# Indian Dairying : An Overview

**Animesh Banerjee**

*Dairying, as an activity, has existed in India from the dawn of civilization as evident from references in ancient history. The article traces the growth of the industry from by gone ages to its present model of cooperative structure and suggests a collaborative pattern between the cooperatives and investment oriented private sector to reap the benefits of modern technology.*

*Animesh Banerjee is President, Indian Dairy Association, Sector IV, R.K. Puram New Delhi 110 022.*

The tradition of cattle keeping and milk consumption is as ancient as the civilization and culture of India. Ancient Indian history is replete with praise for cattle wealth, high quality of milch animals, and India being a land of milk, butter and plenty reference to cattle as the symbol of prosperity and wealth appears in all the Vedas, epics and Puranas. Our folkloric figures depict Lord Krishna disporting with playful milkmaids. Cow's milk has been referred to as the elixir of life. Cows were offered as dowry or as gift signifying love and reverence. Animals – more so cows – were considered as real estate and land was of secondary importance. It is believed that until the Mahabharata period (5,000-6,000 years ago) fights were more often for securing animals than for occupying land.

Centuries of British rule caused social and economic regression in India. Even though the occupation began in the 17th century, the country was too large to be ruled single handed. Fragmentation, as a result of the divide and rule policy, created as much turmoil for the rulers as for the ruled or to be ruled. There were more than 600 states each pitched in battle either against their neighbours or the British regime. Such political fragility hindered the administration to effectively project the interests of the rural populace. The economic and financial status of Indians in general and of the rurals in particular deteriorated.

The varying size of land ownership created the rural classes. Those owning 30-100 acres of irrigated land were the large farmers. Since it was difficult for them to cultivate by themselves, they came to be known as "landlords" and they created the "tenants" or the "sharecroppers", who cultivated their land on a lease-hold tenure basis. Next were the joint- family farmers owning 10-30 acres of irrigated land. These farmers generally employed seasonal or wage labourers and created the "landless labourers". Those owning less than 10 acres of land were the small farmers who undertook highly intensive cultivation. After independence the Central and the State governments legislated many acts to bring about land reforms, e.g., abolition of zamindari

system, tenancy reforms and ceiling of ownership on agriculture and urban land. Most reforms were not of much avail. In the last fifty years there has been a major change in the land ownership mainly because of the population growth that caused fragmentation of the joint-family farmers and the small farmers, while the "landlord" class has continued to consolidate its holdings through its economic and political power.

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**Historical Landmarks**

*Pre-Independence Period* : An epidemic outbreak of rinderpest in 1836 causing heavy mortality amongst cattle and buffaloes, led to the setting up of the Indian Cattle Plague Commission. Recommendations of this and the subsequent commissions set up during 1882 and 1883 started the Indian Civil Veterinary Department in 1891. From there evolved, what are now designated as the Departments of Animal Husbandry and Veterinary Services, in all the states. Also, the Imperial Bacteriological Laboratory at Pune, the fore-runner of the now Indian Veterinary Research Institute at Izatnagar, was set up on the recommendations of these Commissions. This helped in the setting up of a network of facilities to provide preventive health cover to livestock.

*Early Era* : The earliest attempts at dairy development can be traced back to British rule, when the Defence Department established military dairy farms to ensure the supply of milk and butter to the colonial army. The first of these farms was set up in Allahabad in 1913; subsequent facilities were established in Bangalore, Ootacamund and Karnal. These farms were well maintained and, even in the early stages, improved milch animals were raised. As animals were reared under farm conditions, some herd improvement was made using artificial insemination. This approach did not have any impact on the supply of milk to urban consumers, which was of major concern to civilian authorities but less important to the military.

With the growth of the population in the urban areas, consumers had to depend on milk vendors who kept cattle in these areas and sold their milk, often door-to-door. As a result, several cattlesheds came into existence in different cities. This was not an environmentally sound approach. As the main objective of the milk vendors was to maximize profit, they started increasing the lactation period by using the focus system. In the process, these high-yielding cattle developed sterility problems, which considerably reduced the number of calvings. Once the cattle became unproductive, they were sold to slaughterhouses. This practice systematically drained the country of its genetically superior breeds.

To some extent, the Second World War gave impetus to private dairies with modestly modernized processing facilities. In the cities of Bombay, Calcutta, Madras and Delhi, and even in some large townships, processed milk, table butter and ice-cream were available, though not on a large scale. Polsons, Keventers and the Express Dairy were some of the poineer urban processing dairies. These dairies were not concerned with improving the breed of milch animals reared in rural pockets but instead were content with contracting milk supplies through middlemen or their own staff. Milk producers as well as consumers were exploited. These early modern systems did not bring about significant shifts in milk production, nor did they develop quality milch animals. To a large extent, despite modernized processing facilities, dairying remained unorganized.

With the initiation of India's first Five-year Plan in 1951, modernization of the dairy industry became a priority for the government. The goal was to provide hygienic milk to the country's growing urban population. Initial government action in this regard consisted of organizing "milk schemes" in large cities. To stimulate milk production, the government implemented the Integrated Cattle Development Project (ICDP) and the Key Village Scheme (KVS), among other similar programmes. In the absence of a stable and remunerative market for milk producers, however, milk production remained more or less stagnant. During the two decades between 1951 and 1970, the growth rate in milk production was barely 1 per cent per annum, while per capita milk consumption declined by an equivalent amount.

During the 1960s, various state governments tried out different strategies to develop dairying, including establishing dairies run by their own departments, setting up cattle colonies in urban areas and organising milk schemes. Almost invariably, dairy processing plants were built in cities rather than in the milk sheds where

milk was produced. This urban orientation to milk production led to the establishment of cattle colonies in Bombay, Calcutta and Madras. These government projects had extreme difficulties in organizing rural milk procurement and running milk schemes economically, yet none concentrated on creating an organised system for procurement of milk, which was left to contractors and middlemen. Milk's perishable nature and relative scarcity gave the milk vendors leverage, which they used to considerable advantage. This left government-run dairy plants to use large quantities of relatively cheap, commercially imported milk powder. The daily per capita availability of milk dropped to a mere 107 g during this time. High-fat buffalo milk was extended with imported milk powder to bring down the milk price, which resulted in a decline in domestic milk production. As the government dairies were meeting barely one-third of the urban demand, the queues of consumers became longer while the rural milk producer was left in the clutches of the trader and the money lender.

All these factors, combined left the Indian dairying in a most unsatisfactory state. The establishment and prevalence of cattle colonies emerged as a curse for dairying in the rural hinterland as it resulted in a major genetic drain on the rural milch animal population, which would never be replaced. City dairy colonies also contributed to environmental degradation, while the rural producer saw little reason to increase production.

### An Instrument of Development

In India, dairying is recognised as an instrument for social and economic development. The nation's milk supply comes from millions of small producers, dispersed throughout the rural areas. These farmers maintain an average herd of one or two milch animals, comprising cows and/or buffaloes. The animals' nutritional requirements are largely met by agricultural waste and by- products. Ample labour and a small land base encourage farmers to practice dairying as an occupation subsidiary to agriculture. While income from crop production is seasonal, dairying provides a stable, year-round income, which is an important economic incentive for the small farmer to take to dairying.

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Milk production in India is dominated by small and marginal landholding farmers and by landless labourers who, in aggregate, own about 70 per cent of the national