	4	5
2	5	4	6
3	7	5	3
4	3	5	6

Table 6: Facility configuration and cost structure obtained using Solver

No of plants	No. of warehouses	No. of Plants opened	No. of warehouses opened	Total cost (Rs) (fixed and variable costs)
4	4	3	3	26240

Results and Discussions

The result of the proposed model is tabulated in table 6. The number of potential plants for the problem was four, and similarly the number of potential warehouses is four. Solver has found a solution by which only three plants and three warehouses are required for satisfying the demand of the customer and all the other constraints, and has also located these facilities. The minimum cost structure obtained for the above configuration is also shown in table 6.

Conclusion

A multi plant, multi warehouse capacitated facility location problem is proposed and solved using Excel's

solver. Plant and warehouse locations as well as quantities shipped between various points that minimize the total fixed and various costs are found. Development of a distribution system is a long-term endeavour so that the design of the system falls within the realms of the strategic decision making. Facility location affects the cost of doing business, and the flow of goods and services. Hence its location of facilities for a purpose needs great attention for it to be helpful for managers to locate new distribution centres. The future scope of the work is to use non-traditional search techniques for facility location problems.

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□

You're not a real manager unless you've been sacked.

–Malcolm Allison

Feature

Behaviour-Based Safety: A Cultural Approach to Accident Prevention in Construction Industry

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Construction is an accident-prone industry. Unsafe act of workers is a major contributor to accidents and in turn affects the construction safety performance. This paper attempts to identify the significant behavioural issues and their impact on overall safety performance measured in terms of frequency rate of lost time accidents and recordable incidences and severity rate of lost time accidents.

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Construction is one of the major hazardous industries in the world. The gross annual turnover of global construction is estimated to be around 3 trillion dollars of which 120-180 billion dollars is globally traded. Over 130 million workers are engaged in different construction trades around the world (Vaid 2000). Also based on a ILO study Vaid (2000) observed that "by conservative estimate workers suffer 250 million occupational accidents and 160 million occupational diseases each year". A report of the Stanford University, observed that "work related injuries and illness, including fatalities in construction, occur at a rate that is 54% higher than the rate for all the industries thus making it hazardous amongst all the occupations" (Report no. A-3,1982).

The construction industry in India is labour intensive and employs about 32 million workers of which about 68% are unskilled (Swarup 2002). Many amongst the unskilled workers are from agricultural fields and employed on a seasonal basis. Besides they move to the site along with their family/children. Coupled with the above there is the issue of piece rate wages system, which may influence the workers in going ahead with the task and even ignoring the hazards prevailing. The small/medium contractors employing them cannot afford to provide the necessary training and personal protective equipments so as to sustain competition in the construction work. Under such circumstances, it is very difficult to adopt pro-active measures in accident prevention. The issue therefore needs greater attention on the part of all the agencies involved in the construction process. This paper outlines the influence of behavioural issues on construction safety performance.

Accident Prevention Through Behavioural Approach

There is a common saying "Accidents do not hap-

pen, they are caused". In order to prevent accidents from occurring we must know what causes an accident. In general terms (without going into the theories of accident causation) it is widely accepted that an unsafe condition or unsafe act or a combination of both give rise to an accident. Whereas management is responsible for the unsafe condition(s) prevailing in the work place (liability clause), it is the worker who may indulge in an unsafe act and in an accident. The question arises as to why our worker may sometimes demonstrate a behaviour that is an unsafe act? The reasons may be multiple in numbers. In a construction site the behaviour is dependent on the organizational culture. Edwin and Raymond (2003) highlight the meaning of culture as perceived by different researchers as follows:

(i) "The collective programming of the mind which distinguishes the members of one human group from others. Culture in this sense, includes systems of values and values are the building blocks of culture".

(ii) "Culture of a society is its shared values, understandings, assumptions and goals learned from earlier generation. It results in common attitudes, codes of conduct and expectations that guide behaviour".

(iii) "Culture is about shared behaviour, practices, rules and rituals; it is not limited to groupings by race or ethnicity, but can describe a sub-culture within a society - designers for instance; it is often associated with language and communication; it is viewed as a mental or cognitive construct created in the mind of the people; it is learned; it can be found in materials, objects, artifacts, clothing, art work, and so forth; and it can emanate from social institutions and structure, such as governments, economies and legal systems, as well as geographic and environmental factors".

From an overview of these concepts of culture it is noted that researchers have one thing in common about the perception of culture and that is the shared values, belief and group, mental or cognitive construct makes the culture and culture gets manifested in the behaviour. In the context of accident prevention, if the workmen group has a strong belief about the organization goal of zero accident, the same will be reflected in their work behaviour.

The Working Principles of BBS

The fundamental premise on which Behaviour Based Safety (BBS) rests is the belief that accidents are the outcome of unsafe act(s) of the workers. The belief is not beyond doubt. As we have noted, accidents are caused by unsafe acts, or unsafe condition or both. It is, therefore, not correct to say that by implementing BBS alone in the construction activities, probability of accidents happening can be eliminated. Therefore, accident prevention can best be achieved through a two-pronged approach, viz, management behaviour and actions (demonstrating commitment & support) to eliminate workplace hazards arising out of unsafe conditions and BBS approach for attaining a goal directed behaviour of workers towards maintaining the desired safety culture, thereby leading to improved safety performance.

Impact of Behavioural issues on Construction Safety Performance

Safety performance is measured by various criteria in different countries. The main purpose of safety performance measurement is to achieve continual improvement of the safety management process through accident prevention. Effectiveness of accident prevention programme can be judged by monitoring and measurement of safety performance. The question naturally arises as to what characteristics/property do we measure?

The criteria for measurement are decided based on the reasons for having them. There are multiplicities of reasons, which include (Raouf & Dhillon 1994):

- Carrying out comparisons.
- Estimating forecasts.
- Conducting trend analysis.
- Evaluating safety improvement programme effectiveness
- Identifying problem areas, and
- Optimal allocation of resources for improving safety performance.

In majority of the organizations, safety performance measurement criteria include safety accident statistics like: accident frequency rates/severity rates, lost-time injury frequency rates & severity rates, workers compensation statistics (Mohammed 2003) etc. These indices are termed as the lagging indicators of safety performance and are known to have drawbacks in establishing the path-forward for continual improvement.

The accident/incidence frequency rate and severity rates are defined as

$$\text{Frequency Rate of Accidents/Incidents} = \frac{\text{No. of Accidents/Incidents} \times 10^6}{\text{Total Employee Hours worked}}$$

and

Severity Rate =

$$\frac{\text{No of days lost due accidents/incidents} \times 10^6}{\text{Total Employee Hours worked}}$$

The above definition of safety performance is used by the Indian Construction Sector. However, it may be noted here that the Bureau of Labour Statistics (BLS) of U.S.A. and Occupational Health and Safety Administration (OSHA) uses the accident/incident frequency and severity rate with a multiplier of 200,000 in place of 106 in the above mentioned formulae.

In spite of having wide acceptance by the construction industry, according to various researchers accident frequency and severity rates cannot be taken for granted as a safety performance indicator of a construction site because it cannot be said with certainty that a site with zero-accident is safer than sites with multiple accidents (Mohammed 2003). The safety statistics indicated above are the fundamental measures of safety performance as per the prevailing practice and sets an initial step for the improvement journey.

Impact of Behavioural issues in Safety Performance of Indian Construction Companies - A Study

A study was made to determine the various behavioural issues impacting safety performance at construction sites in India. The performance criteria considered for the study includes the following:

- Frequency rate of lost time accident (FRLTA),
- Frequency rate of recordable incidences (FRRI), and
- Severity rate of lost time accidents (SRLTA).

For the purpose of identifying significant aspects of safety performance management practices in the Indian Construction Sector, a set of questionnaires was developed and sent to selected Construction Organizations, Engineers & Consultants. The details of questionnaire are as per annexure-1. A total of 150 respondents were contacted for obtaining their valued response/ feedback. The responses were invited on a 1 to 5 point Likert's scale with the following meaning:

1 = Not at all important/totally disagree,

2 = Somewhat Important/Tend to Agree

3 = Important/ Generally Agree/Neutral,

4 = Very Important/ Mostly Agree

5 = Totally Agree.

Out of 150 respondents, 46 replies were received thus making a response rate of 30.7%. This response rate and Likert's type response is generally considered as reasonable as can be seen from other research papers in various international journals. To cite a few, Yeats & Lockey (2002) suggest that a goal of 27% is the normal requirement for the surveys. Keyseling, et al (1992) supports the use of Likert's response to a 1 to 5 point scale as reliable and observes that, "Three point checklist type of analysis is usually in close agreement or over estimates the risk factors when compared to the expert findings".

Of the 46 replies only 15 had responded to the query on safety performance data for a 5-year period or part thereof. Balance 31 respondents did not indicate the performance data. However the "mode" of responses of the group of 31 who did not furnish safety performance data were found to match with the 15 respondents who had indicated the safety performance data. These 15 responses were thus considered as representing the entire population of response (46 sets) received and taken into the analysis.

These data were analyzed for the following:

- Mode, Mean, Standard Deviation
- Correlation
- Regression

The analysis was done using SPSS 11.0 software

Survey Data Analysis

The analysis of data were conducted to determine:

(i) The modal response of the construction industry about their perception of the various factors under behavioural Issues.

(ii) The agreement or otherwise of the analysis based on mode vs. mean and standard deviation.

(iii) The correlation of safety performance criteria with respect to various behavioural issues and

(iv) Regression of the behavioural issues (considered as independent variables) with the outcome (dependent variable) safety measures.

Survey Response Statistics

The survey data was analyzed for mapping the perception of importance of the various behavioural issues

Table 1: Frequency Distribution of Questionnaire Survey Response on Behavioural Issues

S.No.	Behavioural Issue ↓ / Response Classification →	Totally Agree (5)	Mostly Agree (4)	Agree/Neutral (3)	Tend to Agree (2)	Totally disagree (1)
1	Top Management considers Safety is a strategic issue and provides active support & resources	26 (56.5%)	12 (26.08%)	4 (8.69%)	2 (4.34%)	1 (2.17%)
2	Project/Construction Manager owns primary responsibility for safety & exhibits compliance to project safety norms	28 (60.86%)	5 (10.86%)	8 (17.39%)	3 (6.52%)	1 (2.17%)
3	Necessary PPEs are provided to all employees/ workers and used by them when at work	27 (58.69%)	8 (17.39%)	7 (15.21%)	1 (2.17%)	0
4	Workers hesitate to carry on with their work in case any unsafe condition is detected	15 (32.60%)	3 (6.52%)	19 (41.30%)	2 (4.34%)	4 (8.69%)
5	Construction accidents occur due to workers failure to identify any unsafe condition (pre-existing or developed during the course of work)	13 (28.26%)	16 (34.78%)	12 (26.08%)	1 (2.17%)	0
6	Workers going ahead with the job in spite of an unsafe condition is a common phenomenon at construction sites	10 (21.73%)	13 (28.26%)	14 (30.43%)	5 (10.86%)	3 (6.82%)
7	Workers indulging into unsafe act irrespective of prevailing work environment lead to accident	12 (26.08%)	11 (23.91%)	11 (23.91%)	4 (8.69%)	7 (15.21%)
8	Workers unsafe act is due to lack of awareness of possible hazards	11 (23.91%)	18 39.18%)	14 (30.43%)	2 (4.34%)	1 (2.17%)
9	Delayed communication/miscommunication of hazards at work may lead to an unsafe act by workers	5 (10.86%)	22 (47.82%)	10 (21.73%)	6 (13.04%)	2 (4.34%)
10	Workers proceeding with the job totally ignore work place hazards may lead to accidents.	15 (32.60%)	14 (30.43%)	8 (17.39%)	3 (6.82%)	1 (2.17%)

(Figures in the parenthesis represent percentage of response)

Table 2: Cumulative frequency distribution of strongly supportive responses (Response '5' & '4')

Sl. No.	Behavioural Issues	Cummulative Response of Category '5' & '4'
1	Top Management considers Safety is a strategic issue and provides active support & resources	38
2	Project/Construction Manager owns primary responsibility for safety & exhibits compliance to project safety norms	33
3	Necessary PPEs are provided to all employees/workers and used by them when at work	35
4	Workers hesitate to carry on with their work in case any unsafe condition is detected	18
5	Construction accidents occur due to workers failure to identify any unsafe condition (pre-existing or developed during the course of work)	29
6	Workers going ahead with the job in spite of an unsafe condition is a common phenomenon at construction sites	23
7	Workers indulging in unsafe acts irrespective of prevailing work environment, lead to accidents	23
8	Workers unsafe act is due to lack of awareness of possible hazards	29
9	Delayed communication/ miscommunication of hazards at work may lead to an unsafe act by workers	27
10	Workers proceeding with the job totally ignore work place hazards which may lead to accidents.	29

on a 1 to 5 point Likert's scale. The results of analysis showing frequency response of the behavioural issues against the category of response in Likert's scale is shown in Table 1.

The above frequency distribution highlights the entire response category varying from 'totally agree' to 'totally disagree'. For achieving excellent safety performance the most important responses considered

are those which indicate a strong support against the various issues and provide a path forward for continual improvement. It is therefore necessary to identify these issues for effecting an improvement action plan. For this purpose, the frequency distribution of Cumulative response frequency of type-5 "Totally agree" & type-4 "Mostly agree" are developed as shown in Table 2.

From the cumulative supportive response in Table 2 the behavioural issues in sl no I, i.e Managements view of safety as a strategic issue is the most important aspect as per perception of respondents being the highest frequency of 38. This is followed by other issues sl.no. 3 with frequency of 35, sl no. 2 (freq.33), sl.nos. 5, 8 and 10 with frequency 29, sl.no 9 with freq. 27, sl.nos 6 and 7 with freq. 23 and sl. No 4 with freq. 18 respectively. The above results indicate a priority for control measures of accidents at construction sites.

Results of 'MODE' analysis

Using SPSS 11 the survey data was analysed for mode of response.

From the mode analysis the behavioural Issues were categorized into 3 groups viz., 1, 2 & 3 depending upon the respondents perception of their significance for achieving better safety performance as elaborated in Table 3:

Table 3: Matrix of Various Factors (Behavioural Issues) and Their Classification

Sl.No.	Type of Issues	Group 1 (Q.Nos)	Group 2 (Q.Nos.)	Group 3 (Q.Nos.)	Remarks
1	Behavioural Issues (BI)	1,2,3,6(iii) (Total 4)	5(i),6(i), 6(ii) (Total 3)	4,5(ii),5(iii) (Total 3)	

Legend:

Group 1: Issues having Likert's Responses '5' (Totally Agree)

Group 2: Issues having Likert's Responses '4' (Mostly Agree)

Group 3: Issues having Likert's Responses '3' (Neutral/Agree)

Response 2 & 1 being 'tend to agree' and 'totally disagree' are considered less important for the present analysis.

The details of classification of the behavioural issues represented by various question nos. in Table 3 are elaborated in Table 4.

Results of analysis of survey data based on mean and standard deviation

The response data were analyzed for mean and standard deviation to check for the central tendency of data response and the findings are as per Table 5.

From a study of the mean values of response, it is observed that the highest value of mean is 4.60 representing the issue of management view of safety as a strategic issue. This observation matches with the

Table 4: Classification of Behavioural Issues (Factors) Based on Mode Analysis

S.No.	Survey Question No.	Description
	Group-1 : Totally Agree	
01	1	Top Management considers safety a strategic issue and provides active support & resources
02	2	Project/Construction Manager owns primary responsibility for safety & exhibits compliance to project safety norms
03	3	Necessary PPEs are provided to all employees/workers and used by them when at work
04	6(iii)	Workers proceeding with the job totally ignoring workplace hazards, which may lead to accidents.
	Group-2: Mostly Agree	
01	5(i)	Construction accidents occur due to the failure of the worker to identify an unsafe condition (pre-existing or developed during the course of work).
02	6(i)	Awareness about the possible hazards not available
03	6(ii)	Delayed communication/miscommunication of the hazard(s) at work
	Group-3: Neutral	
01	4	Whether the workers/employees hesitate to carry on with their work in case of any unsafe situation (broken ladder, improper scaffolding, damaged tools etc,) is detected. ?]
02	5(ii)	Workers proceeding with the job even after identifying an unsafe condition but prior to its mitigation is a common phenomenon
03	5 (iii)	Indulging in an unsafe act irrespective of the prevailing work environment

results of analysis of frequency distribution and also tallies with the results of mode analysis as per table 5. Similarly the other observations related to provision of PPE's and their use by employees appear to be the next important issue (mean 4.36) of safety performance (accident prevention outcome) that matches with those of mode analysis Table 5 and frequency distribution as shown in Table 3. Likewise for the other behavioural issues an analogy can be drawn from the three observations of Tables 2, 4 and 5.

Table 5: Results showing Mean & Standard Deviation Questionnaire Survey Response - Analysis

S.No.	Behavioural Issue	Mean	Standard Deviations
1	Top Management considers safety a strategic issue and provides active support & resources	4.60	0.67
2	Project/Construction Manager owns primary responsibility for safety & exhibits compliance with project safety norms	4.10	0.95
3	Necessary PPEs are provided to all employees/workers and used by them when at work	4.36	0.80
4	Workers hesitate to carry on with their work in case any unsafe condition is detected	3.74	0.90
5	Construction accidents occur due to workers failure to identify any unsafe condition (pre-existing or developed during the course of work)	4.29	0.66
6	Workers going ahead with the job in spite of an unsafe condition is a common phenomenon at construction sites	3.67	0.95
7	Workers indulging in unsafe act irrespective of prevailing work environment leads to accidents	3.89	0.88
8	Workers unsafe act is due to lack of awareness of possible hazards	4.22	0.689
9	Delayed communication/miscommunication of hazards at work may lead to an unsafe act by workers	4.04	0.42
10	Workers proceeding with the job totally ignore work place that hazards may lead to accidents.	4.36	0.92

Correlation Analysis

Behavioural issues were further studied for their correlation with the following three kinds of safety performance measures:

(i) Frequency rate of Lost Time Accident (FR LTA) of Q.no 11(i) annexure-1

(ii) Frequency Rate of Recordable Incidences (FRRI) of Q no 11(ii) annexure-1

(iii) Severity Rate of LTA (SR LTA) of Q no 11(iii) annexure-1

The 'SPSS' OUTPUT for Correlation (Bivariate) were studied and the results showing various behavioural issues having significant correlation (Pearson 2-tailed) with the above three performance measures at 0.01 level (*) and 0.05 level (**) are highlighted in Table 6.

The results of Pearson's correlation (bivariate) yields the following findings:

Frequency rate of Lost Time Accidents (FRLTA) has a negative correlation at 95% confidence level with Project Managers/Construction Managers owning responsibility and demonstrated compliance to safety norms. This is in agreement with the most likely safety outcome that the more the ownership of responsibility and adherence to safety norms, the less will be the number of accidents and hence the lesser the FRLTA.

Frequency rate of Lost Time accidents has a positive correlation at 99% confidence level in respect of (i) workers hesitation to carry on with the work on the face of a detected unsafe condition and (ii) workers going ahead with the job in spite of the detected unsafe condition. This result also matches with the common occurrence of accidents.

Frequency rate of recordable Incidences (FRRI) was found to have a negative correlation at 99% confidence level with the issue of workers proceeding with the job totally ignoring the workplace hazards.

Severity rate of Lost Time Accidents was found to have a very significant correlation at 99% confidence level in respect of the following:

(i) Negative correlation with workers hesitation to carry on with the work in case any unsafe condition is detected. This is generally true when because of the hesitation they do not proceed with the job and therefore the occurrence of accidents and the time lost (severity of accidents) due to the same will be reduced.

(ii) Positive correlation with the issue of occurrence of accidents due to failure of workers to identify a hazard (pre-existent or developed during the course of work). This observation also matches

Table 6: Correlation coefficients of Behavioural issues with Safety performance indicators (FR LTA, FR RI & SR LTA)

S.No.	Behavioural Issues	Pearson Correlation With		
		FR LTA	FR RI	SR LTA
1	Top management considers safety a strategic issue and provides active support & resources.	-.129	-.162	-.173
2	Project/construction Manager owns primary responsibility for safety & exhibits compliance to project safety norms.	-.270*	-.143	-0.86
3	Necessary PPEs are provided to all employees/workers and used by them when at work.	-.028	-.018	.143
4	Workers hesitate to carry on with their work in case any unsafe condition is detected.	.386**	.081	-.417**
5(i)	Construction accidents occur due to workers failure to identify any unsafe condition (pre-existing or developed during the course of work).	.091	-.154	-497**
5(ii)	Workers going ahead with the job in spite of an unsafe condition is a common phenomenon at construction sites.	.387**	-.120	-.133
5(iii)	Workers indulging in unsafe act irrespective of prevailing work environment leads to accidents.	.200	-.251	-.210
6(i)	Workers unsafe act is due to lack of awareness of possible hazards.	.044	.117	.496**
6(ii)	Delayed communication/miscommunication of hazards at work may lead to an unsafe act by workers.	.006	.057	-.205
6(iii)	Workers proceeding with the job totally ignoring work place hazards may leads to accidents.	.154	-.537**	-.087

**Correlation is significant at 0.01 level (2-tailed)

*Correlation is significant at 0.05 level (2-tailed)

with practical phenomenon as can be seen from the fact that the more is the failure to identify a hazard (and take adequate measures accordingly), the more the likelihood of an accident taking place.

(iii) Positive correlation at 99% significance level was also observed for the issue that unsafe act by an worker is due to lack of awareness of possible hazard. This finding appears to be correct as is seen from the day-to-day observations at site. The more aware the worker is, the more careful he/she is expected to be at work.

Regression Analysis

The regression analysis was done with the behavioural issue questions no 1 to 6 (iii) independent variables (total 10 nos. of independent variables) identified in the SPSS output as VAR00001 to VAR00010 and Q no. 7 (Safety performance data) as the dependent variable identified as VAR000011. The variables are referred to as V1, V2, V3,... etc in the regression model.

The SPSS output for regression of behavioural issues were studied with regard to the three performance criteria namely FRLTA, FRRI & SRLTA discussed above and results are as described below:

Regression with frequency rate of LTA

The model summary of regression obtained from SPSS output is as shown in Table 7.

Table 7: Regression Model Summary of Behavioural issues with FRLTA

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.637	.406	.254	5.10930

a Predictors: (Costant), VAR00010, VAR00007, VAR00008, VAR00002, VAR00006, VAR00004, VAR00009, VAR0003, VAR00005, VAR000001. B. Dependent Variable: VAR00011

From Table 7 it is apparent from the R2 value (.406) that the regression fit of behavioural issues with LTA frequency rate is not strong enough to go in for an empirical model. Similar conclusion can be derived from the model coefficients shown in Table 8.

From Table 8 the 't' statistic s shows that the predictors in the regression model do not lead us to

Table 8: Model Coefficients[a] of Behavioural issues with FRLTA

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-110.516	119.787		-.923	.362
	VAR00001	6.187	10.163	.701	.609	.546
	VAR00002	-2.403	3.327	-.387	-.722	.475
	VAR00003	2.904	5.057	.394	.574	.569
	VAR00004	2.623	1.741	.399	1.507	.140
	VAR00005	-1.814	7.330	-.226	-.247	.806
	VAR00006	4.302	3.706	.673	1.161	.253
	VAR00007	.260	3.559	.040	.073	.942
	VAR00008	4.077	6.847	.533	.596	.555
	VAR00009	13.503	11.702	.918	1.154	.256
	VAR00010	-1.529	1.179	-.260	-1.297	.202

a Dependent Variable: VAR00011

recongnize them as useful, because for usefulness of the predictors the 't' statistics generally lies well below-2 or above +2 which is not the case in our findings.

Regression with Frequency Rate of Recordable Incidences.

The SPSS output for Regression of FRRI with the various Behavioural issues were studied from the Model summary as per Table 9.

Table 9: Model Summary of regression of behavioural issues with FRRI

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.747	.559	.437	2.49181

a Predictors: (Constant), VAR00010, VAR00004, VAR00008, VAR00002, VAR00006, VAR00009, VAR00007, VAR00001

b Dependent Variable: VAR00011

As can be seen from the model summary, R2 value is 0559 which is better than the previous one for FRLTA, is till not good enough for an appropriate regression fir of the dependent variable. The same conclusion can be arrived at form a review of 't' statistics of model coefficients shown in Table 10.

For a useful predictor in the model the 't' value is supposed to be much higher than +2 or lower than -2. From the present data therefore an empirical model for regression of behavioural issues with Frequency Rate of Recordable incidence (FRRI) cannot be recommended.

Regression with Severity Rate of LTA (SR LTA)

The response data on Severity Rate of Lost Time Accident (SRLTA) was processed with SPSS software to determine the model summary and identify outlier, if any, through Casewise Diagnostic. The Model summary and Case wise Diagnostic are as per Tables 11 and and 12.

From the model summary it may be inferred that the regression fit (R2 = .883) of predictor variables versus the output variable (SRLTA) is reasonably strong. Further casewise diagnostics (appended in Table 12) was used to identify the outlier and run the SPSS programme for obtaining an improved model.

The regression analysis was also performed after removing case no. 1 as suggested by case wise diagnostic and improved model summary was obtained as shown in Table 13.

The model summary above shows a great improvement in the regression fit indicated by R-square value (R2 = .942) with the exclusion of outlier. Following from this analysis the coefficients of predictors are determined for development of a suggested model for SRLTA.

The coefficients of the predictors in the model are as per Table 14.

From the data on 'coefficients' the suggested empirical model for Severity Rate of LTA (SRLTA) is obtained as noted below:

Table 10: Model Coefficients of behavioural issues with FRRI

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-132.609	85.904		-1.544	.134
	VAR00001	14.697	10.048	1.975	1.463	.154
	VAR00002	-3.431	2.943	-.832	-1.166	.253
	VAR00004	2.893	2.010	.781	1.439	.161
	VAR00006	-1.105	1.610	-.356	-.686	.498
	VAR00007	-.717	1.354	-.172	-.530	.600
	VAR00008	7.516	4.556	1.484	1.650	.110
	VAR00009	15.066	7.493	1.411	2.011	.054
	VAR00010	-3.134	.955	-.715	-3.281	.003

a Dependent Variable: VAR00011

Table 11: Model Summary of regression of Behavioural issues with SRLTA

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate 1
1	.940	.883	.850	319.03850

a Predictors: (Constant), VAR00010, VAR00007, VAR00008, VAR00002, VAR00006, VAR00004, VAR00009, VAR00003, VAR00005, VAR00001

b Dependent Variable: VAR00011

Table 12: Casewise Diagnostics

Case Number	Std. Residual	VAR00011	Predicted Value	Residual
1	3.982	2976.00	1705.6787	1270.3213

a Dependent Variable: VAR00011

Table 13: Model Summary of regression of Behavioural issues with SRLTA (after removal of outlier).

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.971	.942	.925	206.15648

a Predictors: (Constant), VAR00010, VAR00009, VAR00008, VAR00003, VAR00004, VAR00002, VAR00006, VAR00007, VAR00005, VAR00001

b Dependent Variable: VAR00011

SRLTA = 34170.248 - 2838.365V1 + 575.297V2 - 431.100V3 -558.772V4 + 689.173V5-15.980V6 −136.357V7 -1101.312V8-4032.821 V9-99.696V10

Where V1, V2, V3 .... Etc are the predictor variables listed under the coefficients in Table-14, via, VAR0001, VAR0002 ... respectively and represent the response to Q. Nose 1, 2, 3,4, 5(I), 5(ii), 5(iii) 6(I),6(ii) & 6(iii) on a five point Likert's scale as stated above in this paper.

Findings

This paper reflects a specific study conducted to identify the various behavioural issues having significant impact on construction safety performance. The important findings of the study include:

(i) Top management's view of safety as a strategic issue is most crucial in accident prevention. This has been established through analysis of frequency distribution of questionnaire survey, analysis based on mode of response and review of the response mean and standard deviation. This was found to be the most critical item of behavioural issues studied.

(ii) The next important issue identified was providing of PPE's to all employees and ensuring their usage. This factor was also agreed in the three different types of analysis referred to in para (i) above.

(iii) Project/Construction Managers owning responsibility and demonstrated compliance to project safety norms was found to be the third important behavioural issue in accident prevention.

(iv) The fourth significant issue was found to be:

- Workers failure to identify any unsafe condition at workplace.
- Workers unsafe act due to lack of awareness of possible hazards, and
- Workers proceeding with the job totally ignoring workplace hazards.

Table 14: Model Coefficients of Behavioural issues with SRLTA (after removal of outlier).

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	34170.248	3330.717		10.259	.000
VAR00001	-2838.365	287.988	-2.269	-9.856	.000
VAR00002	575.297	132.725	.734	4.334	.000
VAR00003	-431.100	141.199	-.474	-3.053	.004
VAR00004	-558.772	51.412	-.651	-10.869	.000
VAR00005	689.173	209.364	.686	3.292	.002
VAR00006	-15.980	105.670	-.020	-.151	.881
VAR00007	-136.357	72.393	-.161	-1.884	.068
VAR00008	-1101.312	150.907	-1.115	-7.298	.000
VAR00009	-4032.821	364.645	-1.974	-11.060	.000
VAR00010	-99.696	47.268	-.143	-2.109	.042

a Dependent Variable: VAR00011

(v) The fifth significant criteria was noted to be 'Delayed Communication/miscommunication of hazards at work'.

(vi) The sixth significant issue evolved included:

- Workers proceeding with the job in spite of prevailing unsafe condition &
- Workers indulging in unsafe acts irrespective of prevailing work environment.

(vii) The seventh significant issue identified was workers hesitation to carry on with the work in case any unsafe condition is detected.

(viii) Behavioural issues having significant correlation with Safety Performance (FRLTA) includes:

- Project/Construction Manager's owning responsibility for safety and compliance to safety norms (-.270*, p= .05),
- Workers hesitation to carry on with the work in case any unsafe condition is detected (p=.386**) and
- Workers proceeding with the job in spite of an unsafe condition (.387**, p=.01)

(ix) Behavioural issues having significant correlation with other safety performance measure (FRRI) includes:

- Workers proceeding with the job totally ignoring hazards (-.537**, p=.01)

(x) Behavioural issues having significant correlation with SRLTA includes:

- Workers hesitation to carry on with the work in case any unsafe condition is detected (-.417** p=.01). This issue was also significant for FRLTA.
- Construction accidents occur due to failure of workers to identify unsafe condition (.497**, p = .01), and
- Workers unsafe act is due to lack of awareness of possible hazards (.496**, p=.01).

(xi) Regression analysis results pointed to the following:

- Regression fit of Model for FRLTA with behavioural Issues is not strong enough to prescribe an empirical model.
- Similarly regression fit of model for FRRI with behavioural issues is not strong enough to suggest an empirical model.
- However, regression fit of model for SRLTA with behavioural issues was found to be strong enough (R2=.942) to recommend an empirical model. Suggested empirical model for Severity Rate of Lost Time Accidents has been depicted above. From the model coefficients shown in table 15, all the predictors was found to be quite significant, excepting var 0006, having a significance of 0.881.

Conclusion

The study has identified the various behavioural is-

sues needing attention for performance improvement based on the industry response. The study also identified issues having significant correlations with the outcome safety performances like, Frequency rate of Lost Time Accident (FRLTA), Frequency rate of Recordable Incidence (FRRI), and severity rate of Lost Time Accidents (SRLTA). The outcome of the study recommends a regression model for Severity rate of Lost Time Accidents.

The analysis of survey response data did not point out a strong relationship (Regression) with FRLTA and FRRI. This limitation could be overcome through whole hearted participation of construction organizations of all categories like, large, medium and small so that a good number of completed responses are received for further analysis.

The findings of the study has identified a number of issues which require effective training of all workers, supervisors and managers for creating awareness and skills to combat the safety challenges at construction sites. Motivation and proactive leadership for implementation of safety programme cannot be overlooked.

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Annexure-1

Questionnaire Survey on Implementation of Safety Excellence Programme

Based on your Experience, kindly indicate the importance of the following issues/statements on a 5 point (1-5) Likert scale with the following ratings:

1 = Not at all important 2 = Somewhat important 3 = Important.
4 = Very Important 5 = Most important.

Behavioural Issues

(1)	Organization's top management considers safety as a strategic issue and demonstrates active support by providing budgetary allocation and other resources (manpower, PPE, training, promotional expenditure etc) (Please respond on a 1 to 5)	1	2	3	4	5
(2)	Does your Project/Construction Manager consider safety as a primary responsibility and exhibit behaviour in compliance to the project safety norms?	1	2	3	4	5
(3)	Whether the employees/workers of contractors/subcontractors are provided with necessary PPE's and use them when at work.	1	2	3	4	5
(4)	Whether the workers/employees hesitate to carry on with their work in case any unsafe situation (broken ladder, improper scaffolding, damaged tools etc,) is detected.?	1	2	3	4	5
(5)	Please give your response to the following statements:					
	(i) Construction accidents occur due to the failure of the worker to identify an unsafe condition that existed before the start of the job or developed during execution	1	2	3	4	5
	(ii) Workers proceeding with the job even after identifying an unsafe condition but prior to its mitigation is a common phenomenon	1	2	3	4	5
	(iii) Indulging in an unsafe act irrespective of the prevailing work environment	1	2	3	4	5
(6)	Unsafe act by a worker is primarily due to:					
	(i) Awareness about the possible hazards not available	1	2	3	4	5
	(ii) Delayed communication/miscommunication of the hazard(s) at work	1	2	3	4	5
	(iii) Proceeding with the job totally ignoring the hazards	1	2	3	4	5

(7) Summary of your Safety Accomplishment Record for the last 5 years -

	1998	1999	2000	2001	2002
(i) Frequency rate of accidents (loss time)					
(ii) Frequency rate of Recordable Incidences					
(iii) Severity rate of Lost Time Accident					

Name :

Designation :

Organization :

Signature (optional)

Date :

Feature

Analysis of a PVC Pipe Manufacturing Plant in a Medium Scale Industry

Peeyush Tewari & Khalid Akhtar

PVC is one of the most widely used plastics globally as its application is very wide. PVC is a heat sensitive material. It degrades before reaching to its processing temperature, but with the compounding of suitable additives, it enables the production of a large variety of product range. There are several processing techniques of plastics, but here, study is done to know the processing technique used in manufacturing of pipes. In this paper, an in-depth analysis has been conducted to decide optimum values of various parameters using the Taguchi approach which provides a systematic way to optimize design the performance, quality and cost.

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PVC is the most versatile of all the plastics available today. With the small addition of various additives it can be used for the manufacture of a wide variety of rigid articles. PVC pipes and fittings cover 30 per cent area of rigid PVC consumption. PVC is made by all the polymerisation technique, but the suspension technique covers 75 per cent of PVC polymerisation. PVC has the tendency to degrade and adhere to metal, and suitable additives are required solve this problem.

There are several parameters that affect the quality of the PVC pipes. Some of them we can control and some are uncontrollable, or we do not want to control due to economical reason. These are classified as control factor and noise factor. We obtained the optimum parameter setting without removal of noise factor.

Taguchi method is a powerful tool that helps in improving the cost and quality simultaneously. The Taguchi method emphasizes pushing quality back to the design stage. Taguchi method builds around three components (i) quality loss function, (ii) orthogonal array (iii) S/N ratio. Any product which deviates from its target causes loss of the quality. For calculating this loss Taguchi offers a Quality Loss Function. Orthogonal array provides an experimental configuration to optimized the control factor. It reduces the number of experimental configuration to optimize the control factor. It reduces the number of experiments and saves valuable time and materials. Another method was Trial and Error, in which in each step opened the door for the next. Still it undecided about which factor should be considered in the next step. If full factorial method is used with all the factors, then one has to perform 2187 experimental runs.

The Taguchi method has been applied to deal with one of the practical problems. There are 7 control factors at 3 levels. Negative results may windup the experiment, but Taguchi provide an orthogonal array, which systematically and drastically cuts the number of experiments from 2187 to only 18 runs.

Background

In a PVC pipe manufacturing plant, PVC is one of the products of PVC resin. The PVC base polymer is white granular amorphous material with a density of 1.4 gm/cm^3 containing about 56 per cent chlorine. Some of the important properties of PVC include:

- Excellent water resistance
- Resistance to chemicals, including petrol mineral oil, most acids and alkali
- Fire resistance due to chlorine content
- very good tensile strength
- Good abrasion resistance
- Unlimited colour possibilities, from crystal clear to opaque black.

PVC can not be processed without usage of additives at high processing temperature. PVC itself is a rigid material with limited heat stability and with a tendency to adhere to a metallic surface when heated. This is why additives are needed in compounding of PVC to make it useful plastic material. Using plasticizer, PVC becomes soft and flexible and even behaves like rubbery material (when loaded in excess) at room temperature. It distinguishes the PVC into two parts (i) unplasticized which is rigid PVC or UPVC and (ii) plasticized PVC.

It is not necessary that all the additives are used in each and every PVC formulation. It depends upon the requirement. Compounding is an integral part of the PVC processing where all the additives are mixed together with PVC resin into a nearly homogeneous mass as possible. Further, the emphasis has given to understanding the machines utilized in processing of rigid PVC pipe. All the machines which are in line are considered. Before analysis of the process of PVC pipes, it is most important to understand the features and importance of the machine. Extruder is indisputably the most important piece of machinery in the PVC pipe processing plant. The extruder melts the material and then pumps the melt through the die; the material acquires the shape of the die opening. So, die head with die insert is responsible for giving form to melt. The thermoplastic melt leaving the die head is cooled and calibrated by passing through the sizing unit either vacuum or pressure sizer. As the pipes leave the die head it is necessary to cool the pipe to withstand the pressure in the haul-off which is responsible for pulling the pipe away from the die without jerking and transporting it through the calibration unit and cooling section at constant speed. After that pipes are cut into fixed length in cutting unit. Socketing is being done for jointing purposes. There are two types of socketing, one for pressure pipes and another for non-pressure pipes. In this paper, a detail process has been analyzed from taking instruction of manufacturing the pipe, to end the product and at the same time also considering the person who is responsible to do the task. This is an important part of the PVC pipe manufacturing unit, to obtain the desired quality. Process is directly related to the quality. So it is most important to carry out the whole process in a most effective way.

By using Taguchi terminology, it has been observed that there are both control and noise factors which affected the processing. Control factors are those that can be set and maintained. Noise factors are those that cannot be controlled or are too expensive to control. Here the objective is to select the best combination of control parameters so that the product and process is most robust with respect to noise factors. For studying this, one has to perform a series of experiments to measure it after each experiment by using all the factors. There should be a trial and error approach, which after every experiment opens the door for the next. Still it will be undecided to adjust the next parameter which should be taken as considered. Negative results may discourage. This leads to a very long and expensive time span for completing the design. Another is the full factorial traditional method. If we go for this and consider 7 options, each of which has three values, the test set would require $(3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3) = 2,187$ test experiments, which are rather exhaustive to complete the test. The orthogonal array method of analysis pioneered by Genichi Taguchi provides a sensible solution to this problem.

The Taguchi approach is a collection of principles which provide an efficient and systematic way to optimize design for performance, quality and cost. Using this approach can economically satisfy the need of problem solving and product process design optimization projects in the manufacturing industry.

The Taguchi approach is built around three elements:

(i) Quadratic Loss Function (also known as quality loss function) is used to quantify the loss incurred by the user due to deviations from target performance.

(ii) Signal-to-Noise ratio is used for predicting the field quality through laboratory experiments.

(iii) Orthogonal arrays are used for gathering depend able information about control factors with a small number of experiments.

Again traditionally quality is uniformly good between the specification (lower specification and upper specification). But Taguchi believes that the customer becomes increasingly dissatisfied as performance deviates from the target, for this he defined a Quadratic Loss Function.

To analyze the results the Taguch method a statistical measure of performance called S/N ratio is used. It is a performance measure to choose control levels that best cope with noise. There are three standard S/N ratios:

(i) smaller-the-better

(ii) bigger-the-better

(iii) normal-the-best

Quality Loss Function

Taguchi defines quality in terms of a loss to society caused by a product failure. This economic loss is associated with losses due to rework, waste of resources during manufacturing, warranty cost, customer complaints and dissatisfaction, time and money spent by customers failing products, and eventual loss of market share. The loss function establishes a financial measure of the user dissatisfaction with the products performance as it deviates from a target value.

When a critical quality characteristic deviates from the target value, it causes a loss. Quality simply means no variability or very little variation from target performance. Lowest cost only is achieved at zero variability.

Quality Loss Function offers a way to quantify the improvement from the optimum design determined from an experimental design study.

Quality loss, L, suffered by an average customer due to a deviation a product from target is given by the following equation:

$L = K(Y-T)^2$ for a single sample

$L = K\ (l/n)\ \sum(Y-T)^2$ for a whole population

Where $K = (A_0/\Delta_0^2)$

Ao = loss due to a defective product

Δ_0 = allowed deviation from the target

T = target value of the quality characteristic.

Y = measured value of the quality characteristic.

Taguchi's quadratic loss function is the first operational joining of cost of quality and actually calculates the optimum design based on cost analysis and experimentation with design.

Taguchi's target is customer satisfaction by developing products which meet the target value on a consistent basis. So quality is best achieved by minimizing the deviation from the target, not a failure to confirm to specification.

Signal-to-Noise (S/N) Ratios

The S/N equation depends on the criterion for the quality characteristic to be optimized. There are many different possible S/N ratios, three of them are considered standard and are generally applicable in the situations below:

Smaller-The-Better

n = −10 Log10 [mean of sum of squares of measured data]

This is usually the chosen S/N ratio for all undesirable characteristics like "defects" etc. for which the ideal value is zero. Also, when an ideal value is finite and its maximum or minimum value is defined (like maximum purity is 100 per cent or maximum Tc is 92 k or minimum time for making a telephone connection is 1 sec.) then the difference between measured data and ideal value is expected as small as possible. The generic form of S/N ratio then becomes,

$n = -10\ \text{Log}_{10}$ [mean of sum of squares of {measured - ideal}]

Larger-The-Better

$n = -10\ \text{Log}_{10}$ [mean of squares of reciprocal of measured data]

This case been converted to SMALLER-THE-BETTER by taking the reciprocals of measured data and taking the S/N ratio as in the smaller-the-better case.

Nominal-The-Best

$$n = 10\ \text{Log}_{10}\ \frac{\text{Square of mean}}{\text{Variance}}$$

This case is applicable when a specified value is

most desired. It means that neither a smaller nor a largest value is desirable.

Orthogonal Array

With more parameters, the number of replications increases exponentially for full factorial design, and the need for resources and time can become a real problem. The orthogonal Array method of analysis provides an authentic solution to this problem. Orthogonal design aids in the study of the relationship between process input parameters and their corresponding output function. According to Song and Kleinman, "Orthogonal arrays have a pair wise balancing property so that every level of a parameter occurs in the experiment with every level of every other parameter the same number of times. This pair wise balancing property enables parameter to be studied on the same time without distorting the effects of any individual parameter. By using orthogonal array the number of simulations run can be greatly reduced". The Orthogonal array method allows the maximum amount of information to be derived by using the fewest experiments.

An orthogonal array is always presented in a matrix format consisting of top row and left hand column, with various numbers occurring at the intersections of each column and row. Each element in the left-hand column represents an experiment run, and each element in the top row represents and independent input parameter, or factor. The numbers at the intersections indicate the level setting that apply to the various factors for various experimental runs. A matrix is orthogonal only if the following requirements are met:

- The number of occurrences of each level setting must be equal within each column.
- All rows having identical level settings in a given column must have an equal number of occurrences of all other level settings in the other columns.
- The matrix for a given number of columns must be the one with the minimal numbers of rows that satisfy the above conditions.

Orthogonal arrays are most often named following the pattern:

L_{RUNS} ($LEVELS^{FACTORS}$). The concept of orthogonal arrays is used to efficiently explore the parameter domain and reduce simulation costs and time. Table 1 shows some available orthogonal arrays.

Some Orthogonal Array

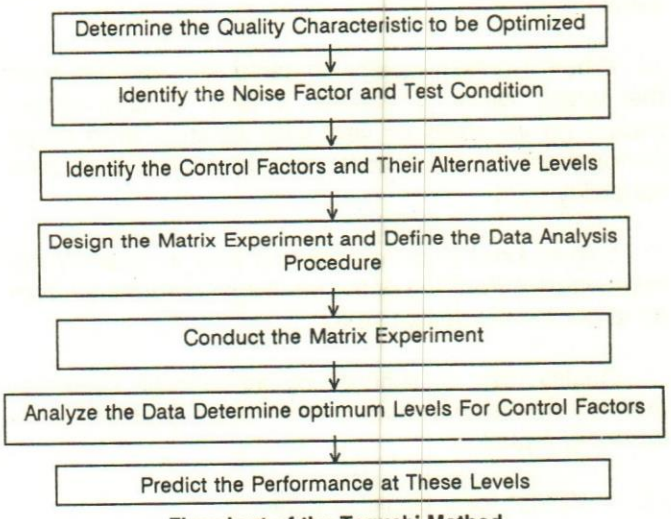
Table 1

$L_4(2^3)$	$L_8(2^7)$	$L_{16}(4^5)$	$L_{16}(4^1 \times 2^{12})$
$L_{12}(2^{11})$	$L_{20}(2^{19})$	$L_{64}(4^{21})$	$L_{16}(4^3 \times 2^6)$
$L_{16}(2^{18})$	$L_{32}(2^{31})$	$L_8(4^1 \times 2^4)$	$L_{32}(4^9 \times 2^4)$
$L_9(3^4)$	$L_{12}(3^1 \times 2^4)$	$L_{25}(5^6)$	$L_{128}(4^{41} \times 2^4)$
$L_{18}(3^7 \times 2^1)$	$L_{18}(6^1 \times 3^6)$	$L_{24}(3^1 \times 2^{16})$	$L_{24}(3^1 \times 4^2 \times 2^{13})$
$L_{27}(3^{13})$	$L_{36}(3^3 \times 6^3)$	$L_{36}(2^1 \times 6^2 \times 3^5)$	$L_{49}(7^8)$
$L_{50}(5^{10} \times 10^1)$	$L_{50}(5^{11} \times 2^1)$	$L_{54}(3^{25} \times 2^1)$	$L_{54}(6^3 \times 3^{24})$
$L_{64}(8^9)$	$L_{81}(3^{40})$	$L_{81}(3^4 \times 9^1)$	$L_{81}((^{10})$
$L_{98}(7^{15} \times 2^1)$	$L_{98}(7^{14} \times 14^1)$	$L_{121}(11^{12})$	$L_{125}(5^{31})$
$L_{169}(13^{14})$	$L_{16}(8^1 \times 2^8)$	$L_{27}(9^1 \times 3^9)$	

Table (2) compares the number of trials required by orthogonal arrays method with the number of trials required by a full factorial experiment. For a design involves 15 factors, each with two levels to test, the number of runs required for a full factorial design is 2^{15} = 32,768. But this number is reduced to 6 by using $L_{16}(2^{15})$ Orthogonal array.

Steps in Taguchi Approach

The Taguchi Approach in parameter design has seven main factor steps as shown in the flowchart below:



Flowchart of the Taguchi Method

Experimental Details and Data Analysis

This experiment was conducted in a medium scale PVC pipe manufacturing plant in the Sultanate of Oman. It was found that the Battenfeld 92 Extruder 4" class E pipe of BS 3505: 1986 (British standard) had very poor impact strength, when it tested in accordance with the

Table 2

Orthogonal Array	Number of factor	Number of levels per factor	Number of trial runs required by orthogonal array	Number of trial runs in a traditional full factorial experiment
$L_4(2^3)$	3	2	4	8
$L_8(2^7)$	7	2	8	128
$L_9(3^4)$	4	3	9	81
$L_{12}(2^{11})$	11	2	12	2,048
$L_{16}(2^{15})$	15	2	16	32,768
$L_{16}(4^5)$	5	4	16	1,024
$L_{18}(2^1 \times 3^7)$	1	2	18	4,374
	7	3		
$L_{27}(3^{13})$	13	3	27	1,594,323

test method specified in clause 6.5 of this standard. The internal testing report of the last six production runs in mentioned in Table 3. The ideal value in set to zero. Testing shows the result on 42 strikes on the test piece.

Table 3

Production runs	No. of test piece failure
1	3
2	4
3	3
4	4
5	2
6	3

It was found that there is quality loss caused by the variable performance of the product. This loss is quantified by the Taguchi Loss Function.

The average loss of the data is

$$L = K\, l/n \sum (Y\text{-}T)^2$$

As ideal value is zero so,

$$L = (\text{mean of square of measured data})$$

$$L = K \times 10.50$$

As our study is based on optimizing the parameter, so a constant value for K, loss is set \$1 for a unit,

$$L = \$\ 10.50$$

In order to rectify the above problem it was decided to perform an orthogonal array based on the Taguchi Approach for optimizing a PVC pipe process for the objective of setting optimum parameters for achieving the impact strength of the pipe.

It was decided to study 7 factor at 3 levels each to optimize the parameter. Table 4 exhibits the control factor and its level.

Table 4: Control Factors with 3 Levels

Factor	Level 1	Level 2	Level 3
Stabilizer (kg)	2.4	2.6	2.8
Filler (kg)	08	12	20
Lubrication (gm)	40	60	80
Compounding mixer heating temperature (°c)	105	110	115
Barrel vacuum (bar)	0.30	0.60	0.90
Screw speed (rpm)	10	11	12
Extruder torque (%)	40	45	50

Constant Factor:
PVC resin: 100 kgs in each batch

The Steps Involved in the Experiments

The steps involved in this particular problem are summarized below:

1. **Nature of the Problem:** Failure in impact strength
2. **Selection of the Quality Characteristic:** Improve impact strength
3. **Selection of the Control Factor:** It was decided that seven control factors i.e. stabilizer, filler, lubrication, heating temperature of compounding mixer, barrel vacuum, screw speed, and extruder torque had to be taken consider during experiment.
4. **Selection of Noise Factor:** Screw, barrel as it might be worn out and die mandrel which was only available for the production.
5. **Number of Factor Levels:** It was decided to analysis all the seven factors at 3 levels (i.e. level 1, level 2 & level 3).
6. **Choice of Suitable Experiment:** There are 7 factors with 3 levels each and most suitable design was L_{18} found from the orthogonal array.
7. **Experimental Execution:** After forming the orthogonal array, each experimental trial was conducted in random order with the 42 strokes on the test pieces.

8. **Experimental Analysis:** After each trial run testing has been done the number of failure test pieces is recorded. Analysis was performed to identify the most dominant factors. The analysis of all tests has been conducted with the help of Smaller-the-better S/N ratio. Our target was achieved to the idle value i.e. zero.
9. **Determination of Optimum Parameter:** After analysis of the S/N ratio optimum parameter setting were determined.
10. **Conformation Runs:** After getting optimum setting a final conformation run have passed the impact test.

Experimental Design: Here, the total number of factors is seven with three levels for each factor. Using the full factorial method, this required 2187 trial runs, which would required time and consumed materials. It is very difficult to perform and handle such a long numbers of experiment in a full running production plant. It would hamper the necessary production schedule and cause delaying in shipment of products, which is the goal of the organisation. But using orthogonal array requires only 18 trial runs.

Notations

For control factors:

A = Stabilizer

B = Filler

C = Lubrication

D = Compounding Mixer Heating Temperature

E = Barrel Vacuum

F = Screw Speed

G = Extruder Torque

For levels of factors

a_1	= 2.4 kgs	a_2	= 2.6 kgs	a_3	= 2.8 kgs
b_1	= 8 kgs	b_2	= 12 kgs	b_3	= 20 kgs
c_1	= 40 grams	c_2	= 60 grams	c_3	= 80 grams
d_1	= 105°c	d_2	= 110°c	d_3	= 115°c
e_1	= 0.30 bar	e_2	= 0.60 bar	e_3	= 0.90 bar
f_1	= 10 rpm	f_2	= 11 rpm	f_3	= 12 rpm
g_1	= 40%	g_2	= 45%	g_3	= 50%

For expressing the test results

R_1 = Experimental Test result of trial test run 1

R_2 = Experimental Test result of trial test run 2

R_3 = Experimental Test result of trial test run 3

R_4 = Experimental Test result of trial test run 4

R_5 = Experimental Test result of trial test run 5

R_6 = Experimental Test result of trial test run 6

R_7 = Experimental Test result of trial test run 7

R_8 = Experimental Test result of trial test run 8

R_9 = Experimental Test result of trial test run 9

R_{10} = Experimental Test result of trial test run 10

R_{11} = Experimental Test result of trial test run 11

R_{12} = Experimental Test result of trial test run 12

R_{13} = Experimental Test result of trial test run 13

R_{14} = Experimental Test result of trial test run 14

R_{15} = Experimental Test result of trial test run 15

R_{16} = Experimental Test result of trial test run 16

R_{17} = Experimental Test result of trial test run 17

R_{18} = Experimental Test result of trial test run 18

Following notation are used in the expressing of the effect of level of each factor

A_1 = Effect of level 1 of factor A

A_2 = Effect of level 2 of factor A

A_3 = Effect of level 3 of factor A

B_1 = Effect of level 1 of factor B

B_2 = Effect of level 2 of factor B

B_3 = Effect of level 3 of factor B

C_1 = Effect of level 1 of factor C

C_2 = Effect of level 2 of factor C

C_3 = Effect of level 3 of factor C

D_1 = Effect of level 1 of factor D

D_2 = Effect of level 2 of factor D

D_3 = Effect of level 3 of factor D

E_1 = Effect of level 1 of factor E

E_2 = Effect of level 2 of factor E

E_3 = Effect of level 3 of factor E

F_1 = Effect of level 1 of factor F

F_2 = Effect of level 2 of factor F

F_3 = Effect of level 3 of factor F

G_1 = Effect of level 1 of factor G

G_2 = Effect of level 2 of factor G

G_3 = Effect of level 3 of factor G

Selection of Suitable Experiment

There are 7 factors at 3 level each. We look for an array that has at least 3 levels and 7 factors. We find from orthogonal array table that such array is L_{18} ($2^1 \times 3^7$). Our problem fit is inside this array. It means this array contains 7 factor at 3 level and 1 factor at 2 level and it required to run only 18 trial test run is (Table 5) to achieve the result.

Orthogonal Array Before Mapping Levels

Table 5

Trial Test runs	A	B	C	D	E	F	G	Exp. result
1	a_1	b_1	c_1	d_1	e_1	f_1	g_1	R_1
2	a_1	b_2	c_2	d_2	e_2	f_2	g_2	R_2
3	a_1	b_3	c_3	d_3	e_3	f_3	g_3	R_3
4	a_2	b_1	c_1	d_2	e_2	f_3	g_1	R_4
5	a_2	b_2	c_2	d_3	e_3	f_1	g_2	R_5
6	a_2	b_3	c_3	d_1	e_1	f_2	g_3	R_6
7	a_3	b_1	c_2	d_1	e_3	f_2	g_3	R_7
8	a_3	b_2	c_3	d_2	e_1	f_3	g_1	R_8
9	a_3	b_3	c_1	d_3	e_2	f_1	g_2	R_9
10	a_1	b_1	c_3	d_3	e_2	f_2	g_2	R_{10}
11	a_1	b_2	c_1	d_1	e_3	f_3	g_3	R_{11}
12	a_1	b_3	c_2	d_2	e_1	f_1	g_1	R_{12}
13	a_2	b_1	c_2	d_3	e_1	f_3	g_3	R_{13}
14	a_2	b_2	c_3	d_1	e_2	f_1	g_1	R_{14}
15	a_2	b_3	c_1	d_2	e_3	f_2	g_2	R_{15}
16	a_3	b_1	c_3	d_2	e_3	f_1	g_2	R_{16}
17	a_3	b_2	c_1	d_3	e_1	f_2	g_3	R_{17}
18	a_3	b_3	c_2	d_1	e_2	f_3	g_1	R_{18}

Calculation of the Factor Level Effects

We have selected the S/N ratio smaller-the-better

n = −10 log 10 [mean of sum of square of measured data]

We have calculated the factor effect on the basis of above S/N ratio. After the result obtained the effect of parameter is calculating by combining the simulation result as follows:

$$A_1 = R_1^2 + R_2^2 + R_3^2 + R_{10}^2 + R_{11}^2 + R_{12}^2/6$$

$$A_2 = R_4^2 + R_5^2 + R_6^2 + R_{13}^2 + R_{14}^2 + R_{15}^2/6$$

$$A_3 = R_7^2 + R_8^2 + R_9^2 + R_{16}^2 + R_{17}^2 + R_{18}^2/6$$

$$B_1 = R_1^2 + R_4^2 + R_7^2 + R_{10}^2 + R_{13}^2 + R_{16}^2/6$$

$$B_2 = R_2^2 + R_5^2 + R_8^2 + R_{11}^2 + R_{14}^2 + R_{17}^2/6$$

$$B_3 = R_3^2 + R_6^2 + R_9^2 + R_{12}^2 + R_{15}^2 + R_{18}^2/6$$

$$C_1 = R_1^2 + R_4^2 + R_9^2 + R_{11}^2 + R_{15}^2 + R_{17}^2/6$$

$$C_2 = R_2^2 + R_5^2 + R_7^2 + R_{12}^2 + R_{13}^2 + R_{18}^2/6$$

$$C_3 = R_3^2 + R_6^2 + R_8^2 + R_{10}^2 + R_{14}^2 + R_{16}^2/6$$

$$C_3 = R_3^2 + R_6^2 + R_8^2 + R_{10}^2 + R_{14}^2 + R_{16}^2/6$$

$$D_1 = R_1^2 + R_6^2 + R_7^2 + R_{11}^2 + R_{14}^2 + R_{18}^2/6$$

$$D_2 = R_2^2 + R_4^2 + R_8^2 + R_{12}^2 + R_{15}^2 + R_{16}^2/6$$

$$D_3 = R_3^2 + R_5^2 + R_9^2 + R_{10}^2 + R_{13}^2 + R_{17}^2/6$$

$$E_1 = R_1^2 + R_6^2 + R_8^2 + R_{12}^2 + R_{13}^2 + R_{17}^2/6$$

$$E_2 = R_2^2 + R_4^2 + R_9^2 + R_{10}^2 + R_{14}^2 + R_{18}^2/6$$

$$E_3 = R_3^2 + R_5^2 + R_7^2 + R_{11}^2 + R_{15}^2 + R_{16}^2/6$$

$$F_1 = R_1^2 + R_5^2 + R_9^2 + R_{12}^2 + R_{14}^2 + R_{16}^2/6$$

$$F_2 = R_2^2 + R_6^2 + R_7^2 + R_{10}^2 + R_{15}^2 + R_{17}^2/6$$

$$F_3 = R_3^2 + R_4^2 + R_8^2 + R_{11}^2 + R_{13}^2 + R_{18}^2/6$$

$$G_1 = R_1^2 + R_4^2 + R_8^2 + R_{12}^2 + R_{14}^2 + R_{18}^2/6$$

$$G_2 = R_2^2 + R_5^2 + R_9^2 + R_{10}^2 + R_{15}^2 + R_{16}^2/6$$

$$G_3 = R_3^2 + R_6^2 + R_7^2 + R_{11}^2 + R_{13}^2 + R_{17}^2/6$$

The value obtained from this calculation is put on the above S/N ratio formula. Optimal setting of the factor would be found by on the basis of value of S/N ratio, smaller-the-better. Comparison has taken on the resultant value of the factors level effect and is mentioned in the table. The smaller factor value is the most desired level for the particular.

Orthogonal Array After Mapping Levels

Application of L_{18} (3^7) Orthogonal Array for Optimization

Table 6

Trial run	A	B	C	D	E	F	G	No. of failed test piece	Total no. of strikes
1	2.4	8	40	105	0.30	10	40	3	42
2	2.4	12	60	110	0.60	11	45	3	42
3	2.4	20	80	115	0.90	12	50	6	42
4	2.6	8	40	110	0.60	12	40	4	42
5	2.6	12	60	115	0.90	10	45	1	42
6	2.6	20	80	105	0.30	11	50	6	42
7	2.8	8	60	10.5	0.90	11	50	1	42
8	2.8	12	80	110	0.30	12	40	4	42
9	2.8	20	40	115	0.60	10	45	6	42
10	2.4	8	80	115	0.60	11	45	0	42
11	2.4	12	40	105	0.90	12	50	0	42
12	2.4	20	60	110	0.30	10	40	5	42
13	2.6	8	60	115	0.30	12	50	0	42
14	2.6	12	80	105	0.60	10	40	4	42
15	2.6	20	40	110	0.90	11	45	5	42
16	2.8	8	80	110	0.90	10	45	3	42
17	2.8	12	60	115	0.30	11	50	3	42
18	2.8	20	40	105	0.60	12	40	4	42

Random order is used for tests and the result of each test is mentioned on the above table. Based on the results shown above the factor level effects are as follows:

Table 7

			S/N Ratio	
A1	$= 3^2+3^2+6^2+0^2+0^2+5^2$	$= 79/6$	$= 13.167$	-11.1949
A2	$= 4^2+1^2+6^2+0^2+4^2+5^2$	$= 94/6$	$= 15.667$	-11.9499
A3	$= 1^2+4^2+6^2+3^2+3^2+4^2$	$= 87/6$	$= 14.500$	-11.6137
B1	$= 3^2+4^2+1^2+0^2+0^2+3^2$	$= 35/6$	$= 5.834$	-7.6597
B2	$= 3^2+1^2+4^2+0^2+4^2+3^2$	$= 51/6$	$= 8.500$	-9.2941
B3	$= 6^2+6^2+6^2+5^2+5^2+4^2$	$= 174/6$	$= 29.000$	-14.6240
C1	$= 3^2+4^2+6^2+0^2+5^2+4^2$	$= 102/6$	$= 17.000$	-12.3044
C2	$= 3^2+1^2+1^2+5^2+0^2+3^2$	$= 45/6$	$= 7.500$	-8.7506
C3	$= 6^2+6^2+4^2+0^2+4^2+3^2$	$= 113/6$	$= 18.834$	-12.7494
D1	$= 3^2+6^2+1^2+0^2+4^2+4^2$	$= 78/6$	$= 13.000$	-11.1394
D2	$= 3^2+4^2+4^2+5^2+5^2+3^2$	$= 100/6$	$= 16.667$	-12.2186
D3	$= 6^2+1^2+6^2+0^2+0^2+3^2$	$= 82/6$	$= 13.667$	-11.3567
E1	$= 3^2+6^2+4^2+5^2+0^2+3^2$	$= 95/6$	$= 15.834$	-11.9959
E2	$= 3^2+1^2+6^2+0^2+4^2+4^2$	$= 78/6$	$= 13.000$	-11.1394
E3	$= 6^2+1^2+1^2+0^2+5^2+3^2$	$= 72/6$	$= 12.000$	-10.7918
F1	$= 3^2+1^2+6^2+5^2+4^2+3^2$	$= 96/6$	$= 16.000$	-12.0411
F2	$= 3^2+6^2+1^2+0^2+5^2+3^2$	$= 80/6$	$= 13.333$	-11.2493
F3	$= 6^2+4^2+4^2+0^2+0^2+4^2$	$= 84/6$	$= 14.000$	-11.4612
G2	$= 3^2+4^2+4^2+5^2+4^2+4^2$	$= 98/6$	$= 16.333$	-12.1307
G2	$= 3^2+1^2+6^2+0^2+5^2+3^2$	$= 80/6$	$= 13.333$	-11.2493
G3	$= 6^2+6^2+1^2+0^2+0^2+3^2$	$= 82/6$	$= 13.667$	-11.3567

Effect of factor on the basis of S/N ratio is calculated and the effect of each level of the factor are mentioned in Table 7. We also placed a column for the difference between maximum and minimum value of the each levels of the factor. As our result is based on S/N ratio, so all the values mentioned are in term of S/N ratio.

Main Effect of the Factor

Table 8

Factor	Level 1	Level 2	Level 3	Difference
Stabilizer	-11.1949	-11.9499	-11.6137	0.7550
Filler	-7.6597	-9.2941	-14.6240	6.9643
Lubrication	-12.3044	-8.7506	-12.7494	3.9988
Comp. Mixer Heating Temp.	-11.1394	-12.2186	-11.3567	1.0792
Barrel Vacuum	-11.9959	-11.1394	-10.7918	1.2041
Screw Speed	-12.0411	-11.2493	-11.4612	0.7918
Extruder Torque	-12.1307	-11.2493	-11.3567	0.8814

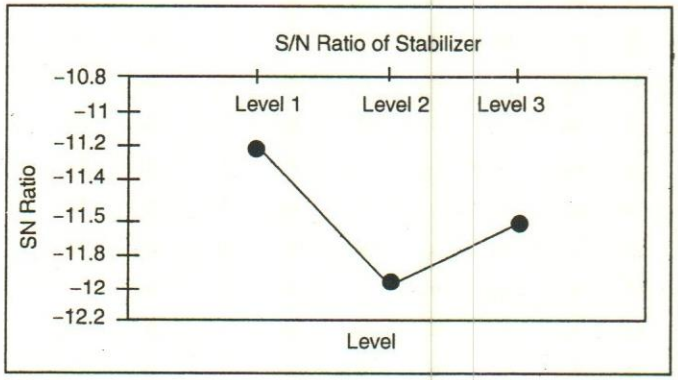


Fig. 1.

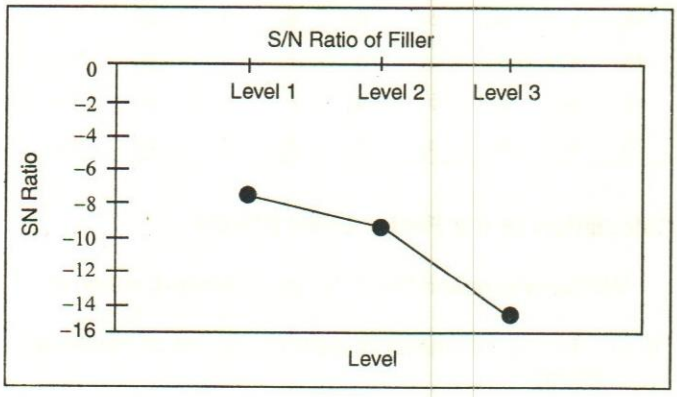


Fig. 2.

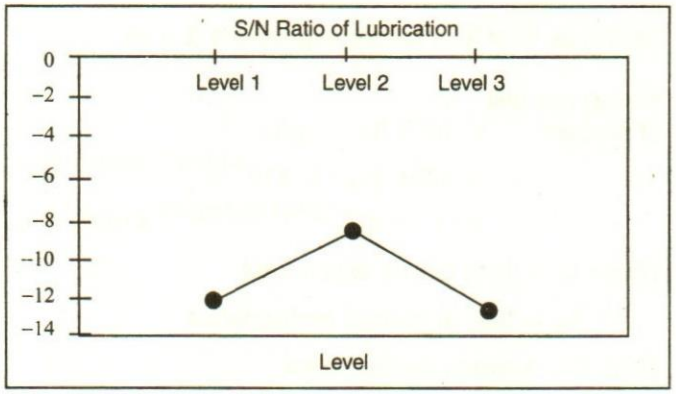


Fig. 3.

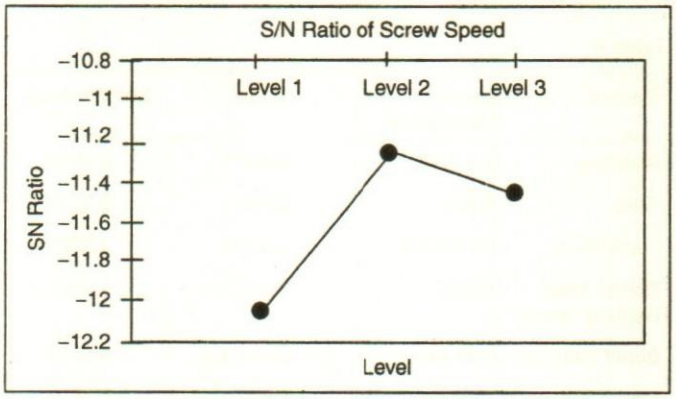


Fig. 6.

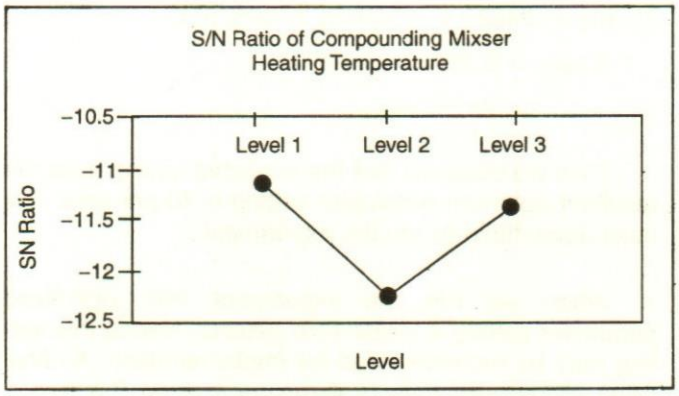


Fig. 4.

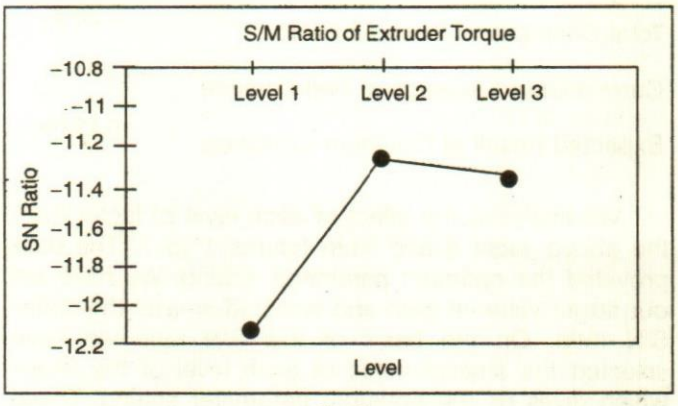


Fig. 7.

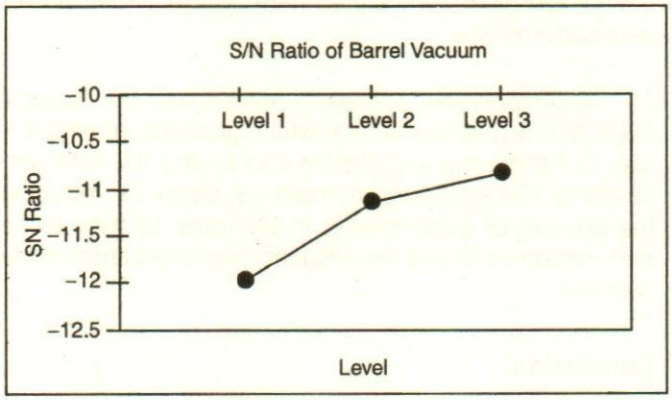


Fig. 5.

Result and Discussion

Based on the above analysis it has been observed that 4" class E pipe of BS 3505: 1986 (British Standard) has very poor impact strength when it was tested in accordance with the same standard. We required an optimum parameter setting that provides us to maintain the quality of the product. There are several parameters which can affect the above said quality defect, few of which we can control, set and maintain. But at the same time we had the limitation of not being able to alter the screw and barrel and not replace the existing die and mandrel, which was the only way to extrude the pipe. These two we consider as noise factor, and considered seven control factors with their alternative values.

In this particular problem there are several factors which affect the process. Theoretically one needs to perform a series of experiments by using all the factors. The full factorial method required 2187 experiments. Usually this number of experiment requires time and material and also it is exhaustive. The seven factors with their value of each levels were tabulated. Then an appropriate orthogonal array was selected from the orthogonal array table. This data is analysed on the basis of selected S/N ratio, i.e. smaller-the-better, as our idle value was zero. After that we calculated the factor levels effect that means which level of the factors having great influence on the experiment. These results are presented in a Table 8 and graphs are shown for each factor-level effect [Figure 1, 2, 3, 4, 5, 6, 7].

Optimum Parameter Setting

Table 9

Factors	Levels Description	Level	Contribution
Stabilizer	2.4 KGS	Level 1	0.2516
Filler	8 Kgs	Level 1	2.3214
Lubrication	60 Grams	Level 2	1.3329
Comp. Mixer Heating Temp.	105ãC	Level 1	0.3597
Barrel Vacuum.	0.90 Bar	Level 3	0.4013
Screw Speed	11 RPM	Level 2	0.2639
Extruder Torque	45%	Level 2	0.2938

Total Contribution From All Factor	5.2246
Current Grand Average of Performance	–11.3462
Expected Result at Optimum Condition	–6.1216

We analyzed the effect of each level of factor from the above Table 8 and from figures 1 to 7. The data provided the optimum parameter setting. We have set our target value at zero and selected smaller-the-better S/N ratio. On the basis of this S/N ratio we have selected the smaller value of each level of the factor which gives us the optimum parameter setting. These results are presented in Table 9.

Figure 7 shows which level is having less S/N ratio. On this basis, we determined the optimum parameter setting. Also it can be concluded the filler having the least S/N ratio, is the most significant factor. Before conformation run the performance improvement on the optimum setting is predicted.

Performance improvements:

Average performance = –11.3462 (S/N Ratio of all trials)

Optimum performance = –6.1216 (S/N Ratio)

Improvement expected = 46% (over the average performance, S/N Ratio)

Expected saving

Saving (%) represents the percentage of $ loss at the current performance level. Lack of current performance status (in term of S/N) the saving in relation of loss at the average performance (average S/N of all trials) to be calculated using the formula below:

Saving as % of loss before experiment (L_1) as

$$\text{Saving per unit of product} = 100X\ (L_1 - L_2)/L_1$$

$$= 100X\ \{L_1 - L_1X10^{+[(S/N)1-(S/N)2]/10}\}/L_1$$

$$= \{1 - X10^{+[(S/N)1-(S/N)2]/10}X100\% \text{ of } L_1$$

Where L_1 = loss before experiment

L_2 = loss at current performance

(S/N) 1 = average performance

(S/N) 2 = improved design, i.e. optimum performance

$\{1–10(–11.3462+6.1216)/10\}$ X100% of L_1.

1–0.300 = 0.700

= 70.0% of L_1

Thus we obtained that the expected saving from the resultant optimum parameter setting is 70 per cent. It is quite acceptable to run the experiment.

When we run the experiment with optimized parameter setting it yields zero defects. Hence this setting may be recommended for implementation. As final value yields zero defects it means it is on the target, and L_2 is zero, hence we achieved 100 per cent saving in final run. That shows that there are no $ loss at current performance.

This experiment approach reveals that the Taguchi Approach is a powerful tool, which provides an effective way to handle the experiment and saving the time and resource. Orthogonal array method allows for reducing the number of experiments. In this only 18 runs to be performed to achieve the efficient characterization of the process.

Conclusion

Taguchi approach is a powerful method which pushes quality back to the design stage to find the cause of problems. It measures quality by deviation from the target and not simply by the failure. We have briefly described the steps involved in the Taguchi method. It reduces the number of experiment. It provides us the way of experiment to find an optimum parameter for quality and cost. It saves the precious material resource and time. It also determines the dominant factor affecting the process and quality.

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The bad news is that time flies. The good news is that you're the pilot.

– Michael Althsuler

Feature

Total Quality Management Implementation Models for SMES – A Review

R.S. Dalu & S.G. Deshmukh

This paper highlights the status of Total Quality Management (TQM) in Small and Medium Enterprises (SMEs) and explains various implementation models available to them.

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There is a growing interest in quality management worldwide since quality is an important factor in today's competitive market. The main reasons for growing interest are:

(i) The increasing demand for products, which satisfy the need of the customers, at the right price;

(ii) Increase in domestic and global competition;

(iii) The pervasive need to integrate several organisational functions for improvement of total output of the organisation as well as the quality of output within each function;

(iv) The success stories of Total Quality Management (TQM) in USA, Europe and for eastern countries such as Japan.

Therefore, many governments throughout the world are seen to stimulate the application of TQM in their country (Hartz, 1998; Wilkes, et al., 1998). Indian Government is also not an exception to it (NPC Research Division, 1996; Shah, 1997). Literature (Motwani, et al., 1993; Maheshwari, et al., 1994; Sharma, 1997) shows that in India, except for a few large-scale industries, TQM is still not well understood and therefore several practices in isolation are treated as TQM initiatives, leading to somewhat disappointing results. It is also observed that adaptation of TQM could be the single most important factor in accelerating business growth, profitability and success. The most important issue in the field of quality management is the implementation of TQM in an organisation. The problem of organisational adaptation and change is more prominent for small and medium enterprises (SMEs).

A review of the literature reveals that there is no universally recognized definition of TQM. There is little agreement as to whether TQM should be described in terms of its ultimate goals or by the operational elements that need to be addressed to achieve these

Table 1: Definition of TQM

Sr.No.	Definition	Researcher
01	"An effective system for integrating the quality development, quality maintenance and quality improvement efforts of various groups in an organisation so as to enable production and service at the most economical level which allows for full customer satisfaction".	Feigenbaum (1991)
02	"Total Quality Management is a system approach to management that aims to continuously increase value to customers by designing and continuously improving organisational processes and systems. TQM involves all employees and extends backward and forward to include the supply chain and the customer chain".	Rampey and Roberts (1992)
03	"A comprehensive approach to improving competitiveness and flexibility through planning, organizing and understanding each activity, and involving everyone at each level. TQM ensures that the management adopt a strategic overview of quality and focus on prevention rather than inspection".	Oakland (1993)
04	"A Management approach of an organisation centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction, and benefits to the members of the organisation and to society". The expression "all its member's" denotes personnel in all departments and at all levels of the organisational structure.	ISO 8402: 1994

goals. Various researchers define TQM differently (Table 1).

TQM in SMEs

Literature shows that SMEs play an important role in the development of the economy. For example in UK alone more than 70% of all businesses employ under 100 people (Huxtable, 1995). Also 18 per cent of UK gross output (Manufacturing) is generated by businesses with fewer than 100 employees (Ghobadian & Gallear, 1996). In India, SMEs accounts for about 40 per cent of the total industrial output and contribute nearly 35 per cent of the total direct exports. The contribution of the SSI sector to employment is next only to agriculture.

The SMEs include a wide range of processes and products. Nearly 50 per cent of the SMEs can be classified in this category. So quality improvement in this category will definitely contribute to the national development.

Inspite of success stories of TQM, still the concept has not been readily adopted by SMEs. The main reasons for low use of TQM in SMEs are, first, cost constraint and lack of resources (Wilkson, 1994); second, lack of information on TQM, especially oriented to SMEs; and third, lower level of awareness and understanding.

Some SMEs have implemented TQM and they are enjoying the benefits arising from TQM (Kehoe & Mann, 1994). Survey reports found that stated reasons for adopting TQM in SMEs are promotion of growth, (TQM as a marketing tool) changing customer expectations consistent with management style, and improving poor company performance. Ahir & Goller (1999), concluded that TQM implementation in SMEs "represent a good strategy to execute quality management practices in an integrated manner". It was found that TQM businesses reported better product quality than non-TQM businesses despite a lack of market clout, capital and managerial expertise, that they can and do implement TQM elements as effectively as large businesses, and in turn achieve high product quality. The survey reports shows that higher quality products, improved business performance, customer satisfaction, improved supplier relationship, improved processes, improved people, improved policy deployment, development of quality culture and improved training were the main benefits achieved by introducing TQM in SMEs (Kehoe and Mann, 1994).

Literature shows that SMEs are using different approaches to achieve TQM. One most commonly used approach is ISO 9000 series registration (Maheshwari, et al., 1994; Motwani, et al., 1993; Sharma, 1997). This certification acts as a bridge between the traditional management of SMEs and a more sophisticated one, and plays a catalytic role in the adoption of new management tools. The Department of Trade and Industry (1995) commented, "The ISO standard is viewed as a good foundation on which to build".

TQM Implementation in SMES

Researchers (Wilkes and Dale, 1998) have found that the present quality award models (MBNQA and EFQM) are not ideal for SMEs in the present form. Some of the short-comings with the award models of today are:

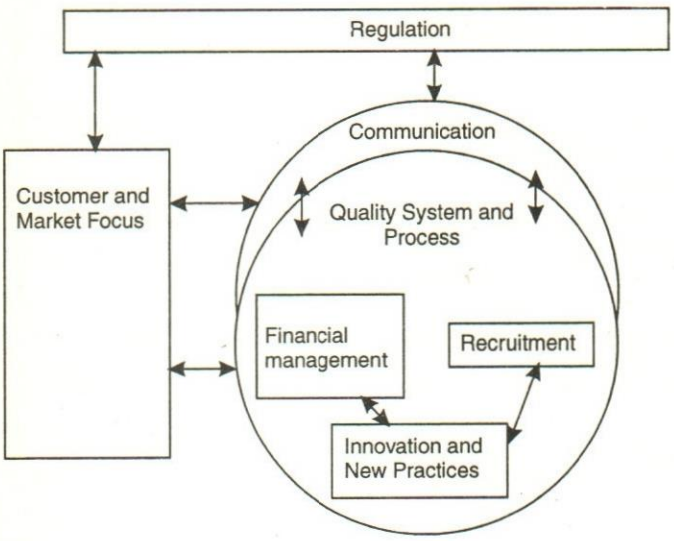

Fig. 1. TPSBESS Model

(i) They are too extensive for the reality of small organisations;

(ii) The model provides a good framework for TQM, but takes no account of the needs of small organisations;

(iii) The language used is too difficult to understand;

(iv) The models are often written in large company language and not with the small business in mind.

Literature review shows that very few TQM implementation models are developed for SMEs. The four models identified are as follows –

TPSBESS model

Trafford Park small business evaluation and support services (TPSBESS) developed "TPSBESS" model of TQM for SMEs. The factors of evaluation includes customer and market focus, communication, quality systems and processes, financial management, recruitment, people management, innovation and new practice regulations (Watts, B. et al, 1999). Fig. 1 show the framework of the model. Drawback of the model is that the model does not use weighting system for its components.

Springboard model

Springboard model of TQM has been developed in cooperation with small organisations. It is simple in structure and language. The four dimensions of the model are approach, deployment, result, evaluation and improvement (Table 2). The main focus of the model is on customer cooperation, leadership, employee commitment and process management (Hellsten, 1997).

For the purpose of researching the value of TQM in SMEs, these models are of limited use. The models do not help to quantify the effort require and the benefit achieved through quality management.

Table 2: The evaluation Matrix

Scale	Approach	Deployment	Results	Evaluation and Improvement
100%	Systematic and Preventive	Always in all relevant processes	First class sustained	Systematic, planned and proved
↑	↑	↑	↑	↑
0%	Defective, not systematic	Not described, not applied	Not reported	Not described, not accomplished

The S-P model of TQM

This model overcomes some of the existing problems in the study of TQM. The model provided a structure for research into TQM. It is based on the argument in favour of TQM and allows the testing of those arguments. Further, it provides a basis for determining how widely TQM is applicable and can also be used to identify the aspects of the environment required for successful implementation of TQM. The limitations of this model is that it can't:

(i) identify the degree to which the various components of the TQM are present in the organisation; and

(ii) compare the industries on the basis of components of TQM.

Modified S-P model

The modified S-P Model (Dalu and Deshmukh, 2002) is useful for assessing the organisations on the basis of components of TQM (Fig. 2). It helps to identify whether the policies and practices of SMEs include components of the S-P model of TQM. It can also identify the degree to which the various components of TQM are present in the organisation. The index value of each component makes it very clear where the improvement is needed. So this model not only compares the overall quality performance, but also guides for the improvements programme.

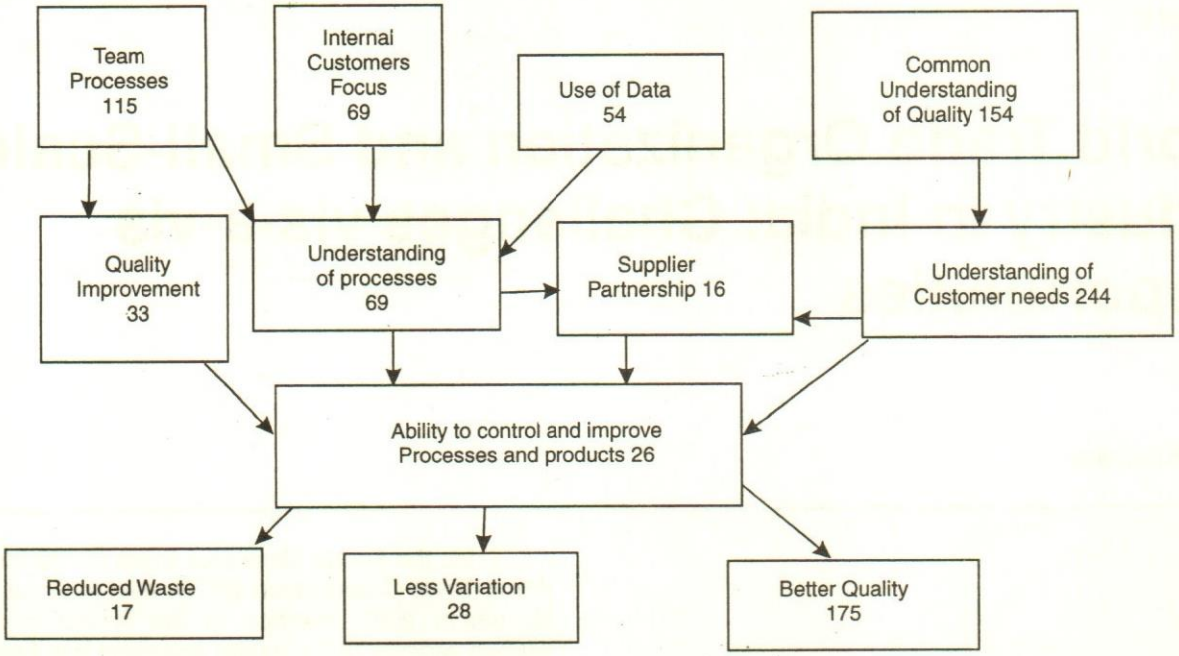

Fig. 2. Modified S-P model

Conclusion

The importance of TQM for managing quality has been recognized by large-scale industries worldwide. They are using TQM as an effective tool for continuous improvement. The industries which have implemented TQM, are enjoying the benefits of it. The various approaches are being used to achieve TQM. Out of all, ISO 9000 certification is mostly used as a step to TQM. There are various TQM implementation models but there are no such things as "one fit all" model.

Even though SMEs play as important role in the development of the economy, still the concept of TQM is not yet adopted widely by SMEs. In today's competitive age, to survive and grow, it is essential that small and medium scale industries should also adopt the principals of TQM. The models explained here will be useful to them in the implementation process.

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Feature

World Trade Organization and Small-Scale Industry in India: Challenges vis-à-vis Opportunities

S.S. Khanka

Given that globalisation is no longer an option but a fact, this paper examines the impact of the WTO on small scale industries in India, both as a challenge and as an opportunity.

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Since the Fourth Ministerial Doha Conference of the World Trade Organisation (WTO) held in Doha, Qatar in November 2001, mention of the impact of WTO on various aspects of the Indian economy has become frequent. The belief that it is something to do with industries or for people who are in international trade only, should be vigilantly guarded against, for this is an illusion. There is no economic activity in the world that will go unaffected by the WTO and its agreements. In fact, it is as important for farmers, scientists, doctors, singers, writers etc., as it is for an industry, a trader, a banker or a sundry service provider.

Nonetheless, it is feared that small scale and cottage industries will be most hit by the agreements of WTO. The major fear expressed is that the dumping of cheaper goods from outside in the Indian market will create competition for the products of small-scale industries in India, which has already been noticeable in the case of some of the products in the country. There are already 30 cases of anti-dumping going on in India. Recognizing the vital role of small-scale industries in terms of production (40% of value addition in the manufacturing sector), employment (80% of manufacturing employment), and exports (35% of total exports) in the Indian economy (Gupta, 2001), the small sector is to be not only protected but strengthened too. Therefore, the impact that the WTO-membership would make on the Indian economy is an issue of paramount national importance. However, it is a little pre-mature to make a judgement at this stage, essentially because things have just started evolving. A neat picture will certainly emerge well after all WTO agreements are implemented world-wide and some time has passed. Nonetheless, the heated discussions and debates going on about WTO and its impact on the Indian economy underline the need for a perspicacious examination of the impact of the WTO on small-scale industry in India. The main

foci of this paper is, therefore, to assess the implications of World Trade Organizations (WTO) negotiations/agreements for the small-scale industry in India.

Genesis of WTO

Towards the end of World War II, the Bretton Conference in July 1944 decided to establish three international institutions, namely, (i) The International Bank for Reconstruction and Development (now known as the World Bank); (ii) International Monetory Fund (IMF); (iii) and the International Trade Organization (ITO). While the first two came into existence on 27 December 1945, the third one (ITO) could not be established due to resistance from the US Senate. In its place, a protocol of Provisional Application was signed by 23 countries including India. The protocol ushered in the General Agreement on Tariffs and Trade (GATT), in Geneva, on 1st January, 1948 to bring order into the law of jungle in international trade. The principal purpose of GATT was to encourage free commodity trade through the removal or reduction of trade barriers on imports imposed by the member countries and, thus, encourage growth and development of all member countries.

Since its inception, several rounds of negotiations were held under the GATT. World trade had undergone structural change during the four decades since the establishment of GATT in 1948. While the share of agriculture in world merchandise trade dropped from 46 per cent in 1950 to 13 per cent in 1987, the share of service sector in the Gross Domestic Production (GDP) of developed countries reached from 50 to 70 per cent by 1986. The share of employment in the service sector was also increasing. In the United States of America (USA), the service sector employed over 70 per cent of the work force. These factors impelled the developed countries, under the leadership of the USA, to take the initiative of bringing the service sector into trade negotiations.

The 8th round of GATT was held against such a background in September 1986 in Punta del Este in Uruguay. This 8th round became popular because it sought to bring services (in the form of protection of intellectual rights) under GATT. The differences on this issue that surfaced among the member nations on various issues were so acute that the round failed several times and lasted for eight years. Mr. Arthur Duncle, the then Director General of GATT, presented a compromise draft-'Final Draft,' which became basis for the Final Agreement. Finally, the agreement was signed by 123 ministers of the participating countries representing their Governments on 15th April 1994 at Murrakesh in Morocco. India was a founder signatory of the agreement ratifying it in its Parliament on 30th December, 1994. In this way WTO came into being on 1st January 1995, as the only body dealing with the rules of trade between the nations. At present, WTO has 145 member countries including China. The main objective of WTO is to regulate trade between member countries to benefit them. This is done through three agreements and one body in this regard.

WTO Agreements

1. GATT i.e., General Agreements on Tariffs and Trade (which deals with industrial products, consumer durables, etc.)
2. GATS i.e., General Agreement on Trade in Services (which deals with issues of services like banking, insurance, consultancy, etc.)
3. TRIPS i.e., Trade Related Intellectual Property Rights (which deals with patents, copyrights, trademarks, industrial designs, etc.)
4. Trade Dispute Settlement Body.

Aspects of Impact on SSIs

The Fourth ministerial conference of WTO held in Doha, Qatar in November 2001 gives the mandate for the negotiation on market access for non-agricultural goods, which includes the small-scale industry (SSI). This mandate is a cause of concern for the Indian small-scale industry as well. The declaration highlights reduction and elimination of tariffs, tariff peaks, high tariff, tariff escalation, and non-tariff barriers. The product should be comprehensive and without *a priori* exclusions.

Reduction of Tariffs/Import Duties

The WTO has been urging India to remove controls on consumer goods, reduce quantitative restrictions and lower import duties. India has been scrupulously following the WTO agreements to reduce tariffs year after year. With this, the protection offered to the indigenous goods by import duties has gradually disappeared and, as a consequence, the Indian goods were bound to face competition with imported (foreign) goods in both quality and predatory price. As a result, as per the Confederation of Indian Industry (CII), the indigenous capital goods industry on a conservative estimate lost orders worth Rs. 5,000 crore from foreign countries. The major fall out of lowering import duties on the Indian economy as a whole, in general, and on small scale industries has been the dumping of foreign cheaper goods in the Indian market. Here, the dumping of Chinese goods in the Indian market in the recent past immediately comes to mind.

What is dumping? When a country exports its product at a price lower than the one is normally charged in its own market or if it sells at less than the cost of the production, it is said to be dumping the product in the importing country. Though the WTO Agreements through Anti-Dumping Duty (ADD) provide provisions against dumping to check dumping of foreign goods, it is not easy to execute the same. In recent years, Chinese goods iike battery cells, cigarette lighters, locks, car stereos, energy saving lamps, VCD players, wrist watches, toys, fans, electric ovens, and a large variety of consumer articles have flooded the Indian market. Not only that, Chinese goods are not only coming through normal channels of trade, but are also being smuggled via Nepal at zero duty. A very porous border from Nepal has increased clandestine imports from China. Both regular and clandestine imports from China are making serious forays into the Indian markets, thus, hurting quite a large number of industries. Since it is difficult to assess the material injury caused to the domestic product due to the imported product and price of the imported product in the exporting country due the non-availability of required data, anti-dumping duty under the provisions of WTO Agreements cannot be imposed to restrict the dumping of foreign goods like Chinese goods in India. In this context, Dr. B. R. Sahade (as quoted by Datt and Sundharam, 2004) is of the view, "It is extremely difficult to make a case about dumping of Chinese goods. The Government can impose a preliminary duty, introduce a trigger price mechanism or declare China as a non-market economy."

Though the WTO provide provisions against dumping it is not easy to execute the same.

Removal of Quantitative Restrictions

As per the Agreements of the WTO, countries, whether developed or developing can use chiefly two methods to control import of foreign products to protect their indigenous products. One is through levying import duties i.e., tariffs. The second is through restrictions such as : (i) Mandatory licensing for import; (ii) Fixing quotas for imports; and (iii) Enacting stricter quality standards for imported goods than those being followed by domestic industries, etc.. The second set of policies are termed as Quantitative Restrictions (QRs). Why QRs? There are two justifications for it :

- To control import of foreign products to protect domestic products, and
- To maintain the Balance of Payment (BOP).

The use of QRs is allowed to countries having critical BOP problem (HS Code under Article XVIII-B). However, QRs later were considered as distortions in free flow of goods and services between the countries. Hence, WTO prescribed agreements to remove QRs and control of imports through tariffs only. The WTO has directed India from time to time to lift QRs on its imports. In pre-1990, there were QRs on imports of about 8,000 items which came down to 2,700 items in 1997. India presented a plan to the WTO for elimination of these restrictions in 9 years in 1997 which was rejected by the major trading partners of India, chiefly by the developed countries. Then India signed agreements with major trading partners except US, to phase out the QRs in 6 years i.e., January 1, 2003. The US filed a case in WTO against India and contended that India's pursuing of QRs are unjustified under BoP clause (Article XVIII-B) as its BoP position has substantially improved. The WTO Panel on India's QRs case ruled in favour of the US in April 1999 (WT/DS90/R). The Appellate Body in the WTO also upheld the ruling in August 1999 that India must lift its QRs on imports within 6 years as laid down in the WTO Agreements. As a result, today India is now a QR–free regime. It is apprehended that the major fall out of QR–free regime will be on SSIs in India.

As the protection afforded by the import duties and quantitative restrictions have gradually disappeared due to India scrupulously following the WTO agreements and provisions, Indian industry and especially the small-scale industries has had to face increasing competition from foreign goods. The main items to be affected in the SSI sector are consumer goods and agricultural products. The entry of multinationals in ordinary consumer goods like ice cream, *agarbatti* manufacturer, food processing, mineral water etc., has also been adversely affecting the SSI sector since these were the traditional areas of this sector. In the soft drink industry, the entry of powerful Coca Cola and Pepsi have eliminated practically all small units engaged in the manufacture of aerated water. In fact, in the name of consumer interest, MNCs continue to swallow SSIs and eliminate them from the market.

The Uruguay Round Agreement on Agriculture has only in theory favoured agriculture in developing countries, but in practice, its implementation has seriously affected its development. Researchers (Chadha 2000, Dhar and Chaturvedi 1999, Rangarajan 1999 and Reddy 1999) have detailed documents how WTO agreements on agriculture are considered as unfair. According to these agreements, developed countries agreed to reduce these subsidies by 20 per cent over six years and the developing countries by 13 per cent

over ten years. However, the developed countries under Green Box and Blue Box subsidies continue to support agriculture. Green Box subsidies include amounts spent on Government services such as research, disease control, infrastructure and food security and Blue Box subsidies are certain direct payments made to farmers where the farmers are to limit production, certain government assistance programmes to encourage agriculture and rural development in developing countries. Similar to domestic support subsidies, while developing countries are not allowed to increase their negligible level of export subsidies, developed countries are allowed to maintain 64 per cent of their subsidy outlays on the base level. The consequence is agriculture imports from developed countries are available at much below the market price in the domestic economy. The UNDP while reviewing this problem mentions in its Human Development Report (1997): "According to the OECD, the per capita transfer to US farmers amounted to $29,000 in 1995. In the main maize producing areas of Mindanao and Cagayen valley, the average per capita income amounts to less than $ 300. Thus, each US farmer receives in subsidies roughly 100 times the income of a maize farmer in Philippines."

According to the UNDP (1997), "Implementation of the Uruguay Round Agriculture Agreement over the next five years will not materially change the picture..... Agriculture remains the only area of international trade in which export dumping is accepted as a legitimate trade practice." That is mainly the reason why developed countries are interested to make inroads in Indian agriculture (Sahai 1996). Before the agriculture agreement, Indian agricultural prices were lower than international prices mostly. But as a result of heavy subsidization of agricultural exports by developed countries, the situation undertook a dramatic about-turn. This has created panic for the Indian farmers for selling their agricultural and dairy products. The panic had culminated in farmers committing suicide in several states of India. Some economists have, therefore, drawn the attention of the Government to such sad plight of Indian farmers due to WTO obligations. Professor P. R. Brahmananda has gone so far as to assert : "We have to think of domestic interests as paramount. If we have to leave WTO for the interests of our farmers, I would not mind it."

Other Aspects of Impact

Adverse Effects of TRIPS: There are some critics who say that Trade-Related Intellectual Property Rights (TRIPS) as embodied in the GATT agreement will have disastrous effects on the Indian economy, especially on the pharmaceutical and agricultural sector. Both these sectors affect the well-being of the people. Mr. B. K. Kealya (1994) Convenor, National Working Group on Patent Laws, states that under the new patent regime, nearly three-fourths of drugs will be covered under the new patent laws. Consequently, he says, heavy payments will have to be paid to the patent holders under TRIPS which, in turn, raise drug prices by 5 to 10 times. As a consequence, the size of population affording drugs will decrease from present 30 per cent to 10 per cent. However, the Government (Mukherjee 1994) and some economists (Debroy 1994) consider the price rise in drugs as exaggeration. They defend their view that under the agreement, the government would be able to undertake compulsory licensing for non-commercial public use as well as to prevent situations of either inadequate availability or exorbitant pricing. Besides, government retains the right to institute price control on drugs.

Of late, the issue of patent piracy has become topical all over the world. The current patent debate has rocked the issue of piracy in India too, as it has been bleeding the national economy on an increasing scale (Dhavan and Viswanathan 1994). Today, it has posed a serious problem of bio-piracy for India's rich bio-diversity. Haldi (*Turmeric)* an ancient spice of India was sought to be patented under the American Law in 1995. As a protest against America's piracy of Indian Haldi, Dr. R. A. Mashelkar, Director General of Council of Scientific and Industrial Research challenged it. The US patent office acknowledged its mistake and cancelled the patent on Haldi. An American company has been granted a patent right for Neem as a pesticide. Basmati rice, which was a universal variety of rice in India, has been patented as Kasmati and Texmati. Not only that, danger has been lurking for India's ancient herbal Tulsi (*Basil*) plant as well. These are a few illustrative cases of bio-piracy of India's herbal wealth. In order to stop the India's ancient herbal being pirated by others, there has been a need to undertake documentation of use of its rich herbal wealth.

That the problem of piracy has been quite an old one originating from the developed countries itself like America is confirmed. Doron S. Ben-Atar (2004) has detailed research to prove that all developed countries, especially the US, did not respect IP rights and indulged in rampant piracy. Tracing the roots of patent and copyright laws in early America, Ben-Atar says that during the country's industrial revolution, its very prosperity was founded on copyright infringement, industrial espionage and outright theft of IP. Much of the buzz around Ben-Atar's thesis has been occasioned by the growing competition to a range of American industries from the giant manufacturing hub of China, and to a lesser degree, India and other emerging economies in the world. The irony of the fact is that the US and

allies have been imposing the WTO-mandated trade related aspects of intellectual property rights (TRIPS) agreement on developing countries. Ben-Atar asks: does history have any lessons for today's IP warriors in an intensely contested arena? The answer given is: "Before American rush to condemn those who pirate our knowhow, they must not forget how the US became the richest and most powerful nation on earth". The inference is if past patterns are going to be repeated, local entrepreneurs in the developing world will acquire, by whatever means, America's trade secrets and produce the desired goods and services on their own. The literature on international trade has categorically argued that free trade does not necessarily imply fair trade (Panchamukhi 2001). This is well substantiated by the latest collision between the US and China on IP violations."

The recent confrontation between the two trading partners has accelerated over US charges that China's state-owned car manufacturer, Chery Automobile Company, had stolen the design from General Motors to make its QQ model. In December 2004, GM filed a lawsuit against Chery Automobile for alleged piracy of the design of its Chevrolet Spark, developed by its South Korean affiliate Daewoo. In recent days, US officials have been stepping up the heat on the Chinese government to crack down on IP theft. While Chery Automobile has denied the piracy charge saying that it is one of the key state-backed automakers that depends on itself for development, the Chinese government's response has been laconic. According to the US Commerce Department, the Chinese piracy is bleeding America of nearly $24 billion annually (Businessworld, 2005). All above and other similar things underline two things: *One,* enforcing of IP laws by the developed countries on developing countries is hyporocritical and sometimes even cruel, *second,* devoting resources for enacting IP legislation a futile act. The IP history suggests that a country's most valuable asset is not yesterday's invention, but tomorrow's innovation.

Import of Second Hand Cars: The Government of India had allowed the import of second hand cars into India. Like other consumer items, the Indian consumer has always been crazy for foreign goods. The Government's policy to import second hand cars has seriously hit the Indian automobile industry. Considering its impending impact on the domestic automobile industry, Mr. Rahul Bajaj described this as "*anti-national and anti-India Act*". This statement has meaning. The experience the world over has evidenced that wherever second hand imported cars are allowed, they seriously damaged the domestic industry. To quote, the import of Japanese second hand cars in New Zealand destroyed the car industry of the latter. In fact, the adverse impact of the import of second hand cars on the domestic car industry is rejected by most of the business executives. Mr. Phil Spender, Managing Director, Ford India rejects the policy of importing second hand cars in these words: "If the Government asks us what to do (about the used cars), I'll be the first to volunteer ways to keep used cars imports out of India (Sabade 2001)". Mr. Richard Swano, Managing Director, General Motors, also echoed the similar views about the import of used cars saying that the import tariff on used cars should be 100% and not 40-50 per cent. If India allows for the import of second hand cars, it will have serious repercussions on capital equipment manufacturers and, in turn, adverse impact on income and employment of national economy.

Conclusion

The upshot of the entire preceding analysis is that the international agreements, particularly under World trade Organisation (WTO), have not helped the developing countries including India as was professed at the time of the establishment of WTO in 1995 (Vyas 2002). But, given the whole world becoming a 'global trading village', there is no escape from globalization and, for that matter, from the WTO. As the Report on Human Development in South Asia (2001) rightly mentioned, globalization is no longer an option, it is a fact. Keeping in view the lurking dangers of some of the agreements of WTO on Indian economy, especially on its small sector, the vital question is what needs to be done to avoid the adverse effects and benefit the economy from the WTO agreements. There could be mainly two levels at which action has to be taken. ***First*** is the domestic level and the ***second*** is at the international level.

At the national level, we need to strengthen our competitiveness not only to compete with the imported products from developed countries in our domestic markets, but also to penetrate into the overseas markets to market our products and services. The challenges posed by the international trade need to be converted into opportunities to be availed. In today's highly competitive both domestic and global markets, the rhetoric is not going to help, only the knowledge and strength is. As regards actions to be taken at the international level, developing countries need to create combined pressure on developed countries to make them bound share the benefits of globalization equitably between the developed and the developing countries. It is a happy augury that such realization on the part of developing countries has started surfacing. The Cancan Round of WTO is the example which members from developing countries combinedly brought the concern of develop-

ing countries to the centre stage of discussion and forcefully stalled the intentions of developed countries. Such a pressure from the developing countries on developed countries needs to be intensified unabatedly to compel the latter to take the WTO philosophy in its true spirit so that it benefits all the member countries equally.

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Art, it seems to me, should simplify. That indeed is very nearly the whole of the higher artistic process; finding what conventions of form and what detail one can do without and yet preserve the spirit of the whole.

– Willa Cather

Feature

An Analysis of Operational & Productivity Efficiency of Public Sector Banks in India

Usha Arora & Richa Verma

With the changing scenario of the banking industry in the liberalized era, the importance of efficiency has assumed critical significance for the viability of the public sector banks operating in India. This paper studies the relative efficiency of public sector banks from 1991-92 to 2003-04, using the Average Compounding Growth Rate (ACGR) method.

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The banking system in India, being the dominant segment of the financial sector accounting for a major portion of fund flow, is the main vehicle for monetary policy signals, credit channel and is the facilitator of the payment system. The Indian banking sector has experienced growth in terms of branch expansion, deposits and bank lending since independence. Up to 1969 the commercial banks were confined to the affluent urban customer, industry, trade and commerce. Banking sector was in the hands of the private operators. In 1969, as a result of economic development and capital formation, major commercial banks were nationalized. Another six banks were nationalised in 1980.

The regulators have directed these banks to go in for branch expansion in rural and semi-urban areas of the country and provide concessional credit to certain specified priority sectors like agriculture, small-scale industry, transportation, exporters, distribution of food and other agriculture products. Banking sector is entering a New World and exciting developments are changing the face of banking. National and institutional boundaries are becoming less important. Consolidation of institutions, globalization of operations, development of new technologies and universalization of banking are taking place at a rapid pace. This leads to increase in resource productivity, by transferring funds throughout the nation and even internationally.

Aggressive bank branch expansion programmes increased financial savings and investments but credit control had a negative effect on deposit mobilization, capital accumulation and its efficient utilization. All this led to an erosion of the bank's profitability and rapid growth in operating expenditure. In 1990-1991, the Indian economy faced unprecedented external crisis arising out of macro-economic imbalances. Indian banks are facing innumerable challenges such as a worrying level of NPAs, deteriorating assets quality, increasing pressures on profitability, assets-liability management,

and liquidity risk management and ever-tightening prudential norms. In 1991, the government took the decision to liberalize many sectors of the economy. Narasimham Committee on financial sector reforms shed light on the various weaknesses of Indian banks and they made recommendations on various issues like investments and credit policies, assets classification and maintenance of reserve etc.

On the one hand, keeping in view the global trends the financial liberalization of the economy has given sufficient freedom to banks to operate more efficiently, but on the other hand it has also enhanced competition for banks by easing the entry of new institutions in the financial sector. The strengthening of the institutional framework took the form of recapitalization, strengthening the supervisory process and creating new institutions like Debt Recovery Tribunals. Thus now banks have to be more conscious of their financial, productivity, profitability and operational efficiency. All these aspects become vital areas of concern for management of banks. In the present paper an attempt has been made to determine Operational and Productivity Efficiency of Public Sector Banks, that includes nationalized banks and state bank and its associates.

Many studies consider the operational and productivity efficiency of the banking sector using various approaches. Some of these studies are:

Ketkar, Noulas and Aggarwal (2003) in their paper had analyzed the efficiency and productivity growth of the Indian state-controlled, nationalized, private and foreign banks. They concluded that the Indian domestic banks need to greatly improve their efficiency through the introduction of computer technology, improved management skills and through consolidation and mergers of banks.

Naidu and Nair (2003) have analyzed the technical efficiency of commercial banks between the pre and post-reform periods. They concluded that a technical efficiency level among bank groups has declined in the post-reform period, indicating the enhanced competition among banks.

Singh (2003) has examined the performance of banks on the basis of different conventional and modern parameters that include like operational efficiency, capital adequacy, earning quality, assets quality, management quality, liquidity etc. and some other operating and financial ratios as modern techniques for evaluating the bank's performance.

Cheema and Aggarwal (2002) have examined the productivity in commercial banks. They consider that productivity is a measure to know whether the resources or inputs have been used efficiently or not. Their study shows that the commercial banks operating in India are below the average level of efficiency.

All studies have been done with the various mathematical tools for measuring the productivity and operational parameters of the banks, but no one has studied the growth of the banks on the basis of the operational and productivity parameters. This paper examines the performance of the Public Sector Banks by using the Average Compounding Growth Rate (ACGR) method.

Database and Methodology

Farrell (1957) defined efficiency as the ability of a production organization to produce a good at the minimum cost. The objectives of the present paper are as follows:

- To calculate the operational and productivity efficiency of the public sector banks.
- To study the factors influencing the operational and productivity efficiency of public sector banks.
- To arrive at a comprehensive view of a bank, by incorporating as many indicators as possible.
- To calculate the Average Compound Growth Rate (ACGR) of each variable.
- Ranking of banks by considering different parameters.

After liberalization many private and foreign banks have entered the market, but still the maximum business is in the hands of public sector banks. Therefore, the present study is confined to Public Sector Banks only that includes 19 nationalized banks and 8 state banks and its associates. These are – Allahabad Bank (Al.B), Andhra Bank (AB), Bank of Baroda (BOB), Bank of India (BOI), Bank of Maharashtra (BOM), Canara Bank (CB), Central Bank of India (CBI), Corporation Bank (Co.B), Dena Bank (DB), Indian Bank (IB), Indian Overseas Bank (IOB), Oriental Bank of Commerce (OBC), Punjab and Sind Bank (PSB), Punjab National Bank (PNB), Syndicate Bank (SB), United Commercial Bank (UCOB), Union Bank of India (UBI), United Bank of India (UBOI), Vijaya Bank (VB), State Bank of Bikaner and Jaipur (SBB&J), State Bank of Hyderabad (SBH), State Bank of India (SBI), State Bank of Indore (SBIn), State Bank of Mysore (SBM), State Bank of Patiala (SBP), State Bank of Saurashtra (SBS), State Bank of Travancore (SBT).

The bank's performance has been studied on the basis of two basic aspects, namely are operational and productivity. These aspects themselves include various parameters. Operational Parameters include Total Income (T.I.), Interest Earned (Int.E.), Interest Spread (Int.S.), Net Profit as percentage to Interest Spread (N.P./Int.S.), Interest Income as percentage to Working Funds (I.I./W.F.), Non-Interest Income as percentage to Working Funds (N.I.I./W.F.), Non-Performing Assets as percentage to Net Advances (NPA/N.A.), Capital Adequacy Ratio (CAR) etc. Productivity Aspects includes Return on Assets (ROA), Business Per Employee (BPE), Profit Per Employee (PPE) etc.

Factors affecting the Operational and Productivity Efficiency of banks

Total Income: It is the aggregate of interest earned and other income. For a bank to get a progress its total income should be increased, which shows its better operations with the customers. Total income has a direct impact on the utilization of resource available.

Interest Earned: It is the main component of total income of a bank. It includes interest/discount on advances, interest on balances with RBI etc. If the amount of interest earned is higher then the bank is having a good position in the market and vice versa.

Interest Spread: There is difference between interest earned and interest paid by a bank. This difference is known as Interest spread. The higher the difference between the two, the better it will be for the bank. As the growth achieved is higher, the score assigned will be higher.

Net Profit as a percentage to Interest Spread: This ratio reveals that out of net income i.e. spread, how much net profit can be earned. This ratio can be regarded as an important variable to assess performance of banks.

Interest Income as a percentage to Working Fund Ratio: This ratio defines the relationship between interest income and working fund. It helps to know how efficiently the funds have been used to gain on working funds. Working fund is the aggregate of all deposits, borrowings, reserves, capital, revenue and other liabilities and provisions. And the relationship of these two gives the results of whether an institution is in a position to use its resources efficiently or not.

Non-Interest Income as a percentage to Working Fund: It defines bank's non-interest income to its working fund i.e. how maximum can be earned on working fund with other income. It will reveal how much income has been generated other than the business of lending by a bank in relation to working fund.

Non-Performing Assets (NPA) as percentage to Net Advances: This ratio is calculated by dividing net NPA by net advances of the bank. It reflects the percentage of NPA in total advances of the bank. The lower ratio signifies higher profitability and low bad debts for the bank. The ratio has been used as a measure of safety and soundness indicator.

Capital Adequacy Ratio (CAR): CAR has been recommended by the Basle Committee as a minimum capital adequacy standards in banking companies and it is recommended to be calculated on the basis of risk adjusted assets and capital funds. There is strict RBI provision on banks for Capital Adequacy Norms. This ratio is calculated by dividing the debt and equity of the bank. This ratio shows the strength of a bank. The higher the ratio, higher will be the score of the bank. Currently it is at 10 % level.

Return on Assets: The return on assets shows the proportion of net income to total assets of the bank. The higher ratio depicts the better utilization of assets. The ratio has been used as a measure of productivity indicator.

Business Per Employee (in Rs Lakhs): This ratio is calculated by dividing the total turnover of the bank by total number of employees of the bank. This ratio shows the productivity of human forces of the bank. Higher the ratio the better it will be for the bank.

Profit Per Employee (in Rs Lakhs): This ratio is calculated by dividing the total profit of the bank by total number of employees of the bank. This ratio shows the surplus earned per employee. Higher ratio signifies higher productivity for the bank.

The data for evaluation has been taken into consideration from 1991-92 to 2003-04 i.e. for 13 years. The data is collected from various sources as Annual Reports of the Banks, Indian Banking Association Journal, Reserve Bank of India (RBI) Bulletin, Journal of Banking Studies, Journal of Accounting and Finance and Indian Journal of Commerce. Internet has been an important source of secondary data. The site assessed for this research is www.rbi.org.in. The techniques used for this purpose include the following steps:

The Annual Compound Growth Rate (ACGR) is calculated from the statistical tools of SPSS software of all the banks for defined period, using:

$$Y = ab^t$$

Table 1: Growth in Operational Parameters (in percentage) Period - 1991-92 to 2003-04

Banks	T.I.	Int.E.	Int. S.	N.P./Int.S.	I.I/W.F	N.I.I/W.F.	NPA/N.A.	CAR	T.Average
Al.B	12.70	11.83	19.21	0.60	9.45	1.56	10.75	11.11	9.65
AB	18.80	17.70	22.77	1.31	10.27	1.75	2.86	12.77	11.03
BOB	10.71	10.04	11.66	0.60	9.11	1.40	5.92	12.49	7.74
BOI	11.85	10.68	14.46	0.98	8.67	1.61	6.62	11.05	8.24
BOM	18.00	17.13	20.77	1.79	9.84	1.30	6.81	10.85	10.81
CB	13.85	12.89	12.26	0.56	9.43	1.74	5.55	10.90	8.40
CBI	13.52	13.15	18.46	0.91	10.14	1.27	9.53	10.68	9.71
Co.B	21.97	21.45	21.55	1.57	10.09	1.79	2.28	15.50	12.03
DB	15.94	14.48		1.20	9.99	1.71	11.84	9.96	8.14
IB	7.46	6.46	13.90	0.52	8.44	1.47	14.54	0.99	6.72
IOB	13.85	14.01	25.16	1.21	9.31	1.20	6.28	10.45	10.18
OBC	21.66	20.73	20.78	0.74	10.49	1.26	3.33	13.86	11.61
PSB	14.84	13.91		0.58	9.63	1.50	10.90	10.84	7.78
PNB	14.23	13.20	16.10	0.38	9.66	1.48	6.79	10.64	9.06
SB	13.41	12.82	17.95	2.07	9.30	1.24	4.50	10.83	9.02
UCOB	11.95	11.12	20.75		9.01	1.40	8.03	8.95	8.90
UBI	15.54	15.03	15.77	1.05	9.97	1.14	6.53	11.20	9.53
UBOI	14.49	13.49	25.74	1.54	9.60	1.29	11.05	11.31	11.06
VB	16.43	15.91	20.09	2.42	9.95	1.35	5.79	11.62	10.45
SBB&J	18.79	14.52	16.17	1.35	9.75	2.04	6.831	1.99	10.18
SBH	16.60	15.88	15.35	1.31	9.54	1.81	6.88	12.34	9.96
SBI	12.77	12.54	12.08	1.30	8.75	1.54	5.83	12.99	8.48
SBIn	18.41	16.81	17.24	1.77	9.97	2.35	6.51	11.72	10.60
SBM	15.06	13.88	14.89	1.58	9.90	2.07	7.94	11.28	9.58
SBP	14.97	13.54	14.18	0.93	9.83	1.55	4.57	12.70	9.03
SBS	15.03	14.17	14.56	1.28	9.76	1.92	5.49	14.30	9.56
SBT	14.87	14.19		1.46	9.70	1.63	7.29	11.00	7.52

Where, Y= dependent Variables (deposits, advances etc), A = Constant, B = Slope of Trend Lines (Growth Rate), T = Time.

On the basis of ACGR, the ranks have been provided. Higher the growth rate, higher would be the score of particular bank. But this rule gets reversed in the case of Contingent Liabilities, NPA as percentage to Net Advances, Operating Expenses.

The study has considered different variables, then a combined table including all variables under a parameter has been designed to rank the banks.

Empirical Results

Operational Efficiency

This is defined as the measure of output over inputs. The inputs are owned funds (capital and reserves), deposits, borrowings, wage bills (labour) and outputs are investments, advances, loans, spreads and non-interest income etc. A bank should minimize its expenses and maximize its profits by taking all these variables (parameters) into account. A bank must meet capital adequacy norms; it should manage to recover its loan against the public and try to decrease its non-performing assets. Thus we have taken into consideration certain operational parameters to evaluate the performance of banks. The results related to operational performance of the banks are depicted in Tables 1 and 2.

Tables 1 and 2 reveal that the growth of Total Income is higher in the case of Corporation Bank with 21.97 per cent followed by the Oriental Bank of Commerce with 21.66 per cent. Indian bank ranks lower with 7.46 per cent growth.

In the case of *interest earned*, the Corporation Bank ranks higher with a growth of 21.45 per cent and the

Table 2: Ranking of public sector banks on the basis of ACGR of operational parameters (in percentage) period - 1991-92 to 2003-04

Banks	T.I.	Int.E.	Int. S.	N.P./Int.S.	I.I/W.F	N.I.I/W.F.	NPA/N.A.	CAR	T.Average
AI.B	23.00	23.00	9.00	21.50	19.00	12.00	5.00	15.00	15.94
AB	3.00	3.00	3.00	10.50	2.00	7.00	26.00	5.00	7.44
BOB	26.00	26.00	24.00	21.50	23.00	18.50	18.00	7.00	20.50
BOI	25.00	25.00	19.00	17.00	26.00	11.00	14.00	16.00	19.13
BOM	6.00	4.00	6.00	3.00	10.00	21.00	12.00	19.00	10.13
CB	18.50	20.00	22.00	24.00	20.00	8.00	21.00	18.00	18.94
CBI	20.00	19.00	10.00	19.00	3.00	23.00	6.00	22.00	15.25
Co.B	1.00	1.00	4.00	6.00	4.00	6.00	27.00	1.00	6.25
DB	9.00	10.00	15.00	5.00	9.00	2.00	25.00	9.38	
IB	27.00	27.00	21.00	25.00	27.00	17.00	1.00	27.00	21.50
IOB	18.50	13.00	2.00	14.00	21.00	26.00	17.00	24.00	16.94
OBC	2.00	2.00	5.00	20.00	1.00	24.00	25.00	3.00	10.25
PSB	15.00	14.00		23.00	16.00	15.00	4.00	20.00	13.38
PNB	17.00	18.00	14.00	26.00	15.00	16.00	13.00	23.00	17.75
SB	21.00	21.00	11.00	2.00	22.00	25.00	24.00	21.00	18.38
UCOB	24.00	24.00	7.00	24.00	18.50	7.00	26.00	16.31	
UBI	10.00	8.00	15.00	16.00	6.50	27.00	15.00	14.00	13.94
UBOI	16.00	17.00	1.00	7.00	17.00	22.00	3.00	12.00	11.88
VB	8.00	6.00	8.00	1.00	8.00	20.00	20.00	11.00	10.25
SBB&J	4.00	9.00	13.00	9.00	13.00	3.00	11.00	9.00	8.88
SBH	7.00	7.00	16.00	10.50	18.00	5.00	10.00	8.00	10.19
SBI	22.00	22.00	23.00	12.00	25.00	14.00	19.00	4.00	17.63
SBIn	5.00	5.00	12.00	4.00	6.50	1.00	16.00	10.00	7.44
SBM	11.00	15.00	17.00	5.00	9.00	2.00	8.00	13.00	10.00
SBP	13.00	16.00	20.00	18.00	11.00	13.00	23.00	6.001	5.00
SBS	12.00	12.00	18.00	13.00	12.00	4.00	22.00	2.00	11.88
SBT	14.00	11.00		8.00	14.00	10.00	9.00	17.00	10.38

growth is lower in the case of Indian Bank with 6.46 per cent.

United Bank of India ranks higher with 25.74 per cent growth in the case of *Interest Spread*. But Bank of Baroda ranks lower with 11.66 per cent growth.

In case of Net Profit as percentage to Interest Spread, Vijaya Bank ranks higher at 2.42 per cent growth, followed by Syndicate Bank with 2.07 per cent growth. The Punjab National Bank ranks lower with 0.38 per cent growth.

The growth of Interest Income as percentage to *Working Fund* ranges from 8.44 per cent to 10.49 per cent. Oriental Bank of Commerce ranks higher with 10.49 per cent growth followed by Andhra Bank with 10.27 per cent growth. The Indian Bank ranks lower with 8.44 per cent growth.

Non-Interest Income as percentage to Working Fund ranges from 1.14 per cent to 2.35 per cent. The State Bank of Indore ranks higher with 2.35 per cent growth followed by State Bank of Mysore with 2.07 per cent growth. The Union Bank of India ranks lower with 1.14 per cent growth.

In case of *NPA as a percentage to Net Advances* the rule gets reversed. The bank with higher ratio will get lower rank and vice-versa. The Corporation Bank will rank higher with lower growth of 2.28 per cent. But Indian Bank ranks lower with higher growth rate of 14.54 per cent.

Capital Adequacy Ratio is higher in the case of Corporation Bank with 15.50 per cent growth followed by

State Bank of Saurashtra with 14.30 per cent growth. Indian Bank ranks lower in the case of Capital Adequacy with only 0.99 per cent growth.

Productivity Parameters

Productivity is measured in terms of output divided by inputs. It is the ratio, which describes how efficiently the resources should be utilized. It can be said that the higher the productivity, the better the performance of the bank will be. In banks branches, employees etc form the basis for measuring productivity. Due to non-availability of exact data related to branches, only employees are taken as base for measuring productivity efficiency of banks in the present study. The results related to productivity parameters are depicted in Tables 3 and 4.

Table 3: Growth in productivity parameters (in percentage) period - 1991-92 to 2003-04

Banks	ROA	BPE	PPE	T.Average
Al.B	0.61	127.50	0.71	128.82
AB	0.92	146.66	1.42	149.00
BOB	0.86	172.48	1.381	74.72
BOI	0.77	166.20	1.02	167.99
BOM	0.61	148.52	0.82	149.95
CB	0.73	173.44	1.12	175.29
CBI	0.50	113.59	0.51	114.60
Co.B	1.64	231.85	2.72	236.21
DB	0.57	173.24	0.73	174.54
IB	0.25	129.33	0.36	129.94
IOB	0.58	143.52	0.79	144.89
OBC	1.26	245.40	2.34	249.00
PSB	0.31	144.31	0.28	144.90
PNB	0.88	133.41	0.92	135.21
SB	0.92	126.44	0.79	128.15
UCOB	0.04	118.25	0.34	118.63
UBI	0.77	170.74	1.13	172.64
UBOI	0.45	113.34	0.57	114.36
VB	0.71	132.78	1.00	134.49
SBB&J	1.02	103.24	1.32	105.58
SBH	0.93	152.76	1.33	155.02
SBI	0.77	132.40	0.97	134.14
SBIn	1.03	132.55	2.02	135.60
SBM	0.74	102.57	0.99	104.30
SBP	1.23	160.74	1.62	163.59
SBS	1.09	121.56	1.10	123.75
SBT	0.69	151.40	0.91	153.00

Table 4: Ranking of public sector banks on the basis of acgr of productivity parameters (in percentage) period- 1991-92 to 2003-04

Banks	ROA	BPE	PPE	T. Average
Al.B	19.50	20.00	22.00	20.50
AB	8.50	12.00	5.00	8.50
BOB	11.00	5.00	6.00	7.33
BOI	13.50	7.00	12.00	10.83
BOM	19.50	11.00	18.00	16.17
CB	16.00	3.00	10.00	9.67
CBI	23.00	24.00	24.00	23.67
Co.B	1.00	2.00	1.00	1.33
DB	22.00	4.00	21.00	15.67
IB	26.00	19.00	25.00	23.33
IOB	21.00	14.00	19.50	18.17
OBC	2.00	1.00	2.00	1.67
PSB	25.00	13.00	27.00	21.67
PNB	10.00	15.00	16.00	13.67
SB	8.50	21.00	19.50	16.33
UCOB	27.00	23.00	26.00	25.33
UBI	13.50	6.00	9.00	9.50
UBOI	24.00	25.00	23.00	24.00
VB	17.00	16.00	13.00	15.33
SBB&J	6.00	26.00	8.00	13.33
SBH	7.00	9.00	7.00	7.67
SB	I13.50	18.00	15.00	15.50
SBIn	5.00	17.00	3.00	8.33
SBM	15.00	27.00	14.00	18.67
SBP	3.00	8.00	4.00	5.00
SBS	4.00	22.00	11.00	12.33
SBT	18.00	10.00	17.00	15.00

Tables 3 and 4 reveal the growth of *Return on Assets* which ranges from 0.04 per cent to 1.64 per cent. The growth of Corporation Bank is higher with 1.64 per cent and lower in case of UCO Bank with 0.04 per cent.

The growth of *business per employee* is higher in the case of Oriental Bank of Commerce with 245.4 per cent and lower in case of State Bank of Mysore with 102.57 per cent growth.

The *profit per employee* rank higher with 2.72 per cent growth in case of Corporation Bank and lower with 0.28 per cent growth in case of Punjab and Sind Bank.

Conclusion

Operational and Productivity parameters are of

major concern for measuring the performance of public sector banks in India. After liberalization the performance of public sector banks has improved a lot and they have become more innovative and have the largest market share in today's competitive era. This study proves that Corporation Bank ranks higher in operational and productivity parameters, which results in higher efficiency. Indian Bank in operational parameters and United Commercial Bank in case of productivity parameters rank lower, and hence, prove inefficient. Thus the inefficient banks have to concentrate on utilization of funds (by emphasizing on Real Time Gross Settlement system) in order to improve operational and productivity efficiency of their banks. In order to improve their position further the public sector banks need to greatly improve efficiency through introduction of computer i.e. electronic banking technology, improved management skills and through consolidation and mergers of banks. They should try to reach the International Standards of Capital Adequacy.

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Humor is a serious thing. I like to think of it as one of our greatest, earliest natural resources, which must be preserved at all costs.

– James Thurber

Feature

Determinants of Managerial Effectiveness through IT

V. Nanda Mohan & V. Ajaya Kumar

This study has identified the factors determining the success of the development of IT-enabled management systems. Managerial strength of the firm, expertise available in computer areas, whether the information architecture had been designed before software development was started, the number of hierarchical levels in the organisation etc, are the important factors identified. Factors relevant to different types of organisations are also found out separately. Manufacturing firms are only at the initial stages of development of IT-enabled management systems. Private organisations are ahead of others in exploiting IT.

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IT-enabling and automation are not synonyms. In automation, the labour-intensive part of the old business process is replaced by computers, but the business process as a whole is reformed in the IT-enabling process. Though technology is an integral part of the new process, the process is more decisive than the technology in determining the success of IT enabling. IT enabling is superior to automation, because of its capability to provide the benefits of the new process along with that of automation. Managerial capability of the firm plays a very significant role in the development of the new business process.

Automated systems have to be effectively integrated for retrieving information for tactical decision making at the middle levels and strategic management at the top level. Lack of integration prima face reveals underutilization of resources. The ineffective use of IT not only incurs opportunity costs, but also creates new problems due to the underutilization of imported technology. Identification of factors determining the effective use of computers for managerial decision-making is relevant in this context.

Approach

The success of IT-enabled management depends very much on the effectiveness of conversion of the firm from manual to IT-enabled. Development of a new system which can effectively tap the potential of the new computer technology is an important pre-requisite for successful IT-enabling. The strength of the firm in IT and Management areas is evaluated as part of this study. It is measured in terms of the computer infrastructure, number of IT and management professionals whose services are available etc. The data needed for the study were collected from Indian organisations, which have undergone IT-enabling during the late 1990s and early 2000s. Data on the performance of the firm before computerization and after computerization (each covering

three years) were analysed. The study covered both manufacturing and service sector firms. Though the survey covered a large number of firms, only 39 of them gave almost all the relevant data needed for the study. Twenty factors influencing the success of conversion of the firm into an IT-enabled one have been identified. Composite indices of performance have been developed using the responses from the firms. The correlation of conversion effectiveness index with managerial effectiveness measured in terms of profit margin (as a percentage of capital) has been found out. The most significant of the variables considered for calculating composite indices have been found out using regression analysis.

In the second phase of the study, the IT-related factors influencing the managerial effectiveness in each category of firms (viz. manufacturing, service etc.) are identified using regression analysis. The factors relevant in the case of private and public sector firms also are identified separately.

Composite indices method

Two types of composite indices were found out based on the responses. These are called G-Score and Conversion score. These indices provide the basis for detailed analyses discussed in the ensuing sections.

G-Score

Responses of firms were classified as infrastructural, software-related, personnel, managerial and transformational. Each one was further divided into sub-constituent variables as discussed below.

The hardware facilities, network infrastructure, uptime index of the systems and government policies form the first group called *infrastructural*. The sum of the scores obtained in these areas is called *infra score.* Information architecture, effective computer expertise, software index and adequacy of appropriate software are grouped under the head, *software*. Whether the design of the information architecture had been completed well before the commencement of software development was considered. Similarly, if the software procured by the firm is not appropriate to its requirements, the IT strength of the firm will be poor even when the software index of the firm is high. Adequacy of appropriate software is included as a study variable to consider this aspect of the system. The attitude of employees, nature of training given to managers, expertise in both computer and management areas and the degree to which managers resort to general automated solutions are components of the category, *personnel.*

Usage of specific management software for financial analyses, market research etc., effective management expertise available in the organisation, authority of computer professionals and the urgency of the IT solutions are study variables included in the fourth group. The variable degree to which managers resort to general automated solutions is different from usage of specific management software in the sense that the former refers to general use of computer systems by managers, but the latter is related to usage of specific management software for market research, financial analysis etc. The authority of the computer professionals depends on the hierarchical level in the organisation where he/she is placed. Since salary is an index of such a level, the salary difference with reference to the highest paid manager is assumed as a measure of authority. *Management score* is computed by adding together values obtained for the four variables listed above. The transformational aspect covers the organisational changes required, the nature of digital connectivity of the firm to the external world, degree of diffusion of technology into the firm and percentage of revenues from the new IT-based services or products etc. *G-score* is found out by adding together infra score, software score, personnel score, management score and transformational score.

Of these, hardware facilities, network infrastructure, uptime index of the systems, software architecture, authority of computer professionals, organisational levels and the new IT-based services are study variables comparable to factors considered in the study Kanungo (1999).

Conversion Effectiveness Score

The second index is based on the effectiveness with which the conversion has taken place in the organisation. Twenty components have been hypothesized as having influence on the performance of the IT-backed firm.

- hardware employed
  technical environment
- knowledge about hardware
- concern about system architecture
- quality of the IT staff
- awareness of general management software
- knowledge about the design of application software
- qualification of users excluding management and computer staff
- quality of managing staff

- presence of a project leader
- general use by managers
- use by senior managers
- profile of professional team
- user involvement
- nature of organisation levels
- organisational preparedness
- urgency of the solution
- easiness to change the organisation
- threat to existing personnel

Of these components ten are the same as those considered in the study by Peter Weill (1990). Hardware employed, concern about system architecture, awareness of management software, awareness of application development tools, knowledge about the design of application software, quality of management staff, organisational preparedness, nature of organization (levels), general use of computers by managers and use by senior managers, are components added in this study.

Variables of composite indices—a comparison

Of the 20 variables considered for the calculation of conversion score index, ten are comparable with those used for computing G-score index. These ten variables are hardware employed, knowledge about hardware, technical environment, concern about system architecture, quality of the IT staff, quality of managing staff, general use by managers, urgency of the solution, nature of organisation-hierarchical levels, threat to existing personnel etc.

In G-score analysis care has been taken to include equal number of study variables from each of the areas viz. infrastructural, software, personnel, managerial and transformational. But managerial and computer-related variables are given slightly more importance in the analysis of conversion index. Majority of the variables included in the conversion score analysis belong to three categories viz. managerial, IT-related and organisational. There are seven variables related to management aspects when the IT-related variables are six. The number of organisational variables is five and hardware-related is two. The values of the different indices are shown in Table 1.

Correlation studies

The firms have been ranked based on the composite indices, conversion score and g-score. The coefficients of rank correlation also have been found out. The coefficient of rank correlation between conversion score and g-score is 0.931. Also the correlation between conversion score and profit margin (as a percentage of investment) has been found out to be 0.91.

Table 1: Composite Indices—a comparison

Firm No.	G-Score sum	Conversion score sum
1.	15.909	14.4825
2.	17.511	16.6966
3.	6.278	6.3083
4.	23.423	18.6494
5.	10.575	9.6251
6.	17.587	18.3000
7.	12.943	15.5655
8.	14.939	12.5244
9.	9.083	8.7352
10.	9.615	8.0251
11.	7.265	7.8974
12.	12.849	10.9385
13.	12.601	10.2198
14.	15.960	13.0789
15.	9.339	9.6122
16.	13.392	17.0368
17.	15.817	13.2738
18.	7.605	8.8840
19.	7.572	8.8160
21.	14.951	15.2769
22.	20.007	19.1352
23.	8.225	6.7742
24.	13.517	13.9546
25.	5.418	6.1598
26.	6.336	8.6632
27.	26.307	24.2514
28.	14.424	14.7372
29.	21.800	20.7463
30.	20.792	17.6317
31.	15.626	13.0413
32.	18.389	17.3371
33.	7.802	9.4540
34.	9.196	9.4217
35.	25.697	22.6118
36.	13.098	11.3007
37.	6.081	7.2906
38.	21.500	20.7463
39.	11.705	10.6152
40.	13.014	11.9475

Assessment of relative importance

A close examination of the indices mentioned in previous sections and an assessment of the relative importance of the variables used for calculating these indices are done in the following sections. Conversion effectiveness index and G-score index were calculated based on twenty variables each. A regression analysis considering all the firms has shown that ten out of the twenty variables considered for calculating G-score index explain more than 98 per cent of the phenomena represented by the index. Similarly thirteen out of twenty variables of the conversion effectiveness index are found to explain 90 per cent of the phenomena.

Variables found significant in different methods

Hardware facilities, concern about the design of information architecture, quality of IT professionals, quality of management staff, general use of computers by managers, awareness about management software and flexibility of organisation to induct experts from outside are the variables found significant in both cases. Of these seven variables, hardware facilities, concern about design of information architecture and quality of IT professional are the variables of technical nature. Three of the other four variables are management-related.

IT-related factors: The study identified seven factors, which had influence on the performance of IT-enabled firms. The management-related variables are explained in later sections. This section explains the IT-related variables viz. concern about design of information architecture, quality of computer professionals and hardware facilities.

Concern about design of information architecture: This is an important factor, which determines the quality of IT-enabled systems. Identification of the information requirements of the firm in the next decade and planning based on those requirements have to be completed before starting the work on the plan. The capability of the designer to perceive future requirements of the firm and the vision of the top management to foresee the future play a crucial role in the design of the information architecture.

The need to change the structure of the database, in order to provide room for any new data or to retrieve any new information, is to be viewed as a major drawback of the design. Organisations attempting to automate office procedures section by section without designing information architecture may have to change the structure of databases too frequently. Concern about design of information architecture has been found out to be an important variable explaining both conversion effectiveness index and G-score index.

Table 2: Summary of Study Variables

Sr.No.	Variables in G-score study		Variables in conversion effectiveness study
1.	Hardware employ	√	Hardware employed
2.	Uptime index	P	Technical environment
3.	Funds & Policies		
4.	Network infrastructure		
5.	Information Architecture.	√	Concern about system design
6.	Effective Computer Expertise	[P]	Quality of IT Staff
7.	Software Index		
8.	Appropriate software		
9.	Attitude of Employees	[P]	Attitude of employees
10.	Nature of Training		
11.	Computer & management qualifications		
12.	Degree of use of automated solutions by managers	√	General use by managers
13.	Usage of Management s/w		
14.	Effective Expertise of Managers	√	Quality of managerial staff
15.	Authority or Computer professionals		
16.	Urgency of IT solutions	P	Urgency of the solution
17.	Organizational levels	√	Organizational level
18.	Nature of digital connectivity		
19.	Knowledge about technology	[P]	Knowledge of Hardware features
20.	Products based on IT		
		√	General management software
		P	General Qualifications
		[P]	Presence of project leader
		√	Use by senior managers
		P	User Involvement
		√	Organizational preparedness
		[P]	Easiness to change
		P	Profile of Professional team
		√	Knowledge about Application tools
		√	Knowlege about design

√ Conversion effectiveness factors added in this study.
Factors found significant in relative analysis

P Used by Peter Weill

[P] Used by Peter Weill—found significant in this study also

Table 3: t-values in Regression Analysis (Profit as Dependent Variable)

Study Variable	Manu.		Service		Public		Private		All	
	t	Sig	t	Sig	t	Sig	t	Sig	t	Sig
Appropriate software	3.9	0.001								
Computer Expertise	5.6	0.000	4.1	0.001			3.1	0.007		
Knowledge about Application tool	2.4	0.029	2.78	0.013	1.98	0.066	2.7	0.016	4.5	.000
Conversion score					1.8	0.091	3.5	0.003		
After sales support							1.9	0.077		
Nature of Organisation levels							2.0	0.057	1.93	.061
Organisational preparedness					4.4	0.000				
Level of Expertise									5.33	.000

IT expertise: The IT expertise available in the firm is a very important variable influencing the success of IT-enabling process. The contribution of IT-personnel is relevant right from the conception stage to the commissioning of the project. As the knowledge component of the IT-enabled system is more important than any hardware infrastructure, the capability of the IT personnel to impart knowledge assumes more importance. The process of procuring tools and training the existing employees on the tools form only a part of the IT enabling process. A considerable portion of the knowledge, the system requires, has to be internally developed for which IT expertise is essential. Even for procuring the right kind of tool and giving the right type of training, proper IT expertise is indispensable.

Hardware facilities: Hardware is essential for any IT enabling process. Examination of the variables of both conversion effectiveness analysis and G-score analysis has shown that the variable, hardware facilities, is significant in all types of firms. Firms that are not able to invest properly on hardware will not be able to benefit from IT.

Management-related factors: IT enabling, as the name implies, is a techno-centric process. But management factors play a crucial role in determining the success of IT enabling. Quality of management staff, general use by managers and awareness about management software are the management-related variables found significant in both methods. Organisations generally attach too much importance on the generation of the technology. In fact management of technology is more important than technology itself.

Quality of management staff: Quality and expertise of the management personnel especially at the top level is a very important variable influencing the performance of IT-enabled organisations. Since this variable has a decisive role in determining other significant variables like hardware facilities, quality of IT expertise etc. also, any compromise on ensuring quality and expertise of management staff will drastically bring down the performance of IT-enabled firms.

Awareness of general management software: Since in-house development of management software may not be cost-effective, managers have to be aware of the availability and potential of each type of management software in the market. Analysis of conversion effectiveness variables has shown that awareness about management software is significant in the case of service and public sector firms. A similar analysis of G-score variables has also indicated that use of management software is a significant variable determining the value of G-score for all types firms.

Organisational factor: Organisations with too many hierarchical levels and restrictions for direct appointments at higher levels find it difficult to get the managerial and computer expertise needed for the IT enabling process. An analysis of G-score variables showed that this factor is statistically significant in all types of organisations except those in the public sector. The analysis of conversion effectiveness variables has shown that this factor is significant in manufacturing firms and public sector firms.

Regression runs

Regression analysis has been used to find out the determinants of performance of firms. In the first phase, responses from all the 39 firms were included for analysis. Knowledge about application software tools, nature of organisational levels and level of expertise are found to be significant with an adjusted R square value of 71.3 per cent and F value of 32.543.

Table 4: F Values in Regression analysis (Profit as Dependent Variable)

Type of firm	Adjusted R	F
Manufacturing	0.819	28.0
Service	0.734	18.4
Private	0.844	21.6
Public	0.763	20.3
All	0.713	32.5

In the second phase of analysis, the firms are classified based on the nature of business as manufacturing and service organisations. Initially, nineteen firms of the former category have been considered for study. The variables found to have significance are expertise in computer area, knowledge about application tools and availability of application software. The first variable is found to be significant at zero per cent level and the second at 2.9 per cent. Availability of application software is found to be significant at 0.1 per cent levels. The adjusted *R* square and *F* values are .819 and 28.094 showing that these variables explain the phenomenon at a reasonably good level (Table 3 and Table 4).

The analysis of data from twenty organisations in the service sector was also carried out. Computer expertise and knowledge about application tools have been found to be significant in the service sector. The significance levels of these variables are 0.1 per cent and 1.3 per cent respectively. The adjusted *R* square and *F* values are 0.734 and 18.468 respectively.

In the third phase of regression, the firms are classified into private sector and public sector. Twenty private sector firms are included in this study. The effectiveness of conversion is found to have influence on performance at 0.3 per cent significant level. Expertise in computer field, knowledge about application tools, nature of organisation levels and after sales support are the other variables found to have influence on the dependent variable, profit, at significance levels, 0.7 per cent, 1.6 per cent, 5.7 per cent and 7.7 per cent respectively. The value of adjusted *R* square is .844 and F is 21.604.

Based on the regression analysis of the public sector firms, knowledge about application tools, conversion score and organisational preparedness are the variables found to influence the performance, the significance levels being 6.6 per cent, 9.1 per cent zero per cent respectively. The comparatively lower values of adjusted R-square (0.763) and F (20.314) show that the phenomenon is not as much explained as in the case of private sector firms. Table 3 gives the t-values and the significant levels of each of the study variables. Table 4 gives adjusted R square and F values corresponding to each type of organisation. When such variables as expertise in computer field, after sales support and organisational levels are found to have significant influence on the performance of private sector firms, these variables are found to have no significance at all in public sector firms.

Important findings

Design of the information system architecture: This study could identify that design of the information system architecture is an important pre-requisite for the development of IT-enabled management systems. Since the information architecture is designed not only for providing solutions to the present business problems, but for the anticipated ones also, it is the most important phase of the IT-enabling process.

Organisational hierarchy: IT enabling provides a new organisation with new procedures, rules and style of management. The rigid organisations having too many hierarchical levels, as seen in Government and public sector organisations, may provide stiff resistance to the much-needed business process redesign for successful IT-enabling.

Quality of computer professionals is decisive: As described earlier the quality of the IT staff is another major factor found to have a significant influence on the performance of different types of firms. The quality and effectiveness of the IT solution is in a way the quality of the IT staff itself.

Manufacturing firms are at the initial stages of IT enabling: A variable, which has been found to influence the performance of manufacturing firms, is the non-availability/non-affordability of application software suitable for each functional are of management (Table 3). Since variables such as non-availability of appropriate software, knowledge about application tools and computer expertise are found significant, it can be concluded that most of the Indian manufacturing firms are at the initial stages of employing IT in management. Existing discriminated technology policies in terms of taxes and customs duties towards manufacturing units, as compared to R&D activities, has got a negative impact on application of IT in manufacturing sector. The finding in this study that manufacturing firms lag behind service firms in respect to IT-enabled transformation, may be viewed in the light of Government policies to provide IT infrastructure which are more beneficial to service firms in general and those offering IT and ITES in particular.

Knowledge about the potential of software tools: Senior executives should have knowledge about the potential of all software tools available for managerial use. Also, they can get the best out of computer professionals in their firm, only if they are aware of the software architecture developed for the firm. Senior executives need not get trained on all office automation tools. Instead, this type of training should be made mandatory for all new generation office assistants.

Effective conversion in private sector: The type of organisation (whether private or public sector) has been found a variable of high level of significance.

Resistance from employees not significant: Resistance from employees has been often cited as the major reason for the difficulty or delay for the development of IT-enabled systems in our organisations. Even though it is true that development of IT-enabled management will not be successful in the absence of required co-operation and support from the side of employees, the blame for the non-development of such systems cannot be put entirely on them.

Conclusion

IT-enabled management methods have been in use for many years. But IT-enabling of management functions in India is yet to gain momentum. Lack of scientific management methods and design of initial transaction systems with less planning content are the common problems. This study has identified some of the important factors determining the success of IT-enabling of management. Managerial strength of the firm, expertise available in computer areas, whether the information architecture had been designed before software development was started, the number of hierarchical levels in the organisation etc. are the important factors identified. Factors relevant to different types of organisations are also found out separately. It was found out that manufacturing firms are only at the initial stages of development of IT-enabled management systems, whereas service firms are comparatively better off. Non-availability of appropriate application software at affordable rates is one of the major problems manufacturing firms face. As hierarchical levels are not so rigid and induction of experts at top levels is comparatively easier, private organisations are ahead of others in exploiting IT. But in this group also, the number of successful firms are very limited. The composite indices calculated on the basis of study variables have been found to have very good correlation with the managerial effectiveness measured in terms of profit.

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People want a version of McDonald's for their own class.

– Eric Garcetti

Feature

Downsizing in India: Advocating an Employee-friendly Approach to Implementation

Sanghamitra Bhattacharyya & Leena Chatterjee

Downsizing as a change initiative has gained a lot of popularity among organisations today for improving their performance. The present study attempts to understand the process of implementation of downsizing among Indian organisations, from the perspective of the individual implementer. The findings provided valuable insights into how Indian managers in different industries were approaching their task as implementers, their convictions regarding the downsizing decisions, their methods of dealing with affected employees, lessons learnt from the experience and their overall reactions to the process.

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In order to cope with the rapid changes taking place in the business environment today, organisations all over the world are being forced to take recourse to various survival exercises such as restructuring, layoffs, downsizing, rightsizing, delayering etc. Of all such initiatives, the practice of 'downsizing' appears to have attained maximum popularity, and has become a favoured strategy of companies attempting to survive in the changed scenario (Mishra and Spreitzer, 1998).

While the practice of downsizing is not new in India, the earlier efforts were more scattered and unplanned, undertaken more as a response to some major survival crisis. It is only in recent years, perhaps following the example of its prevalence in the West, that this practice has started to gain popularity among Indian organisations, as a strategy for improving their effectiveness. As a result, since the early 1990s, a large number of Indian organisations including banks, multinationals, public sector units and private undertakings have started implementing downsizing initiatives.

While various scholars have come up with varying definitions of downsizing (e.g. Cameron, Freeman & Mishra, 1991; Cascio, 1993; Shaw & Barrett-Power, 1997; Nelson & Burke, 1998), most of them seem to agree that in principle, downsizing would primarily involve a reduction of headcount in an organisation's workforce (Mentzer, 1996). However, looking at downsizing merely as a means of reducing headcount might prove to be a short-term approach, since such an approach has the potential to give rise to enormous negative consequences on the individual employee and the organisation as a whole (Cascio, 1993).

The increasing regularity with which organisations are going in for downsizing initiatives, and the negative consequences that could arise if such an exercise is not

properly managed, makes the study of downsizing extremely relevant in today's context. In a country like India, already staggering under the burden of high unemployment and underemployment, and without any well-defined social security system in place, the social and economic implications of adding to the unemployed numbers through these headcount-reduction exercises can be extremely grave.

Importance of implementation

Downsizing has now come to be accepted as an inevitable reality in organisations, rather than one among many available options to be considered. Hence, the important question today is not so much whether or not to downsize as how best to do it in a way which will help an organisation to reap long-term and sustainable benefits (Mishra, Spreitzer & Mishra, 1998). Keeping in mind the expectations that organisations have from a downsizing exercise, the issue of properly managing the process of implementation of downsizing in an effort to reduce its negative consequences assumes a great deal of importance. Once the overall decision to downsize has been taken by the organisation, the responsibility for actual execution of this decision rests with the implementers. Scholars have suggested that the way is which the downsizing implementation is handled by the implementers, and the approaches he/she adopts, might significantly affect the success or failure of any downsizing initiative (Labib & Applebaum, 1993; Mishra et al, 1998; Krishnan & Park, 1998).

Research design

Given this background, a research study was conducted among 100 implementers in India who had been directly involved in implementing downsizing initiatives in their organisations. These implementers were drawn from seven large, professionally run organisations in various locations in India, belonging to both the public and private sectors, involved in both manufacturing and service industries. The organisations in the public sector included two nationalized banks and one integrated steel plant; those belonging to the private sector included an integrated steel plant, two automotive majors, and a hotel chain.

The study aimed to understand the process by which downsizing was implemented in a sample of Indian organisations, from the point of view of the individual implementer, in terms of the approaches he/she adopts during the implementation process. The study helped to identify various issues relating to implementation practices being followed by Indian organisations while downsizing. The findings of the study are presented in the subsequent sections. Based on these empirical findings, as well as evidences from existing literature, certain desirable practices for implementation have been suggested in this paper. Moreover, the implications of these findings for managers and change agents in Indian organisations have also been discussed. It is expected that these suggestions might be helpful to academicians and practitioners alike in addressing the issue of implementation of a sensitive exercise like downsizing.

For all the organisations in the sample, downsizing was done either through VRS (Voluntary Separation Scheme) or ESS (Early Separation Scheme), implying that at least on paper, the employees were offered the choice of leaving, rather than being asked to leave by the organisation. In some cases, however, the actual findings indicated otherwise.

Issues related to the implementation process

In the initiation of change management exercise, the first step involves identifying the rationale for change, and deciding which change strategy to adopt in the circumstances. The next step would involve planning the details of the process, such as deciding on the criteria for reducing manpower, designing separation packages, communication strategies to be employed, training and other employability initiatives to be initiated etc.

Rationale for downsizing

Most organisations appear to downsize mainly as a reaction to market forces/government directives/ deteriorting performance.

In this study, it was found that for public sector organisations, directives from the government to reduce manpower and cut costs provided the 'motivation' to downsize. For the automotive sector, the impetus for downsizing was provided by increased competition, falling market share and financial losses. Only one among the seven organisations studied appeared to have taken up its downsizing initiative while at the peak of its performance, as a means of facilitating flexibility, change implementation and turnaround, which was being hindered by its huge manpower.

Planning/preparedness for downsizing

By and large, Indian organisations appear to have approached the issue of downsizing in an ad hoc manner, without proper prior planning as to the procedural details.

In the present study, only one organisation (an automotive company) had adopted a planned and systematic approach to downsizing. Prior to launching their VRS, a team of managers was sent to other organisations that had already downsized, to learn from their experiences and mistakes. Another group of managers were given training to act as VRS counsellors. Around six months of planned effort went into this downsizing exercise. For all the other organisations, there appeared to have been no prior planning or training given to implementers to handle the implementation process.

Criteria for manpower reduction

Age and tenure are the normally used criteria for reducing manpower in organisations.

In this study, it was found that the main criteria for reducing manpower were age and tenure. However, some informal efforts were made by the implementers, especially in the manufacturing sectors, to motivate and encourage non-performers in the targeted categories to apply for VRS and leave.

Voluntary departures versus coercion employed

Officially, organisations claimed that their manpower reductions were through voluntary separations; however, when the need arose, organisations took recourse to 'counseling' and sometimes even coercion to force certain employees to opt for VRS.

In the present study, all organisations claimed officially that the separations had been voluntary. However in reality, the implementers admitted having had to resort to counseling and sometimes even coercions to reduce manpower to the targeted level. Here too, the opinions voiced by the HR personnel and line managers differed. While HR managers in the public sector organisations claimed that the VRS was purely voluntary, line managers reported that a considerable amount of coercion, counseling and motivation had to be used to 'induce' employees, especially the poor performers, to leave. In the private sector however, both the HR personnel and line managers claimed that a considerable amount of coercion and force, and at times, even threats, had to be resorted to.

Main focus of separation package: monetary/ non-monetary

Despite suggestions in literature, organisations continue to focus primarily on the financial (monetary) component while designing the separation package for VRS employees. Some organisations, however, showed initiatives in offering some non-monetary benefits, in addition to the financial package offered.

It was found that for all organisations, the main focus of the separation packages was monetary. In terms of non-monetary compensations, the private sector organisations adopted other employability initiatives such as training, or outsourcing internal activities on a contract basis to downsized employees. These measures, in addition to the lump sum money offered, helped employees to plan out and take up alternative careers, and get resettled in life. In the public sector, however, no such employability initiatives were planned for. Nonetheless, on a personal level, most implementers, with the exception of those in the banking sector, claimed to have helped a few downsized employees to get employment elsewhere, through their personal contacts in the industry.

Communication with employees during implementation

By and large, organisations do appreciate the need to have extensive communication with their employees throughout the process of downsizing.

In the present study, most of the organisations claimed to have held extensive communications with the employees, including both 'survivors' and 'victims', throughout the process of downsizing.

Specific employability initiatives taken by organisations

Some organisations have taken initiatives in offering employability opportunities to employees to enable them to take up alternative careers after VRS.

As already mentioned, private sector organisations had undertaken employability initiatives to benefit the affected employees. In one organisation, as a part of the ESS (Early Separation Scheme) package, substantial efforts were made for workers in terms of improving the employability of their dependant wards, as well as providing the employees themselves with a number of post-downsizing benefits (housing, continuing medical welfare etc). Using its own funds, the organisation had trained dependants of employees in a variety of skills, so that in the future, if needed, it could employ them. Even if the trained wards joined some other organisation, it would have been a social responsibility discharged by the organisation. Moreover, some outplacement services were made available for downsized officers. In another organisation, downsized employees were given training in alternative skills as well as substantial help in setting up businesses of their own, often as ancillaries to the parent organisation. Yet another company made some outplacement services

available to the downsized workers, but because this service was held only once and at a neutral venue outside the plant premises, it was felt that this was merely an exercise in public relations on the part of the organisation. Finally, as discussed earlier, in most of the organisations, implementers claimed to have informally helped some downsized colleagues to get employment elsewhere.

Extent of delegation of responsibility

By and large, organisations delegate implementation responsibility among middle and senior managers, both among line and staff functions.

In the present study, except in the banking sector, there appears to have been wide delegation of implementation responsibility among the middle and senior managers.

Learnings from the experience

Organisations have tried to learn from their first experience in terms of managing the subsequent downsizing exercises in a more planned and proactive manner.

It was found that based on their learnings from the downsizing experiences, most organisations have taken initiatives to change their way of functioning. They have attempted to bring about changes in their performance appraisal systems, introduced large-scale mechanizations, and are trying to project a more proactive and customer-friendly image in the market to survive and grow. In addition, some organisations have arranged for training for surviving employees to enable them to cope with their increased workload as a consequence of reduction in manpower. Other organisations have relied on on-the-job practice for their employees to get trained in their additional jobs.

Future downsizing planned

Most of the organisations appear to have either planned for further rounds of downsizing or expect to have additional manpower reductions in the future.

Issues related to the implementers

Literature has established the importance of the role of the change agent in successfully managing a change initiative. The current study brought out a number of relevant issues pertaining to the attitudes, convictions and approaches of the implementers. These are discussed below:

Conviction regarding need for downsizing

Research has suggested that it would be important for the implementers themselves to be convinced about the rationale for downsizing, in order to be committed to the exercise and to persuade other employees.

In this study, by and large, most of the implementers appeared to have been convinced about the need for downsizing per se. However, there appeared to be a lot of cynicism among them regarding the criteria (viz. age and tenure, rather than performance) adopted for downsizing, and the efficacy of such a criteria.

Implementers' perceptions about organisation's achievement against expected benefits from downsizing

Implementers' perceptions appeared to have been mixed about whether the stated aim of downsizing had been achieved. For example, among the banks, it was felt that this aim was only partly achieved, since, apart from counseling and motivation, no other coercion could be used to force a non-performing employee to leave the organisation. In the manufacturing sector, there were differences of opinion voiced by HR personnel and line managers. While the HR personnel claimed that the aim had been achieved, line managers sounded more skeptical about the final outcomes. In their opinion, reducing manpower based on non-performance rather than age and criteria could have helped in achieving the aim.

Perceptions regarding performance evaluation methods prevalent in organisations

In all the organisations, there was a feeling of dissatisfaction among the implementers with regard to the performance appraisal systems for managers currently in place. Most of them felt that the existing criteria for evaluating performance were too subjective and dependant on the perceptions of senior managers. In fact, one organisation claimed that lack of an effective performance evaluation system which would yield objective, legally acceptable ratings of performance was one reason for choosing age and tenure as the criteria for downsizing, rather than inefficiency and poor performance.

Awareness regarding psychological contract issues

The concept of 'psychological contract' is defined as "an individual's belief in mutual obligations between that person and another party, such as an employer"

(Rousseau & Tijoriwala, 1998). The increasing job insecurity among the workforce on account of the continuing popularity of downsizing has necessitated a drastic revision in the psychological contract between an employee and his employer. Earlier, this psychological contract was based on providing job security and lifetime employment to the employee in return for his/her hard work and loyalty to the organisation. Today, downsizing is perceived to be resulting in a violation of the psychological contract (Cascio, 1993; Rousseau, 1996; Turnley & Feldman, 1998; Singh, 1998), leading to a host of negative psychological and behavioural consequences for the employees. Hence, an organisation, while downsizing, needs to ensure a renegotiation of this psychological contract with its employees (Singh, 1988), perhaps in terms of ensuring an employee's employability in lieu of job security.

The present study revealed that among the public sector organisations, there appeared to be no awareness of the concept of "psychological contract". In fact, on being explained the concept, the general feeling among implementers was that any violation of expectations which might have occurred were suffered by the organisation, since it was the employees, especially the better performers, who had let down the organisation by opting for VRS. The HR personnel and managers in the private sector organisations however, appeared to be aware of this concept, and agreed that since the organisation had so long been taking care of its employees and looking after their welfare, it was a shock to the employees to perceive the drastic change in attitude, and felt that employees were justified in feeling let down and violated. They further agreed that since the organisation was now unable to provide job security to its employees, it was imperative that it took initiatives to provide employees with employability through alternative training and institutionally-provided support mechanisms to enable them to relocate to another career.

Implementers' feelings regarding their experience of downsizing

Evidence from literature suggests that implementers are likely to suffer feelings of guilt and trauma following a downsizing experience (Kets be Vries et al, 1997). In this study, however, findings were mixed in this respect.

None of the implementers in the banking sector claimed to have felt any guilt or trauma for having downsized employees, because it was predominantly voluntary, and even where some amount of coercion and counseling was required, it was perceived to be just a part of their jobs. In one of the banks, the existing atmosphere of job insecurity was seen as positive by most implementers, in terms of serving as a warning to habitual slackers. In the other bank, there was a general feeling of apathy and indifference regarding the exercise.

In the steel sector too, implementers by and large claimed to have felt no guilt or trauma following the exercise, since the separation package was considered to be very lucrative to the departing employee.

In the automotive sector, implementers appeared to have experienced mixed feelings about this issue. While initially, most implementers claimed to have felt traumatized and guilty for having had to downsize long-term colleagues and subordinates, they finally claimed to have got over whatever initial guilt feelings they might have experienced, by rationalizing within themselves that they had merely carried out a necessary job. They also felt that the lucrative monetary compensations offered through the VRS was adequate compensation for the job loss.

Hence, it appeared that the quantum of monetary compensation served as a reasonable justification for implementers to rationalize whatever negative feelings they might have had during the process.

Overall, while HR personnel claim to have felt no guilt or trauma about having to downsize employees, managers at the plant level admitted to feeling guilty and traumatized by the process.

Implementers' perceptions about employee response

Findings from literature have shown that most employees affected by a downsizing initiative are likely to suffer from negative feelings of dissatisfaction, low morale, lack of commitment, heightened stress etc. (Brockner, 1988).

In this study, the implementers' perception of employees' feelings supported the above findings. By and large, employees of all organisations were perceived to have been suffering from lowered morale, dissatisfaction and ill-feelings towards the organization subsequent to downsizing. However, employees from the private sector organisations appeared to be under greater stress on account of job insecurity and uncertainty, while public sector employees, felt comparatively more secure.

Implications for managers

Downsizing is a type of change management activity (Lewis, 2000) involving individuals i.e. human

resources, of the organisation (Cameron et al, 1991; Kets de Vries & Balazs, 1997; Applebaum, 1996). Therefore the process of downsizing needs to be managed sensitively to minimize its negative fallouts. Based on the findings from the present study, and comparisons with some prescribed 'best practices' advocated in downsizing literature, a few suggestions for adopting employee-friendly implementation practices are outlined below. It is hoped that these might benefit managers and scholars who would be either directly or indirectly associated with implementing a downsizing exercise or handling change interventions.

- **Rationale for downsizing:** Existing literature strongly advocates that downsizing initiatives should be a proactive strategy rather than a 'knee-jerk' reaction to financial losses (Kets de Vries et al, 1997; Freeman, 1999). A majority of the organisations in the study have taken their decision to downsize in a reactive manner, in response to some business downturns. It is proposed, however, that downsizing exercises need to be taken up not as a reaction to losses or fall in performance, but as a proactive strategy to cope with the challenges of the future. This would also provide organisations with sufficient time to lay the groundwork for such an exercise by communicating with their employees and understanding their expectations while planning out the implementation details.
- **Planned approach to downsizing:** Downsizing needs to be taken up as a planned exercise, in terms of trying to learn from others' experiences, planning out the details of the employability initiatives, training the implementers, and arranging for counseling to help the affected employees to cope with the effects of the downsizing. The same has been emphasized repeatedly in literature.
- **Criteria for downsizing:** Though the suggested practices (Mishra et al, 1998; Cameron et al, 1991) advocate non-performance as the criteria for downsizing, the present study highlighted that in India, most organisations predominantly used age and tenure as the criteria for identifying the candidates for VRS. In the study, it was found that the majority of employees who opted for VRS were the good performers, while the poor performers either refused to leave, or had to be coerced into leaving. An added implication of a VRS scheme based on age and tenure is that the organisation may face a loss of valuable knowledge, skills and competencies. If downsizing is to be used as a means to reduce the non-performing manpower of any organisation, it would be the responsibility of the HR department to devise an objective Performance Appraisal system that can be used to objectively identify non-performers, and contribute to the long-term benefit of the organisation.
- **Communication:** In the study, all the organisations claimed to have had extensive communication with their employees at various stages of the downsizing process. However, the results have been mixed at best. Literature has repeatedly stressed the importance of communication in implementing not only downsizing but any change initiatives per se (Linton, 2000; Singh, 1998; Mishra et al, 1998 etc). It is also essential that communication, in order to be effective, should be a two-way process and address the expectations and needs of affected employees and help them to cope with the negative perceptions generated among employees.
- **Employability initiatives from the organisation:** As mentioned earlier, Indian organisations appear to be somewhat lacking in terms of awareness and initiative levels in addressing the issue of employability of their employees in lieu of their job security. Most of the organisations in the study, with only two exceptions, did not invest in any special employability initiatives for their downsized employees, preferring to focus more on the monetary compensations rather than non-monetary benefits. However, it was found that organisations that had performed better after downsizing had been adopting employee-friendly and long-term approaches similar to those prescribed in existing literature. Khandwala (1992) had earlier recommended that for countries like India, employee-friendly and long-term implementation approaches would be more acceptable and beneficial. Issues of employee dependence and need for renegotiation of psychological contract, which have been proposed by other researchers, appear relevant in the Indian context too. Sinha, Gupta, Singh, Srinivas & Vijaykumar (2001) have established that in Indian organisations, employees expect their top management and supervisors to watch over them, and to create a caring environment which can induce employees to perform their tasks well and relate to each other meaningfully. This seems to reflect a need for dependency among employees and a tendency to expect the organisation to take responsibility for their welfare and performance. The findings from the interviews in the study also appeared to indicate a similar attitude. In a country like India, employees have traditionally been used to looking on the organisation as a parent (Sinha, 1995). Therefore, in some organisations, the negative feelings generated in employees as a result of the drastic change in attitude of the organisation, might have arisen from a perception of violation of expectations and of being let down by the organisa-

tion. Moreover, there might have been a perception of unfairness and breach of trust regarding the implementation process on the part of the managers who were largely left to fend for themselves after being downsized. This might have accentuated their ill-feelings and resentment. These issues would also have implications for leadership styles suitable for managing such change interventions. As Sinha (1995) postulates, the most effective leadership style for the Indian manager would be the nurturant-task style, where the leader or change agent would need to understand and fulfill the employees' expectations and needs, before bringing about other organisational changes.

- **Attitude towards managers:** A crucial issue which emerged from interviews is that managers and officers who have been downsized have been largely left to fend for themselves, and most of the employability initiatives taken by the organisation have been directed more towards workers than managers. This is evident from the fact that in most of the organisations, the negative reactions and hostility among employees was more among managers than workers. There might be various reasons for this:
  - General perception that managers have higher employability compared to workers, and hence the latter need to be taken care of by the organisation
  - Perceived strength of workers represented by their overall numbers, and affiliation to unions
  - Attempt to prevent union problems by focusing on workers' welfare.

However, as Kets de Vries et al (1997) have established, managers are as likely to suffer negative psychological and behavioural consequences from downsizing as workers, and hence would need help in coping with the change as much as workers. This differential treatment towards managers is one of the aspects that Indian organisations might need to reconsider while drawing up their implementation plans.

- **Renegotiating the psychological contract with employees:** In India, organisations have traditionally encouraged and cultivated a mindset of dependency among employees. In the current scenario, organisations need to encourage employees to be self-dependant in terms of taking more responsibility for their job and career welfare (Singh, 1998). This would involve encouraging employees to change their mindset, and wake up to the inevitability of job insecurity so that they become more proactive partners in assuming responsibility for their own career development.

Conclusion

In the context of downsizing, Indian organisations do appear to be following some practices similar to those recommended in literature. However, there are a number of areas which need to be given greater importance. The issues highlighted above reveal that there exists a lot of scope for improvement in the way downsizing is being currently implemented in Indian organisations. The study has attempted to identify some of these apparent shortcomings which need to be improved upon. It is expected that such suggestions would help both the practicing manager and the organisational researcher to arrive at a better understanding for effective management of change initiatives.

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□

Your work should be an act of love, not a marriage of convenience.

– Haruki Murakami

Feature

An Instrument for Measuring Total Quality Management Practices in Higher Education

B. Mahadevappa

Total Quality Management (TQM) has found its way into many institutions of higher education around the world to help colleges and universities to respond to current challenges. This study developed a research instrument that can be used for measuring and evaluating the extent of current practices of total quality management in colleges and universities. The measures proposed were empirically based and shown to be reliable and valid.

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Total Quality Management has found its way into many institutions of higher education around the world to help colleges and universities to respond to current challenges, including the need for creating value for students and stakeholders; openness and transparency in governance and ethics; and the challenges of rapid innovation and capitalizing on knowledge assets.

Literature is full of descriptions of TQM in higher education (Bonser, 1992; Edwards, 1991; Hansen, 1993: Doraiswamy, 1995; Sharples, et al., 1996; Madu et al., 1994; Matthews 1993; Madhu & Kuei, 1993; Williams, 1993) and case studies of successful implementation of TQM in colleges and universities (Clayton, 1993; Coate, 1993; Cowles & Gilbreath, 1993; Doherty, 1993; Dowlatshai, 1996; Ellis, 1993; Grant et al., 2004; Greenbaum, 1993; Kanji et al., 1999a, 1999b; Lawarence & McCollough, 2004). In general, studies have been descriptive and not based on any model for the effectiveness of the TQM approach in higher education. The need is for a model that will identify the logical links between the elements of a TQM approach and thus allow the identification of those elements necessary for successful application of TQM in higher education. The conceptual model and an associated research instrument developed here overcome the limitations of earlier research by providing a theory and an instrument for TQM research and practice.

The specific objectives of this study were to:

- develop a conceptual model of total quality management for implementation in higher education,
- construct an associated research instrument that measures total quality management practices in an education organisation, and
- test the theory behind the model that "leadership drives the system that creates results".

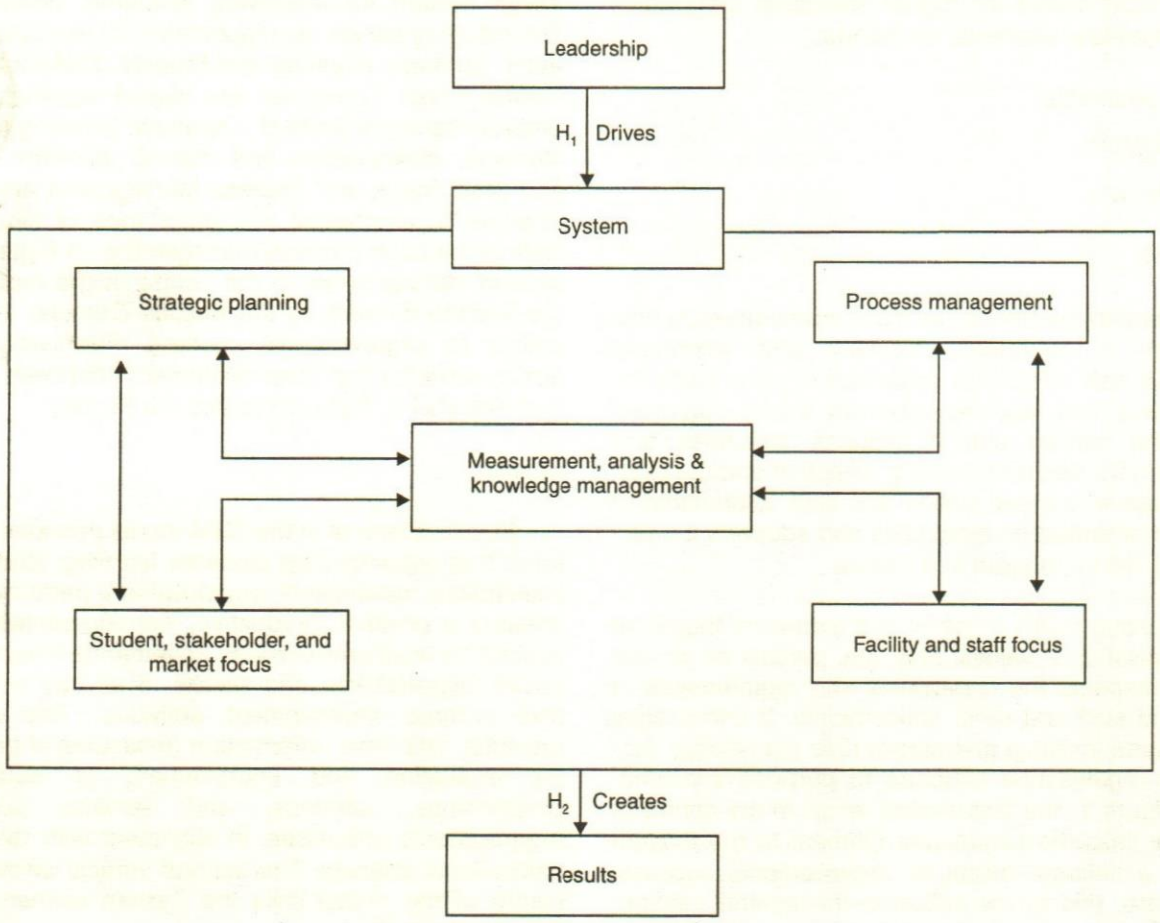

Fig. 1. A Conceptual Model of Total Quality Management in Higher Education

Insight into any one of these objectives is a contribution to the total quality management and performance management literature in higher education.

A Conceptual Model of TQM in Higher Education

A realistic and sustainable model of TQM has been developed for implementation in the institutions of higher education in India as shown in Fig. 1. This TQM model is based on the BNQA Education Criteria for Performance Excellence [2004]. The Baldrige Award not only codifies the principles of quality management in clear and accessible language. It also goes further: It provides organisations with a comprehensive framework for assessing their progress toward the new paradigm of management and such commonly acknowledged goals as customer satisfaction and increased employee involvement [Garvin, 1991].

In 1999, BNQA Education Criteria for Performance Excellence was added to help education organisations respond to current challenges: The need to create value for students, stakeholders, and the organisation; openness and transparency in governance and ethics; and the challenges of rapid innovation and capitalizing on its knowledge assets.

The Baldrige Education Criteria consists of seven categories: Leadership; strategic planning; student, stakeholder and market focus; measurement, analysis, and Knowledge Management, faculty and staff focus, process management and organisational performance results. Each category is assigned with a certain number of points defined in the award criteria. Hundreds of quality experts using consensus expert opinion allocated a total of 1,000 points to these seven Baldrige categories and sub areas. The Baldrige Criteria currently provides the best framework for an interdisciplinary approach to total quality management [Wilson & Collier, 2000].

The main theory behind the proposed TQM model is "leadership drives the system that creates results". Leadership indeed drives the system development and its management that creates the results in an education organisation.

The TQM model for higher education consists of three conceptual elements, as follows:

- Leadership
- System
- Results

Leadership

Leadership Element in the TQM model refers to how leadership is exercised, formally and informally, throughout the education organisation – the basis for and the way that key decisions are made, communicated, and carried out. It includes structures and mechanism for decision-making; selection and development of senior leaders, faculty and staff. Leadership of education organisation articulates and supports a clearly defined vision, mission and values.

Leadership builds loyalties and teamwork based on the organisation's values and the pursuit of shared goals. It respects the capabilities and requirements of faculty and staff and other stakeholders. It encourages and supports initiative and appropriate risk taking, subordinates organisation structure to purpose and function. In Figure 1, the first vertical arrow in the centre of the model links the Leadership Element to the System Element, a linkage critical to organisational success. Furthermore, this arrow indicates the central relationship between Leadership and System i.e. "leadership drives the system".

System

System Element in the TQM model views an education organisation as a total system. A focus on the organisation as a total system suggests that complex higher educational problems cannot be addressed by a simple, patchwork solution, but instead require a hard-nosed assessment of how the entire chain of education design and delivery might contribute to the problem and its solution. The System Element includes five categories – Strategic Planning, Student, Stakeholder and Market Focus, Measurement, Analysis and Knowledge Management, Faculty and Staff Focus, and Process Management. Within the System Element, the Measurement, Analysis and Knowledge Management Category shows direct linkages (two-headed arrows) to the other four System Categories, which also provide feedback to the Measurement, Analysis and Knowledge Management Category.

Measurement, Analysis, and Knowledge Management Category is critical to the effective management of education organisation and to a fact-based, knowledge-driven system for improving academic performance. The category serves as a foundation for the System Element. Strategic Planning and Student, Stakeholder and Market Focus Categories are placed together to emphasise the importance of a strategic planning focus on students, stakeholders and market. Similarly, Faculty and Staff Focus and Process Management are placed together to emphasise the importance of faculty and staff to focus on process management. In Figure 1, the second vertical arrow in the centre of the model links the System Element to the Results Element, a linkage critical to organisational success. Furthermore, this arrow indicates the focal relationship between System and Results i.e. 'System creates the Results'.

Results

Results Element in the TQM model provides a result focus that encompasses students' learning; student and stakeholder satisfaction; organisation's performance in creating a positive, productive, learning-centered, and supportive work environment, governance structure and social responsibility; and results of all key processes and process improvement activities. This element provides "real-time" information (measures of progress) for evaluation and improvement of educational programmes, offerings, and services and the organisation's processes, in alignment with overall organisational strategy. The second vertical arrow in the centre of the model links the System element to the Results element.

Categories of TQM Model in Higher Education

The three conceptual Elements of TQM model in turn are subdivided into seven categories, as follows:

1. Leadership
2. Strategic Planning
3. Student, Stakeholder, and Market Focus
4. Measurement, Analysis, and Knowledge Management
5. Faculty and Staff Focus
6. Process Management
7. Organisational Performance Results

Figure 1 provides the conceptual model connecting three elements and integrating the seven categories.

Based on a thorough review and synthesis of BNQA Education Criteria this study identifies forty operational measures which are grouped into the

Table 1: Categories of TQM Model in Higher Education

Categories of TQM Model in Higher Education		Explanation of Categories
1.	Leadership	Articulation and use of a clearly defined vision, mission and values. Creation of a work environment for empowerment. Responsible governance system. Evaluation of organisational performance. Addressing societal responsibilities.
2.	Strategic Planning	Development of a competitive student-stakeholder, and market-focused strategy. Implementation of specific short and longer-term action plans. Provision for performance measures and indicators for tracking progress.
3.	Student, Stakeholder and Market Focus	Acceptance of the students and stakeholders as customers. Understanding the needs, requirements and expectations of students and stakeholders. Relationship building with students. Determination of students and stakeholders satisfaction. Empowerment of faculty to address problems of students.
4.	Measurement, Analysis and Knowledge Management	Measurement and analysis of internal and comparative quality data. Use of quality data for competitive comparisons, benchmarking and to support strategic decision-making and innovation. Availability of quality data for faculty and staff, suppliers and partners, and students and stakeholders.
5.	Faculty and Staff Focus	Creation of a work system to promote co-operation, initiative and innovation. Recruitment and retention of knowledge and skilled faculty and staff. Compensation and recognition system to reinforce high faculty and staff education, training, and development. A system for faculty and staff motivation and career development. Maintenance of a safe and secure work environment.
6.	Process Management	Effective course curriculum design and delivery. Alignment of educational delivery to curriculum objectives. Design and implementation of best instructional approaches with a focus on student learning. Use of a variety of data for timely information to improve learning. Management of support processes to improve overall operational performance.
7.	Organisational Performance Results	Student learning results. Student and Stakeholder focused satisfaction results. Faculty and staff results. Overall education organisational performance results. Governance and social responsibility results.

original seven Baldrige categories. Operational measures can be used to produce a profile of total quality management in an institution of higher education. These measures are tested for reliability and validity using perceptual data collected from a sample of 284 respondents from 42 NAAC accredited colleges and two NAAC accredited universities in India. Table 1 shows the operational measures identified in seven Categories of TQM model in higher education.

Hypotheses

The theory behind the TQM model in higher education is tested in this study by formulating the following two specific hypotheses.

H_1: Leadership predicts system

Leadership Element has a direct effect on System Element including on each of the System Element components (H_1)

H_2: System predicts Results

System Element has a direct effect on Results (H_2)

Construction of Research Instrument

Psychologists have developed rigorous methods for constructing research instruments to measure social science variables (e.g. Likert, 1967; Nunnaly, 1967). The process used in this study to develop research instrument for measuring total quality management practices in higher education was based on the generally accepted psychological principles of instrument research design. The research instrument development process is shown in Fig. 2.

Steps 1, 2 and 3 of the process, the literature review, development of a conceptual model of TQM in higher education and selection of specific TQM items to represent and measure each category, have been discussed above. In steps 4, 5, and 6 detailed item analysis, reliability analysis and validity analysis were used to construct research instrument (step 7).

A reliable and valid research instrument was constructed by selecting 40 specific items to represent and measure each category. Each question is clearly traceable to specific category of Baldrige Education Criteria. Respondents of this study were asked to indicate the extent to which they believe their college/university has the feature described by the statement using a 5- point interval rating scale from 'Strongly Agree (=5) to Strongly Disagree (=1)' permitting a rational interpretation of scale scores. A typical questionnaire item is shown below:

Table 2: Responses received by College/University Grade and the State

Grade of College/ University	Number of Responses	Percentage	State	Number of Responses	Percentage
A. Colleges					
A	73	26	Karnataka	176	62
B++	6	2	Kerala	14	5
B+	74	26	Tamil Nadu	16	6
B	78	28	Maharashtra	65	23
3*	12	4	West Bengal	13	4
B. Universities			Total	284	100
4*	13	4			
5*	28	10			
Total	284	100			

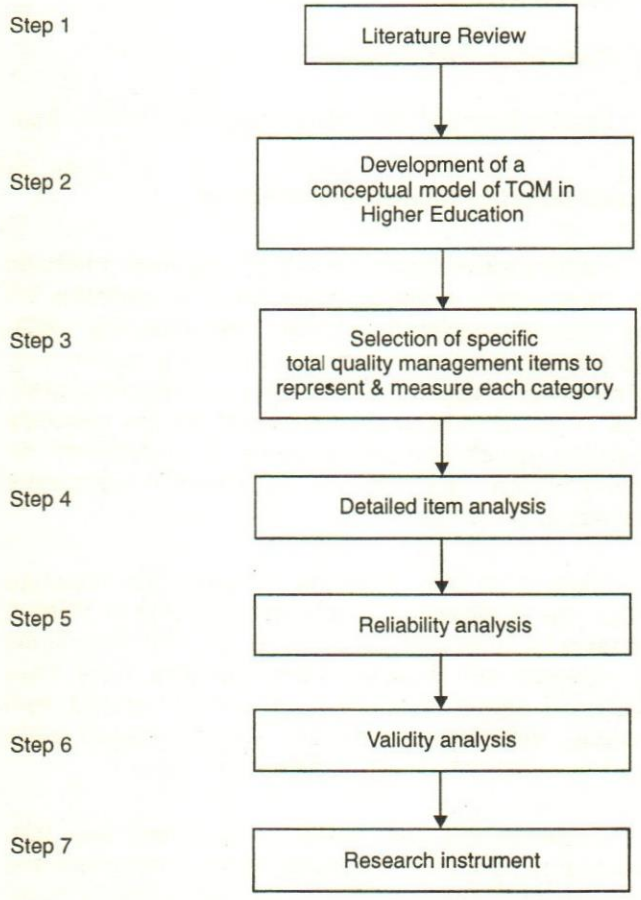

Fig. 2. The Research Instrument Development Process

Extent to which you believe your College/University has the feature described by the statement is

Strongly Agree	Agree	Medium	Disagree	Strongly Disagree
5	4	3	2	1

1.1 Extent to which leadership continually articulates and supports a clearly defined vision, mission and values.

A higher scale score indicated that an education organisation has a high degree of that feature of total quality management, while a lower scale score indicated that an education organisation has a low degree of that feature of total quality management. How the respondents felt were used to conclude where improvement is needed in developing and deploying a total quality management strategy for higher education. The research instrument appears in Appendix A.

Administration of Research Instrument

The Universe and the Frame: As the aim of this study is to develop a TQM model for higher education, the universe represents all the colleges, universities and institutions of higher education India, whether accessible or not. A suitable frame for a universe of colleges and universities in India is the directory published by the National Assessment and Accreditation Council (NAAC), which contains the list of colleges and universities accredited by it. As on September 16, 2004 the NAAC has accredited 2021 institutions in India that include 111 universities and 1910 colleges (NAAC, 2004). The directory published by NAAC provides the name, address and accredited status of these universities and colleges. The proposed frame is satisfactory as it covers enough of the universe to make the study worthwhile.

The Sampling Unit and Size of Sample: The sampling units for this study are colleges and universities accredited by the NAAC. Forty-two colleges and two universities were randomly selected as the sample size from the frame. They were stratified on the basis of accreditation grade i.e., A, B+, B and the state to which they belong. The NAAC classified the colleges into nine grades under the new grading system using 9 point

Table 3: Demographics of Respondents

Gender	Number of Respondents	Percentage	Position	Number of Respondents	Percentage
Male	172	61	Principal	16	6
Female	112	39	Vice-Principal	6	2
Total	284	100	Professor	38	13
			Reader	20	7
Qualification			Lecturer (Selection Grade)	110	39
Ph.D.	101	35	Lecturer (Senior Scale)	37	13
M.Phil	45	16	Lecturer	41	14
Post Graduates	130	46	Office Staff	14	5
Graduates	8	3	Research Officer	2	1
Total	284	100	Total	284	100
			Experience		
Age			03-10 Years	42	15
28-40 years	47	17	11-20	102	36
41-50	153	54	21-30	96	34
51-64	84	29	31-39	44	15
Total	284	100	Total	284	100
Average age of Respondents: 47 years			Average Experience of Respondents: 21 years		
Standard Deviation of 7 years			Standard Deviation of 8.6 years		

scale. The colleges with 85 to 90 points (exclusive of upper limit) are classified as 'A' grade, colleges with 75 to 80 points are classified as 'B+' grade and colleges with 70 to 75 points are classified as 'B' grade. The colleges with less than 70 points (C++, C+, C grades) were not considered since the total quality management practices of these colleges were likely to be unsophisticated, or at the very least highly variable. For reasons of practicality and convenience, respondents were chosen from the colleges and universities in the five states. The profiles of responses received by grade and by state are shown in Table 2.

The Respondents: The respondents for this study include Principals, Senior Faculty Members and Senior Office Staff of NAAC accredited colleges and Professors, Readers and Lecturers of universities. These are the people who are responsible for design and delivery of educational service in a college. The demographics of respondents are given in Table 3.

The research instrument was administered to the sampled respondents. The statistical analysis of responses was carried out by using SPSS. Simple descriptive statistics were computed to analyze the extent to which respondents believe their college has the feature of total quality management and its results described by the statements. Reliability and validity of research instrument was verified. Regression analysis was used to test the hypotheses.

Reliability Analysis

Four methods were used to assess the reliability of empirical measurements: (1) the retest method, (2) the alternative form method, (3) the split-halves method, and (4) the internal consistency method (Nunnally, 1978). Of these, the first three have major limitations (particularly for field studies) such as requiring two independent administrations of the instrument on the same group of people or requiring two alternate forms of the measuring instrument. In contrast, the internal consistency method works quite well in field studies because it requires only one administration. Further, it is the most general form of reliability estimation (Nunnally, 1978). Hence, the internal consistency method was chosen to assess the reliability of the research instrument.

The internal consistency of a set of measurement items refers to the degree to which items in the set are homogeneous. Internal consistency can be estimated using a reliability coefficient such as Cronbach's alpha (Cronbach, 1951). Cronbach's alpha is computed for a scale based on a given set of items. A scale score for all measures is the mean of item scores. It can also be

calculated for any subset of the items. Therefore, it is possible to identify the subset (category) that has the highest reliability coefficient. The scale constructed from that subset is likely to be the best with regard to internal consistency. Using the SPSS reliability programme (Hull & Nie, 1981), an internal consistency analysis was performed separately for the items of each category of total quality management research instrument.

Table 4 presents the reliability coefficients associated with the seven categories of total quality management. The number of items measuring each category, its mean and standard deviation are also shown. Higher values of alpha indicate higher reliability. Reliability values in this research study are greater than 0.80 for all the categories, which are quite high for this kind of exploratory research, compared to a minimum recommended value of 0.7 (Nunnally, 1978).

Table 4: Results of Reliability Analysis (n-284)

Categories of TQM		Number of Items	Mean	S.D.	Alpha
1.	Leadership	7	4.07	0.72	0.88
2.	Strategic Planning	3	3.88	0.84	0.83
3.	Student, Stakeholder and Market Focus	5	4.12	0.69	0.81
4.	Measurement, Analysis and Knowledge Management	6	3.73	0.79	0.88
5.	Faculty and Staff Focus	6	4.00	0.72	0.84
6.	Process Management	4	4.00	0.79	0.80
7.	Organisational Performance Results	9	4.15	0.67	0.92

Validity Analysis

After a model has been chosen for the construction of a measuring instrument and the instrument has been constructed, it is necessary to inquire whether the instrument is useful scientifically. This is usually spoken of as determining the validity of an instrument (Nunnally, 1978). Validity of measuring instrument refers to the extent to which it measures what it intended to be measured. In a very general sense, a measuring instrument is valid if it does what it is intended to do. Three different types of validity are generally considered: (1) predictive validity, (2) content validity, and (3) construct validity. These types of validity constitute different issues concerning the concept of scientific generalizations.

Predictive validity, sometimes called criterion-related validity is concerned with the extent to which a measuring instrument is related to an independent measure of the relevant criterion. For example, predictive validity of an entrance test employed for admission of students to first year degree or postgraduate degree course is to predictive validity.

The leadership measuring instrument of TQM Model has criterion-related validity if this measure is highly and positively correlated with the five categories which comprise of system in the TQM model proposed earlier i.e., Strategic Planning, Student, Stakeholder and Market Focus, Faculty & Staff Focus, Process Management and Measurement, Analysis and Knowledge Management.

The system measuring instrument of TQM model has criterion-related validity if this measure is highly and positively correlated with the organisational performance results in a college. In other words, these measures taken together should account for the performance of the higher education institution with respect to the quality of its educational service.

The criterion-related validity of the leadership category of TQM model was evaluated by examining the multiple correlation coefficients computed for the leadership category and the five categories, which comprise of system. The multiple correlation coefficient of the leadership category and system was 0.83, indicating that the leadership category has a high degree of criterion-related validity.

The criterion-related validity of system which comprise of five categories in the TQM model was evaluated by examining the multiple correlation coefficient computed for the system which comprise of five categories, and two quality performance measures. The multiple correlation coefficients of the system and Organisational Performance Results was 0.75.

Detailed Item Analysis

Nunnally (1978) developed a method to evaluate the assignment of items to scales. The method considers the correlation of each item with each scale. Specifically, the item-score to scale-score correlations are used to determine if an item belongs to the scale as assigned, belongs to some other scale, or if it should be eliminated. If an item does not correlate highly with any of the scales, it is eliminated.

Table 5 shows the correlation matrix for the seven scales or measures of the critical factors (labeled Scale 1, Scale 2, ..., Scale 8) and the measurement items. For

Table 5: Item to Scale Correlation Matrix for the Categories of Total Quality Management in Higher Education

Category		Item Number							
1.	Leadership (Scale 1)	1.1	**.82**	.66	.58	.58	.64	.56	.50
		1.2	**.83**	.61	.59	.58	.58	.57	.46
		1.3	**.81**	.55	.60	.53	.58	.61	.54
		1.4	**.73**	.58	.54	.52	.58	.54	.49
		1.5	**.69**	.65	.59	.64	.53	.52	.50
		1.6	**.70**	.37	.49	.46	.38	.47	.40
		1.7	**.73**	.46	.57	.52	.51	.54	.50
2.	Strategic Planning (Scale 2)	2.1	.65	**.86**	.49	.59	.49	.53	.41
		2.2	.60	**.87**	.52	.61	.53	.49	.44
		2.3	.64	**.87**	.56	.67	.54	.54	.52
3.	Student, Stakeholder and Market Focus (Scale 3)	3.1	.52	.40	**.71**	.41	.57	.46	.50
		3.2	.63	.47	**.77**	.56	.62	.55	.54
		3.3	.54	.47	**.77**	.43	.49	.45	.47
		3.4	.49	.46	**.77**	.47	.49	.44	.48
		3.5	.61	.47	**.75**	.53	63	.56	.55
4.	Measurement, Analysis and Knowledge Management (Scale 4)	4.1	.52	.48	.49	**.73**	.53	.49	.49
		4.2	.52	.62	.48	**.80**	.53	.46	.42
		4.3	.52	.62	.48	**.80**	.53	.46	.42
		4.4	.55	.56	.56	**.83**	.59	.56	.55
		4.5	.63	.56	.52	**.83**	.56	.56	.50
		4.6	.62	.60	.54	**.80**	.62	.67	.55
5.	Faculty and Staff Focus (Scale 5)	5.1	.57	.58	.60	.65	**.78**	.61	.54
		5.2	.42	.32	.51	.44	**.71**	.48	.41
		5.3	.52	.50	.50	.51	**.73**	.44	.47
		5.4	.57	.43	.59	.58	**.76**	.58	.55
		5.5	.55	.38	.63	.50	**.81**	.64	.57
		5.6	.54	.47	.48	.48	**.71**	.56	.61
6.	Process Management (Scale 6)	6.1	.53	.43	.53	.50	.55	**.78**	.55
		6.2	.51	.37	.52	.47	.61	**.81**	.55
		6.3	.65	.56	.53	.59	.63	**.82**	.62
		6.4	.56	.55	.47	.58	.56	**.76**	.52
7.	Organisational Performance Results (Scale 7)	7.1	.35	.34	.44	.48	.54	.52	**.73**
		7.2	.52	.39	.51	.46	.57	.54	**.80**
		7.3	.46	.43	.54	.49	.46	.57	**.81**
		7.4	.39	.41	.52	.37	.44	.51	**.80**
		7.5	.52	.42	.61	.48	.54	.54	**.80**
		7.6	.43	.50	.49	.41	.48	.48	**.74**
		7.7	.67	.39	.62	.59	.67	.63	**.80**
		7.8	.53	.36	.47	.44	.56	.55	**.75**
		7.9	.42	.52	.50	.51	57	.62	**.75**

example item 1.1 has correlations of .82, .66, .58, .58, .64, .56, and 50 with the seven scales of the TQM Categories. Since Scale 1 (Leadership) is the average items 1.1 to 1.7 the high correlation between Scale 1 and item 1.1 was expected. In addition, since item 1.1 showed relatively smaller correlations with the other scales, it was concluded that it had been assigned appropriately to Scale 1. All other items were similarly examined.

As seen in Table 5, all items have high correlations with the scales to which they were originally assigned

relative to all other scales. Accordingly, it was concluded that all items had been appropriately assigned to scales. Since the detailed item analysis results were satisfactory, the items reported in Table 3 are the final scale items.

Regression Analysis

Table 6 reports the results of regression analysis between (a) leadership (independent variable) and system (dependent variable); (b) system (independent variable) and Organisation Performance Results (dependent variable).

Table 6: Results of Regression Analysis

Hypothesis	Beta	t-value	P-value	Hypothesis Supported?
H_1. Leadership predicts System	0.83	25.32	0.000*	Yes
H_2. System predicts Results	0.75	19.25	0.000*	Yes

$\alpha < 0.01$

The underlying theory behind the TQM model for higher education that "leadership drives the system that creates results" is supported by this research.

Conclusion

This research study successfully developed a model of TQM based on BNQA Education Criteria for Performance Excellence that can be used to implement total quality management in the institutions of higher education. This study also successfully developed a research instrument that can be used to measure and evaluate the extent of current practices of total quality management in the colleges and universities and its impact. The measures proposed were empirically based and shown to be reliable and valid. The reliability coefficients (alphas) of the measures ranged from 0.80 to .92. Further, the 0.83 multiple correlation coefficients between the leadership construct and system construct and 0.75 multiple correlation coefficients between the system construct and results construct offer a strong evidence of criterion- related validity.

The underlying theory that "leadership drives the system that causes results" is supported by this research. The TQM model implied that the Leadership of an education organisation has a direct impact on System. The System creates Results. The strongest conclusion that emerges from this analysis is the need for top management to create and maintain a System for better Results.

Given its long history, surprisingly little is known about total quality management in higher education. Academic research on the subject is in its infancy. The TQM model and the associated research instrument suggests a number of directions for further research, each likely to be of some benefit to students, stakeholders, faculty and staff and leaders of colleges and universities. There is a clear need for a more precise empirical study by using a larger sample size to test the theory behind the model proposed in this study. A second line of research would focus on studying the current practices of total quality management in the institutions of higher education to distinguish effective from ineffective practices. The author hopes that this study will provide impetus for future research aimed at gaining a better understanding the application of total quality management in higher education.

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Appendix A describes the 40 items included in the research instrument.

Total Quality Management in Higher Education

[Post Doctoral Research Sponsored by University Grants Commission]

Directions: This study deals with your opinions of TQM in higher education. Please show the extent to which you believe your university/college has the feature described by the statements. If you strongly agree that your education organisation has that feature, circle the number 5. If you strongly disagree that your education organisation has that feature, circle the number 1. If your feelings are not strong, circle one of the numbers in the middle. How you feel will help us to decide where we most need to improve in developing and deploying a TQM strategy for higher education. We will not be looking at individual responses but will use the information from our whole sample to make inferences. It should take you about 10 to 15 minutes to complete this questionnaire. Please fill in the following questionnaire.

Name of the University or College being discussed

1. Leadership

1.1 Continually articulates and supports a clearly defined vision, mission and values.

1.2 Uses vision, mission and values to guide ongoing decision-making.

1.3 Creates a work environment for empowerment, learning, agility and ethical behaviour that help faculty and staff do their jobs.

1.4 Has a responsible, informed and accountable governance system that can protect the interests of key stakeholders.

1.5 Regularly reviews organisational performance and the review findings are used for continuous and breakthrough improvement and innovation.

1.6 Addresses societal responsibilities in a proactive manner and accomplishes ethical practices in all student and stakeholder interactions.

1.7 Encourages and supports the key community services to develop social and citizenship values and skills among faculty, staff and students.

2. Strategic Planning

2.1 Develops a competitive student, stakeholder, and market-focused strategy to guide ongoing decision making, resource allocation and overall management.

2.2 Develops and implements specific short and longer term action plans to achieve strategic objectives.

3. Student, Stakeholder and Market Focus

3.1 Knows that the students and stakeholders are the most important customers of an education organisation.

3.2 Understands the needs, requirements, expectations and preference of the current and future students, stakeholders, and the markets.

3.3 Builds relationships with the current and potential students and stakeholders to meet and exceed their expectations.

3.4 Determines students and stakeholders satisfaction or dissatisfaction with educational services.

3.5 Empowers faculty and staff to make decisions to solve problems of students and stakeholders.

4. Measurement, Analysis and Knowledge Management

4.1 Collects wide range of data and information related to student and stakeholders, faculty and staff and internal operations to support organisational decision-making.

4.2 Collects comparative data and information by benchmarking and competitive comparisons to support strategic decision-making and innovation.

4.3 Aligns and integrates the performance measures and indicators throughout the organisation to yield organisation-wide data and information.

4.4 Conducts analyses of all types of data to gain an understanding of performance and needed follow-up actions.

4.5 Ensures the availability of high-quality, timely data and information for faculty and staff, students and stakeholders, suppliers and partners for day-to-day management.

4.6 Keeps current with educational needs and

directions, and develops innovative solutions that add value for the student, stakeholder and the organisation.

5. Faculty and Staff Focus

5.1 Has a work system to promote co-operation, initiative, empowerment, innovation agility and organisational culture.

5.2 Recruits and retains the knowledge and skilled faculty and staff.

5.3 Has a compensation and recognition system that reinforces student achievement and high faculty and staff performance.

5.4 Has a system for continuous faculty and staff education, training, and development to meet their overall personal and professional objective.

5.5 Has a system for faculty and staff motivation and career development to realise their full potential.

5.6 Maintains a safe and secure work environment that contribute to the well-being, satisfaction and motivation of all faculty and staff.

6. Process Management

6.1 Designs an efficient and effective course curriculum to maximise student success and growth.

6.2 Ensures education delivery is aligned to curriculum objectives and that instructional approaches reflect best practices.

6.3 Uses a variety of data through observations and measurements to provide timely information to help students and faculty improve learning.

6.4 Ensures that support processes i.e. administrative, library, canteen, and sports services meet the requirements of students, faculty and staff.

7. Organisational Performamce Results

7.1 Student learning results reflects student and stakeholder needs, requirements and expectations.

7.2 Student learning results reflect the education organisation's overall mission and primary improvement objectives.

7.3 Student and stakeholder satisfaction shows the effectiveness of educational programmes and academic activities.

7.4 Student and stakeholder satisfaction shows a disciplined, and learning-cent red academic environment.

7.5 Student and stakeholder shows loyalty, student persistence, positive referral, Perceived value and better image building for the university/college.

7.6 Academic environment shows effective teamwork between faculty and staff; knowledge and skill sharing across departments and student's retention.

7.7 Faculty and staff job satisfaction shows a positive, productive, learning-centered, and caring work environment.

7.8 Overall organisational performance show evidence of continuous improvement in educational and support services.

7.9 Societal responsibilities show evidence of regulatory and legal compliance, fiscal Accountability, stakeholder trust and ethical behaviour.

Would you like to give more information about any of your responses? Please include the number of the statement you are discussing (for example, 2.1 or 7.8).

□

Freedom is not worth having if it does not connote freedom to err.

– Mohandas K. Gandhi

Feature

Performance of Foreign Direct Investment Companies in India

A.C. Kutty Krishnan Nambiar

In this era of liberalization, developing countries like India are taking a number of policy measures to attract foreign direct investment (FDI), which is expected to contribute to economic development in a variety of ways. This paper attempts to shed some light on the performance of FDI companies in India, by making a comparative analysis of the working of FDI and domestic companies in India.

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The economies of the world are getting integrated and a new world economic order is being shaped with the adoption of globalisation policies by most of the countries. Free trade in goods and free flow of capital are the two pillars upon which the new world economic order will be erected. No doubt both volume of trade and capital flow in assuming new heights now a days. There are also certain distinguishing features to the flow. Capital flow has overtaken the trade in growth.

During the 1980-97 period global foreign direct investment (FDI) increased at an average of about 13 per cent a year compared to the 7 per cent growth of world export of goods including non-factor services and growth of world GDP at current prices (Padma and Karl, 1999, 134). Another feature is that the flow of capital to developing countries has been episodic as the share of developing countries in the total FDI inflows increased from 26 per cent in 1980 to 37 per cent in 1997 (ibid, 35). For developing countries FDI is the most desirable form of external private finance as it is a bolted down type of investment and has the strongest developmental impact. Thus in economic policy architecture, special emphasis is given to FDI liberalisation.

FDI and economic development: The theoretical background

Economic theory suggests that capital will move from countries where it is abundant to countries where it is scarce because the returns to new investment opportunities are higher where capital is limited. Such a reallocation will boost investment in the recipient country and as suggested by Summers, bring in enormous social benefits (Summers, 2000). Important benefits are that it is a means of transferring production technology, skills, innovative capacity, organisational and managerial practices that are vital for open competitive economies (Padma and Karl, 1999). They can access external markets by sourcing manufactured

goods and services from domestic firms thus boosting exports and easing the balance of payment problems (Bruton, 1989). FDI companies generate substantial corporate tax revenue (Prakash and Asaf, 2001). While these are important direct benefits, FDI give spill over benefits of potential knowledge to other firms (Blomstrom and Arikokko, 1997).

However the moot point is: does capital move freely from where it is abundant to where it is scarce? Certainly not. The subdued flow of capital to developing countries compared to the size of flow in industrial countries is proof of this. Precisely, capital flow to developing countries is influenced by a host of factors. According to Dunning three factors such as ownership advantages, the locational advantages and the internalization advantages are decisive in the inflow of FDI (Dunning, 1981). Also according the Dunning's investment development path theory there are four stages stretching from the low level of development to a mature economy as far as the inflow and outflow of FDI is concerned (Dunning, 1994). The supply of FDI also depends on economic growth in the host country, its political stability and the institutional and policy features. Here what Hausmann and Arias suggest is that "countries should concentrate on improving the environment for investment and the functioning of markets. They are likely to be rewarded with increasingly efficient overall investment as well as with more capital inflows" (See Prakash and Asaf, 2001, 8). Privatisation played a major role in stimulating investment according to Pedro (Pedro, 1992). As against this, quite paradoxically, share of FDI in total inflow is found as higher in riskier countries and in countries where quality of institutions is poor (Rui, 2000). An explanation is that foreign investors prefer to operate directly instead of relying on local financial markets, suppliers or legal arrangements. The significance of education and availability of skilled workforce has been emphasised by Lucas and Eduardo and Lee (Lucas, 1990, Eduardo and Lee, 1998). In the case of spill over benefit studies show that the magnitude of spill over benefit depends upon the technical capabilities of indigenous firms that would enable them to assimilate knowledge (Pack and Larry, 1986). All this brings home the fact that developing countries have to do a lot of homework to attract FDI.

FDI companies are considered as dynamic and harbingers of development in a number of ways. Thrust to exports, technical change, innovation and sound management of resources, including financial, are some of them. This paper attempts to shed some light on some of these aspects by attempting a comparative analysis of the finances FDI and domestic companies (DC). The reference period of the study is 1991-92 to 2002-03.

The data for the paper is mainly drawn from the Reserve Bank of India (RBI) bulletin. The RBI publishes annually the finances of a large number of non-government non-financial companies separately of the public and private limited companies covering important sectors of the Indian industry. Similarly the finances of non-financial FDI companies are also published separately. However the finances of private and public limited companies are not exclusive to the FDI companies. Therefore for the purpose of our analysis the public and private limited companies are combined and from the combined finances the finances of FDI companies are excluded to arrive at the finances of domestic companies. The number of units covered by the annual RBI study ranged from 268 to 334 in respect to FDI companies and from 2305 to 2980 in respect to domestic companies during the 1991-03 periods. There are some limitations to the RBI data. When some companies either extended or shortened their accounting year, income, expenditure and appropriation accounts are annualized and published by the RBI. At the same time the balance sheet data are usually retained as presented in the annual accounts of such companies with the result that the data reported in the balance sheet in such cases refer to varying periods. This implies that there are limitations in working out financial ratios relating to the data of income/expenditure/appropriation accounts with the balance sheet data. We have worked out two such ratios namely net sales to gross fixed assets and gross profit to total net assets. Hence these ratios have to be read with this limitation in mind. At the same time it has also to be borne in mind that this limitation is equally true of FDI and domestic companies. Also as the RBI study covers a large number of companies and as our study covers a 12-year period, the broad trend that emerges from the analysis can reasonably be taken as realistic.

Performance of FDI companies

FDI companies can contribute to the growth and development of developing countries in a variety of ways. Based on a comparative analysis of the performance and financial policies of FDI and domestic companies we examine this aspect.

Investment and financing pattern

First let us consider the investment and financing pattern. The investment pattern is shown in Table 1. To know the changing investment pattern the average value of assets for the two six- year periods is shown in the table. Fixed capital formation has increased in both FDI and domestic companies as the share of net fixed assets, which was 46.20 per cent in the domestic com-

Table 1: Structure of assets

(Rs. crores)

Item	FDIC 92-97	%	DC 92-97	%	FDIC 98-03	%	DC 98-03	%
Net fixed assets	11140	34.72	83397	46.48	31199	41.44	174319	48.74
Inventories	7612	23.72	28678	15.98	12146	16.13	46554	13.02
Loans and advances	10012	31.20	45454	25.33	20352	27.03	81921	22.91
Investments	1799	5.61	13620	7.59	6276	8.34	35535	9.94
Cash in hand and bank	1261	3.93	6224	3.47	4393	5.84	12334	3.45
Others	261	0.81	2063	1.15	919	1.22	6922	1.94
Total	32085		179436	100.00	75285	100.00	357585	100.00

FDIC-Foreign Direct Investment Companies DC-Domestic Companies

panies increased to 48.75 per cent and from 34.71 per cent to 41.44 per cent in FDI companies. The domestic companies thus invested more in fixed assets. Whereas the level of inventory holding was more among the FDI companies, the share in both the sectors declined over the years. Similarly in the case of FDI companies the share of loans and advances was high compared to the domestic companies. In both the sectors miscellaneous investment was on the rise and more or less corresponded. This indicates that in the corporate sector in India in general there was sizable use of funds for non-business purposes of miscellaneous type investment.

Table 2: Debt equity ratio

Year	FDIC	DC
1991-92	0.56	1.10
1992-93	0.53	0.90
1993-94	0.42	0.75
1994-95	0.31	0.61
1995-96	0.28	0.63
1996-97	0.45	0.63
1997-98	0.48	0.70
1998-99	0.48	0.75
1999-00	0.44	0.79
2000-01	0.51	0.70
2001-02	0.51	0.72
2002-03	0.44	0.67
Average		
1991-03	0.45	075
1991-97	0.43	0.77
1998-03	0.48	0.72

Coming to the financing pattern the debt equity ration is shown in Table 2. There are certain diverging features to the financing pattern. The role of debt is low particularly among the FDI companies. Overall the ratio worked out to 45 per cent among the FDI companies and 75 per cent among the domestic companies. There is a tendency to reduce the debt burden in both the sectors. Thus while among the FDI companies the ratio declined from 43 per cent to 48 per cent from the first half of the period, the decline was from 77 per cent to 72 per cent among the domestic companies. Clearly reliance on outside finance is high among the domestic companies as the ratio is still high compared to FDI companies.

Table 3: Operational performance ratios

Year	Assets turnover ratio (FDIC)	Assets turnover ratio (DC)	Profit rate (FDIC)	Profit rate (DC)
1991-1992	1.97	1.26	13.81	9.98
1992-1993	1.88	1.14	12.55	8.81
1993-1994	1.94	1.08	13.02	8.86
1994-1995	1.89	1.14	13.46	9.60
1995-1996	1.95	1.13	14.29	9.96
1996-1997	1.57	1.08	12.03	8.88
1997-1998	1.49	0.92	11.10	7.49
1998-1999	1.46	0.88	10.05	6.68
1999-2000	1.50	0.90	11.01	6.91
2000-2001	1.37	1.08	10.68	6.69
2001-2002	1.30	0.98	10.82	6.53
2002-2003	1.30	1.01	11.86	6.77
Average				
1991-2003	1.64	1.05	12.06	8.10
1991-1997	1.87	1.14	13.19	9.35
1997-2003	1.41	0.96	10.92	6.85

FDI firms are known for the adoption of best corporate management practices. While on the operational

front this will result in the optimum use of resources, on the financial front this will lead to high profitability. Assets turnover ration can reveal the resource use efficiency. The ratio is shown in Table 3. The FDI companies have attained better efficiency in resource use, as the average asset turnover ratio was 1.64 in the FDI companies and 1.05 in domestic companies. In all the years the FDI companies maintained high assets turnover ratio. It is also significant to note from the year wise figures that the assets turnover ratio more or less declined till 1998-1999 in both the sectors. Though the trend got reversed during the last three years, the ratio stood lower than the initial years of reform. When the two time periods are compared, it can be seen that while in the FDI sector the ratio declined from 1.87 to 1.41, in the case of domestic companies the decline was from 1.14 to 0.96 indicating that the decline was quite moderate in the case of domestic companies. The yearly results also show that though the ratio was low among the domestic companies their rate of decline in asset utilization was low.

Here it is pertinent to note that in the initial years of reform there was considerable rise in the investment activity to restructure the firms. However the latter half of 1990 decade was characterized by deceleration in the growth of the Indian economy and in tune with this the asset utilization rate of both the categories declined. Evidently the domestic firms have been able to somewhat absorb the shock, as the decline in the ratio was moderate compared to the FDI companies. In this context it has also to be pointed out that initially the FDI companies had overestimated the sized of the Indian domestic market and made large investments. Later they realized the smallness of the market and started suffering from excess capacity (Financial Times, April 25, 2002). This can be cited as a reason for the decline in the assets turnover ratio of FDI companies.

Profitability is the best indicator of the performance of a firm. In fact FDI moves in search of most profitable opportunities. It will therefore be interesting to observe the relative profitability of FDI and domestic companies. The comparative figures are quite revealing (Table 3). The FDI companies are more profitable than the domestic companies. Invariably in all the years the profit ratio was high in the FDI sector compared to the domestic companies. Thus while the average profitability of domestic companies during the 12-year period was 8.10 per cent, the rate was 12.06 per cent among the FDI companies. Compared to the first half of the period in the second half in both the categories the profit rate declined and the rate declined by 2.27 percentage points in the foreign companies and by 2.50 percentage points among the domestic companies. Evidently the FDI have attained better efficiency if asset turnover ratio and profitability are indicators of operational efficiency.

Profit appropriation pattern

Business savings is an important source of finance for the corporate sector. They also account for a significant share in the savings of the Indian economy. The retained profit as percentage of profit after tax is shown in Table 4. The dividend rate is also shown in the table. Overall taking the twelve-year period as a whole in appears that the foreign companies are contributing more to savings as the ratio was 59-61 per cent against 56.47 per cent saving by the domestic companies. At the same time in the first half of the period the savings of the domestic companies was significantly high as the average saving ratio was 68.81 per cent compared to the 61.48 per cent saving ratio of the FDI companies. This got reversed by a big margin in the second half, as the saving ratio was 57.75 per cent on an average in the FDI sector and 44.13 per cent in the domestic corporate sector. Evidently though savings declined and the foreign companies have come to contribute more to savings in recent years.

Table 4: Profit appropriation pattern

Year	Retained profit rate (FDIC)	Retained profit rate (DC)	Dividend rate (FIDC)	Dividend rate (DC)
1991-1992	58.39	64.23	27.25	15.70
1992-1993	54.76	60.95	26.20	15.03
1993-1994	58.55	70.05	31.11	18.01
1994-1995	64.32	74.56	30.54	19.24
1995-1996	67.53	75.37	33.45	19.55
1996-1997	65.32	67.67	21.68	16.94
1997-1998	67.89	57.74	24.56	13.85
1998-1999	64.13	45.16	26.93	11.56
1999-2000	58.98	47.96	31.63	12.04
2000-2001	46.86	50.74	22.21	8.88
2001-2002	51.41	8.78	24.73	10.82
2002-2003	57.21	54.42	26.77	12.56
Average				
1991-2003	59.61	56.47	27.26	14.52
1991-1997	61.48	68.81	28.37	17.41
1997-2003	57.75	44.13	26.14	11.62

Coming to the dividend ratio it can be seen that the owners of FDI companies enjoyed a fat return compared to the domestic companies. In the FDI sector the average return on equity worked out to 27.26 per cent and in the domestic companies the return was 14.52 per

cent. In domestic companies the dividend ratio was slightly less than one half of the rate paid by the FDI companies. The difference in the dividend rate was observable in all the years. As is evident from the table the FDI companies maintained high dividend rate ranging from 21.68 per cent to 33.45 per cent during the period of this study while the range was from 11.56 per cent to 19.55 per cent in the case of domestic companies. On the whole it appears that the profitability of operation of FDI companies was high and the owners of FDI companies were rewarded with high dividend payments compared to the owners of domestic companies.

Tax contribution

Corporate tax is an important source of revenue to the government. What is the relative contribution of FDI companies?An analysis of this tax provision as percentage of sales is shown in Table 5. Tax contribution of FDI companies can be seen as high compared to the domestic companies. Though there was year-to-year variation in both the categories uniformly in all the years, the contribution of FDI companies stood high indicating that they are substantial contributors of corporate tax revenue in India. Given the high profitability it naturally follows that the FDI companies contributes more tax revenue to the government.

Table 5: Tax contribution

Year	FDIC	DC
1991-1992	3.52	1.89
1992-1993	2.81	1.25
1993-1994	3.15	1.27
1994-1995	3.69	1.33
1995-1996	3.87	1.46
1996-1997	3.18	1.60
1997-1998	2.79	1.39
1998-1999	2.54	1.29
1999-2000	3.08	1.36
2000-2001	3.26	0.92
2001-2002	3.16	1.08
2002-2003	3.69	1.47
Average		
1991-2003	3.23	1.36
1991-1997	3.37	1.47
1997-2003	3.09	1.25

Trade performance

FDI companies can be an important source of foreign exchange resources to developing countries. Apart from the capital inflow contribution can take place by way of exports. At the same it has to be recognized that significant outflow can occur by way of imports and on other accounts. Exports and total foreign currency earnings as percentage of sales of FDI and domestic companies is shown in Table 6. A few important observations can be made from the table. In the case of FDI companies exports as percentage of sales showed some initial acceleration and hence moved from 9.88 per cent to 11.52 per cent in the initial three years of reform. Exports remained subdued in the later six years and were less than 9.86 per cent of sales. However, the last three years were marked by a spurt in exports as the ratio stood above 14 per cent. At the same time it is quite revealing to note that barring very narrow fluctuations there was consistent increase in the share of exports of domestic companies throughout and hence the share increased from 6.52 per cent to 15.42 per cent. An identical trend is discernable in respect to the total foreign currency earnings. Among the FDI companies there was fluctuation as the tempo of growth recorded in the initial years of reform was not maintained and there was a reversal. However, there was a sizable spurt in the foreign currency contribution during the last three years, whereas in the case of domestic companies there was consistent growth as the ratio increased from 7.56 per cent to 20.47 per cent. Uniformly in the last nine years the ratio stood higher than the FDI

Table 6: Export intensity and foreign currency earnings

(as % of sales)

Year	Export intensity (FDIC)	Export intensity (DC)	Foreign currency Earnings (FDIC)	Foreign currency earnings (DC)
1991-1992	9.88	6.52	10.73	7.56
1992-1993	10.57	7.64	11.67	8.86
1993-1994	11.52	8.01	13.13	9.32
1994-1995	9.86	8.63	12.16	10.14
1995-1996	9.21	8.47	11.03	10.07
1996-1997	9.78	10.36	12.31	12.69
1997-1998	9.72	10.66	13.47	13.49
1998-1999	9.40	10.41	11.78	13.64
1999-2000	9.33	10.45	11.77	13.94
2000-2001	14.39	13.38	18.31	17.37
2001-2002	14.06	13.93	18.74	18.95
2002-2003	14.79	15.42	19.41	20.47
Average				
1991-2003	11.04	10.32	13.71	13.04
1991-1997	10.14	8.27	11.83	9.77
1997-2003	11.95	12.38	15.58	16.31

Table 7: Import intensity and foreign currency expenditure

(as % of sales)

Year	Import ratio (FDIC)	Import ratio (DC)	Foreign currency expenditure (FDIC)	Foreign currency expenditure (DC)	Export import ratio (FDIC)	Export import ratio (DC)
1991-1992	6.36	7.19	8.05	8.42	1.51	0.88
1992-1993	8.01	8.25	9.94	9.86	1.29	0.90
1993-1994	7.80	8.58	9.61	10.07	1.49	0.93
1994-1995	10.43	11.03	12.76	11.05	0.92	0.77
1995-1996	12.65	13.30	15.14	15.99	0.72	0.62
1996-1997	13.33	13.36	15.33	16.05	0.77	0.77
1997-1998	11.74	15.41	14.22	18.63	0.82	0.66
1998-1999	11.54	14.22	14.27	18.02	0.81	0.73
1999-2000	10.44	13.31	13.80	16.49	0.89	0.78
2000-2001	11.28	18.73	15.49	22.13	1.26	0.71
2001-2002	11.23	19.41	15.16	22.78	1.25	0.72
2002-2003	11.47	19.72	15.45	23.38	1.29	0.77
Average						
1991-2003	10.52	13.53	13.27	16.07	1.09	0.77
1991-1997	9.76	10.27	11.81	11.91	1.12	0.81
1997-2003	11.28	16.80	14.73	20.24	1.05	0.73

companies. Thus it clearly emerges that the performance of domestic companies is commendable on the export front and as earners of foreign currency, as they have maintained consistent growth in exports and foreign currency earnings.

In the case of FDI companies as Table 7 reveals in the initial years there was rise in the intensity of imports as the ratio increased from 6.36 per cent in 1991-92 to 13.33 per cent in 1996-97. Since then the ratio stood lower than this and fluctuated within the narrow range of 10.44 per cent and 11.74 per cent. Also as can be seen from the table, while the overall ratio was 10.52 per cent from the first half to the second half of the period, the average ratio rose from 9.76 per cent to 11.28 per cent. At the same time the import intensity of production of domestic companies appears to be on the rise throughout as the ratio increased from 7.19 per cent in 1991-92 to 19.72 per cent in 2002-03. Except 1994-95, uniformly in all the years the ratio was higher than the FDI companies. Further as can be observed from the table, while the overall ratio was 13.53 per cent from the first half to second half of the period the ratio increased from 10.27 per cent to 16.80 per cent. Clearly the domestic companies are becoming more import intensive. The foreign currency expenditure trend too corresponded to this trend. Foreign currency expenditure of domestic companies are consistently on the rise as the ratio increased from 8.42 per cent to 23.38 per cent, while in the case of FDI companies the ratio increased from 8.05 per cent in 1991-92 to 15.33 per cent in 1996-97. In later years the ratio was more or less stagnant and fluctuated within the range of 13.80 per cent to 15.49 per cent. Clearly the domestic companies have become more import intensive and sizable absorbers of foreign currency. Here it may be mentioned that trade liberalisation would make available imported raw materials and capital goods to produce quality goods for exports. This will mean that with import growth exports will also grow. As already evidenced imports have grown substantially in the post-liberalisation period in the corporate sector. How far this has led to the export growth can now be verified by examining the export-import ratio. The ratio is also shown in Table 7. Export-import ratio was markedly high among the FDI companies (the ratio on an average was 1.09 against 0.77 in the case of domestic firms). Compared to the first half of the decade the rate declined in the second half in both the sectors. At the same time the year-wise figures shows that the export intensity of imports was high in the beginning in the case of FDI companies and this declined later. Though during the last three years there is marked improvement, still the ratio stood lower than the previous years. Whereas in the case of domestic companies the export intensity increased in the initial years, later it declined. Looked from this perspective the performance of domestic companies appears poor compared to the FDI companies.

The net inflow as percentage of sales is shown in Table 8. Clearly the domestic companies are negative contributors of foreign currency resources as invariably in all the years there was net outflow. In recent years the negative earning has gone up as the ratio, which was 1.06 in the first half of the period, increased to 3.04. Contrary to this the FDI companies were negative earners by a sizable amount in the beginning. Gradually there was decline in the outflow and in the last three years they were positive contributors of foreign currency. For this angle it appears that the working of the FDI companies in India is more favourable.

Table 8: Net foreign currency earnings and degree of openness

(% of sales)

Year	Net foreign currency receipts (FDIC)	Net foreign currency receipts (DC)	Foreign trade (FDIC)	Foreign trade (DC)
1991-1992	2.67	-0.86	16.42	13.88
1992-1993	1.73	-1.00	18.78	16.09
1993-1994	3.52	-0.75	19.27	16.63
1994-1995	-0.60	-0.91	20.42	19.83
1995-1996	-4.10	-5.91	22.02	22.11
1996-1997	-3.02	-3.35	22.55	23.71
1997-1998	-0.76	-5.14	21.61	26.25
1998-1999	-2.49	-4.37	20.94	24.66
1999-2000	-2.03	-2.56	19.81	23.94
2000-2001	3.04	-3.27	25.72	32.22
2001-2002	3.57	-1.98	25.29	33.26
2002-2003	3.95	-0.90	26.28	35.36
Average				
1991-2003	0.46	-2.58	21.59	24.00
1991-1997	0.03	-1.06	19.91	18.71
1997-2003	0.88	-3.04	23.28	29.28

With liberalization firms get globalised as imports and exports rise. The degree of openness can be examined for which we have related the value of exports plus imports to total sales. The degree of openness is perceptibly on the rise among the domestic companies (Table 8). In the beginning the FDI companies were more open but later the domestic companies have overtaken them. As can be seen from the table in 1991-92 the ratio was 16.42 in the case of FDI companies and 13.88 in the case of domestic companies. Leaving mild fluctuations the ratio increased to 26.28 in the FDI companies by 2000-03. At the same time in the case of domestic companies the ratio increased to 35.36 per cent. Evidently the domestic companies are getting more globalised.

Technological aspects

To stay competitive firms have to adopt the best technology and make improvements constantly. Here comes the significance of research and development expenditure. To get a focus on this aspect we examine the capital intensity and expenditure on research and development. Capital intensity is calculated as the ratio of gross value added (less of total remuneration given to workers) to total remuneration of workers. Research and development expenditure as percentage in sales was also worked out (Table 9).

Table 9: Capital intensity and expenditure on research and development

Year	Capital intensity (FDIC)	Capital intensity (DC)	R&D expenditure (FDIC)	R&D expenditure (DC)
1991-1992	1.53	1.87	0.41	0.22
1992-1993	1.46	1.90	0.38	0.21
1993-1994	1.50	1.98	0.35	0.21
1994-1995	1.72	2.25	0.43	0.19
1995-1996	1.81	2.42	0.37	0.18
1996-1997	1.84	2.32	0.42	0.22
1997-1998	1.83	2.29	0.36	0.20
1998-1999	1.65	2.15	0.45	0.19
1999-2000	1.72	2.21	0.44	0.18
2000-2001	1.76	2.15	0.31	0.20
2001-2002	1.74	2.06	0.29	0.23
2002-2003	1.84	2.01	0.38	0.18
Average				
1991-2003	1.70	2.13	0.38	0.20
1991-1997	1.64	2.12	0.39	0.21
1997-2003	1.76	2.15	0.37	0.20

Interesting observations can be made from the table. FDI companies are less capital intensive compared to the domestic companies, as the overall ratio was 1.70 for FDI companies and 2.13 for domestic companies. The capital intensity in both the categories is on the rise as the year-wise figures reveal. The observation is not surprising as in the post-reform period there was considerable restructuring of the corporate sector in India. Modernization and employment rationalization being the integral part of the process, the outcome can be said to be rising capital intensity. Coming to research and development expenditure what emerges from our analysis is that FDI companies are spending more on research and development as they on an average spent 0.38 per cent of sales on research and development

while the domestic companies on an average spent 0.20 per cent of sales. However what is revealing to note is the fact that there has been a decline in the spending over the years in both the sectors.

Conclusion

From the comparative analysis of the working of the FDI companies and domestic companies based on their financial statements, it has been found that there is less reliance on outside finance by the FDI companies compared to the domestic companies. Resource use efficiency and profitability was also found as high among the FDI companies. The FDI companies are also contributing more to domestic savings and to the exchequer by way of corporate tax. On the trade performance front however the emerging trend in not very encouraging, as export intensity of FDI companies are low and is recording subdued growth compared to the domestic companies. When considered the total foreign currency earnings trend is more or less similar. At the same time it is also significant to note that on the import front and on total foreign currency expenditure too there was similar performance that import intensity and foreign currency expenditure of FDI companies are low compared to the domestic companies. As a result on a net basis the performance of FDI companies appears as better in recent years as they have contributed to foreign exchange while the domestic companies are net spenders. Compared to domestic companies the FDI companies are less capital intensive and are also spending more on research and development. Thus on the whole on several counts performance of FDI companies appears to be better. However their export orientation needs acceleration.

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Man can't help hoping even if he is a scientist. He can only hope more accurately.

– Karl A. Menninger

Feature

WTO and the Behaviour of the External Sector of India

Apurba Kumar Chattopadhyay

This paper reveals short run vulnerability of our external sector under the WTO regime. However, the steady inflow of FDI, the upward trend in the net invisibles and private transfers have resulted in a surplus in India's current account balance over the last couple of years, even though, the share of India's export in context of world export continued to remain at less than one per cent. The long-term impact of the WTO regime on the Indian economy will thus remain dependent on the success of the new foreign trade policy, which has emphasised the doubling of India's share of global merchandise trade by 2009, with a thrust on employment generation.

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The behaviour of India's foreign trade sector has become an important research area ever since the formation of the WTO (World Trade Organisation). It is widely believed that the transformation of GATT into WTO, whose scope and coverage is much wider than the former, was an implicit attempt to strengthen the domination of the so-called first world countries over the former colonial countries (developing countries) (Datt 1997; Ghosh 1998; Bagchi 1999; Bhaduri 1999). However, the avowed aim of the WTO was to create a fair and equitable rule-based multilateral trade system, which would ensure greater trade flows for all its participating members thereby ensuring fair distribution of the fruits of global economic development. But the desire to integrate nation states within the overall framework of the WTO reminds us of the arguments favouring the theory of 'comparative cost advantage' and free trade.

The imperialist nations during the (nineteenth and twentieth centuries emphasised capital and technology flows into the colonial countries. However, the evidence from history reveals that all these trade, capital and technology flows helped the imperialist nations benefited at the cost of the colonial countries that remained in stagnation and poverty (Datt 1997).

The proponents of the new-liberalisation policy, on the other hand, have sought to rubbish the fear of the developing countries of 'unfair trade' by the developed countries (Bhagwati 2004). In fact, the present day globalisation at the behest of the WTO is fundamentally different from the nineteenth and early twentieth centuries in that the earlier integration of the world economy was driven more by technological developments in transportation and communications than policy changes. Secondly, the new information technologies have created a landscape where movements of services and capital are faster by several orders of magnitude. Thirdly, the sense of vulnerability or economic insecurity is greater today than in earlier

periods because the growing integration of nations worldwide into the international economy has intensified competitive pressures from actual and potential rivals elsewhere. Finally, fears that globalisation intensifies interdependence among nation states and increasingly constrains their ability to provide for the welfare of their citizens have a relevance that did not quite obtain in the earlier period. Thus it is argued that the "long-term effects of policies depend much more on the nature of the society in question and, in particular, on the nature and strengths of the various social forces within it" (Pederson, 2000).

The WTO has already completed more than ten years of its existence with 148 members in February 2005 and 95 per cent of the global trade governed by the rules and regulations of the WTO. On the whole India did well during the period. The restructuring of the economy has been going on steadily with the tertiary sector and the secondary sector improving their share in the GDP at the cost of the primary sector. It is interesting to note that during 1990-91 to 2002-03, the share of the primary sector in the real GDP has reduced from 35 per cent to 24 per cent and the share of the service sector increased from 41 per cent to 51 per cent. The overall growth of the economy during the 1990s has been impressive compared to the same during the earlier decades. The rate of growth of real GDP was 3.78 per cent during 1951-52 to 1981-82, which increased to 5.14 per cent during 1981-82 to 1991-92 and further in 6.09 per cent during 1991-92 to 2001-02 with the service sector growing at the highest rate during the later periods.

This paper seeks to review India's experience in terms of her external sector to find out how the WTO regime has impacted on its trends and prospects. Further, it also tries to relate the changes in the external sector with the changes in the overall economy during the period.

Evolution of Government's Policy Relating to the External Sector

The government's economic policies have evolved over time to meet the requirements of the process of economic development in different phases. It is well known that we have started planned economic development in 1951 with the inception of the First Five Year plan. However, it was only in the Second Five Year Plan that the planners had clearly spelt out the strategy of development. This strategy emphasised investment in heavy industry to achieve industrial base in the country, which was assumed to be the prerequisite for rapid economic development. This called fro massive investment in heavy industries with long gestation period and very low profitability and thus this strategy assigned a dominant role to the public sector. This 'heavy industries' investment strategy formulated during the second plan was the basis of the development of the Indian economy till the 1980s. An important feature of the planning since the second plan has been the heavy trade deficit. It was due to large imports of capital goods to develop heavy and basic industries, the failure of agricultural production to meet the increasing domestic demand for food and raw materials and the inability of the economy to increase export. In fact due to inadequate infrastructure, lack of experience and the necessity of learning by doing, the gestation period and the cost of production had increased many fold. This in turn increased the cost of production of all industries that used them as inputs. As the country was following 'import substituting industrialisation policy', these high cost domestic industries were protected against foreign imports by the imposition of tariffs and quotas. To stimulate investment in spite of the high costs of domestically produced capital goods, capital was subsidised through cheap credit and thus, factor prices got distorted. This resulted in choice of more capital-intensive techniques than was appropriate and this aggravated the unemployment problem (Parikh, 2002).

This restrictive import policy along with thrust for export promotion continued till 1975-76, to alleviate adverse balance of payments (BOP) problems (the rupee was devalued in June, 1966). Then came a stage when the government adopted a policy of import liberalisation with a view to encourage export promotion. However, our experience with this policy was also not good and India faced a serious BOP (balance of payment) crisis in the middle of 1991. The foreign exchange reserves had reduced to a level barely adequate to meet essential imports for a few weeks. Thus India seemed to be entering into a situation of imminent default on foreign payments. To cope with the imminent problem India adopted the policy of economic reforms. The external sector was at the centre stage of reform package that included exchange rate devaluation in 1991, introduction of the market based exchange rate system in a phased manner, dismantling of tariff and non-tariff barriers and encouragement of foreign direct investment (FDI).

Behaviour of India's External Sector

The behaviour of import and export clearly reveal that India since her independence has failed to achieve surplus in the trade balance excepting in the years 1972-73 and 1976-77. As we have noted earlier the policy of import substitution along with emphasis on

heavy industry without inheriting adequate capital, technology, skill and efficiency have led to a tremendous outflow of resource in terms of the remittances of profit, dividend technical fees, etc. during the 1950s and early 1960s. This along with the extensive dependence of Indian industries on foreign technologies, skills and capital has been acting as the proximate factors behind the chronic BOP deficit pressing our economy.

On the other hand, the oil price hike in the international market was an important cause of adverse trade balance in the 1970s, which culminated in crisis situation at the end of the 1980s. In fact, the Gulf war of 1990 disrupted oil supplies in the international market causing huge escalation of India's oil import bill after nearly a decade of relatively cheap oil imports. This conflict also affected the remittances sent in by the large number of migrant Indian workers in Kuwait and Iraq, which were an important element of total invisible inflows (Ghosh 1999, p. 323). It is now well known that the immediate cause of the 1991 crisis was the BOP problem when India seemed to be entering into a situation of imminent default on foreign payments. The data on annual rate of growth of export and import in India have been presented in Table-1. It is seen that during 1981-91, the export and import were growing at an annual rate of 7.67 per cent and 4.33 per cent respectively. As a result of the policies of globalisation followed by India since 1991, the annual rates of growth of export and import have increased. However, the increase in the rate of growth of import has been greater than of export. Thus, during 1990-91 to 2002-03, the increase in the rate of growth of export was 2.06 percentage points as against 5.11 percentage points increase in the rate of growth of import during the same period in comparison with the earlier decade. Now if we consider the period after the formation of WTO in 1995 (India is a founder member of WTO), the export of India has grown at an annual compound rate of 9 per cent (Table 1) whereas, the import has grown at a rate of 10 per cent during the same period (1994-95 to 2002-03).

Table 1: Annual Rate of Growth of Export and Import in India

(Percent)

Year	Export	Import
1981-1991	7.67	4.33
1991-2001	9.06	8.89
1991-2003	9.73	9.44
1991-1995	11.17	8.19
1995-2003	9.02	10.07

Note: The compound Growth rates have been calculated on the basis of three yearly moving averages of exports and imports (in million $) for the end years.

Source: Economic Survey 2004-05, Government of India.

The overall growth rates in the trade sector during the WTO regime are no better than the same during the first half of the 1990s. The rate of growth of import also surpassed the rate of growth of export in the post WTO-period. In fact, during 1991-95 the export had grown at a higher rate than in the following period. This fact is also corroborated by the time profile of relative share of export and import (Table 2). The ratio of export to import increased from 0.66 to 0.85 during 1990-91 to 1993-94 indicating that the increase in export has been more than the increase in imports during the period. However, the ratio decreased thereafter till 2000-01, which meant sharper increase in import relative to export. This may be because of the fact that following liberalisation the industrial structure in India has become more dependent upon and also sensitive to imports than ever before. The domestic producers of manufactured goods rely increasingly on assembly of imported inputs rather than creation of higher value added goods and enter into collaborations based on exploiting multinational brand names in fairly standard multinational brand names in fairly standard consumer products (Ghosh, 1999). The trade policies pursued internationally seem also to have adversely affected the external sector of our economy. Our performance would have been much better if the globalisers had not followed protectionist policies on one pretext or another (Chattopadhyay and Ghosal, 2004).

Table 2: Selected Indicators of External Sector

Year	Imports (c.i.f.)	Exports (f.o.b.)	Trade Balance	Net Invisibles	Current Account Balance	Export/ Import
1990-1	50086 (09.80)	33153 (6.49)	–16933 (3.31)	-433 (0.08)	–17366 (3.40)	0.66
1993-4	83869 (10.73)	71146 (9.11)	–12723 (1.63)	9087 (1.16)	–3636 (0.47)	0.85
1995-6	146542 (13.65)	108481 (10.11)	–38061 (3.55)	18416 (1.72)	19645 (1.83)	0.74
1996-7	173753 (13.97)	121194 (9.75)	–52560 (4.23)	36279 (2.92)	–16281 (1.31)	0.70
1997-8	190508 (13.71)	132703 (9.55)	–57805 (4.16)	36922 (2.66)	–20883 (1.50)	0.70
1998-9	199914 (12.37)	144436 (8.94)	–55478 (3.43)	38689 (2.39)	–16789 (1.04)	0.72
1999-0	240112 (13.63)	162753 (9.24)	-77359 (4.39)	57028 (3.24)	–20331 (0.12)	0.68
2000-1	264589 (13.90)	207852 (10.92)	–56737 (2.98)	45139 (2.37)	–11598 (0.61)	0.79
2001-2	268300 (12.89)	213345 (10.25)	–54955 (2.64)	71381 (3.43)	+16426 (0.79)	0.80
2002-3	311766 (13.83)	260079 (11.53)	–51697 (2.29)	82357 (3.65)	+30660 (1.36)	0.83

Note: 1. Amounts are in Rupees (Crores) & the figures in parentheses indicate percentage of GDP (at current prices).

Source: Economic Survey 2000-01, 2004-05, Govt. of India.

However, one of the primary aims of globalisation of our economy was to integrate the Indian economy with that of the global economy. This goal has been accomplished during the period. The shares of exports and imports in the GDP have moved upward. The export rose to about 12 per cent of the GDP in 2002-03 from about 6 per cent in 1990-91 (Table 2). Imports on the other hand, have grown from 10 per cent in 1990-91 to 14 per cent of the GDP in 2002-03. Thus the Indian economy is increasingly becoming more integrated with the global economy with foreign trade accounting for more than 25 per cent of the GDP in 2002-03 from 16 per cent of GDP in 1990-91. However, the data in Table-2 reveals clearly that the changes in the merchandise trade were larger during the first half of the 1990s compared to the later period. For example, export as a proportion of GDP increased from about 5 per cent to 10 per cent during 1990-91 to 1995-96, which further increased to about 12 per cent during the subsequent period. Thus the share of foreign trade (exports and imports taken together) increased from 16 per cent to 24 per cent of the GDP during 1990-91 to 1995-96 but the same increased by only one percentage point during the subsequent period ending with 2002- 03.

Now, let us focus our attention on the year-to-year change in the Indian trade sector. We find the growth of exports has not been uniform over the years. It was negative (-5.1%) in 1998-99 as compared with the previous year but improved to 11 per cent in the following years. It is now believed that the East Asian crisis during 1997-98 had contributed largely towards the slump in export growth in the following year. The growth of exports witnessed a sharp increase to 21 per cent during 2000-01 following the recovery of the East Asian Crisis and due to the buoyancy in world demand. However, the performance has once again been dismal in 2001-02 with a negative growth rate of about 2 per cent, which has been followed by a further increase of more than 20 per cent in the two subsequent years 2002-03 and 2003-04, as the world economy recovered from earlier sluggishness. It is clearly manifested in a sharp increase in demand for merchandise exports from the export-oriented economies of developing Asia accompanied by strong inflow of workers' remittances which, as we will see, resulted in surplus in the current account balance followed by a concomitant rise in the volume of reserves.

On the other hand, the imports too show an uneven performance in the post-globalised period. During 1991-95, it has grown at an annual rate of 8 per cent, which increased to 10 per cent during 1995-2003 periods i.e., during the WTO regime. The import value (in terms of US dollar) increased by 28 per cent during 1995-96 as compared to the previous year. But, the increase in import was Just 2 per cent in 1998-99 before rising again to 17 per cent in 1999-00 and then falling to about 2 per cent again during the following two consecutive years before finally rising to about 27 per cent in 2003-04. The recent growth in the import bill is mainly due to a rise in the international price in oil. The behaviour of export and import over the period under consideration can be discerned from Fig. 1. It reveals a highly undulating profile of the annual percentage change in respect of total exports and imports during the WTO period. This clearly indicates both long run potential and short run vulnerability of our external sector under the new regime.

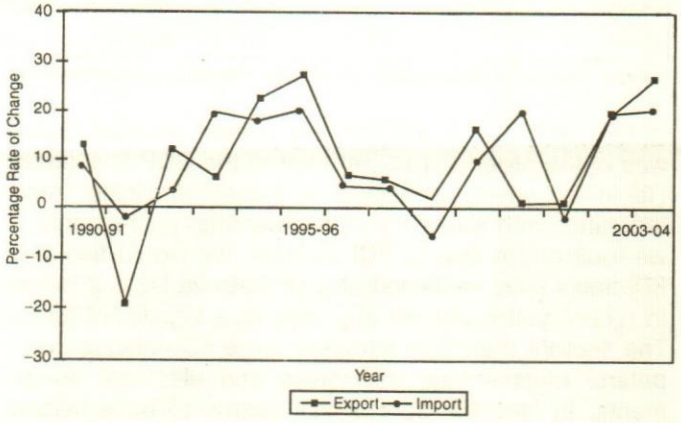

Fig. 1. Pattern of growth of Export & Import in India

It is interesting to note the changing profile of the flows of net invisibles in the current account balance. The net invisibles in current account include receipts and payments for such services as shipping, banking, travel, non-factor services and private transfers. The non-factor services include net export of software services and private transfers include workers remittances. In India the net invisibles is generally positive (it was negative in 1990-91) and is used to reduce trade deficit. We have presented data on the selected indicators of external sector in Table 2. It may be seen that the net invisibles have increased steadily during the reforms period. It was just 1.16 per cent of the GDP in 1993-94, which increased to 3.65 per cent in 2002-03. The increases were particularly sharp from the year 2002-02. The upward trend in the net invisibles is the result of the buoyancy in the software service exports and private transfers. In fact, non-factor services and private transfers comprised more than 70 per cent of total invisible receipts in dollar terms during 2001-02 to 2003-4. The current account balance has been witnessing surplus in last couple of years. This current account surplus during the current decade can largely be attributed to the buoyant inflows of invisible receipts.

It is well known that the performance of current account can be best judged by expressing it as proportion

Table 3: Export Growth and Share in World Exports of Selected Countries

	Percentage Growth Rate			Share in World Export						
Country	1995-01	2002	2003	1995	1997	1998	1999	2001	2002	2003
China	12.4	22.4	34.5	2.92	3.32	3.39	3.50	4.3	5.1	5.9
Malaysia	6.6	6.0	6.5	1.45	1.43	1.35	1.52	1.4	1.5	1.3
Indonesia	5.7	3.0	5.1	0.89	0.97	0.90	0.87	0.9	0.9	0.8
Singapore	4.1	2.8	15.2	2.32	2.27	2.03	2.06	2.0	1.9	1.9
Thailand	5.9	5.6	17.1	1.11	1.04	1.01	1.05	1.1	1.1	1.1
India	8.5	13.6	15.8	0.60	0.64	0.62	0.65	0.7	0.8	0.8
Developing Countries	7.9	7.9	18.4	32.01	33.83	32.24	33.09	36.8	37.9	38.7
World	5.5	4.8	15.9	100	100	100	100	100	100	100

Source: Economic Survey 2004-05 & International Financial Statistics February, 2001.

of the GDP. It is found that the current account deficit was of the order of 1.83 per cent of the GDP in 1995-96 (Table 2), which witnessed a steady declining trend thereafter with some minor fluctuations. Interestingly, if we look at the flow of FDI to India, we would find that FDI flows have remained at a little above US $ 2 billion in recent years without any sign of a significant jump. The sectors that have attracted large FDI include computers, engineering, electronics and electrical equipments. In fact, the flow of FDI seems to have helped improving India's BOP. The above developments led to an overall surplus, which was added to the foreign exchange reserves during 2001-02.

Overall, the above indicators point toward a moderate level of external debt and a fairly comfortable level of resources at present. The strength in the external sector is reflected by the fact that India has been able to withstand the adverse effect of the financial crisis in East Asia, the international oil price rise and the removal of quantitative restrictions following the WTO agreement. Thus, our experience with India's external sector over the last couple of years does not quite support the pessimistic view expressed by some scholars earlier regarding possible impact of the WTO regime. However, so far as the performance domestic economy or to be specific, the performances of the industry and agricultural sectors are concerned, we do not find any buoyancy in respect of growth of either production or productivity since the economic reforms. Further, world competition of technology and the inability of our economy to adapt and assimilate the modern sophisticated technology in the manufacturing sector have also led to a fall in the demand for Indian products in the international market, thereby leading to an unimpressive expansion of export in relation to the import. Further, the trade policies pursued internationally seems also to have adversely affected the external sector of our economy especially after the inception of the reform package. Astonishingly, the policy of liberalisation of agricultural trade focusing mainly on the reduction and eventual elimination of subsidies and complete deregulation of trade in agricultural goods, has made Indian agricultural products unable to compete with the same coming from European countries and Japan, especially after the reforms.

On the other hand, it is widely recognised that we have experienced a chronic stagnation in respect of industrial production for a long period from mid-1960s to 1978. Nevertheless we had been able to overcome this stagnation through a gradual liberalisation of the export sector since the 1980s and the pursuance of the FDI friendly policy for the modernisation of our industries in 1980s. However, even after the extensive deregulation of the trade, investment and finance as an outcome of the adoption of the policy of reform, we continued to experience a disappointing performance of Indian industries since 1992. In fact, whatever remarkable growth has been achieved during the WTO regime has been the service sector driven growth indicating structural transformation of the Indian economy. So one can plausibly say that the formation of the WTO has failed to provide the required impetus to the industrial and agricultural sectors of the Indian economy.

Comparative Study of Performance of India and other Developing Countries during the WTO Regime

One way of judging the performance of one's economy is to make a comparative study with other countries. We present data on the percentage growth rates of exports and share of their exports in the world exports for some selected Asian countries in Table 3.

During the entire period, the rate of growth of exports of the developing countries was higher than the world as a whole. Thus, while world exports grew at the rate of 5.5 per cent during 1995-01, the exports of the developing countries grew at the rate of 7.9 per cent. Similarly during

the last few years also the rate of growth of exports of the developing countries as a whole exceeded the world export growth. However, within the developing countries, India's export growth rate cannot be termed as spectacular although her export growth rates mostly remained greater than the growth rates of exports of the developing countries. On the contrary, the rate of growth of exports of China was spectacular during the entire period. However, we must remember of the WTO. China's share in the world export has doubled during 1995-03 while the share of India in the world export has increased from 0.6 per cent to 0.8 per cent during the same period. The shares of many small countries in the world exports and greater than India even so many years after the initiation of the globalisation process in India. Thus, the new foreign trade policy for 2004-09 envisages "doubling India's share of global merchandise trade by 2009 and using trade policy as an effective instrument of economic growth with a thrust on employment generation".

Concluding Observations

India after her independence has changed policies concerning the external sector several times to suit the goals of her planned economic development. However the impact of policy changes effected for being a member of the WTO on the Indian economy has become an important research area ever since the formation of the WTO. This paper has attempted to address the issue by focusing on the external sector, which remained at the heart of the globalisation process initiated by India in 1991. It is found that the exports and imports have increased during the post-WTO period. The shares of exports and imports in the GDP have also moved upward indicating further integration of the Indian economy with the world economy. However, the annual percentage change of total exports during the period reveals a highly undulating profile. This clearly indicates short run vulnerability of our external sector under the new regime. On the other hand, India has witnessed remarkable changes in the current account balance during last few years. The steady inflow of FDI, the upward trend in the net invisibles as a result of the buoyancy in the software service exports and private transfers have resulted in surplus in India's current account balance during the last couple of years even though, the share of India's export in the world export continued to remain at less than one per cent.

The growing strength of the economy has been amply demonstrated by its ability to cope with the recent tsunami disaster without any external assistance. It could also withstand the adverse effects of the financial crisis in East Asia, sharp rises in the international oil price and removal of quantitative restrictions following the WTO agreement. The overall growth rate has been very impressive compared to the earlier decades. The structural transformation of the economy has got a fillip during the period with the tertiary sector accounting for more than half of the GDP.

However, the performances of the industry and agricultural sectors during the period were far from impressive. The formation of the WTO has failed to impart any impetus to the industrial and agricultural sectors of the Indian economy. The policy of liberalisation of agricultural trade focusing mainly on the reduction and eventual elimination of subsides and complete deregulation of trade in agricultural goods has put Indian agricultural products at a disadvantage. The lack of meaningful growth in agriculture and industry, which are the main source of employment, resulted in unemployment. The employment growth rates have been negative in the 1990s both in the rural and urban areas. This has been the most devastating impact of globalisation and subsequent formation of the WTO in the 1990s. The new foreign trade policy (2004-09) of India thus has emphasised two major objectives:

1. doubling of India's share in the global merchandise trade by 2009 and
2. making the trade policy an effective instrument of economic growth with a thrust on employment generation. The long-term impact of the WTO regime on the Indian economy will thus remain dependent on the success of the new foreign trade policy.

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Feature

Ownership and Diffusion of Household Durables

Bijaya Kumar Panda

This study explores the effect of some of the important determinants on ownership of major and minor durables. Income plays a vital role in the purchase of both major and minor durables. At a certain threshold level of income, different major and minor durables are owned. This study has estimated the ownership probabilities, threshold level of income for ownership and extent of diffusion of various major and minor durables among different groups of households using the Logit and Probit model.

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The traditional neo-classical theory of consumer behaviour is static in nature, yielding equilibrium values for quantities demanded and implying an instantaneous adjustment to new equilibrium values in response to change in prices or total expenditure. In practice, however, consumers frequently adjust only gradually to such changes, i.e. there are 'lags' involved in their movement to a new equilibrium. There are two main reasons for such lags – the durability of many consumer goods and the existence of habits developed as a result of past consumption. The fact that stocks of durables last for more than one 'period' means that past purchases influence present behaviour and that present behaviour has implications for the future. Unlike the demand for most non-durables which can reasonably be treated as continuous variables, the typical demand for durables is very much a discrete quantity. A household cannot increase expenditure on such items by purchasing one-fourth or one-fifth of it.

The purchase behaviour of durables is quite different from that of non-durables. The very nature of infrequent purchase behaviour of durables paves the way for separate studies on ownership pattern of durables. Ownership of durables has certain peculiar characteristics. When a new durable is introduced the fraction of owners in the population will increase. This is what we call diffusion of durables, which may be the outcome of numbers of economic variables. This will continue till all the potential buyers own it. Ultimately it becomes an established commodity in the process. Some durables become outmoded which are no longer in demand due to availability of better substitutes. In this study an attempt is made to estimate the ownership probabilities and the threshold income of acquiring durables, and also to explore the effect of some of the important determinants of ownership of durables and extent of diffusion of these durables among different categories of households.

A number of studies had been done relating to television ownership in U.S. (Masy, 1960); in U.K. (Bain

1962, 1964); in West Germany (Bonus, 1968); and in Finland (Lerviks, 1969) in which a cumulative log, normal growth of television ownership, was observed. The logit model has been estimated in a number of other studies, viz., Pyatt (1964); Cramer (1962, 1969); Cragg and Uhler (1970); Libermann and Paroush (1982) for ownership by major durables. Bowden and Turner (1993) have identified distinct diffusion curves for the different models of motorcars and found significant differences in the regional motorcar ownership in the UK economy. The authors assessed the viability of applying mass production strategy as pursued in USA. Given the demand-side constraints present in the UK market, the price of motorcar was reduced by exploiting economies of scale to create a mass market. But the response for motorcar ownership was relatively low due to the constraints perceived by the firms. Pattanaik (1994) has used logit model and Pattanaik (2004) has used both logit and probit models to examine for ownership and diffusion of both major and minor durables.

The objective of the present study is to explore various aspects of consumer behaviour in the purchase of major and minor durables. The study explores the effect of some of the important determinants on ownership of major and minor durables. Income plays a vital role in the purchase of both major and minor durables. At a certain threshold level of income different major and minor durables are owned. We have estimated the ownership probabilities, threshold level of income for ownership and extent of diffusion of various major and minor durables among different groups of households using logit and probit models.

Methodology

It is an empirical study based on primary data collected during the first quarter of 2004 (January to March, 2004). The primary data was collected by a sample survey of 300 households of Digapahandi NAC, a small town of Orissa with commercial importance. The area of investigation has been divided into three segments on the basis of location and occupation of the head of the household. Segment-1 basically constitutes small colonies of government and semi-government officials, segment-2 is a commercial area with thick concentration business community on the either sides of the National Highway and finally segment-3 constitutes the lanes where farmers and other working class people reside. The list of households of the three segments were prepared separately for each segment and 100 households were drawn at random (using random table) from each segment of the town. For the collection of the data, Household Expenditure Survey schedules specially prepared for the purpose were canvassed.

Data has been collected in the course of homely discussion with the head of the household and his wife. Sometimes, the children of the family and other elder members were also consulted to get answers of certain sensitive questions related to decision-making process. The time-series data on the stock of durables has been generated from the information collected on the year of purchase of different durables already possessed by the households.

Models on Ownership and Diffusion of Durables

For many durables, the choice is between ownership and non-ownership, and so conventional demand analysis is irrelevant in the situation of discrete choice. It is assumed that ownership can be had on payment of an annual rental, v^*. The single period budget constraint conditional on total expenditure is then,

$$pq + v^*s = x \qquad \ldots(2.1)$$

where 'p' is price vector and 'q' is the quantity vector of non-durables. We take $s=1$, if a particular durable is owned and $s=0$, if it is not owned by a household. Let the single period utility function be,

$$U = U(q, s, \varepsilon) \qquad \ldots(2.2)$$

where 'ε' represents parameters, which differs from household to household and that pick up difference in tastes and preferences, in some circumstances also the variation in households size and its composition, region, rural or urban resident and so on (which can be part of ε). If ε is given, the latter tells us the threshold expenditure of a family of given type.

If the households choose not to own durables, non-durable consumption is x/p and when they choose to own, it is $(x-v^*)/p$. U_0 is taken as utility level for non-ownership and U_1 is taken as utility level for ownership of durables. We find

$$U_0 = U_0(x/p, 0, \varepsilon) \qquad \ldots(2.3)$$

$$U_1 = U_1\{(x-v^*)/p, 1, \varepsilon\} \qquad \ldots(2.4)$$

When $U_i > U_0$, households will own a durable; if $U_i < U_0$ households will not own a durable; and x and ε determine that which households belong to which category.

In general if $f(x,\varepsilon)$ is the joint density function of x and ε, the proportion of households with expenditure 'x', who own the durable g(x) is given by

$$g(x) = \frac{\int_{-\infty}^{\phi(x/v^*)} f(x,\varepsilon)\, d\varepsilon}{\int_{-\infty}^{\infty} f(x,\varepsilon)\, d\varepsilon} \qquad \ldots(2.5)$$

Where ϕ (x/v^*) is an increasing function (x/v^*) and $(x/v^*\text{-}1\text{-}a)$, defining the highest level of ε that results in ownership. Equation (2.5) provides a basis in utility theory for 'Quasi' Engel curves linking ownership in any income bracket (Aitchison and Brown, 1957; Cramer, 1969 and Pyatt, 1964). These models can be estimated directly by maximum likelihood method. If we ignore taste differences other than those captured by ε, then g(x) in (2.5) is the probability of a randomly selected household owning the durable conditional on household expenditure, x. In the traditional formulation 'x' is usually interpreted as income and 'ε' itself as the threshold income level above which ownership occurs, hence, $s = 0$ if $x < \varepsilon$ and $s = 1$ if $x \geq \varepsilon$. If we assum 'ε' is distributed independently of 'x', it has log-normal distribution with parameters μ and σ^2 then (2.5) is replaced by

$$g(x) = \text{Prob}(s=1;\, x) = \int_{-\alpha}^{x} f(\varepsilon;\, \mu,\sigma^2) = f(x;\, \mu,\, \sigma^2) \qquad \ldots(2.6)$$

where (2.6) is the cumulative distribution function of the log normal distribution. Note that (2.5) is considerably more general than (2.6) and the former has the advantage of giving systematic basis for the inclusion of variables such as prices or household characteristics as well as suggesting explicit form of threshold income.

Bonus (1973) has observed that when a new durable good is introduced, the fraction of owner of the new durable good in the population increases. The fraction of owner of a new durable good when plotted again time; the result is a growth curve (or a Quasi Engel curve) which is logistic in some cases or skewed in others. It is the joint outcome of both innovation and diffusion or rising income etc. The logistic curve is usually taken as evidence for 'epidemic diffusion'. Empirical analysis of a series of subsequent cross-sections reveals, however, that logistic growth curves results when 'no diffusion' occurs that is growth is fully income induced (Bonus and Schweinitz, 1968). Skewness of growth curves is obtained when there is 'learning' or when a durable good is transformed from a luxury into a necessity. This type of growth curve is positively skewed and resembles a cumulated log-normal curve. It was observed during the spread of television ownership in USA (Massy, 1960); in UK (Bain, 1962 and 1964); in West Germany (Bonus, 1968) and in Finland (Lerviks, 1969). The most familiar interpretation of the symmetric logistic curve is that it results from a simple epidemic diffusion process. Consequently, most of the models for new durables adoption are built around a logistic which represent the diffusion component and its parameters are made functions of economic variables like income. The changes in the economic variables had, therefore, no effect on ownership growth and hence, the growth curve was caused by diffusion alone. But observed logistic growth curve indicates absence of diffusion and at least absence of diffusion by learning.

Suppose a household would purchase a given durable at time 't', provided his income 'm' reached or exceeded a certain critical level. He is then called a potential owner. Among all potential owners whose income is 'm_0' and those with critical incomes not exceeding 'm_0' will be the actual owners. A Quasi Engel curve assigns at a given point of time and to each income level the corresponding fraction of actual owners. It may be viewed as the cumulative distribution of critical incomes of the population. Let us denote the Quasi-Engel curve at 't' by $f_i(m)$, the income distribution by $g_i(m)$, fraction of owners in the population by F_t and $f_t(m)$ is the fraction of owners among all households with income 'm' then,

$$F_t = \int_0^{\infty} f_t(m) g_i(m) dm \qquad \ldots(2.7)$$

Quasi Engel curve have been measured from cross-sectional data by several authors (Farrell, 1954; Cramer, 1958, 1962 and Vangrevelinghe, 1965). It was also found that these curves are approximately lognormal in most cases and the corresponding curves are termed as Pseudo Engel curve. The Pseudo Engel curves as referred by Aitchsion and Brown (1957) is,

$$f_t(m) = F_t^* \Lambda\, (m/\mu_{1t},\, \sigma_{1t}^2) \qquad \ldots(2.8)$$

Where F_t^*, $0 < F_t^* < 1$, is the fraction of potential owners in the population. If F_t^* increases with time, more households than before become 'susceptible' to the innovation. This is due to vertical diffusion but not due to quality improvement. This does not mean that they will purchase the good as their critical income is well above their actual income. It implies that they will assign a critical income for the possession of the good. Ryan and Gross (1943) distinguished two types of diffusion - vertical diffusion and horizontal diffusion. Vertical diffusion is associated with underlying learning process by which households become sufficiently aware of the commodity and desire its ownership. As the desire to own the durable good is intensified, their critical and threshold income of actual ownership is reduced.

Horizontal diffusion, on the other hand, induces households that are aware of the durable good and potentially interested in its possession by revising their budget to allow for actual ownership of the good at a lower income.

For computational convenience Bonus (1968) has used the simple logit model to estimate the parameters μ_{it} and σ_{it}^2 of equation (2.8). Suppose the fraction of potential owner, $F_t^* = 1$. and let P_{it} be the probability that a randomly selected household given the income, m_{it} owns the durable. The odds in favour of ownership are $\left(\frac{P_{it}}{1-P_{it}}\right)$ and the model will be that of the odds is a log-linear function of real household income.

$$\log\left(\frac{P_{it}}{1-P_{it}}\right) = \alpha_t + \beta_t \log m_{it} + \in_t \ (m_{it} > 0) \quad \ldots(2.9)$$

It can be shown that $\mu_{it} = -\left(\frac{\beta_t}{\alpha_t}\right)$ and $\sigma_{it}^2 \cong \frac{2}{\beta_t^2}$ (where $\beta_t > 1$) are estimates of the parameters (2.9) which links (2.7) and (2.8). The probabilities 'p_{it}' associated with (2.9) is not known and to be substituted by observed fractions f_{gt} of owners within the 'g_{th}' income group, $g = 1,2,\ldots..G_t$; 'G_t' being the number of income brackets in the sample. Let $x_{gt} = \log \overline{m}_{gt}$ where $\overline{m}_{gt}$ is the average household income of the 'g_{th}' income brackets at time 't'. Then, the model becomes

$$\log\left(\frac{f_{gt}}{1-f_{gt}}\right) = \alpha_t + \beta_t x_{gt} + v_{gt} \ (g = 1,2,\ldots..G_t) \quad \ldots(2.10)$$

The term on the left hand side of (2.9) and (2.10) are called the logits of ownership. Assuming f_{gt} as an binomial approximation of probability of ownership of a durable, the variance the disturbance term, v_{gt} is the,

$$\text{Var}(v_{gt}) = \frac{\sigma_t^2}{n_{gt} f_{gt} (1 - f_{gt})} \quad \ldots(2.11)$$

Where n_{gt} is the number of households in the 'g_{th}' income bracket. This suggests to use the method Weighted Least Squares (WLS) for the estimation of (2.10).

Bonus used (2.10) for estimating the ownership probability and extent of diffusion of some durables like camera, refrigerator, vacuum cleaner, automobiles and television in West Germany. He observed that television was completely unknown when its spread began in 1954. The fraction of the potential owners grew from 30 per cent, by 1958 to more than 90 per cent in 1967. It was possible due to vertical diffusion. Television was considered to be a luxury item by 1958, but it became an absolute necessity by 1967.

Diffusion of new durables studied by Ironmonger (1972) using deterministic epidemic model gives sigmoid shaped growth curve of the logistic. When a new durable is introduced, some consumers start to consume it; other consumers obtain some knowledge of the want satisfying powers of the new durable as a result of which consumption of that durable increases. The process will continue till stability is reached. He considered a simple model with a constant infection rate, the absolute number of new buyers per unit of time is

$$\frac{dn_a}{dt} = \beta n_a n_b = N\beta n_a - \beta n_a^2 \quad \ldots(2.12)$$

Where, n_a = number of buyers

n_b = number of non-buyers

N = total number of consumers = $n_a + n_b$

The solution of this differential equation gives the logistic equation.

$$n_a = \frac{N}{1+be^{-N\beta t+c}} \quad \ldots(2.13)$$

When c = 0 at t=0, the initial number of 'a' type consumers is $\frac{N}{1+b}$. The initial number of consumers buying a durable is expressed as

$$P_0 = \frac{100}{1+b} \Leftrightarrow b = \frac{100-P_a}{p_0} \quad \ldots(2.14)$$

This initial number of buyers starts to infect the remaining population so that the proportion of buyers in the population increases, exhibiting the sigmoid shaped growth curve. The growth has five stages in which consumers shift from being type 'b' to type 'a' as (i) in first stage, a few initial consumers shift; (ii) in second stage, shifting process increase at an increasing rate; (iii) in third stage, rate of shifting process declines; (iv) in the fourth stage, practically no more shifts occur and (v) finally, a stage is reached when all potential consumers of the durable have become actual owners.

Maximum Likelihood Estimation of Logit and Probit Model

For the estimation of binary choice models, we distinguish two types of data i) data at individual or micro

level and ii) grouped or replicated data. The method of weighted least square (WLS) is appropriate for LPM, logit, probit in case of replicated data but it is not appropriate for the tobit model. But in case of ungrouped micro data neither OLS nor WLS is a suitable method of estimation for all the models except LPM. So in this study, we have resorted to a non-linear method of estimating procedure using the method of maximum likelihood (ML). Since most of the econometric softwares have routines to estimate linear probability, logit, probit and tobit model, a brief outline of this method is necessary for the interpretation of the estimates of this model.

For the estimation of the ownership probabilities of the durables, let us assume the following formulation of the logit model with parameter β_0 and β_1.

$$P_i = \frac{1}{1+e^{-(\beta_0+\beta_i x_t)}} \qquad ...(2.15)$$

We don't actually observe P_i, but only observe the outcome Y = 1 if a household owns a durable and Y = 0 if the household does not own it. Since each 'Y_i' is a Bernoulli random variable, we can write Prob(Y_i = 1) = P_i and Prob(Y_i = 0) = (1 – P_i). Let f_i (Y_i) denote the probability Y_i = 1 or 0; the joint probability of observing all the 'n' values of Y_i is given by the likelihood function (LF).

$$L=f(Y_1,Y_2,.....Y_n)=\prod_{i=1}^{It} f_i(Y_i)=\prod_{i=1}^{It} P_i^{Y_i}(1-P_i)^{1-y_i} \qquad ...(2.16)$$

Taking the natural log of (2.16), the log-likelihood function is

$$\ln(L)=\ln[f(Y_1,Y_2,.....Y_n)]=\sum_{i=1}^{n}[Y_i \ln P_i+(1-Y_i)\ln(1-P_i)] \qquad ...(2.17)$$

$$=\sum_{i=1}^{n}[Y_t \ln P_t+\ln(1-P_t)-Y_t \ln(1-P_t)]$$

$$=\sum_{i=1}^{n}\left\{Y_i \ln\left(\frac{P_i}{1-P_i}\right)+\sum \ln(1-P_i)\right\} \qquad ...(2.18)$$

From (2.15) we have,

$$\text{But } (1-P_i)=\frac{1}{1+e^{\beta_0+\beta_i x_i}} \text{ and } \quad \ln\left(\frac{P_i}{1-P_i}\right)=\beta_0-\beta_1 X_i \qquad ...(2.19)$$

Substitute the equations from (2.19) into (2.18) we have,

$$\ln(L) = \ln[f(Y_1, Y_2, ...Y_n)]$$

$$=\sum_{i=1}^{n} Y_i(\beta_0+\beta_1 X_i)-\sum_{i=1}^{n}\ln\left[1+e^{\beta_0+\beta_1 X_i}\right] \qquad ...(2.20)$$

Since all X_i's are known, the log-likelihood function (2.20) is a function of the parameter β_0 and β_1. The objective is to maximize (2.20) w.r.t. β_0 and β_1, to obtain the unknown values of the parameters such that the probability of observing the 'Y_i' values will be the maximum. For this we differentiate (2.20) partially w.r.t. to β_0 and β_1, we find the resulting expressions become highly non-linear in the parameters and no explicit solution can be obtained. So we will have to use one of the methods of non-linear estimation, the method of maximum likelihood (ML). The ML procedure for the probit model is similar to that of logit model except that in (2.15), we use the normal CDF rather than the logistic CDF. The resulting expression becomes rather more complicated but the procedure is almost same.

As the method of maximum likelihood is a large sample method, instead of using "t' statistic to evaluate the individual statistical significance of the coefficients we have to use the 'z' statistic (standardised normal) to evaluate the individual significance of the coefficients. But as the sample size increases, the 't' distribution approaches to a 'z' distribution, we can still use 't' test to evaluate the individual statistical significance of the coefficients in both the logit and probit models.

It should be noted that in binary choice models, goodness of fit test is of secondary importance. What matters is the expected signs of the regression coefficients and their statistical and practical significance. The conventional method of goodness of fit, R^2 is not particularly meaningful in binary regression models. A variety of pseudo R^2, measures similar to R^2, are used to test the joint significance of the parameters. One such measure is McFadden R^2 or R^2_{McF}. R^2_{McF} also ranges between 0 to 1. Technically, it is defined as,

$$R^2_{McF} = 1 - (LLF_{ur} / LLF_r) \qquad ...(2.21)$$

where LLF_{ur} is the unrestricted log-likelihood function in which all the regressors are included in the model and LLF_r is the restricted log-likelihood function in which only the intercepts are included in the likelihood function.

A second option is to calculate the residuals $\hat{\varepsilon}_i = Y_i - \hat{P}_i$. These residuals will be all positive for Y_i = 1 and all negative for Y_i = 0. Their values will be smaller in absolute value as the model better explains the

choices being made. From these residuals, it is easy to calculate another measure of goodness of fit denoted as R^2_{MI}, (Pindyck and Rubinfeld,1997).

$$\text{Let ESS} = \sum_{i=1}^{n} \varepsilon_i \quad , \text{TSS} = \sum_{i=1}^{n} (Y_i - \hat{P})^2 ,$$

$$\text{then } R^2_{ML} = 1 - (\text{ESS/TSS}) \qquad \ldots(2.22)$$

Another comparatively simple measure is Count R^2, where Count R^2 = number of correct predictions/ total number of observations. Since, the regressand in the logit/probit model takes a value 1 or 0, if the predicted probability is equal to or greater than 0.5, we classify that as 1, but if it is less than 0.5, we classify that as 0. We can then count the number of correct predictions or the percentage of correct predictions.

To test the null hypothesis that all slope coefficients are simultaneously equal to zero or some of the slope coefficients are simultaneously equal to zero, the appropriate test statistic is the Likelihood Ratio (LR) statistic (like 'F' test in linear regression). Technically, it is defined as, $\lambda = L(\beta_R) / L(\beta_{UR})$. Where λ is the likelihood ratio, $L(\beta_R)$ is the maximum value of the restricted log-likelihood function with restrictions that β's are equal to zero (except the constant term), and $L(\beta_{UR})$ is the maximum value of the unrestricted log-likelihood function. In this ratio the denominator is as great as the numerator. Therefore, λ must lie between 0 to 1. If the null hypothesis is true, we expect the value λ is close 1; if it is not true, we expect the value λ is close 0. Therefore, we expect the null hypothesis is rejected when λ is sufficient. Given the null hypothesis, alternatively the LR statistics follow a χ^2_m distribution with degrees of freedom equal to the number of restrictions, m (or the number of explanatory variables) as sample size increases as follows:

$$-2\,[L(\beta_R) - L(\beta_{UR})] \supseteq \chi^2_m \qquad \ldots(2.23)$$

To test the above null hypothesis, compare the calculated value of χ^2_m with it's critical value. If the value of χ^2_m is greater than the critical value, we reject the null hypothesis that the restriction are not appropriate i.e. β's are not equal to zero.

In this study, we have used the method of maximum likelihood to estimate the parameters of logit and probit models vis-a-vis to predict the ownership probabilities, threshold level of income for ownership and extent of diffusion of various major and minor durables among different groups of households.

Hypothesis

The following hypotheses are formulated and tested in the present study:

1. The threshold level of income varies among different major and minor durables.
2. Both major and minor durables have different degrees of diffusion.
3. The ownership of durable is influenced by the age and level of education of the head of the household.
4. The household size has a significant influence on ownership of the durables.
5. The number of durables possessed by a household have a strong positive affect on durable ownership.

Empirical Results

In order to estimate the probability of ownership of durables, binary choice models-logit and probit are considered in the study. In these models the dependent variable Y=1, if the household owns a durable and Y=0 if it does not. The index function of general logit and probit model are estimated for four major durables viz., colour television, two wheeler, refrigerator and air cooler and for seven minor durables viz., radio, fan, gas stove, costly watch, pressure cooker, steel almirah and bicycle. Probit and logit models are estimated separately for each major and minor durables by a non-linear estimating procedure, the method of maximum likelihood using primary data collected from 270 households. The determinants for ownership of both minor and major durables are the total income of the household, households size, number of durables possessed by the household, age and level of education of the head of the household. Years of schooling is a proxy variable for the level of education of the head of the household. We have classified durables as major and minor durables. If the current price of the durable good is less than Rs 2000, it is considered as minor durable and if the price is Rs 2000 and more it is treated as major durables. Table 1 to Table 4 summarize the index function of the logit and probit models estimated for four major durables and seven minor durables.

Table 1 represents the regression results of the index function of logit model for major durables. It is observed from this table that total income, number of durables possessed, age and education level of the

Table 1: Regression Results of Index Function of General Logit Model for Ownership of Major Household Durables

Sl. No.	Major durables	Constant	X-coefficients					$L(\beta_R)$	$L(\beta_{UR})$	LR (λ)	χ^2- Value	R^2_{McF}	R^2_{ML}	Count R^2(%)
			Income	HH Size	Total Durables	Age	Education							
1	T.V	-6.6430 (-1.989)	0.2691* (3.168)	-0.4840** (2.597)	0.3604* (2.706)	0.1526* (2.828)	0.2212* (2.923)	-15.681	-25.837	0.607	21.311*	0.412	0.359	87.5
2	Two-Wheeler	-2.4275 (-1.121)	0.1657* (3.117)	0.1608* (2.680)	0.1727* (2.828)	-0.5648* (3.156)	0.1042* (3.167)	-24.770	-31.756	0. 781	14.369*	0.526	0.258	86.8
3	Refrigetor	-1.1897 (-0.245)	0.3106* (4.295)	-0.4061 (-0.657)	0.3736** (2.243)	-0.1070* (3.937)	0.3581 (0.212)	-16.531	-23.164	0.714	25.265*	0.545	0.409	91.7
4	Air Cooler	-5.9324 (-1.605)	-0.4801* (3.604)	0.2394 (0.066)	0.8660* (4.670)	0.7323* (4.107)	0.1754* (4.166)	-13.125	-16.039	0.815	5.827*	0.181	0.114	87.5

Note: Estimated from Survey data using Limdep Software- Version 7.0.3 (Econometrics Software). The figures in the parenthesis are 't' values; LR-likelihood ratio;
$L(\beta_R)$-Restricted Likelihood Function; Unrestricted Likelihood Function $L(\beta_{UR})$; R^2_{ML}-Maximum Likelihood Coefficient of determination, R^2_{McF} – McFadden R^2
* represents 1% level of significance and ** represents 5% level of significance.

Table 2: Regression Results of Index Function of General Probit Model for Ownership of Major Household Durables

Sl. No.	Major durables	Constant	X-coefficients					$L(\beta_R)$	$L(\beta_{UR})$	LR (λ)	χ^2- Value	R^2_{McF}	R^2_{ML}	Count R^2(%)
			Income	HH Size	Total Durables	Age	Education							
1	T.V	-3.7788 (-2.035)	0.1433** (2.130)	-0.2690** (1.967)	0.1906* (2.661)	0.8685** (2.261)	0.1250** (2.165)	-15.256	-25.837	0.591	21.160	0.409	0.357	87.5
2	Two-Wheeler	-1.3245 (-1.063)	0.9017** (2.055)	0.8832 (0.641)	0.1117* (2.977)	-0.3359** (-2.164)	0.5139** (2.102)	-24.530	-31.755	0.772	14.449	0.528	0.259	86.8
3	Refrigerator	-0.6817 (-0.248)	0.1736* (2.335)	-0.2130 (-0.662)	0.2209* (2.454)	-0.6101* (-2.930)	0.7949 (0.097)	-16.311	-23.164	0.704	25.707	0.555	0.415	91.7
4	Air Cooler	-2.9655 (-1.661)	0.2779* (2.676)	0.4724 (0.025)	0.5608* (2.671)	0.3937* (1.119)	0.7175 (1.130)	-13.076	-16.039	0.815	5.927	0.185	0.116	87.5

Note: Estimated from Survey data using Limdep Software- Version 7.0.3 (Econometrics Software). The figures in the parenthesis are 't' values; LR-likelihood ratio;
$L(\beta_R)$-Restricted Likelihood Function; Unrestricted Likelihood Function $L(\beta_{UR})$; R^2_{ML}-Maximum Likelihood Coefficient of determination, R^2_{McF}- R^2 McFadden
* represents 1% level of significance and ** represents 5% level of significance.

head have significant influence on the ownership of all the four durables. But household size, which is an important variable, has significant influence on the ownership of TV and two-wheeler. Household size has no effect on the ownership of refrigerator and air cooler. Most of the regression co-efficients are significant at 1% of level of significance.

The value of Chi-squares and likelihood ratio (LR) which are generally used to test the joint the significance of slope of coefficients of the logit index function, are also found to be significant for all the four major durable goods. The McFadden R^2 is the highest for refrigerator (0.55) and the lowest for air cooler. The value of R^2_{McF} is found to be not so high but the R^2_{ml} which is also a measure of goodness of fit is found to be more than 0.60 for most of major durable. Count R^2 which reflects the correct prediction for ownership of the durables is find to be high in all the model of the four major durables. It is the highest for refrigerator. This clearly indicates that the prediction power of the logit model is high for these durables. It is also noticed that income, number of durables possessed, education of the head of the household, have positive effect on the ownership of all these four durables, but household size has a negative effect as expected on the ownership of television and refrigerator and age of head of the household has negative effect on the ownership of two wheelers and refrigerator. This may be due to the fact that older households do not prefer to own two wheelers and do not prefer to eat food and vegetables preserved in refrigerators.

The results of probit model almost reflect the same behaviour on the ownership of these durables. The

Table 3: Regression Results of Index Function of General Logit Model for Ownership of Minor Household Durables

Sl. No.	Major durables	Constant	X-coefficients					$L(\beta_R)$	$L(\beta_{UR})$	LR (λ)	χ^2- Value	R^2_{McF}	R^2_{ML}	Count R^2(%)
			Income	HH Size	Total Durables	Age	Education							
1	Radio	-2.0515* (-0.558)	0.1414* (3.163)	0.7416 (0.377)	0.1425 (0.182)	-0.2770* (-2.701)	0.8284* (2.142)	-30.721	-33.104	0.934	4.7663*	0.072	0.095	62.5
2	Fan	-43.3075 (-1.718)	0.1105* (3.622)	1.0917* (1.962)	1.1786 (1.354)	0.4843* (2.667)	0.8932* (2.703)	-10.959	-13.768	0.796	19.6191*	0.713	0.336	95.8
3	Gas Stove	-0.9052 (-0.395)	0.7760* (2.515)	-0.1809 (-0.705)	0.2431 (2.197)	-0.1966 (-0.425)	0.6270 (0.749)	-25.141	-32.222	0.781	14.1640*	0.219	0.256	72.9
4	Watch (Costly)	13.7796 (0.000)	-0.6827 (1.068)	9.5507 (0.012)	12.8818 (0.145)	-1.6110 (0.287)	-1.5942 (1.145)	-0.9066	-4.8607	0.187	2.7214	0.012	0.1836	94.8
5	Pressure Cooker	-9.8167 (-2.851)	-0.1927 (0.869)	-0.5520** (-1.980)	0.6033* (2.892)	0.1555* (2.393)	0.1515* (2.535)	-17.981	-32.601	0.552	31.0416*	0.476	0.4766	87.5
6	Steel Almirah	-3.7789 (-1.570)	0.2719* (2.601)	-0.1477 (-0.637)	0.1839* (1976)	0.3924* (2.876)	0.2482 (0.303)	-23.305	-28.975	0.604	11.3404*	0.196	0.2106	70.8
7	Bicycle	3.9864 (1.002)	0.5203* (2.318)	0.5005** (1.970)	0.9019** (1.995)	-0.2002 (-1.919)	-0.3578* (-2.789)	-11.406	-16.039	0.739	15.2661*	0.476	0.2726	93.8

Note: Estimated from Survey data using Limdep Software- Version 7.0.3 (Econometrics Software). The figures in the parenthesis are 't' values; LR-likelihood ratio;
$L(\beta_R)$ – Restricted Likelihood Function; Unrestricted Likelihood Function $L(\beta_{UR})$; R^2_{ML}-Maximum Likelihood Coefficient of determination, R^2_{McF} – McFadden R^2
* represents 1% level of significance and ** represents 5% level of significance.

Table 4: Regression Results of Index Function of General Probit Model for Ownership of Minor Household Durables

Sl. No.	Major durables	Constant	X-coefficients					$L(\beta_R)$	$L(\beta_{UR})$	LR (λ)	χ^2- Value	R^2_{McF}	R^2_{ML}	Count R^2(%)
			Income	HH Size	Total Durables	Age	Education							
1	Radio	-0.6513 (-0.556)	0.8997* (2.198)	0.4040 (0.345)	0.6603 (0.137)	-0.1645* (-2.689)	0.5203* (2.172)	-30.709	-33.104	0.928	4.791*	0.072	0.095	62.5
2	Fan	-25.7826 (-1.743)	0.6582* (2.716)	0.6339** (1.991)	0.7024 (1.365)	0.2890** (1.991)	0.5322** (1.983)	-10.869	-13.768	0.789	19.798*	0.719	0.338	95.8
3	Gas Stove	-0.4861 (-0.357)	0.5320* (-0.595)	-0.1086 (-0.703)	0.1491 (2.351)	-0.1333 (-0.474)	0.4015 (0.827)	-24.968	-32.222	0.775	14.508*	0.225	0.261	68.9
4	Watch (Costly)	2.9691 (0.000)	-0.1308 (0.000)	2.3589 (0.000)	3.1111 (0.000)	-0.3894 (0.000)	-0.3817 (0.000)	-0.252	-4.860	0.057	2.721	0.125	0.183	93.8
5	Pressure Cooker	-5.3118 (-3.064)	-0.1181 (-0.928)	-0.2851* (-1.903)	0.3356* (3.050)	0.8420* (2.526)	0.4288** (3.403)	-17.372	-32.601	0.533	30.458*	0.467	0.472	85.4
6	Steel Almirah	-2.3653 (-1.653)	0.1677* (2.674)	-0.8580 (-0.611)	0.1044** (2.245)	0.2479* (3.925)	0.2123 (0.442)	-23.131	-28.975	0.799	11.689*	0.202	0.216	70.6
7	Bicycle	2.4994 (1.141)	0.2844* (2.313)	0.2654* (2.944)	0.4698** (2.039)	-0.1101** (-1.969)	-0.2017* (-2.846)	-11.466	-16.039	0.715	15.146*	0.472	0.271	93.7

Note: Estimated from Survey data using Limdep Software- Version 7.0.3 (Econometrics Software). The figures in the parenthesis are 't' values; LR-likelihood ratio;
$L_{(R)}$ – Restricted Likeli-hood Function; Unrestricted Likelihood Function $L_{(UR)}$; R^2_{ML}– Maximum Likelihood Coefficient of determination, R^2_{McF} – McFadden R^2
* represents 1% level of significance and ** represents 5% level of significance.

only difference between the two models is that co-efficient of logit model are highly significant compared to probit models. In probit model, household size only significantly influencing on the ownership of television only and both household size and the level of education have no significant influence in the ownership of refrigerator and air cooler.

The regression results of logit model for minor durables in Table 3 reveal that income is also an impor-

Table 5: Range of predicted probabilities, threshold level of income and probability estimated from the index function of general logit and probit model for major and minor durables

Sl. No.	Durable good	Range of predicted probability of index function		Threshold probability		Threshold income	
		Logit	Probit	Logit	Probit	Logit	Probit
Major Durables:							
1.	Television	0.36 – 0.98	0.37 – 0.99	0.98	0.99	Rs. 4,000/-	Rs. 4,000/-
2.	Refrigerator	0.36 – 0.95	0.37 – 0.99	0.95	0.95	Rs. 9,000/-	Rs. 9,000/-
3.	Two wheelers	0.23 – 0.96	0.27 – 0.96	0.95	0.96	Rs.13,000/-	Rs.13,500/-
4.	Air cooler	0.27 – 0.72	0.29 – 0.75	0.72	0.75	Rs. 7,250/-	Rs. 7,500/-
Minor Durables:							
1.	Steel Almirah	0.48 – 0.98	0.50 – 0.99	0.98	0.99	Rs. 4,000/-	Rs. 4,000/-
2.	Gas stove	0.20 – 0.93	0.21 – 0.94	0.93	0.94	Rs. 7,250/-	Rs. 7,250/-
3.	Pressure Coker	0.13 – 0.99	0.13 – 0.99	0.99	0.99	Rs. 5,000/-	Rs. 4,500/-
4.	Cycle	0.48 – 0.98	0.50 – 0.98	0.98	0.98	Rs. 4,000/-	Rs. 4,000/-
5.	Electric Fan	0.29 – 0.98	0.29 – 0.98	0.98	0.98	Rs. 3,200/-	Rs. 3,000/-
6.	Radio	0.18 – 0.92	0.18 – 0.92	0.92	0.92	Rs. 3,000/-	Rs. 3,000/-
7.	Watch	Fully diffused (Probability = 1 for all observation)					

tant variable on the ownership of these durables. It has a positive influence on the ownership of minor durables such as radio, fan, gas stove, steel almirah but insignificant negative influence in the purchase of watch and pressure cooker. It is clearly indicates that the households prefer to own watch and pressure cooker whatever their income may be as these two durables are essential items for the urban households. On the other hand, the important variable - household size, has a positive significant influence on the ownership of fan and negative significant influence on the ownership of pressure cooker. The other determinant, number of total durables possessed by a household has positive significant influence on the ownership of the minor durables likes pressure cooker, steel almirah and bicycles. The households add these minor durables irrespective of the number of durables they possessed. Age of the head of the household is an important determinant in the ownership of durables. In our study, it has a positive significant influence in the purchases of minor durables like pressure cooker and steel almirah and negative significant influence in the ownership of gas stove, watch and bicycle. On the other hand, education level of the head of the household has a positive significant influence on the radio, electric fan, pressure cooker, steel almirah and negative significant influence in the ownership of bicycles. The ownership of gas stove and watch are in no way helpful in the decision-making process of the household. It is observed that even though values of χ^2 (chi-square) and LR ratio are significant in case of radio and watch, most of the coefficients of the determinants are found to be insignificant in the ownership of these two minor durables. The McFadden R^2 is high for all minor durables except watch and radio. The percentage of prediction as reflected by count R^2 is very high for watch (95%) and it is very low for radio. Table 4, which represents the regression results of probit model for all these minor durables, reflects almost the same behavior.

Predicted Probability and Threshold Income of Ownership

The range of predicted probabilities and threshold level of income for the ownership of both major and minor durables are presented in Table 5. The range of predicted probability is necessary to know the degree of diffusion of a durable among it's potential owners, the number of potential owners and also the threshold level of income is necessary for the ownership of a durable.

The critical or the threshold income for the ownership of durables is that level of income at which a potential owner becomes actual owner of the durable. At that level of income, the ownership probability in supposed to be high. Table 5 reveals that the different estimates such as range of probabilities; threshold income and probability of logit and probit model are almost same for the ownership of durable goods. For simplicity of analysis, we have used basically the estimates of probabilities and threshold income of logit model to ascer-

tain the ownership pattern of both minor and major durables. This model (logit) is widely used by a number of researchers in the ownership of durables.

The ownership probability for television ranges from 0.36 to 0.98 and for refrigerator ranges from 0.36 to 0.95. This shows that the range of probabilities for TV and refrigerator are very close to each other. But there is wide variation in their threshold income. This clearly shows that the ownership of television is not only limited to high income groups but also to other categories of income groups. The ownership probability of two-wheelers and air coolers ranges from 0.23 to 0.95 and 0.27 to 0.72 respectively which reflects that potential owners for two-wheelers are more than the potential owners for air coolers. The ownership of these two durables are also limited to high income groups as their threshold incomes are high.

It is observed that both the predicted range of probability and threshold income are the same for steel almirah and bicycle. The predicted probability is 0.48 – 0.99 and threshold income is Rs.4000/- for these two durables. This clearly indicates that the potential owners of these two durables are not limited to any income group. These two durables have potential owners in the lower income groups also. On the other hand, the predicted range probability for gas stove and pressure cooker are close to each other and the ranges are 0.20 to 0.93 and 0.13 to 0.99 respectively. But their threshold incomes are different. This reveals that the potential owners of gas-stoves are limited to middle and higher income bracket and that of pressure cooker among the lower income brackets. It is an essential item for the potential owner of this durable especially in urban area. But the situation for the ownership of electric fan and radio are different. The predicted probability of these two durables are different which implies that the potential owner of these durables are also different and their threshold incomes are same i.e. Rs.3000/-. Watch is fully diffused but electric fan is partially diffused among all level of income groups. The ownership of a watch is independent of level of income. All potential owners are the actual owner of this minor durable (watch). It is possible because watch is a necessity item and available at different prices. Watch has also no threshold income, it can be purchased even at a lower income and similarly electric fan is also an essential item available at different prices. Its potential owners are found in all the income brackets. But the potential owners of electric fan in the lower income bracket are relatively less because to own an electric fan, the owner should have electricity connection in his/her house, which requires additional income. Though the electric fan is an essential durable item and available at low prices, it is not fully diffused. But its potential owners are among all levels of income – low, medium and high.

Diffusion of Durables

There has been significant diffusion of major and minor (diffusion by learning). Black and white television sets were diffused among lower income groups and colour television sets were diffused among middle and higher income groups. Refrigerators witnessed low degree of diffusion, which is restricted to high-income groups alone. On the other hand, light two-wheelers (mopeds) are diffused among lower and middle-income groups and scooter and bikes are diffused among high-income groups (as range of predicted probabilities are high). But air coolers are diffused only among high-income groups. Steel almirahs show a medium degree of diffusion at all levels of income. There is a high degree of diffusion of gas stove and pressure cooker among middle and high-income groups. But there is a high degree of diffusion of bicycles, watches and radio among all the three categories of income groups. The diffusion of electric fans limited to middle and high income groups and partially diffused in lower income groups. The diffusion of bicycle is found to be low among lower and middle-income groups. The extent of its (bicycle) diffusion declines with the increase in income. The diffusion of electric fan is less among the lower income groups and it is high among the middle and higher income groups, it is due to the fact that its demand depends on other factor i.e. electrification of house of the potential owners which is found to be less in number among lower income groups. Watch is fully diffused and radio is on the verge of full diffusion. Consumers can acquire it at any level of income.

Conclusion

In this study, the index function of logit and probit models are estimated separately for four major and seven minor durables. From the index function, the predicted probabilities, the range of predicted probabilities and the threshold income for ownership of the durables are estimated. The index functions of logit and probit model are estimated by using the method of maximum likelihood. The following conclusions can be drawn from the above analysis:

It is concluded that the determinants like the total income, the number of durables possessed, age and education level of head of the household have a significant positive influence on the ownership of both major and minor durables. Income is one of the important variables which has a strong positive influence in the ownership of durables. The level of education has a positive significant influence on the ownership of major durables like television, two-wheeler and air cooler and no such influence on the ownership of minor durables.

The value of the estimates obtained from the logit and probit models are almost same, but the estimates obtained from logit model are found to be more significant than that of the probit model.

The predicted probabilities are almost the same for television and refrigerator among the major durables and also steel almirah and bicycle among minor durables. The threshold income is found to be the highest for two-wheelers and the lowest for television among the major durables. It is the highest for gas stove and the lowest for both electric fan and radio among the minor durables. There has been significant diffusion of black and white television sets among the lower income groups and colour television sets among middle and higher income groups. Refrigerators and air coolers witnessed a low degree of diffusion, which is restricted to high-income groups. Steel almirahs exhibit medium degree of diffusion at all levels of income. On the other hand, bicycles, watches and radios reflect high degree diffusion among all levels of income. Watch is fully diffused and radio is on the verge of full diffusion.

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The object of golf is not just to win. It is to play like a gentleman and win.

– Phil Mickelson

Feature

Electronic Toll Collection System: A Comparative Study of Malaysia and India

M.P. Gupta & B.N. Chakravorty

This study attempts to study the Electronic Toll Collection (ETC) system of Malaysia and India. ETC is that part of e-Governance solution which enhances the life of citizens by making road travelling smoother and easier by use of Intelligent Transport System (ITS). A SWOT analysis has been carried out to extract practical recommendations for India in this context.

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Improving the transport infrastructure remains always high on the political agenda of a state or country. In India, the National Highway Authority of India (NHAI) has recently formulated a policy to implement the Prime Minister's ambitious National Highway Development Project (NHDP) for boosting road transportation in the country. The project involves building a golden quadrilateral (GQ) linking Delhi-Kolkata-Chennai-Mumbai, a North-South corridor from Srinagar to Kanyakumari and East-West corridor from Silchar to Porbandar. Costing Rs 54,000-crore the Golden Quadrilateral project is to set up about 13,150 km of roads. The work on the NHDP is proceeding as per plan, and till August 31, 2002, Rs 9,179 crore, has already been spent and contracts worth Rs 18,579 crore have been awarded. Out of the total GQ length of 5,846 km, work has been completed on 1,159 km and is under implementation on 4,551 km.

A central consideration in the financing and operation of private roads in urban areas is the mechanism for charging road users, and the community at large, for the stream of benefits which accrue from the additional infrastructure. There are three main items to consider: who should pay, what price should be charged, and how should the monies be collected? Hensher (1991) has addressed these concerns in the context of the private provision of urban tollways, which form an important yet specialized component of a larger road system which is currently untolled and financed by indirect means such as fuel and vehicle registration taxes. The traditional toll system involving mechanical collection of tolls in the form of cash, tokens, other physically transferable material, or a document that requires physical inspection, requires all vehicles to complete a transaction at a toll booth. This system of toll collection is inherently inefficient for many reasons. Recent interest in electronic toll collection (ETC) stems from both a recog-

nition of the inefficiencies of the current systems of manual collection and the many attractive features of ETC. It has been implemented in Alesund, Norway over an 8 kilometre distance (Philips Industries, 1988) and on the Dulles Toll Road in Virginia (Davies et al., 1989) and one in Sydney. European project (DRIVE) has established a European standard for ETC (and ERP-Goodwin and Jones, 1989). Two applications in Italy and Holland are operational.

ETC is a *programmable remote automatic vehicle identification (EVI)* system which uses microwave/infrared technology to identify the presence of a vehicle in the traffic stream, and to automatically calculate and charge the vehicle driver/owner for the use of the tolled road. There are a number of ways of establishing a charging procedure, but the most efficient, and *almost private* way involves a computerised identification code in the EVI tag which is placed on the front windscreen of the vehicle. The tag is encoded with units of stored value, purchasable from encoding machines at outlets such as banks and petrol stations. Rules for charging can be incorporated into the software linked to the computers at each check point. In India, current projects in various stages of operation and completion in electronic toll collection comprise of Delhi-Noida-Delhi Bridge, Ahmedabad–Mehsana Expressway, Bangalore–Mysore Expressway, Coimbatore Bypass, Hubly-Dharward Expressway, Jaipur–Kishongad Expressway, Mumbai–Poona Expressway, Narmada Bridge, Vadodara–Halol Expressway and Vatrak Bridge.

The benefits of ETC are extensive. ETC systems are an improvement over conventional toll collection techniques because they have the potential to reduce queues at toll plazas by increasing toll booth service rates; save fuel and reduce mobile emissions by reducing or eliminating deceleration, waiting times, and acceleration; reduce toll collection costs; and enhance audit control by centralizing user accounts. In addition, ETC allows the toll facility operator to improve customer service and satisfaction by speeding their trip through the toll plaza, removing the need for the customer to stop, fumble for change, or roll down their window. It also gives customers the flexibility of paying their toll bill with cash, check, or even credit cards. Customers who use credit cards often have the option of having their credit card account automatically charged when their toll account dips below a predefined level, thereby eliminating the customer's concern for funds for toll payment. In addition, customers can receive monthly statements detailing their toll usage and will not have to ask for receipts. Commercial customers have the added benefit of no longer being required to send drivers out with cash or some form of ticket, which could potentially be misused.

The toll facility operator also benefits from ETC. Facility throughput can be increased without the need to build additional infrastructure such as more tollbooths, and the amount of staff dedicated to the toll collection process can often be reduced. Toll agencies can also save because there is less liquid money passing through the tollbooths, which means that they do not need to employ as many operators to handle the cash.

There are studies undertaken to address the management problems of ETC such as modeling services by Zarrillo et.al (1997) and to maximize social welfare associated with a toll plaza by Levinson and Chang (2002). Ogden (2001) has summarized privacy issues in the context of electronic toll collection (ETC). It has discussed the development of privacy codes of practice by toll road operators, mentioning in particular the recent development in Australia involving the alignment of such codes with Standards Australia (SA) draft guidelines and the privacy principles developed by the Australian Federal Privacy Commissioner. Chiaki Kuranami (2002) and the World Bank's consulting team conducted a study on the toll road experiences in selected countries. They spent eight months in 2001 visiting selected Asian countries, talking to individuals in toll road related agencies, financial institutions, toll road operators, construction firms, law firms, credit rating organizations, and a variety of public sector agencies. They have reviewed 18 economies with specific emphasis on selected East Asian countries. Their study identified issues and lessons in toll road development with specific emphasis on the areas of institutions, regulatory frameworks, and financing issues and made an excellent comparison and presentation of the same. The learning provides opportunities for individuals and organizations involved in toll road development to discuss the future progress of their systems and obtain clearer guidance from the experience of other countries.

This paper presents an analysis of the Malaysian ETC project to the developing Indian scenario based mostly on secondary data. The Malaysian ETC project across the North–South Corridor, using the latest means in IT, has been mapped. This project makes road tolling a part of the Malaysian Government's e-governance effort. The main issues concerning ETC to be examined are:

- Setting up of proper technical solutions
- Information gathering, storage and retrieval
- Installing faith in citizens against data misuse
- Prevention of frauds and minimising corruption
- Smart Card benefits

- Avoid cash system
- Multi application of the smart cards

The Malaysian experience has been captured effectively from secondary data. From the Indian side the details have been obtained from the NHAI website and other companies associated with the projects. A SWOT from the Malaysian experience has been used to superimpose the same on the Indian scenario to develop the recommendations for India.

Road Scenario in Malaysia

Roads in Malaysia are classified into two broad categories, namely Federal Roads and State Roads (Table 1 and Fig. 1). Federal roads are all roads declared under the Federal Roads Ordinance (1959). This category of roads includes the National Expressways and Highways under the administration of the Malaysian Highway Authority (MHA). Toll Expressway like the North-South Expressway and other toll highways are all classified under the category. Also included are the highways and other roads under the administration of the Public Works Department, Malaysia, like the major interurban roads joining the state capitals and roads leading to points of entry to and cut from the country. Other roads classified under this category are the Regional Development Scheme Roads, such as those within the Federal Land Development Authority (FELDA) schemes, Federal Land Consolidation Authority (FELCRA) schemes and other Regional Development Authority Scheme such as Pahang Tenggara Development Authority Scheme etc. Minor roads leading to and within Federal Government Institutions are also classified under this category. State Road generally comprises of the primary roads providing intra-state travel between the district administrative centres. Other roads included in this category are the Urban Collector Roads and other Minor Roads within the villages and the rural inhabited areas. Roads within the Federal Territory of Kuala Lumpur and the island of Labuan which are not designated as Federal Roads are classified under this category.

Table 1: Roads in Malaysia

Roads in Malayisa			
Class/Category	Total Length	Paved Length	Percentage Paved
Toll Expressway & Toll Highway	973	973	100
Other Federal Roads	14554	13590	93.4
State Roads (including Municipality Roads)	45207	30710	67.9

(*Source:* www.jkr.gov.my/jln/hari-jkr/Road8.htm)

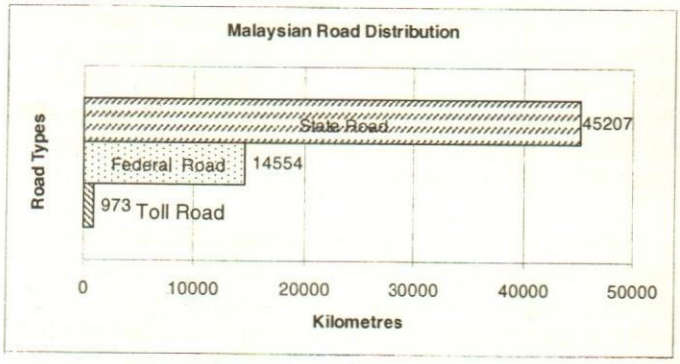

Fig. 1. Road distribution in Malaysia

(*Source:* www.jkr.gov.my/jln/hari-jkr/Road8.htm)

Road Statistics

A total of 59,761 kilometres of roads make up the whole road network of the country, with 24.4% of the network being Federal Roads, whilst the remaining 75.6% forming the State Roads. It is estimated that there are about 4500 road bridges in the country, out of which about 2800 numbers are located on the Federal Roads. Presently the Public Works Department Malaysia has compiled an inventory for 2546 bridges on the Federal Roads in Peninsular Malaysia (www.jkr.gov.my/jln/hari-jkr/Road8.htm).

In March 1999, Malaysia entered a new era of Electronic Toll Collection (ETC) based on a single contactless smartcard for 'Touch 'n Go' payment or, when used with an On Board Unit (OBU) communicating by infrared technology, as a SmartTag for non-stop free flow toll payment. The system was rolled out by Rangkaian Segar, a joint venture between Renong, United Engineers, Park May, Intria, Antara Consolidated and Commerce Asset-Holding. Teras Malaysia system integrators of the scheme, is founded on Austrian company, Efkon's combination of contactless smart card and its CEN-compatible infrared technology. They claim this creates a system with highest flexibility, security and ease of use.

The Teras/Efkon open tolling concept of providing toll operators with the means of combining in one network, cash-collection, 'Touch 'n Go' lanes and non-stop high speed free flow lanes, now covers most of the Malaysian highway network, including the world's longest toll highway, the 800 km Plus-Highway. Moreover, the system is multi-modal and increasingly used for public transport, which has further increased its wide scale take-up. It has been estimated that the 800,000 multi application contactless smart cards currently in use in Malaysia produce more transactions per day than all the European electronic purses combined (http://www.efkon.com/newsmaltg.html).

A brief overview of the payment aspect system in action provides an insight into why the technology is being adopted by other Asian countries, including Taiwan (where some three million OBU's will be in use by 2002), Japan, China and India, for the Bombay Entry/Exit Tolling system.

While cash lanes typically average 250 vehicles an hour in Malaysia, 800 vehicles can be processed by drivers using the contactless smart card to 'Touch 'n Go', with the appropriate toll charge being deducted from the prepaid electronic purse in the card. When the amount in credit has reached a pre-set minimum, a lane signboard informs the customer. At Touch 'n Go retail outlets set up at most toll plazas, as well as a number of bus and railway stations, users need only hold the card close to a programming unit for it to be read and then pay their chosen credit amount by a wide range of methods, including credit card, to replenish the electronic purse. Even more widespread use of the contactless smartcard will result from Government intervention.

While cash lanes typically average 250 vehicles an hour in Malaysia, 800 vehicles can be processed by drivers using the contactless smart card to 'Touch 'n Go', with the appropriate toll charge being deducted from the prepaid electronic purse in the card.

However, Malaysia determined that the smartcard/infrared technology should not just be for tolling applications. An early decision was taken to launch it as a multi-application ITS payment card. Currently it can also be used for fare payment on Cityliner buses and Putra-LRT (Light Rail Transit). Passengers 'touch-in' to specially adapted readers on Cityliner buses as they enter, with Efkon infrared transceivers along the route automatically monitoring bus location, timing and switching zones so that the correct fare is deducted from the contactless card as the passenger 'touches out.' On return to the depot in the evening, all data collected from the reader is communicated via infrared link to the clearing house. For light rail trains, readers are mounted at the entry and the exit of stations and passengers have to touch-in/-out to open the barrier. Malaysian company Rangkaian Segar is further *expanding the card's* applications (by the end of 1999, some 500,000 cards were in circulation) into complementary ITS sectors like parking, petrol stations, taxis, vending machines, public pay-phones, national railway, theme parks and general retail environments. In operation, when a vehicle enters a toll plaza infrared communication zone, the OBU and the contactless smart card communicate with an infrared transceiver mounted on the canopy of the toll plaza. Full featured financial transactions in real-time are performed automatically at very high speed.

While the same contactless smartcard is used in both payment systems, SmartTag users in Malaysia fill in an application form and use their credit cards (Visa, MasterCard) for highway payment. Thereafter, a totally automatic reload is performed via the user's credit card account when the minimum credit level is reached, the transaction normally taking place seamlessly as they drive through the non-stop free flow tolling lanes at highway speeds. However, on plazas without non-stop tolling technology, for multimodal use on buses and trains, or the range of other ITS related applications, the SmartTag is removed from the OBU and becomes a Touch 'n Go card.

The Road Scenario in India

India has 3.3 million kilometres of road network, which is the second largest in the world. Roads occupy an eminent position in transportation as they carry nearly 65% of freight and 87% of passenger traffic (figure 3). Traffic on roads is growing at a rate of 7 to 10% per annum while the vehicle population growth, for the past few years, is of the order of 12% per annum (figure 4). The different categories of roads and authorities responsible for them are:

i. National Highways - Central Government (through Ministry of Road Transport and Highways)

ii. State Highways and Major District Highways - State Governments (PWDs)

iii. Rural Roads and Urban Roads - Rural Engineering Organizations, Local Authorities like Panchayats and Municipalities.

The Ministry of Road Transport and Highways is directly responsible for the development of National Highways which aggregate 57737 km (Fig. 2), which, although is only 1.7 % of total length, carries about 45 % of the road traffic. The National Highways is thus the lifeline of the country, connecting the farthest corners and the remotest border areas (http://morth.nic.in/rthmain.htm.)

It the dream of the Prime Minister of India to develop the national highway to meet world standards. In this the Government is pushing forward infrastructure development projects by embracing IT–related applications so that the common citizen is benefitted. The Na-

tional Highway Authority of India (NHAI) has been given the task of developing the *Golden Quadrilateral* i.e., the highway connecting Delhi – Mumbai – Chennai – Kolkata – Delhi. Another project under its belt is to develop the North-South and East-West Corridors i.e., Srinagar – Kanyakumari and the Porbandar – Shilchar highways respectively. These are to be brought to international levels of acceptance with private companies building the highway and maintaining the same, with facilities like electronic toll collection using cash or contactless smart cards, telephone kiosks, highway motels, ambulance, medical facilities etc. along the highway. This integration will be totally using IT, say for the electronic toll collection and will also develop the cities, towns and villages along this routes. The vision is similar to the Malaysian success story of its North – South Corridor linking Thailand and Singapore to the Malaysians.

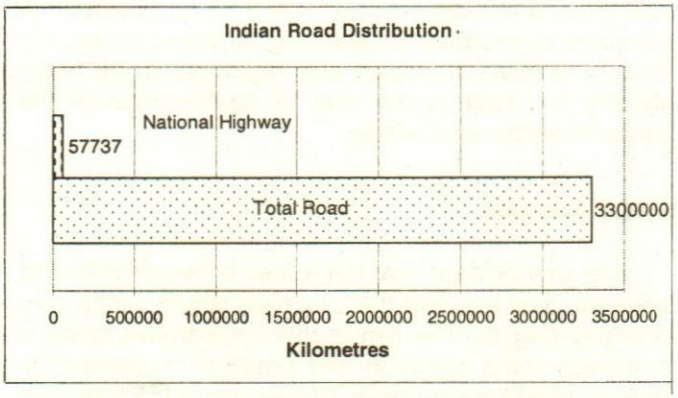

Fig. 2. Indian Road Distribution

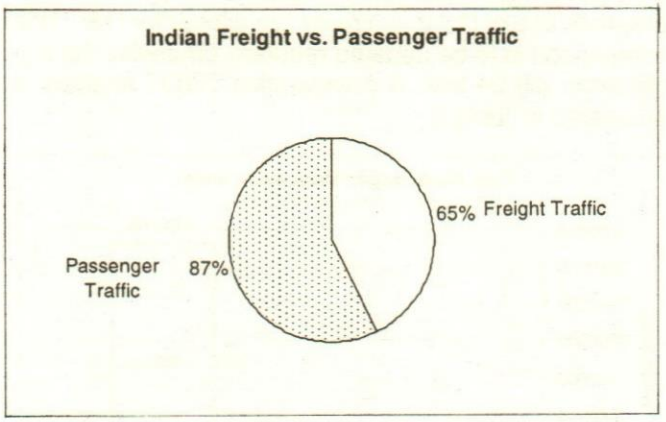

Fig. 3. Indian Freight vs Passenger Traffic

The emphasis is now on developing the quality of National Highways, besides expanding the network. The Ministry of Road Transport and Highways has therefore taken up a number of projects and programmes to achieve this goal. To upgrade the technology and to evolve cost-effective new techniques for design, construction and maintenance of roads and bridges and operation of traffic, this ministry has also taken up a number of studies and research programmes in association with the various Research Institutes and Universities.

The National Highway Development Project (NHDP) has been initiated to upgrade the existing highways to connect the four metropolitan cities Delhi, Mumbai, Chennai and Kolkata by the Golden Quadrilateral and the North-South and East-West Corridors connecting Kanyakumari with Srinagar and Porbandar with Shilchar. This project will involve upgradation to four/six laning of about 13,000 km of National Highways and is to cost Rs. 54,000 crore. The target years for completion of the Golden Quadrilateral and the National Highway Development Project have been set to be 2003 and 2007 respectively, which is a short time frame.

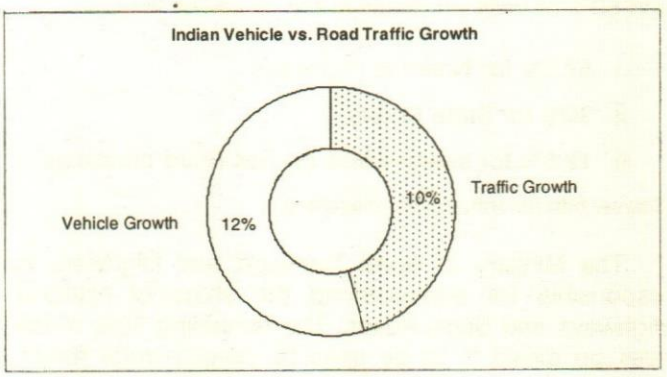

Fig. 4. Indian Vehicle vs Traffic Growth

In addition, a short-term programme for improving the riding quality of other National Highways has also been initiated. The Improvement in Riding Quality Programme (IRQP) aims to cover the entire National Highways network in the next 5 years. The State Governments concerned, through which the National Highways are passing, are executing the works on behalf of the Central Government.

The Central Government is also responsible for keeping the entire National Highway network in traffic-worthy condition. As the nodal Ministry in the roads sector, the Ministry of Road Transport and Highways has been taking an initiative to formulate maintenance norms for all categories of roads, including National Highways. Funds for maintenance of National Highways are being allocated to the extent possible considering the difficult resource position. This year the Central Government has declared 5694 km of roads as National Highways. This has brought the total extent of National Highways declared in the Ninth Plan Period (1997 onwards) to 23,439 km. Most of these National Highways are in remote, hilly or backward areas and they now

require attention to be brought up to National Highways standards. The resource requirement for removal of deficiencies on National Highways is estimated to a whooping Rs. 1650 billion. Mobilising such funds is a big challenge. This is being done by traditional budgetary allocations as well as innovative measures like revamping of Central Road Fund, funding from multi-lateral agencies, private sector participation, market borrowings etc.

To meet the challenges of accelerated funding requirement for all categories of roads in the country, the Central Road Fund has been augmented by increasing the levy of cess on petrol to Rs. 1/- per litre of petrol and charging a cess of Rs. 1/- per litre of diesel. The Central Road Fund Act, 2000 has also been notified on 27-12-2000 to give statutory status. The Central Road Fund seeks to distribute the total of 100% of cess on petrol and 50% of cess on diesel in the following way:

i. 57.5% for National Highways

ii. 30% for State Roads.

iii. 12.5% for safety works on Rail-Road crossings.

(*Source:* http://morth.nic.in/rthmain.htm)

The Ministry of Road Transport and Highways is responsible for administering the share of National Highways and State Roads. The remaining 50% of the cess on diesel is to be used to develop rural roads. From the generated fund, an intensive programme for the development of rural roads has been taken up. The Ministry of Rural Development, Government of India, is responsible for this programme.

The Ministry is also approving the schemes for improvement of State Roads under Economic and Inter-state importance (E&I Schemes). From the revamped Central Road Fund, 10 per cent of the State share will be allocated for E&I Schemes. The sum available for E&I Schemes will be around Rs.100 crore per annum. The Ministry is formulating guidelines for such schemes and is in the process of calling for estimates of projects from the State Governments for sanction of these E & I Schemes.

In addition, the Ministry also provides funds to State Governments and the Border Road Development Board for some strategic roads and certain selected roads in far flung and inaccessible areas. The Ministry of Road Transport and Highways is the nodal Ministry in the country in the roads sector and is guiding different states with regard to the construction and maintenance of quality roads by issuing technical circulars relating to different aspects of Highway Engineering and Practice. The Ministry of Road Transport and Highways has prepared specification for Road and Bridge Works, standard drawings for various types of bridges, culverts and junctions. The Indian Roads Congress (IRC), a premiere body of highway engineers in India, is formulating codes and standards for design, construction and maintenance of roads and bridges and for traffic operations.

The Central Government through the Ministry of Road Transport and Highways is also actively involved with International Organizations like the World Bank, the Asian Development Bank, Japan Bank for International Co-operation for upgradation of the technology and decision-making process. The Central Government is also involved in active co-operation in the field of developing highway linkages like Asian Highways. The Ministry of Road Transport and Highways has also signed a Memorandum of Understanding with its counterparts in Malaysia and France for co-operation in the areas of Highway Engineering. In many cases, the Ministry of Road Transport and Highways is the nodal Ministry for India in the field of co-operation in the transport sector as a whole.

SWOT Analysis

It is very obvious that the issues between India and Malaysia differ and that the total road length varies considerably (Fig. 5). The aim of this comparative study is to extract some common and practical recommendations to avoid known pitfalls. Proper use of ITS can have a very significant economic impact on all actors; inappropriate use of ITS may create "an allergy for ITS". This comparison is to be updated regularly otherwise the significance will be lost. A comparative SWOT analysis is presented in Table 2.

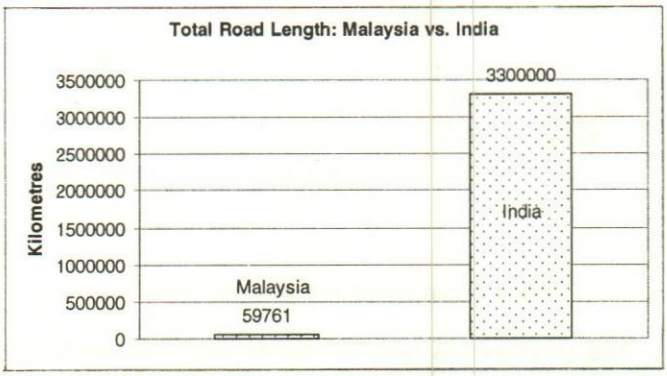

Fig. 5. Total Road Length: Malaysia vs. India

This analysis throws up the following key points:-

- There is a large and medium-and-long-term potential for effective cooperation and sales on

Table 2: SWOT Analysis

Common Issues	Comparison		Remarks
	Case I : Malaysia	Case II: India	
Strength			
Ease of travel to citizens	Already proven	Attempting to prove	It is valid for both countries
Transparency in the toll collection & its audit	Functional & proven	Satisfaction about the system under study	Very high weightage by Governments
Higher income for the Government & no leakage of the toll money	Proven	Convinced, based on revenue leakage study	Very high weightage by Governments
Development of associated industries	Constant process with returns already flowing in	Lucrative initiative to start in full earnest	Spin-offs are crucial aspects in infrastructural ETC or ITS projects
Environmental, economic & social development	Already started	Benefits expected in long run	Government image building
Weakness			
Huge investments	Private participation to offset the same	World Bank aid & BoT projects to offset the same	It is a surmountable issue
Initiation of privately owned roads	Greater responsibility and thus better management	Fear of losing control but understood that management will be superior	Internationally every Government is on same line
Long gestation period before RoI	Understood and accepted	Finicky about it but realizes that there is no option	There is no option but to accept it
Opportunity			
All round economic development possibility	It has already started	Looking forward to the same	One of the motivators for ITS and ETC implementation
Better infrastructure & more revenue to Government	Country developed economically	Part of reforms process	Future of ETC is bright
Threat			
Fast rate of technological obsolescence	Used technology that will be stable for a few years	Adopting currently best technology	Proper planning & research needed as well as upgradation
Susceptible to natural calamities resulting in losses	Properly insured and tough engineering practice maintained to ensure minimal damage	Study initiated and proper steps are being recommended	Part of the process, so early planning needed in civil engineering.

ITS, however the objective of sustainability is a key and plays in the interest of both parties.

- In-depth analysis of local specifications and priority needs is one of the keys of this sustainability; cooperative initiatives are necessary at local level.

A typical and recurrent example of a specific priority need is to very significantly increase road safety; for example, several developing countries have road accident rates 30 times higher than in USA, several EIT have had a doubling in the fatal accident rate in two years, one EIT has had 20 % increase in fatal accident rate on motorways after their privatisation, etc. It is a true challenge for ITS technologies and promoters to effectively help actors on road safety, for example by improving enforcement (speed control, photos at red traffic lights, etc.) at low cost. Another typical issue is the very different traffic mix where the non-motorised vehicles proportion could reach 80% of the total traffic. Such a situation has major implications on the technologies to be used. The same factor of major traffic mix difference should even have a significant impact on ITS priority needs: for example where buses could be four times more numerous than cars, like in China cities for example, ITS applications focused on bus transport effectiveness could bring in large and immediate benefits. The reliability of the outside environment can be very different from highly developed countries and therefore lead to very different ITS designs, for example, reliability of electricity power supply, reliability of telecommunication links, etc.

- This "both-sides sustainability" objective imposes to industrialised country representatives the respect of long-term interest: for example, appropriate advice on future compatibility of

equipment is necessary to avoid a very bad "image of ITS".

- The likelihood of significant constraints on maintenance funding or staff training can be a major recurrent issue in some contexts, therefore the design of "forgiving (robust) products" and the improved arrangements for "after-sale services" should be considered as a major comparative advantage.

These issues of staff training, and maintenance are underlined by the World Bank after many years of large experience in many developing countries: "... implementation has been handicapped by.... staff who are trained to design and maintain systems. As a consequence, simple management schemes, such as ... basic computer-controlled traffic signals, have often been considered more appropriate to developing countries. However developments in electronics have reduced both the initial costs of equipment and the need for maintenance. Renewed support for applications such as giving buses priority at traffic signals, on-line computerised traffic control, traffic enforcement, and electronic charging is now appropriate".

- Some ITS technologies could find a very different market in some countries compared to highly industrialised countries (it could sometimes help overcome higher frequencies of human error, for example for lost wagons or automated block signal systems in railways).
- Appropriate institutional analysis could identify which ongoing changes may create improved incentives for managers to choose new technologies and improve performances (i.e., privatisation of buses/railway operations/highway concessions, etc.).

The following recommendations have emerged on the basis of the above analysis:-

- Well-selected ETC applications can have a very high economic rate of return, especially in highly populated areas, therefore transport decision-makers need to know ETC applications and their potential fields of use.
- The ongoing deployment of ETC in Malaysia already leads to many interesting lessons; one of the most important one is that resolving institutional issues is a key to succeed, and addressing them takes time and commitment. We could therefore take advantage of this experience and start attacking priority institutional issues to prepare ETC deployment.
- ETC consists of a large range of services and products, some are not very sophisticated (traffic light coordination for example); even for those applications, the adaptation to local conditions is always necessary (mix of cars and non-motorized vehicles for example), as in India.
- The same functions can be accomplished with various levels of technology; finding the appropriate choice fully adapted to local conditions is important; the consistency between these choices and the institutional situation for operations and maintenance is essential for getting the benefits of the investments.
- Institutional and economic analysis should also fully take into account:-
  (i) the ratio between salary and capital investment costs (this ratio could be more than ten times lower than in industrialised countries)
  (ii) the competition between various sectors for equipment to be paid in very scarce foreign exchange resources. "Intermediate ETC technologies" could both give a better global level of service thanks to local availability of spare parts and maintenance, and allow progressive transfer to local manufacturing.
- Appropriate progress in ETC deployment is a key for success and can have many advantages (examples of India with computerised ticket reservation system, or progressive traffic surveillance sensors density/technology). A key is to chose an open architecture allowing for future changes, enhancements, and subsystem integration.
- Some contexts in India may lead to some ETC applications with higher economic rate of return than in Malaysia, like the use of GSM for accident detection and emergency services information.
- The same ETC technology could be used for different reasons in India than in Malaysia, like fleet location identification GPS on trucks mainly for security reasons in India, and also like expressway signboards in Malaysia.
- Understanding ETC possible applications and issues is a key to prepare well-prioritised ETC deployment plans; some early very-low-cost actions can be very beneficial for the long-term (i.e., institutional agreements, compatibility specification, etc)
- Maintenance and operations of ETC equipment

usually represent, in average and per year, 10% to 15% of the initial investments (which is significantly higher than in the case of pavements: 4%; or bridges: 1%). This should be carefully taken into account in economic analysis and to secure annual administrative budget; depreciation also has to be considered.

- Sound economic evaluations and true user need surveys can be very helpful for identifying priorities and also for helping actors to convince political decision-makers. Economic evaluation methodologies are being adapted to ETC specificities.

The implications for India are similar to the Malaysian experience i.e.

- All-round development of the transport industry
- Development of any industry and/or activity linked to road transportation
- Indirectly helps in national integration by joining the country by good roads
- Promotes sustainable economic growth and economic reforms
- The potential for greater profits lure project companies to pump in the vast sums of money needed for infrastructural development projects, thus sparing Government funds.
- Citizens attain faith in the governance process
- Make road travel easier in India
- Promotes movement of passengers on roads.
- Improves the image of India and thus leads together FDI flow into India

The case studies come as an eye opener to dispel some of the myths associated with ITS & ETC systems. Some of them are:-

Myth 1: "ITS technology is too sophisticated and costly".

Reality: A wide range of applications, some low-tech/low-cost/high pay-off, are already in use worldwide.

Myth 2: "Products are available off-the-shelf"

Reality: This is much more complex and an in-depth analysis of local specific needs is essential.

Myth 3: "ITS will replace infrastructure investments"

Reality: ITS may help mitigate some congestion under insufficient infrastructure context, or help differ some investments but often not "replace" infrastructure investments

Concluding Remarks

The race between standardisation to new innovations always has a wide gap leading to implementation delays, decision confusion based on technologies and obsolescence risks. Millions of dollars have been spent on R&D in the ETC field, particularly for the vehicle-to-roadside communications component. But the signs are that for a full speed ETC system, it is enforcement, not AVI, where current systems need to improve. A good example is Malaysia. However, comparing with India, the economic, environmental, social and cultural factors are vastly different between the two countries. Disparity in total road length and hence the vastness of the projects is a major differentiator. Initially it seems that the Malaysia road infrastructure is very insignificant as compared to India. However, a look at the total toll roads as compared to the total length of roads is an eye opener. Malaysia utilises at least 1.6% of its roads as revenue generating toll roads, whereas in India the figure is not even 0.1%. Malaysia ETC has to look into the environmental issue of tropics, while the Indian system has to withstand desert, rainfall, snow, sea coast salty air and all other extremes. The Indian system can also work better when multi-application is attained on the same card. All these form a part of the same process and are not to be looked at in isolation. Only proper integration will let everybody benefit from the ETC system.

The bureaucratic hurdles, lack of world standard automation in the road making process, lack of prior experience in ETC, wide variations in climatic conditions all over India etc. pose a huge challenge as compared to Malaysia.

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I learned to make my mind large, as the universe is large, so that there is room for paradoxes.

– Maxine Hong Kingston

Feature

Economics of Production of Green Peas in Punjab

Rohit Singla, S.S.Chahal & P. Kataria

The present study seeks to explore the economics of production and the factors affecting productivity of green peas in Punjab. The sample pea growers were drawn by using the multi-stage random sampling method. The results revealed that the farmers preferred Arkal variety due to its good eating quality and early maturity whereas PPL-87 was favoured due to its high yielding characteristics. These two varieties alone covered more than 85 per cent of area under peas in the study area. The results clearly suggest that the farmers should adopt early maturing varieties of peas in order to reap the benefits of higher pre-harvest season prices.

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Vegetables' potentiality to contribute to the national economy has been well recognized in recent years. Of late, vegetables have a vital place in the food platter of the Indians, with nutrition consciousness on the rise. India is the second largest producer of vegetables, next to China, with a production of 40 million tonnes from four million hectares of land area. The area under green peas in India rose continuously from 177.7 thousand hectares in 1991-92 to 272.6 thousand hectares in 1999-2000, with the percentage of area under peas in India to global pea area increasing from 3.2 per cent in 1991-92 to 4.5 per cent in 1999-2000. The increase in pea acreage has been accompanied by the commensurate increase in production, not withstanding the irregular trends in productivity. The productivity has seen many ups and downs over the period. It rose from 7030 kg per ha in 1991-92 to 10500 kg per ha in 1997-98 and then dwindled down to 9900 kg per ha in 1999-00 (Anonymous 2001).

The peculiarity of the green-peas cultivation is that it is highly labour intensive and also requires a high dosage of manure and fertilizers. The main constituents of the cost of cultivation of peas consist of manure and fertilizers, followed by bullock/labour/tractor and pesticides/chemicals cost. But it should not, in any way, undermine its remunerative aspect as the income obtained from vegetable crops has been reported as being almost four times as compared to food crops per hectare of land (Thakur 1994).

The preference of consumers for the year-round availability of most of the vegetables has paved the way for an increasing demand for vegetables in the processed form and particularly for frozen peas. The farmers, in an effort to capture the off season market demand for peas and also to give tough competition to frozen peas industry, go in for the early season varieties of pea. The present study is, therefore, an effort to study the economics of early and main season varieties of green pea and factors affecting their productivity in Punjab.

Materials and Methods

In order to achieve the objectives of the present study a multistage stratified random sampling technique has been deployed for the selection of the pea growers. The first stage entailed the selection of pea growing districts. The district-wise data on area under peas were obtained from the office of the Director Horticulture, Punjab, for the year 1997-98. All the districts were then divided into two strata, one having area subjected to early season varieties and another having main season varieties. Consequently one district from each stratum was chosen randomly. In the present study, Ludhiana represented the district growing main season varieties while Hoshiarpur district comprised the early season growers. At the next stage, four blocks i.e. two blocks from each district, where the density of pea growers was higher, were purposively selected. The blocks thus selected were Hoshiarpur-I and Mahilpur from Hoshiarpur district whereas Ludhiana I and Jagraon were selected from Ludhiana district. At the third stage, a cluster of three villages was selected from each block where the concentration of pea growers was the highest. From the list of each cluster 30 farmers were selected randomly. This gave a total sample of 120 pea growing farmers for this study. The schematic presentation of sample selection has been presented in Table 1.

Table 1: Detail of the sample selection in the selected districts of Punjab, 2002-03.

District	Names of the sample Blocks	Sample villages	Total
Hoshiarpur (ESG)	Hoshiarpur I	Chhabewal, Jian and Lehli Khurd	30
	Mahilpur	Dhakon, Sherpur and Nangal Khidari	30
Ludhiana (MSG)	Ludhiana I	Detwal, Bains and Gahaur	30
	Jagraon	Sivian, Leelan and Sherpur Kalan	30
Total		ESG: Early Season Growers, MSG: Main Season Growers	120

Cost concepts

Variable costs

The sum total of the costs incurred on seeds, fertilizers, FYM, plant protection chemicals, electricity/diesel charges for irrigation, human labour, animal labour, machinery/tractor hours, interest on working capital @ 12 per cent per annum for half of the period covered under green peas, constitute the total variable costs.

Fixed costs

- Interest on fixed capital: It is taken as 12 per cent per annum on the investment incurred on machinery, equipment, etc.
- Depreciation: It was calculated by the straight line method by deducting junk value from the original value and then dividing by number of useful years of assets under study.
- Land rent: It was taken as Rs. 30,000 per hectare being the modal rate in the sample villages during the study period (2001-02).
- Repair charges: Only minor repair charges for machinery and equipment were considered.

Total costs

It was taken as sum of variable and fixed costs.

Gross and net returns

Gross returns were worked out by multiplying the total output and price received by farmers and net returns were calculated by deducting total costs from gross returns.

Regression analysis for productivity response

To identify the factors affecting productivity and area under green peas a number of equations were exercised with different combinations of explanatory variables. The best fit equation was chosen on the basis of *a priori* theoretical as well as statistical and econometric criteria.

Productivity Response

The equation chosen for yield response is as given below:

$$Y = ax_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4} x_5^{b_5} x_6^{b_6} e^u$$

Or

$$\log y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + b_6 \log x_6 + u$$

Y = Yield of green peas

A = Constant

b_1-b_6 = Regression coefficients corresponding to x_1 through x_6

u = Random error term

e = Base of natural logarithm

x_1 = Net sown area (ha)

x_2 = Irrigation (No.)

x_3 = Human labour (hrs/ha)

x_4 = Machinery used (hrs/ha)

x_5 = NPK (kg/ha)

x_6 = Plant protection chemicals (litres/ha)

The explanatory variables were tested for their stochastic independence. The results were discussed by using simple tabular technique.

Results and Discussion

The results obtained from the analysis of data are presented and discussed under various sub-heads as under:

Distribution of pea growers' with regard to different varieties of peas on the selected farms

The results presented in Table 2 revealed that the Arkal and PPL-87 were the major varieties grown by the selected pea growers. At the overall level, 86.66 per cent of pea area has been covered by the PPL-87 (45.83%) and Arkal (40.83%) varieties while only 13.34 per cent has been put under E-6 (9.17%) and PPL-88 (4.17%) varieties of peas.

Table 2: Distribution of pea growers' with regard to different varieties of green peas on sample farms, 2002-03

(Per cent)

Season	Varieties	Pea growers
Early Season	(i) Arkal	40.83
	(ii) E-6	9.17
Main Season	(iii) PPL-87	45.83
	(iv) PPL-88	4.17
Total	100.00 (120)	

Figures in parentheses show total number of pea growers

The farmers preferred Arkal and E-6 to other varieties due to their early maturity, which ensure higher prices during pre-harvest season, besides good eating quality. Some of the sample farmers preferred PPL-87 and PPL88 due to their higher productivity as compared to other varieties.

Production practices: Early vis-à-vis main season varieties of peas

The results presented in Table 3 clearly shows that the number of ploughings was higher in early season varieties while number of irrigations was higher in main season varieties. The use of family labour was more in main season varieties. Also, the total human labour used was higher in main season varieties (168.57 days/ha) as compared to early season varieties (156.95 days/ha). There was big difference in seed rate between early and main season varieties. The seed rate in early season varieties was 149.37 kg/ha while in main season varieties it was only 67.27 kg/ha. The use of urea and DAP was more in main season varieties while the use of SSP, zinc and other micronutrients was higher in early season varieties.

Table 3: Production practices of early vis-à-vis main season varieties of green peas in Punjab, 2002-03

Particulars	Unit	Early season	Main season
Ploughing	No.	3.47	3.23
Irrigation	No.	4.09	4.91
Total human labour	Days/ha	156.95 (100.00)	168.57 (100.00)
(a) Family	Days/ha	22.37 (14.25)	37.15 (22.04)
(b) Hired	Days/ha	134.58 (85.75)	131.42 (77.95)
Tractor/machinery	Hrs/ha	17.96	13.92
Animal labour	Hrs/ha	7.17	6.11
Seed	Kg/ha	149.37	67.27
Urea	Kg/ha	175.18	186.92
SSP	Kg/ha	19.07	8.93
DAP	Kg/ha	120.78	136.12
Zinc	Kg/ha	5.40	1.08
Other micronutrients	Kg/ha	4.34	1.62
FYM	t/ha	9.67	1.49
Plant protection chemicals	Lt or kg/ha	1.56	0.76
Green pea yield	kg/ha	5945	8793

Figures in parentheses indicate the per cent of total human labour

FYM was used to the tune of 9.67 tonnes/ha in early season varieties which was much more than that in main season varieties (1.49 tonnes/ha) because the farmers used FYM approximately once in two years. The use of plant protection chemicals was more in early season varieties. Again, there was big difference between yield of early and main season varieties. In main season varieties, the yield was found to be 8793 kg/ha while in early season varieties it was 5645 kg/ha.

Cost of production: Early vis-à-vis Main season varieties of green peas

The results presented in Table 4 clearly showed that the cost on seed was higher in early season varieties (16 per cent) as compared to main season varieties (5.95 per cent), because of higher seed rate in early season varieties.

The cost of FYM in early season varieties was Rs. 302.12 per hectare while the same in main season varieties was negligible. The cost on human labour was more in main season varieties because of longer harvesting period as the harvesting is done manually. The total variable cost was higher in early season varieties (Rs. 17983.03 per hectare) as compared to main season varieties (Rs. 16995.73 per hectare). The total cost was also found to be more in the case of early season varieties as compared to main season varieties.

Economics of peas cultivation: Early vis-à-vis main season varieties

The results presented in Table 5 show that although the yield per hectare was lower in early season varieties, yet the gross and net returns were higher in these varieties as compared to main season varieties. This became possible because farmers got higher price for early season varieties. As such the prices realized by the farmers for early and main season crop turned out to be Rs. 1038.93 and Rs. 526.31 per quintal respectively. The net returns in the case of early season varieties were found to be of Rs. 31451.07 per hectare as compared to those of main season varieties (Rs. 18348.02 per ha). The returns over variable costs were also higher in early season varieties (Rs.43781.36 per ha) as compared to main season crop (Rs. 29282.71 per ha).

Factors affecting productivity (yield) of green peas

An attempt was made to study the relative roles of different factors influencing the yield of green peas by using regression analysis. The results are presented in Table 6. The Coefficients of Multiple Determination (R^2) were 0.95, 0.89 and 0.87 for early season, main season and at the overall level. In early season varieties, irrigation, fertilizers and labour use were found to be positive and highly significant whereas in the main season varieties in addition to above mentioned factors, pesticides and machinery were also found to have a positive effect on yield. Pesticides were found to have significant impact on yield in the case of main season varieties, as insect or disease attack in main season varieties was less as compared to early season varieties. At the overall level, irrigation, machinery and fertilizer had significant effects on yield. The results show that with one per cent increase in irrigation or fertilizer or machinery the yield would be increased by 0.60 or 0.35 or 0.20 per cent, respectively.

Table 4: Cost of production of early vis-à-vis main season varieties of green peas in Punjab, 2002-03

(Rs./ha)

Sr. No.	Particulars	Early season		Main season	
		Amount (Rs.)	Per cent	Amount (Rs.)	Per cent
1.	**Variable Costs**				
(i)	Seed	4851.13	16.00	2225.85	7.97
(ii)	Fertilizers				
	(a) Urea	798.08	2.63	868.90	3.11
	(b) SSP	50.67	0.17	23.37	0.08
	(c) DAP	1147.55	3.79	1306.81	4.68
	(d) Zinc	79.58	0.26	15.94	0.06
	(e) Other micronutrients	101.48	0.34	35.84	0.13
(iii)	FYM	302.12	1.00	39.36	0.14
(iv)	Plant protection	402.78	1.33	504.12	1.81
(v)	Electricity/ diesel	584.83	1.93	677.15	2.42
(vi)	Human labour	7301.88	24.09	9267.98	33.18
	(a) Family	1455.30	4.80	2489.90	8.92
	(b) Hired	5846.58	19.29	6778.08	24.26
(vii)	Animal labour	238.45	0.79	143.15	0.51
(viii)	Machinery/ tractor	2006.68	6.62	1798.92	6.44
(ix)	Interest on working capital @12 per cent for half of period under peas	117.86	0.39	87.34	0.31
	Total variable costs	17983.03	59.32	16995.73	60.85
2.	Fixed Costs				
(i)	Interest on fixed capital @ 12 per cent per annum	2407.96	7.94	707.74	2.53
(ii)	Depreciation (straight line method)	1688.43	5.58	323.69	1.16
(iii)	Land rent @ 30,000.00 per ha per year	7295.70	24.07	9679.46	34.66
(iv)	Repair charges	937.80	3.09	223.80	0.80
	Total fixed costs	12330.29	40.68	10934.69	39.15
3.,	Total Costs (1 + 2)	30313.32	100.00	27930.42	100.00

Table 5: Economics of cultivation of early vis-à-vis main season varieties of green peas in Punjab, 2002-03

Sr. No.	Particulars	Unit	Early season	Main season
1.	Yield	Q/ha	59.45	87.93
2.	Price/Rate	Rs./q	1038.93	526.31
3.	Gross Returns	Rs./ha	61764.39	46278.44
4.	Total costs	Rs./ha	30313.32	27930.42
5.	Net Returns	Rs./ha	31451.07	18348.02
6.	Returns over variable cost	Rs./ha	43781.36	29282.71

Table 6: Estimated coefficients for yield response functions of green peas in Punjab, 2002-03

Particulars	Overall	Early season	Main season
Constant	0.4620	0.2094	0.5014
NSA (ha)	0.0570 ^{NS} (0.0451)	0.0710 ^{NS} (0.0577)	-0.0103 ^{NS} (0.0479)
Irrigation (No.)	0.6003*** (0.0833)	0.3199*** (0.0863)	0.4404*** (0.1055)
Labour (days/ha)	0.0948 ^{NS} (0.0761)	0.3304*** (0.1031)	0.2051** (0.0788)
Machinery (hrs/ha)	0.1960*** (0.0447)	0.0595 ^{NS} (0.0563)	0.1961*** (0.0697)
NPK (kg/ha)	0.3490*** (0.0859)	0.1742* (0.0908)	0.2068** (0.1017)
Pesticides (litre/ha)	0.0290** (0.0143)	0.0092 ^{NS} (0.0132)	0.0363** (0.0178)
R^2	0.87	0.95	0.89

***, ** and * significant at one, five and ten per cent respectively.
NS: Non-significant

Conclusion

The farmers preferred Arkal variety due to its good eating quality and early maturity whereas PPL-87 was favoured due to its high yielding characteristics. These two varieties alone covered more than 85 per cent of area under peas in the study area. The seed rate was higher in the case of early season varieties whereas the yield was higher for main season varieties due to comparatively lower rate of germination in the case of former varieties. The cost of labour was higher in main season varieties due to their longer gestation period whereas the total variable costs of production was found to be higher in early season varieties due to higher seed rate. The net returns were also higher in early season varieties as these fetch higher prices in the market. Fertilizer, irrigation and machinery were the impact variables found to be positively influencing the yield of green peas. Moreover the irrigation, labour and fertilizers were positively significant both in early and main season varieties. In the backdrop it can be inferred that the farmers should adopt early maturing varieties of peas in order to reap the benefits of higher pre-harvest season prices.

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Feature

Animal Power Use in Farming Operations of Tamil Nadu

K. Govindarajan & T.R. Shanmugam

The present study was conducted with an aim to explore the growth in population of the draught animals utilized in farming operations. The study has further explored the population dynamics of draught animals in lieu of changes in the cropping pattern. The analyses had revealed that though the increase was seen in absolute numbers, the animal population per hectare of net sown area has actually declined in the state. The study was able to finally conclude that the increased cost of maintenance, spurt in number of tractors and the decline in area of cereal crops were found to be the causative factors for this decline.

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Bovines are the main source of draught power and have been an integral part of the Indian farm economy. Possessing 360 million bovines, India claims first position in the world accounting for 51 per cent of the Asian and 19 per cent of the world population. Recent changes in agricultural technology in general and farm mechanization in particular had affected the livestock sector in the country. There had been variations in livestock population in terms of agro-climatic conditions, demographic pressure, farm size, mechanization, cropping pattern, cost of maintenance and other identifiable socio-economic factors. The present study on draught animal population dynamics and their growth rate is important for the coming years. The following are the objectives of this study:

1. to study the growth in the draught animal population of Tamil Nadu and
2. to analyze the reasons for changes in draught animal population of the state.

Methodology

The present study had utilized both primary and secondary data to meaningful results and conclusions. For the secondary data on population of livestock, the data were compiled from Livestock Census Reports of the state and central governments commencing from the year 1951 to 1997. The secondary was analyzed using the time series and compound growth rate techniques to draw meaningful inferences. Survey conducted under Cost of Cultivation Scheme covering 600 farms in Tamil Nadu during 2001-02 was the source for the primary data, so as to analyze the pattern of animal power utilization. The data were collected by the cost accounting method. The size class of the holdings were divided into two groups viz., farms with less than two hectares and farms with more than two hectares for the purpose of analyzing the cross sectional data.

Table 1: Trend in Draught Animal Population (1951-1997)

Particulars	State	1951	1961	1974	1982	1989	1997
Draught animal population in million	India	67.38	77.99	80.05	81.22	81.36	N.A.
	Tamil Nadu	5.44	6.29	5.70	4.25	3.98	2.18
Draught animal population – cattle in million	India	60.82	70.85	72.67	73.94	73.86	N.A.
	Tamil Nadu	5.03	5.73	5.24	3.95	3.71	3.01
Draught animal population – buffalo in million	India	6.56	7.14	7.38	7.28	7.5	N.A.
	Tamil Nadu	0.41	0.56	0.46	0.30	0.27	0.17
Net sown area in million hectares	India	118.75	133.20	139.37	140.27	142.74	N.A.
	Tamil Nadu	5.27	6.04	5.91	5.45	5.84	5.03
Density of draught animals per hectare of net sown area	India	0.57	0.59	0.57	0.58	0.57	N.A.
	Tamil Nadu	1.03	1.04	0.96	0.78	0.68	0.43

Source: Livestock Census (various issues), Department of Economics and Statistics, Government of Tamil Nadu, Chennai.

Draught animal population dynamics

Vaidyanathan (1978) made an attempt to study the size and composition of bovine population as well as its behaviour over time. He has observed that cattle accounted for 90 per cent of all male bovines while their share in adult females was only 66 per cent, implying the dominance of cattle as a source of draught power. Nair and Dhas (1987) in their paper mentioned that work animal population in India has been estimated to be 81 million in the early eighties. Out of this, 75 per cent were cattle and the rest were buffaloes. The estimated number of work animals per unit of net sown area has been about 0.58. They have analyzed the variation in the density of draught animals over years and found that draught animal density has not reached the declining phase at the all-India level, while in the states of Kerala and Tamil Nadu, the draught animal density had shown a declining trend.

For the present study data was compiled from the State Livestock Census Reports commencing from 1951 to study the variation in draught animal stock and was duly compared with the all-India estimate. The figures are furnished in table 1. It could be seen from the table that although the work animal population has increased in absolute terms, the density, i.e., work animal on the basis of net sown area remained static at the all-India level. Growth rate of draught animal from the year 1951 to 1989 at a national level has been estimated at 0.48 per cent.

The density of draught animal stock in Tamil Nadu has registered an increasing trend in 1961 and tapered off in the year 1974 and remained at 0.68 work animal in 1989 on the basis of per hectare of net sown area. Overall growth rate of draught animal has been estimated at – 0.79 per cent for the period under consideration.

Tamil Nadu, known for its pure breeds like Kangeyam, Bargur, Umbalacherry and Alambadi is now facing a serious threat of slow extinction. Many factors favoured the deterioration of draught animal stock over years. During this period, emphasis has been given to dairy development through Operation Flood programmes which increased the milk production of the country from 17 million tonnes in 1951 to 52 million tonnes in 1991. Milk production of Tamil Nadu has also increased from one million tonnes in 1961 to 3.4 million tonnes in 1991. In almost every state, draught and traction were viewed as secondary products to milk and meat.

Cross breeding with exotic breeds for milk, continuous drought, changing cropping pattern, mechanization of agriculture in terms of tractorization and energisation of wells, inability of small and marginal farmers to maintain draught animals due to high cost of maintenance, opportunity cost of milk and also lack of institutional support might have contributed to the deterioration in the draught animal population. It has been observed that utilization of dry cows and some times dry buffaloes for draught purposes has been a common feature in most of the holdings. During peak seasons, when operations were to be carried out in time, the farmers of larger size groups supplemented the draught force by utilizing the available dry cows/buffaloes for farm operations, particularly in ploughing and lifting water. Small farmers, who could not afford to maintain animals, utilized their milch animals regularly for draught purposes. This fact has been verified when the pattern of animal power use in the farms of Tamil Nadu was analyzed.

Pattern of Animal Power Utilization

Raut (1982) asserted that on an average, one pair of draught animal has been utilized for about four hectares of cropped area. The area varied from 1.8 ha to 10.2 ha per pair of bullocks in different states. Singh et.al. (1971) estimated the availability of bullock power in Eastern Uttar Pradesh, Gujarat, Maharashtra, Punjab and Himachal Pradesh, by utilizing the data collected by the Institute of Agricultural Research Statistics. It was found that male cattle accounted for a substantial proportion of total work animals in all the states. It was also observed that ploughing alone accounted for a high proportion of the bullocks' output in all these states. Nair (1977) using the NSS's 26th round estimate, analyzed the investment in draught animals in agrarian economies of Kerala state. He concluded that reduction in draught animal population in Kerala had taken place mainly through price mechanism from supply side and changes in the distribution of land holdings from demand side.

The data revealed that the number of days employed per farm was positively related with the size of the holding (Table 2). The farms with large holdings employed animals for more days for crop production in a year compared to those with smaller holdings and it was due to larger area under cultivation in the former farms. Generally, hiring out of bullocks decreased with increase in farm size. Animal power utilization for family and social work has increased with the increase in farm size. The practice of exchanging draught animals between the farmers was on a higher side in smaller holdings.

Table 2: Animal Power Utilization in Tamil Nadu (2001-02)

(in pair days)

Work Particulars	I*	II**
Crop Production	33.25	55.29
Other farm works	18.01	35.87
Exchange	11.25	3.58
Social and Family work	5.28	6.21
Hired out	18.71	10.44
Total number days employed	86.50	111.39
Bullock numbers per farm	0.76	2.48
Value per bullock (Rs.)	8815	8937
Average size of holdings (ha.)	1.13	7.69

Note: I. * Farms with less than two hectare, II. ** Farms with more than two hectares.

Small farms did not own a pair of bullocks (they own single animal) and hence they arrange for another animal from his neighbour either by lease or by exchange, during peak season for effective utilization of animal power and family labour. Milch animals had contributed substantially to draught force in the smallholdings and its role on per hectare basis diminished as farm size has increased. This was because small farmers were unable to maintain animals separately for milk and draught purposes. Number of milch animals used for draught purposes decreased with increase in farm size. As expected, number of bullocks per farm was directly proportional to the size of holdings. The value of draught animal invariably increased with increasing size of farms, probably because of good quality of bullocks maintained in larger farms.

Maintenance Cost per bullock

For analyzing the cost of maintenance, a survey conducted under cost of cultivation scheme (2001-02) has been used. In estimating the cost of maintenance, the following variables were considered: (1) Labour for tending cattle, (ii) green and dry fodder fed to the animals, (iii) concentrates actually fed, (iv) depreciation for bullocks, (v) animal health care, (vi) interest on the current expenses at 12 per cent and (vii) interest on the value of the animal @ 10 per cent. Cost of maintenance per bullock has also increased with increase in farm size (Table 3).

Table 3: Cost of Maintenance per bullock in Tamil Nadu (2001-02)

Particulars	I*	II**
Value per bullock in Rs.	4908	4826
Cost of maintenance per bullock	8815.00	8937.00
Dung value per bullock	8241.00	9456.00
Net Cost of maintenance per bullock	188.00	200.00
Cost of maintenance per day per bullock	8053.00	9256.00
Number of work days per bullock	22.06	25.36
Cost of maintenance per day of work per bullock	86.50	111.39
Hire charges per animal per day of work	93.10	83.10
Break even point as number days to be worked	80.36	81.50

Note: I. * Farms with less than two hectare, II. ** Farms with more than two hectares.

However, cost of maintenance per bullock per day of work had decreased with an increase in farm size and it was mainly due to the larger utilization of farm animals

in big farms. Although the maintenance of bullock was not economical, if use could be found out so that the animals could be utilized more number of days per year, the cost per day would come down. Given the cost of maintenance and hire charges per day, the break-even days were estimated and presented in Table 3. It was observed that break even point as number of days to be worked was greater than the actual number of days, the bullocks worked in the farms. It has also revealed that cost of maintenance of bullock per day of work was greater than the hire charges per bullock per day. These factors might have influenced the farmer to reduce the draught animal stock to be maintained in their farm holdings.

Variation in Cropping Pattern

The changes in cropping pattern over years are subjected for analysis to find out whether it has got any bearing on draught animal population. For this purpose, area under major crops were compiled and presented in table 4 and 5.

Table 4: Area of Major Crops in Tamil Nadu

('000 ha)

Year	Paddy	Sor-ghum	Bajra	Ragi	Pul-ses	G.nut	S. cane	Cot-ton
1960-61	2488	765	483	366	422	872	81	391
1970-71	2636	742	475	281	492	983	114	296
1980-81	2299	712	353	195	544	842	183	220
1990-91	1856	541	274	170	847	963	233	239
2000-01	2080	331	129	127	687	699	315	170

Source: Government of Tamil Nadu, Agrostat, various issues, Directorate of Agriculture, Chennai.

The major development has been the decline in area under cereals viz., rice, sorghum, bajra and ragi. In the sixties, the proportion of gross cropped area under cereals was about 64 per cent. This proportion has started declining in seventies and the decline has accelerated from eighties. By 2000-01, the proportion of gross cropped area under cereals has shrunk to about 44 per cent. It might be interesting to note that area under sugarcane has increased from one per cent in 1960-61 to about 5.0 per cent in 2000-01. As was expected cereal crops had utilized more draught animal power than commercial crops. Rice required the highest bullock pair hours, 205 pair hours per hectare, since rice was transplanted after main field preparation involving more intensive tillage (more number of ploughing, for puddling, leveling and bunding). Ragi formed the second in order of bullock labour use with 165 pair hours per hectare implying the importance of animal power required for the cultivation of cereal crops.

Table 5: Per centage of Gross Cropped area under major crops in Tamil Nadu

Crops	1960-61	1970-71	1980-81	1990-91	2000-01
Rice	34.4	35.7	35.5	28.0	32.8
Sorghum	10.6	10.0	11.0	8.2	5.2
Bajra	6.7	6.4	5.4	4.1	2.0
Ragi	5.1	3.8	3.0	2.6	2.0
Total Cereals	63.9	62.5	57.2	45.8	44.4
Total Pulses	5.8	6.6	8.4	12.8	10.8
Groundnut	12.1	13.3	13.0	14.5	11.0
Sugarcane	1.1	1.5	2.8	3.5	5.0
Cotton	5.4	4.0	3.4	3.6	2.7
Other Crops	11.7	12.1	15.2	19.8	28.4
Total GCA in 1000 ha.	7235	7384	6470	6632	6338.0

Source: Government of Tamil Nadu, Agrostat, various issues, Directorate of Agriculture, Chennai.

Sugarcane, a commercial crop grown in the state, was ratooned after one year and hence needed less animal power with 58 pair hours per hectare. Increase in area under commercial crops like sugarcane and declining area under cereals might be taken as the pre-disposing factors for the decline in draught animal population.

Effect of Mechanization

In order to study the impact of mechanization on draught animal population, information on number of tractors, oil engines, electric pump sets and ploughs were gathered for Tamil Nadu and presented in table 6. It is evident from the table that there has been a steady increase in the number of tractors from 1960 onwards. Density of tractors per 100 hectares of net sown area also has registered an increasing trend from 0.005 in 1961 to 1.4 in 1997.

This might be yet another factor for reduction in the population of draught animal population. Similarly the total number of oil engines and electric pump sets has also registered an increasing trend over years of which the increase in the latter was phenomenal. During the period from 1961 to 1981, ploughs have also registered an increasing trend but started declining from 1989. Number of bullock carts has declined in association with reduction in number of draught animals.

Table 6: Agricultural Machinery and Implements in Tamil Nadu

Particulars	1951	1961	1974	1982	1989	1997
Tractors	241	934	7107	16780	26296	88712
Oil Engines	14013	36832	234416	205414	261166	301441
Electric pump sets	15104	98481	681205	945371	366935	884306
Ploughs	NA	3429902	3677359	3847386	2827884	1340781
Bullock Carts	NA	664544	394873	579631	477654	361994
Density of tractors per 100 hectares of net sown area	0.005	0.02	0.12	0.31	0.45	1.40

Note: NA – Not available,

Source: Govt. of Tamil Nadu, Agrostat, various issues, Directorate of Agriculture, Chennai

Summary

The present study has been conducted to study the draught animal population dynamics in Tamil Nadu. Draught animal power based on net area sown remained static at the all-India level and was found to decline in Tamil Nadu. Cattle accounted for about 90 per cent of draught animal population and the balance belonged to buffaloes. The function of maintaining cattle is primarily to produce animal power and buffaloes are kept primarily for milk. Besides changes in cropping pattern, farm size, high cost of maintenance and mechanization are considered as the prime factors for the noticeable decline in the animal power. Average employment of draught animals also decreased with decrease in farm size. Average number of days worked in a year has varied from 87 days to 111 days in big farms. Substitution of mechanical power has completely replaced bullocks for lifting water. Tractorization has partially replaced animal power for ploughing. Phenomenal development of public transport system in rural areas has significantly contributed to less dependence on animal power. These are the major reasons for the declining average employment of the bullock and thereby draught animal population.

Even under best conditions, where industries grow at the rate of six per cent, the organized sector cannot observe the million that will be added to the work force during the years to come. A way has to be found to retain as many as possible in rural areas by utilizing the local resources. It is precisely felt that draught animal power fits in nicely with its labour intensive and least cost-consuming technology well in tune with rural life because of its multifaceted uses. Draught animal power is an outstanding example of mass level application of appropriate technology to the millions of farmers in the third world countries in the context of the present oil crisis.

Policy Suggestions

It is encouraging to note that increased attention is being paid to the role of working animals in national planning. While efforts towards developing these sectors are minimal, their inclusion in national development plans draws attention due to their importance. Some means suggested for increasing the availability of draught animals are

- Starting animal breeding stations that concentrate on the production of draught animals.
- Bringing animal breeds under the purview of the Geographical Indications clause of the Intellectual Property Rights.
- Reserving grass land for the grazing of cattle and
- Using a single animal plough as is being practiced in the Philippines.

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Feature

Factors Influencing Adoption of Drip Irrigation in Mulberry – A Field Investigation of Farmers

P. Kumaresan, R.G. Geetha & S.B. Dandin

Drip irrigation system is advocated for mulberry for the efficient use of irrigation water. However, the decision of adoption of drip irrigation depends on many technical and socio-economic factors. Hence, a field study was taken up to analyze the factors influencing the adoption of drip irrigation for mulberry. The study revealed that the variables namely, variety and spacing, had significant association with the adoption of the drip irrigation system.

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Water is an important input for mulberry, which determines not only the yield but also the leaf quality. But the availability of water is reducing due to frequent failure of monsoon rains, increased demand for drinking and industrial purposes and switching over to cultivation of water-loving crops. In many parts of the country, the use of ground water level is going beyond the socially and economically acceptable limits in agriculturally advanced states (Venkatesha Palaniswamy et al., 2002). Going by past experience, the problem of water scarcity may aggravate in course of time. With the fast decline of available water for future use of irrigation, the approach of water management should focus on augmenting supply of water through conservation or optimum use.

In this context, the problem of the over exploitation of water can be restricted, when the drip irrigation system is adopted extensively. Drip irrigation system is a method of direct application of water on the soil surface encompassing the root zone as continuously or discontinuously by drops. Under this system, water is applied on the soil through mechanical emitters/drippers at a relatively low pressure at the rate of 1-16 litres per hour. This method of irrigation is the most suitable for perennial crops like coconut, mango, sapota, guava, pomegranate etc.

As mulberry is a perennial and water intensive crop, drip irrigation is advocated for efficient use of water. Saratchandra et al. (1992) and Misra et al. (2002) estimated 33 per cent - 40 per cent water saving due to the use of drip irrigation over furrow system of irrigation. They also found that there was yield and quality improvement in gardens irrigated with drip system due to regular watering near root zone of mulberry, which helps in the better utilization of both water and nutrients the mulberry plants. Though the farmers are well aware of the multiple advantages of the drip irrigation system,

the decision of adoption of drip irrigation depends on many other factors.

In this context, a field study has been taken up to analyze the factors influencing the adoption of drip irrigation for mulberry and find out the constraints in adopting the recommended micro-irrigation system for mulberry.

Database

The study was carried out in Kolar district of Karnataka, which is a traditional and the largest mulberry cocoon-producing district in the state. Based on the information collected from the District Sericulture Office on mulberry area and the number of farmers adopting drip irrigation, Kolar and Bangarpet taluks were selected for the study in this district. In each of these two taluks, the required information was collected from a random sample of 60 farmers comprising 30 drip adopters and 30 farmers, following the furrow method of irrigation for mulberry. Thus, altogether, the total sample size was 120 farmers, which included 60 drip and 60 non-drip adopters. While the farmers who have adopted drip irrigation were selected by the random sampling method using the list of farmers received from the District Sericulture Office, the non-drip adopters located adjutant to the sample drip adopters were selected for the data collection in order to minimize the variations between the two categories of the farmers in terms of social and agro-climatic parameters. The data collected from the sericultural farmers for the study pertain to the year 2003-04.

Analytical Framework

A logit model has been used to identify the factors influencing the adoption of drip irrigation, as it is a more appropriate functional form, when the dependent variable contains binary values such as 0 and 1. In the present analysis, the adoption of drip irrigation was scored as 1 and otherwise as 0. Assuming a linear relationship between the adoption index and the socio-economic factors, the following logistic functional form was chosen:

$$AI = \frac{1}{1 + \exp^{-z}} + \mu \quad ...(1)$$

Where

$$Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \quad ...(2)$$

AI = Adoption index which is defined as 1 if the drip irrigation system is adopted for mulberry or else, it is 0

μ = Random disturbance term with zero mean

Though Z is a linear combination of variables that have both upper and lower bounds, no bound can be assigned to the variable Z itself, as values assumed by Z will depend on the values of unknown parameters β_is also. The formulation of equation (1) however ensures that as AI increases with increase in Z, the impact of Z on AI is contained between 0 and 1.

The linear regression model explaining the adoption of drip irrigation is given by equation (3) below:

$$Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \mu \quad ...(3)$$

In this model, as already noted, the dependent variable for the study is binominal: whether the sample farmer has adopted drip irrigation (score = 1) or not (score = 0). The independent variables considered for the study include:

Age (X_1) and education level (X_2) of the sample household head were included as the independent variables in the model, as the studies conducted by Dolli et al., (1992), Singhvi et al., (1994), Doddagadad (1996), Srinivasa et al., (1998), Geetha et al., (2001) and many others indicated that age and educational status of the farmers had a significant relationship with the adoption of the sericultural technologies. In the model, age was accounted as the number of years completed by the individual at the time of interview. The educational level of the farmer was quantified by scoring the formal education completed by the respondent as "0" for no schooling; "1" for primary education, "2" for middle schooling, "3" for secondary education, "4" for pre-university/diploma, "5" for degree and "6" for post-graduation.

The irrigation intensity index (X_3) was considered as the third independent variable in the model. It was worked out as the percentage of gross irrigated area to the net irrigated area. The higher the irrigation intensity of the farm, the better the utilization of the irrigation water by the farm. Hence, the farmer who is concerned about irrigation use efficiency will adopt the drip irrigation for mulberry to irrigate for more area with the available water.

In the study area, the farmers had different mulberry varieties. Generally, the farmers who possess the high yielding mulberry varieties such as V1 and S36 are expected to prefer the drip system. Hence, mulberry variety (X_4) was included as the fourth variable in the model. This variable was constructed using the scores namely, "0" for local variety and "1" for high yielding varieties such as V1, S36 etc.

The fifth independent variable included in the model was mulberry plant spacing (X_5), as the drip irrigation is expensive and difficult to operate in mulberry plantation with closer spacing. The scores assigned for plant geometry were "O" for closer spacing, that is any plant to plant spacing less than 3', "1" for 3'x 3' and "2" for paired row system of plantation with the spacing of (3' + 5') x 2'.

The mean values of the variables included in the model are given in Table 1.

Table 1: Mean values of the variables included in the model

Sl. No.	Variables	Drip method of irrigation	Furrow method of irrigation
1.	Sample size	60	60
2.	Age (years)	41.02	41.07
3.	Education (score)	2.26	1.61
4.	Irrigation intensity index of the farm	222.06	180.30
5.	Variety (score)	0.92	0.35
6.	Plant spacing (score)	1.12	0.35

Results and Discussion

The factors influencing the adoption of drip irrigation was studied by using logistic regression function. In the model fitted for the study, the dependent variable, adoption index for drip irrigation was regressed with independent variables namely age of the farmer, education level of the farmer, irrigation intensity index of the farm, variety and plant spacing. The coefficients of the fitted function are presented in Table 2.

Table 2: Results of non-linear least square estimates of equation for explaining factors influencing drip irrigation

Sl. No.	Variables	Coefficient	Standard error	T statistics	P value
1.	Constant	-4.9749			
2.	Age (years)	0.0016	0.0245	0.0653	0.9480
3.	Education (score)	0.4322**	0.2526	1.7110	0.0870
4.	Proportion of area under mulberry to total land under cultivation	0.7354	0.8087	0.9064	0.3632
5.	Variety (score)	2.5721*	1.1047	2.3283	0.0199
6.	Plant spacing (score)	1.7274*	0.7100	2.4330	0.0150

R^2 = 0.539

Note: * – Significant at 1% level
** – Significant at 10% level

The co-efficient of multiple determination (R^2) of the fitted model was 0.539 implying that 54 per cent of the variation in the adoption of drip irrigation could be explained by the variables included in the model. All the variables included in the model had expected sign. Among the variables, mulberry variety had the strongest association with the adoption of drip irrigation for mulberry. The yield and leaf quality are better with the improved varieties such as V1 and S36 compared to the local varieties. The water use and nutrient use efficiency are also better with the improved varieties. Hence, the farmers who possessed high yielding mulberry varieties preferred drip irrigation to the farmers owning local mulberry varieties. The second significant variable was mulberry plant spacing. As the drip irrigation system is convenient to use in the garden with wider spacing such as (3' + 5') x 2' and 3' x 3' compared to the garden with closer spacing such as 3'x 1', 2' x 1' etc, the farmers with wider spacing garden preferred for drip irrigation. Further, the installation cost of drip system is less in the gardens with wider spacing compared to the gardens of closer spacing. The third variable, which significantly influenced the adoption of drip irrigation for mulberry, was education. Dolli et al., (1992), Doddagadad (1996), Srinivasa et al., (1998) and Geetha et al., (2001) reported a significant relationship of education level with the adoption of improved sericultural technologies.

The coefficients of age and the irrigation intensity of the farm were positive, but were not statistically significant.

Farmers' opinion about advantages of drip irrigation

The farmers were well aware of the multiple advantages of the drip irrigation system. However, the decision of adoption of drip irrigation was decided by many quantitative and qualitative factors. Hence, the opinion of the drip adopters were documented on the distinct advantages of drip irrigation and listed in Table 3. Irrigation water saving was the foremost and highly important factor determining the adoption of drip irrigation for mulberry (90% of response) followed by labour saving (50%), improvement in mulberry leaf yield (44%), high input efficiency (42%), reduction in weed problem (36%) and uniform wetting (34%), in that order. In addition, the possibility of irrigating the whole garden at a time during the period of erratic power supply, survival of mulberry plants during acute water scarcity period, subsidy and reduction in pests and diseases, were the other advantages listed out by the farmers on drop irrigation.

Though there are distinct advantages in the adoption of the drip irrigation system, the constraints faced by the farmers in drip irrigation in the field conditions

were documented (Table 4) to put the technology in the right perspective. Damage caused by rodents, dogs, wild bores etc., were the major constraints expressed by about 72 per cent of the respondents. Salt encrustation and clogging of microtubes, where there is salinity problem of water (54%), delay in sanctioning the subsidy (22%), exorbitant charges for the drip irrigation system when purchased under subsidy (14%), theft and damage by others (10%) and poor quality materials used in the drip system (10%), were the other major constraints expressed by the farmers in drip irrigation system.

Table 3: Farmers' opinion about advantages of drip irrigation

Sl. No.	Advantages	Number (N = 60)	%
1.	Irrigation water saving	54	90.00
2.	Labour saving	48	80.00
3.	Improvement in yield	26	44.00
4.	High input efficiency	25	42.00
5.	Reduction in weed problem	22	36.00
6.	Uniform wetting	20	34.00
7.	To manage erratic power supply	14	24.00
8.	Quality improvement	11	18.00
9.	Survival of plants during acute water scarcity period	7	12.00
10.	Subsidy	4	6.00
11.	Less soil erosion	2	4.00
12.	Entire garden can be irrigated at a time	1	2.00
13.	Soil temperature maintenance	1	2.00
14.	Less deposition of soil particles	1	2.00
15.	Reduction in pest and disease incidence	1	2.00

The reasons for non-adoption of drip irrigations was collected from the sample non-drip adopters and the results are listed in Table 5. Lack of money for investing in the drip system was the major reason for non-adoption of drip irrigation expressed by 50% of the respondents. The next important reason expressed for not adopting the drip irrigation was closer plantation/local mulberry variety (42.50%), which was also indicated by the logit function fitted to study the factors influencing adoption of drip irrigation. No water in the bore well (37.50%), availability of sufficient\surplus water in the well (17.50%) and delay in sanctioning the subsidy (10%), were the other reasons expressed by the farmers for non-adoption of drip irrigation system.

Table 4: Farmers' opinion about constraints in drip irrigation

Sl. No.	Constraints	Number (N=60)	%
1.	Damage by rodents dogs wild bore etc	43	72.00
2.	Salt encrustation and clogging	32	54.00
3.	Delay in sanctioning the subsidy	13	22.00
4.	Exorbitant charges made by the companies	8	14.00
5.	Theft and damage by others,	6	10.00
6.	Poor quality materials used in the drip system	6	10.00
7.	Difficulties in performing intercultural operations	4	6.00
8.	Repair and maintenance problems	4	6.00
9.	Entry of roots of mulberry plants into the gaps	1	2.00

Table 5: Farmers' opinion about reasons for non-adoption of drip irrigation

Sl. No.	Reasons	Number (N=60)	%
1.	Lack of money for investing on drip system	30	50.00
2.	Closer plantation/local mulberry variety	26	42.50
3.	Irrigation water problem	23	37.50
4.	Availability of surplus/sufficient irrigation water	11	17.50
5.	Delay in subsidy amount sanction	6	10.00
6.	Personal problems	5	7.50
7.	No open/bore well	5	7.50
8.	No benefit from drip irrigation	5	7.50
9.	Availability of sufficient labour for sericultural operations	2	2.50
10.	Joint family (land records are not proper)	2	2.50

Summary and Conclusion

Owing to a decline in available water potential and continuous demand for water from different sectors, attention is to be paid to increase the water use efficiency. One of the means for this is drip irrigation. The analysis indicated that the variables namely, variety and spacing, had a significant association with the adoption of the drip irrigation system. This implies that the farmers who

have adopted high yielding mulberry varieties and wider plant spacing preferred the adoption of drip irrigation. But around 85 per cent of the mulberry area in Kolar district, where the study was conducted, was covered under either the local or K2 mulberry variety. Most of these gardens were with the closer plant spacing. When the reasons for non-adoption of drip irrigation was documented from the non-drip adopters, closer plantation/local mulberry variety was the major reason indicated for non-adoption of drip irrigation. Hence, popularization of high yielding mulberry varieties and wider spacing would not only result in increase in quality and productivity in mulberry leaf production, but also help in quick spread of drip irrigation.

As water is becoming a scarce resource and irrigation water charges are becoming expensive in water scarce areas, educating the farmers on irrigation management, judicious crop mix of the water-intensive crops such as mulberry with the less water-intensive crops and increased water use efficiency, is essential in order to avoid the supply-demand gaps in water use for sericulture and other agricultural crops in the coming years.

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A brand for a company is like a reputation for a person. You earn reputation by trying to do hard things well.

– Jeftf Bezos

Feature

Supply Response of Farmers – A Case of Cotton Crop in Andhra Pradesh

A. Nakula Reddy

In economic analysis of farm supply response, price is considered to be the critical economic factor that determines acreage allocation decisions. Farmers face a number of constraints while making acreage allocation decisions in response to changes in economic environment. With respect to the cultivation of cotton crop such constraints i.e. weather uncertainties, yield and price variations, are more severe. In this paper an attempt has been made to test the price response and risk aversion attitude of cotton farmers. The study reveals that farmers are responsive to changes in relative price of cotton, but at a slower rate.

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Price expectations in commercialized agriculture plays an important role in decision making at the micro and macro level. Generally higher prices are expected to result in greater output. This fact indicates the economic rationality of farmers in general and underlines the proposition that the farmers make appropriate adjustment in acreage under crops in response to changes in prices. In economic analysis of farm supply response, price is considered to be the critical economic factor that determines acreage allocation decisions.

Farmers face a number of constraints while making production decisions in response to changes in economic environment. Very often they are not able to make suitable adjustments instantaneously. With respect to the cultivation of cotton crop such constraints i.e. weather uncertainties, yield and price fluctuations are more severe. It is rational to argue that in addition to price, non-price factors also have a significant impact on acreage allocation under different crops. While attempting to analyse farmers response behaviour, one must take into account price as well as non-price factors before arriving at any firm conclusion about farmers' decision-making behaviour.

The present study is confined to Andhra Pradesh state. An attempt has been made to observe the behaviour of farmers at the district as well regional level with the help of secondary data. To conduct the district-level analysis, Adilabad, Warangal, Mahaboobnagar from Telangana region, Guntoor, Prakasam districts from Andhra region and Ananthapur from Rayalaseema region were selected. For regional level analysis of farm supply response of cotton crop, all the three regions of Andhra Pradesh i.e. Telangana, Andhra and Rayalaseema were selected. The present paper aimed at testing price response and risk aversion hypotheses of farmers cultivating cotton crop in Andhra Pradesh. The study covers the time period from 1985-86 to 2002-03. Season and crop reports published by the Direc-

torate of Economics and Statistics, Andhra Pradesh are the basic source of this study. Marc Nerlove's partial adjustment model has been adopted to study cotton cultivators responsiveness to price and non-price variables.

The model:

$$X_{t}^{*} = a + b_1 P_{t-1} + b_2 Y_{t-1} + b_3 R_t + b_4 Y_r + b_5 p_r + Ut \quad ...(1)$$

Where $X_t - X_{t-1} = B (X_{t*} - X_{t-1})$

$$X_t = B (X_t^* - X_{t-1}) + X_{t-1}$$

$$X_t = B X_t^* - B X_{t-1} + X_{t-1}$$

$$X_t = B X_t^* + X_{t-1} (1 - B) \quad ...(2)$$

By substituting equation-1 in place of X_t^* in equation-2, we can derive the final equation of the model as shown below.

$$X_t = B (a + b_1 P_{t-1} + b_2 Y_{t-1} + b_3 R_t + b_4 Yr + b_5 p_r) + X_{t-1} (1- B) + B ut.$$

Here X_t^* = Expected standard area under the crop in time 't'

X_t = Actual standard area under the crop in time 't'

X_{t-1} = Standard area under the crop with time 't−1'.

P_{t-1} = Relative price of cotton per quintal is obtained by deflating price per quintal of cotton with the price per quintal of competing crop. For Telangana region and the sample districts of this region, P_{t-1} is arrived at by deflating the price of cotton per quintal with the price per quintal of mirch. For Andhra region and the sample districts of this region, the price per quintal of cotton is deflated by the weighted average price per quintal of mirch and tobacco. For Rayalaseema region and the sample district, price of cotton per quintal is deflated by price per quintal of ground nut.

Y_{t-1} = Relative yield of cotton is arrived at by deflating the yield of cotton per hectare with the yield of competing crop per hectare (competing crops are same as in the case of P_{t-1}).

Rt = rainfall at the time of sowing season.

Yr = Yield rik. Standard deviation of cotton yield per hectare during the preceding three years used as a measure of yield risk.

Pr = Price risk. Standard deviation of cotton price per quintal during the preceding three years used as a measure of price risk.

Ut = Error term.

B = Adjustment coefficient. The coefficient value of 'B' lies in between 0 (zero) and 1 (one). The implicit meaning of 'B' value is that, farmers able to adjust their acreage only to the extent of fraction 'B' i.e. between 0 and 1. 'B' value is therefore an indicator of the speed of adjustment in acreage under cotton crop.

Analysis of Regression Results: District-wise

Table 1 presents regression coefficients of price and non-price variables with respect to sample districts in Andhra Pradesh. The estimated regression coefficients clearly shows that relative price, relative yield, rainfall at the time of sowing season, yield risk and price risk vari-

Table 1: Regression results: District-wise

District	P_{t-1}	Y_{t-1}	Rt	Yr	Pr	X_{t-1}	R^2
Warangal	1.245** (2.469)	2.078* (3.264)	0.987** (2.076)	−1.809* (4.848)	−1.605* (5.319)	.382 (0.762)	.82
Adilabad	2.056* (3.475)	.734 (1.231)	1.473* (3.098)	−2.653* (5.347)	−3.213* (3.163)	.336 (1.212)	.74
Guntoor	.805* (2.989)	1.678* (3.580)	2.965** (2.119)	−3.614* (4.683)	−4.231* (5.346)	0.510 (0.989)	.84
Prakasam	1.654* (4.356)	1.008** (2.019)	2.704* (3.709)	−1.076* (4.674)	−2.757* (4.354)	0.435 (1.432)	.68
Anantha-pur	2.086* (3.667)	1.330* (2.894)	5.251* (4.541)	−6.262* (5.339)	−2.919* (4.770)	0.426 (1.002)	.87

Note: Figures in parentheses are 't' values.
*Significant at 1 per cent level.
**Significant at 5 per cent level.

Table 2: Regression Results:Region-wise

Region	P_{t-1}	Y t-1	Rt	Yr	Pr	X_{t-1}	R^2
Telan-gana	3.476* (3.202)	1.549* (2.653)	1.121* (2.999)	−1.899* (4.106)	−4.212* (3.703)	.389 (1.006)	0.83
Andhra	1.509* (2.886)	2.072 (1.677)	1.968 (1.409)	−3.210* (2.961)	−3.660* (6.421)	.426 (1.523)	0.64
Raya-laseema	4.268* (2.654)	2.919 (1.489)	6.313** (4.720)	−3.001* (2.938)	−2.947* (5.073)	.468 (1.127)	0.78
A.P.	2.656* (3.490)	3.483* (2.663)	2.898* (4.674)	−4.602* (3.606)	−4.233* (4.088)	.445 (1.804)	0.73

Note: Figures in parentheses are 't' values.
*Significant at 1 per cent level.
**Significant at 5 per cent level.

ables are significant in influencing the acreage under cotton crop in selected districts. As expected the sign of P_{t-1}, Y_{t-1}, Rt is positive (i.e. plus) whereas the sign of Yr, Pr is negative (i.e. minus). Except X_{t-1}, other explanatory variables incorporated in the supply response function are statistically significant. Farmers in selected districts are responsive to changes in relative price, relative yield and rainfall by allocating larger proportion of their acreage under cotton crop. In all the sample districts, relative price, relative yield, rainfall, yield risk and price risk variables are statistically significant at a very high level. The minus (–) sign of the coefficients of Yr, Pr variables implies that, farmers are responsive to changes in these variables by allocating smaller proportion of their area under cotton crop to protect themselves from the risk, arising out of uncertain yield. The 't' values of the regression coefficients are more than double the coefficient values, due to low standard error, indicates high degree of reliability of estimated results. The coefficient of determination (R^2), for all the sample districts varies between .68 to .87. This implies, that the variables specified in regression function are able to account for 68 to 87 per cent of variation in acreage under cotton crop during the study period.

Table 2 presents regression coefficients of price and non-price variables with respect to three regions and the state of Andhra Pradesh. The estimated regression results shows that price and non-price variables specified in the regression function accounts for a major change in acreage under cotton crop. In all the three regions and the state of Andhra Pradesh, farmers are responsive to changes in relative price, relative yield and rainfall by allocating larger proportion of their acreage under cotton crop. These results are in line with the estimates of other studies. In general the 't' values of these coefficients are statistically significant at a higher level of confidence interval. The 't' values of price risk and yield risk variables are more than double the coefficient values due to low standard error, which suggests a greater degree of accuracy and reliability of the estimated results. Between yield risk and price risk, relatively, price risk is accounting for a major change in acreage under cotton crop. The problem of yield risk arises due to the fact that, cotton crop is more prone to diseases. Further, uncertain rainfall coupled with unfavourable weather conditions at the time of crop growing season adversely affects yield levels. The problem of price risk arises due to widespread fluctuations in market prices and lack of adequate state support to lift cotton from market yards. As a result, in general the farmers and in particular the cotton prices are at the mercy of private business people. Under these conditions, it is natural that the farmers in selected sample regions and in Andhra Pradesh are fully taken into account price risk and yield risk while allocating area under cotton crop. This study clearly brought out the fact that whenever they expect price risk or yield risk, as the regression results suggests, farmers allocating large proportion of acreage under competing crops by reducing acreage under cotton crop to avoid risk. Lagged acreage turned out to be insignificant and has no impact on acreage under cotton crop.

Acreage elasticities

Acreage elasticities have been estimated with respect to price and non-price variables such as Y_{t-1}, Rt, Yr and Pr, to examine the relative importance of these variables in influencing area under cotton crop. In this study an attempt has been made to estimate both short-run and long-run acreage elasticities as shown below.

$$\text{Short-run elasticity} = \frac{\text{Mean value of the independent variable}}{\text{Mean value of the dependent variable}} \times \text{coefficient of variable}$$

$$\text{Long-run elasticity} = \frac{\text{Short-run elasticity}}{\text{Coefficient of adjustment ('B' value)}}$$

Analysis of acreage elasticities: District-wise

Table 3 presents acreage elasticities of cotton crop pertaining to sample districts in Andhra Pradesh State. The estimated elasticities reveals that yield risk and price risk elasticities are much higher than the elasticities of other explanatory variables specified in supply response function. Yield risk and price risk variables together accounting for greater degree of impact on acreage under cotton crop in the long-run. For Anantapur District, elasticity of rainfall is relatively higher (.98) and its impact is positive. Relative price elasticity, though positive, was not of a high order. One can find considerable degree of inter-district variation in elasticity, values. Acreage elasticities suggests that farmers are willing to allocate a larger proportion of their area under cotton crop as result of change in relative price, relative yield and rainfall variables. On the other hand, farmers allocate a smaller proportion of their cultivated lands to cotton crop as a result of uncertainty in yield and price. This reveals the fact that farmers are averse to take risk, arising out of yield and price fluctuations.

Acreage elasticities: Region-wise

Table 4 shows that the price elasticities fall under low response category as compared to the elasticities of acreage with respect to other variables incorporated in supply response function. For Telangana region long-run price risk elasticity is (-.69) relatively higher than the elasticity values of other variables. In case of the Andhra

Table 3: Acreage elasticities: District-wise

District	P_{t-1}		Y t-1		Rt		Yr		Pr	
	S.R.	L.R.	S.R.	L.R.	S.R.	L.R.	S.R.	L.R.	S.R.	L.R.
Warangal	.12	.19	.29	.46	.31	.50	–.49	–.79	–.56	–.90
Adilabad	.34	.51	.17	.26	.39	.59	–.56	–.85	–.63	–.95
Guntoor	.20	.41	.24	.49	.16	.32	–.33	–.67	–.42	–.86
Prakasam	.26	.46	.34	.60	.22	.38	–.38	–.67	–.51	–.88
Ananthapur	.30	.52	.25	.43	.57	.98	–.41	–.71	–.48	–.83

Table 4: Acreage elasticities: Region-wise

Region	P_{t-1}		Y_{t-1}		Rt		Yr		Pr	
	S.R.	L.R.	S.R.	L.R.	S.R.	L.R.	S.R.	L.R.	S.R.	L.R.
Telangana	.18	.29	.31	.51	.37	.61	–.29	–.47	–.42	–.69
Andhra	.11	.19	.23	.40	.26	.46	–.14	–.24	–.20	–.35
Rayalaseema	.15	.28	.12	.23	.43	.81	–.30	–.57	–.45	–.85
A.P.	.13	.23	.16	.28	.32	.57	–.26	–.46	–.39	–.67

region, though the price risk and yield risk elasticities have a negative sign, they are relatively low in influencing acreage under cotton crop. With respect to the Rayalaseema region, long-run elasticities of price risk and rainfall are relatively higher than the elasticities of other variables. For Andhra Pradesh as a whole, farmers are relatively responsive to price risk and rainfall.

Conclusion

In the present paper an attempt has been made to estimate price response and the risk aversion attitude of farmers cultivating cotton crop. This study reveals that the farmers are responsive to changes in relative price of cotton, but at a slower rate. Yield risk, price risk, relative yield and rainfall variables exert a predominant influence on acreage allocation decisions of cotton growers. Price risk and yield variables have a negative sign (minus), which indicates that the farmers in selected sample districts, three regions and Andhra Pradesh are not willing to take risk. The expectation of risk related to cotton yield and price, induces farmers to reduce acreage under cotton crop. To reduce yield risk by minimizing fluctuations in yield, the government should focus its efforts towards providing better quality seed and agricultural extension services. To reduce price risk and to inculcate an element of certainty in the minds of farmers regarding market price of cotton, the government should interfere in the market and take steps to buy cotton from market yards through its agencies. These steps may go a long way in improving income levels of farmers cultivating cotton crop and ensuring smooth supply of cotton in the long-run.

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News and Notes

Global E-Government Readiness Report 2005

Global E-Government Readiness Report 2005, From E-Government to E-inclusion assesses the e-government readiness of the 191 Member States of the UN, according to a quantitative composite index of e-readiness based on website assessment, telecommunication infrastructure and human resource endowment. The Part II of the Report illustrates that in most of the developing country, populations face a grave challenge from the new technological revolution. Of course the developing countries which have in place the right mix of reforms, institutions and programes will no doubt benefit from the ICTs, most are likely to be mired in a cycle of low income, poverty and growing disparity in access to modern technology. Expanding the concept of 'real access' to ICT into e-inclusion, Part II: *From E-government to E-inclusion* presents the *Socially Inclusive Governance Framework*, which is a multi-pronged approach to ICT-led real access, with a special focus on the need to promote access and inclusion to the disadvantaged groups in society.

This is the third, in a series, of UN Global E-Government Readiness Reports, published by the UN Department of Economic and Social Affair, Division of Public Administration and Knowledge Management. The reports can be assessed on line by visiting the following URL:http://www.unspan.org/dpepa-egovernment%20readiness%20report.asp

Table 1: E-government Readiness Index 2005

Rank	Country	Index
1	United States	0.9062
2	Denmark	0.9058
3	Sweden	0.8983
4	United Kingdom	0.8777
5	Republic of Korea	0.8727
6	Australia	0.8679
7	Singapore	0.8503
8	Canada	0.8425
9	Finland	0.8231
10	Norway	0.8228
11	Germany	0.8050
12	Netherlands	0.8021
13	New Zealand	0.7987
14	Japan	0.7801
15	Iceland	0.7794
16	Austria	0.7602
17	Switzerland	0.7548
18	Belgium	0.7381
19	Estonia	0.7347
20	Ireland	0.7251
21	Malta	0.7012
22	Chile	0.6963
23	France	0.6925
24	Israel	0.6903
25	Italy	0.6794
26	Slovenia	0.6762
27	Hungary	0.6536
28	Luxembourg	0.6513
29	Czech Republic	0.6396
30	Portugal	0.6084
31	Mexico	0.6061
32	Latvia	0.6050
33	Brazil	0.5981
34	Argentina	0.5971
35	Greece	0.5921
36	Slovakia	0.5887
37	Cyprus	0.5872

Rank	Country	Index
38	Poland	0.5872
39	Spain	0.5847
40	Lithuania	0.5786
41	Philippines	0.5721
42	United Arab Emirates	0.5718
43	Malaysia	0.5706
44	Romania	0.5704
45	Bulgaria	0.5605
46	Thailand	0.5518
47	Croatia	0.5480
48	Ukraine	0.5456
49	Uruguay	0.5387
50	Russian Federation	0.5329
51	Belarus	0.5318
52	Mauritius	0.5317
53	Bahrain	0.5282
54	Colombia	0.5221
55	Venezuela	0.5161
56	Peru	0.5089
57	China	0.5078
58	South Africa	0.5075
59	Jamaica	0.5064
60	Turkey	0.4960
61	Barbados	0.4920
62	Qatar	0.4895
63	Seychelles	0.4884
64	Panama	0.4822
65	Kazakhstan	0.4813
66	Trinidad and Tobago	0.4768
67	Bahamas	0.4676
68	Jordan	0.4639
69	TFYR Macedonia	0.4633
70	Costa Rica	0.4612
71	Lebanon	0.4560
72	Saint Kitts and Nevis	0.4492
73	Brunei Darussalam	0.4475
74	Saint Lucia	0.4467
75	Kuwait	0.4431
76	Kyrgyzstan	0.4417
77	Maldives	0.4321
78	El Salvador	0.4225
79	Uzbekistan	0.4114
80	Saudi Arabia	0.4105
81	Fiji	0.4081
82	Dominican Republic	0.4076
83	Georgia	0.4034
84	Bosnia and Herzegovina	0.4019
85	Bolivia	0.4017

Rank	Country	Index
86	Antigua and Barbuda	0.4010
87	India	0.4001
88	Saint Vincent and the Grenadines	0.4001
89	Guyana	0.3985
90	Botswana	0.3978
91	Samoa	0.3977
92	Ecuador	0.3966
93	Mongolia	0.3962
94	Sri Lanka	0.3950
95	Grenada	0.3879
96	Indonesia	0.3819
97	Belize	0.3815
98	Iran, Islamic Rep.	0.3813
99	Egypt	0.3793
100	Guatemala	0.3777
101	Azerbaijan	0.3773
102	Albania	0.3732
103	Cuba	0.3700
104	Tonga	0.3680
105	Viet Nam	0.3640
106	Armenia	0.3625
107	Paraguay	0.3620
108	Swaziland	0.3593
109	Republic of Moldova	0.3459
110	Suriname	0.3449
111	Namibia	0.3411
112	Oman	0.3405
113	Nicaragua	0.3383
114	Lesotho	0.3373
115	Honduras	0.3348
116	Cape Verde	0.3346
117	Tajikistan	0.3346
118	Iraq	0.3334
119	Dominica	0.3334
120	Zimbabwe	0.3316
121	Tunisia	0.3310
122	Kenya	0.3298
123	Algeria	0.3242
124	San Marino	0.3110
125	Uganda	0.3081
126	Nepal	0.3021
127	United Republic of Tanzania	0.3020
128	Cambodia	0.2989
129	Myanmar	0.2959
130	Bhutan	0.2941
131	Gabon	0.2928
132	Syrian Arab Republic	0.2871
133	Ghana	0.2866

Rank	Country	Index
134	Congo	0.2855
135	São Tomé and Principe	0.2837
136	Pakistan	0.2836
137	Malawi	0.2794
138	Morocco	0.2774
139	Nigeria	0.2758
140	Solomon Islands	0.2669
141	Madagascar	0.2641
142	Papua New Guinea	0.2539
143	Rwanda	0.2530
144	Timor-Leste	0.2512
145	Cameroon	0.2500
146	Mozambique	0.2448
147	Lao P.D.R	0.2421
148	Monaco	0.2404
149	Djibouti	0.2381
150	Sudan	0.2370
151	Benin	0.2309
152	Togo	0.2274
153	Senegal	0.2238
154	Yemen	0.2125
155	Comoros	0.1974
156	Serbia and Montenegro	0.1960
157	Eritrea	0.1849
158	Angola	0.1840
159	Andorra	0.1836
160	Côte d'Ivoire	0.1820
161	Liechtenstein	0.1789
162	Bangladesh	0.1762
163	Gambia	0.1736
164	Mauritania	0.1723
165	Vanuatu	0.1664
166	Burundi	0.1643
167	Sierra Leone	0.1639
168	Afghanistan	0.1490
169	Chad	0.1433
170	Guinea	0.1396
171	Ethiopia	0.1360
172	Burkina Faso	0.1329
173	Mali	0.0925
174	Niger	0.0661
175	Palau	0.0564
176	Micronesia	0.0532
177	Marshall Islands	0.0440
178	Tuvalu	0.0370
179	Nauru	0.0357
	World Average	0.4267

Table 2: E-government Readiness Data 2005

	Country	Web Measure Index	Infrastructure Index	Human Capital Index	E-government readiness Index
1	United States	1.0000	0.7486	0.9700	0.9062
2	Denmark	0.9731	0.7642	0.9800	0.9058
3	Sweden	0.8654	0.8395	0.9900	0.8983
4	United Kingdom	0.9962	0.6471	0.9900	0.8777
5	Republic of Korea	0.9769	0.6713	0.9700	0.8727
6	Australia	0.9038	0.7098	0.9900	0.8679
7	Singapore	0.9962	0.6448	0.9100	0.8503
8	Canada	0.8923	0.6552	0.9800	0.8425
9	Finland	0.8269	0.6524	0.9900	0.8231
10	Norway	0.7962	0.6823	0.9900	0.8228
11	Germany	0.8423	0.6226	0.9500	0.8050
12	Netherlands	0.7346	0.6815	0.9900	0.8021
13	New Zealand	0.8038	0.6021	0.9900	0.7987
14	Japan	0.8154	0.5850	0.9400	0.7801
15	Iceland	0.6077	0.7704	0.9600	0.7794
16	Austria	0.7423	0.5784	0.9600	0.7602
17	Switzerland	0.6038	0.7105	0.9500	0.7548
18	Belgium	0.7115	0.5127	0.9900	0.7381
19	Estonia	0.6962	0.5281	0.9800	0.7347
20	Ireland	0.7115	0.5037	0.9600	0.7251
21	Malta	0.7923	0.4413	0.8700	0.7012
22	Chile	0.9115	0.2773	0.9000	0.6963
23	France	0.6115	0.5060	0.9600	0.6925
24	Israel	0.7308	0.4002	0.9400	0.6903
25	Italy	0.6269	0.4812	0.9300	0.6794
26	Slovenia	0.5923	0.4762	0.9600	0.6762
27	Hungary	0.7038	0.3069	0.9500	0.6536
28	Luxembourg	0.4000	0.6439	0.9100	0.6513
29	Czech Republic	0.5885	0.4102	0.9200	0.6396
30	Portugal	0.4269	0.4283	0.9700	0.6084
31	Mexico	0.8192	0.1491	0.8500	0.6061
32	Latvia	0.4846	0.3805	0.9500	0.6050
33	Brazil	0.7500	0.1644	0.8800	0.5981
34	Argentina	0.6577	0.1737	0.9600	0.5971
35	Greece	0.5115	0.3148	0.9500	0.5921
36	Slovakia	0.5385	0.3176	0.9100	0.5887
37	Cyprus	0.4615	0.4101	0.8900	0.5872
38	Poland	0.5115	0.2901	0.9600	0.5872
39	Spain	0.3923	0.3919	0.9700	0.5847
40	Lithuania	0.5231	0.2528	0.9600	0.5786
41	Philippines	0.7423	0.0840	0.8900	0.5721
42	United Arab Emirates	0.6115	0.3639	0.7400	0.5718
43	Malaysia	0.5769	0.3048	0.8300	0.5706
44	Romania	0.6423	0.1889	0.8800	0.5704
45	Bulgaria	0.5192	0.2522	0.9100	0.5605

	Country	Web Measure Index	Infrastructure Index	Human Capital Index	E-government readiness Index
46	Thailand	0.6654	0.1299	0.8600	0.5518
47	Croatia	0.4423	0.3018	0.9000	0.5480
48	Ukraine	0.5808	0.1161	0.9400	0.5456
49	Uruguay	0.4500	0.2261	0.9400	0.5387
50	Russian Federation	0.4538	0.1947	0.9500	0.5329
51	Belarus	0.4885	0.1571	0.9500	0.5318
52	Mauritius	0.6288	0.1762	0.7900	0.5317
53	Bahrain	0.4192	0.3152	0.8500	0.5282
54	Colombia	0.6154	0.1110	0.8400	0.5221
55	Venezuela	0.5769	0.1113	0.8600	0.5161
56	Peru	0.5577	0.1091	0.8600	0.5089
57	China	0.5692	0.1241	0.8300	0.5078
58	South Africa	0.5692	0.1234	0.8300	0.5075
59	Jamaica	0.4885	0.2008	0.8300	0.5064
60	Turkey	0.5231	0.1648	0.8000	0.4960
61	Barbados	0.2154	0.3107	0.9500	0.4920
62	Qatar	0.3269	0.3116	0.8300	0.4895
63	Seychelles	0.3308	0.2343	0.9000	0.4884
64	Panama	0.4885	0.0980	0.8600	0.4822
65	Kazakhstan	0.4500	0.0638	0.9300	0.4813
66	Trinidad and Tobago	0.3635	0.1969	0.8700	0.4768
67	Bahamas	0.2923	0.2304	0.8800	0.4676
68	Jordan	0.4346	0.0971	0.8600	0.4639
69	TFYR Macedonia	0.3962	0.1237	0.8700	0.4633
70	Costa Rica	0.2538	0.2596	0.8700	0.4612
71	Lebanon	0.3423	0.1857	0.8400	0.4560
72	Saint Kitts and Nevis	0.1115	0.2562	0.9800	0.4492
73	Brunei Darussalam	0.2462	0.2264	0.8700	0.4475
74	Saint Lucia	0.2865	0.1737	0.8800	0.4467
75	Kuwait	0.2500	0.2694	0.8100	0.4431
76	Kyrgyzstan	0.3654	0.0398	0.9200	0.4417
77	Maldives	0.3115	0.0748	0.9100	0.4321
78	El Salvador	0.4269	0.0906	0.7500	0.4225
79	Uzbekistan	0.2731	0.0510	0.9100	0.4114
80	Saudi Arabia	0.3769	0.1445	0.7100	0.4105
81	Fiji	0.2808	0.0836	0.8600	0.4081
82	Dominican Republic	0.3115	0.0912	0.8200	0.4076
83	Georgia	0.2115	0.1086	0.8900	0.4034
84	Bosnia and Herzegovina	0.2731	0.0926	0.8400	0.4019
85	Bolivia	0.2885	0.0568	0.8600	0.4017
86	Antigua and Barbuda	0.1577	0.2454	0.8000	0.4010
87	India	0.5827	0.0277	0.5900	0.4001
88	Saint Vincent and the Grenadines	0.2538	0.1763	0.7700	0.4001
89	Guyana	0.1846	0.1209	0.8900	0.3985
90	Botswana	0.3692	0.0640	0.7600	0.3978
91	Samoa	0.2654	0.0377	0.8900	0.3977
92	Ecuador	0.2500	0.0899	0.8500	0.3966
93	Mongolia	0.2308	0.0679	0.8900	0.3962
94	Sri Lanka	0.3192	0.0359	0.8300	0.3950
95	Grenada	0.0885	0.2254	0.8500	0.3879
96	Indonesia	0.2962	0.0494	0.8000	0.3819
97	Belize	0.2538	0.1407	0.7500	0.3815
98	Iran, Islamic Rep.	0.2962	0.1079	0.7400	0.3813
99	Egypt	0.4462	0.0717	0.6200	0.3793
100	Guatemala	0.4346	0.0484	0.6500	0.3777
101	Azerbaijan	0.1808	0.0712	0.8800	0.3773
102	Albania	0.1615	0.0680	0.8900	0.3732
103	Cuba	0.1500	0.0499	0.9100	0.3700
104	Tonga	0.1269	0.0472	0.9300	0.3680
105	Viet Nam	0.2231	0.0489	0.8200	0.3640
106	Armenia	0.1115	0.0759	0.9000	0.3625
107	Paraguay	0.1654	0.0706	0.8500	0.3620
108	Swaziland	0.2923	0.0456	0.7400	0.3593
109	Republic of Moldova	0.0538	0.1138	0.8700	0.3459
110	Suriname	0.0500	0.1148	0.8700	0.3449
111	Namibia	0.1654	0.0678	0.7900	0.3411
112	Oman	0.1731	0.1385	0.7100	0.3405
113	Nicaragua	0.2500	0.0348	0.7300	0.3383
114	Lesotho	0.2385	0.0135	0.7600	0.3373
115	Honduras	0.2231	0.0412	0.7400	0.3348
116	Cape Verde	0.1731	0.0808	0.7500	0.3346
117	Tajikistan	0.0615	0.0422	0.9000	0.3346
118	Iraq	0.0538	0.0164	0.9300	0.3334
119	Dominica	0.0692	0.1709	0.7600	0.3334
120	Zimbabwe	0.1654	0.0395	0.7900	0.3316
121	Tunisia	0.1538	0.0993	0.7400	0.3310
122	Kenya	0.2308	0.0187	0.7400	0.3298
123	Algeria	0.2462	0.0365	0.6900	0.3242
124	San Marino	0.2846	0.6482	0.0000	0.3110
125	Uganda	0.2154	0.0090	0.7000	0.3081
126	Nepal	0.4000	0.0063	0.5000	0.3021
127	United Republic of Tanzania	0.2750	0.0110	0.6200	0.3020
128	Cambodia	0.2308	0.0060	0.6600	0.2989
129	Myanmar	0.1538	0.0040	0.7300	0.2959
130	Bhutan	0.3846	0.0175	0.4800	0.2941
131	Gabon	0.0923	0.0662	0.7200	0.2928
132	Syrian Arab Republic	0.0654	0.0458	0.7500	0.2871
133	Ghana	0.1885	0.0214	0.6500	0.2866
134	Congo	0.1346	0.0119	0.7100	0.2855
135	São Tomé and Principe	0.0115	0.0797	0.7600	0.2837

	Country	Web Measure Index	Infra-structure Index	Human Capital Index	E-govern-ment readiness Index
136	Pakistan	0.4269	0.0238	0.4000	0.2836
137	Malawi	0.1731	0.0053	0.6600	0.2794
138	Morocco	0.2385	0.0637	0.5300	0.2774
139	Nigeria	0.2231	0.0143	0.5900	0.2758
140	Solomon	0.1000	0.0206	0.6800	0.2669
141	Madagascar	0.1846	0.0075	0.6000	0.2641
142	Papua New Guinea	0.1615	0.0302	0.5700	0.2539
143	Rwanda	0.1154	0.0035	0.6400	0.2530
144	Timor-Leste	0.1135	0.0000	0.6400	0.2512
145	Cameroon	0.0962	0.0139	0.6400	0.2500
146	Mozam-bique	0.2788	0.0057	0.4500	0.2448
147	Lao P.D.R	0.0788	0.0074	0.6400	0.2421
148	Monaco	0.2192	0.5021	0.0000	0.2404
149	Djibouti	0.1731	0.0211	0.5200	0.2381
150	Sudan	0.1615	0.0293	0.5200	0.2370
151	Benin	0.2385	0.0142	0.4400	0.2309
152	Togo	0.0308	0.0313	0.6200	0.2274
153	Senegal	0.2538	0.0275	0.3900	0.2238
154	Yemen	0.0962	0.0413	0.5000	0.2125
155	Comoros	0.0538	0.0082	0.5300	0.1974
156	Serbia and Montenegro	0.4462	0.1417	0.0000	0.1960
157	Eritrea	0.0577	0.0069	0.4900	0.1849
158	Angola	0.1654	0.0066	0.3800	0.1840
159	Andorra	0.2519	0.2990	0.0000	0.1836
160	Côte d'Ivoire	0.0538	0.0223	0.4700	0.1820
161	Liechten-stein	0.1731	0.3637	0.0000	0.1789
162	Bangladesh	0.0731	0.0055	0.4500	0.1762
163	Gambia	0.0962	0.0248	0.4000	0.1736
164	Mauritania	0.0692	0.0278	0.4200	0.1723
165	Vanuatu	0.0500	0.0293	0.4200	0.1664
166	Burundi	0.0385	0.0043	0.4500	0.1643
167	Sierra Leone	0.0962	0.0056	0.3900	0.1639
168	Afghanistan	0.1769	0.0020	0.2680	0.1496
169	Chad	0.0077	0.0023	0.4200	0.1433
170	Guinea	0.0385	0.0102	0.3700	0.1396
171	Ethiopia	0.0154	0.0027	0.3900	0.1360
172	Burkina Faso	0.2327	0.0060	0.1600	0.1329
173	Mali	0.0615	0.0060	0.2100	0.0925
174	Niger	0.0115	0.0069	0.1800	0.0661
175	Palau	0.1692	0.0000	0.0000	0.0564
176	Micronesia	0.1077	0.0519	0.0000	0.0532
177	Marshall Islands	0.0904	0.0416	0.0000	0.0440
178	Tuvalu	0.0269	0.0841	0.0000	0.0370
179	Nauru	0.0577	0.0495	0.0000	0.0357

	Country with no web presence in 2005	Web Measure Index	Infras-tructure Index	Human Capital Index	E-govern-ment readiness Index
180	Central African Republic	0.0000	0.0028	0.4300	0.1443
181	Democratic people's Republic of Korea	0.0000	0.0057	0.0000	0.0019
182	Democratic Republic of the Congo	0.0000	0.0021	0.5100	0.1707
183	Equatorial Guinea	0.0000	0.0254	0.7600	0.2618
184	Guinea-Bissau	0.0000	0.0107	0.3900	0.1336
185	Haiti	0.0000	0.0157	0.5200	0.1786
186	Kiribati	0.0000	0.0253	0.0000	0.0084
187	Liberia	0.0000	0.0032	0.0000	0.0011
188	Libyan Arab Jamahiriya	0.0000	0.0573	0.8700	0.3091
189	Somalia	0.0000	0.0073	0.0000	0.0024
190	Turkmenistan	0.0000	0.0375	0.9300	0.3225
191	Zambia	0.0000	0.0230	0.6800	0.2343

□

Any work of architecture that does not express serenity is a mistake.

– Luis Barragan

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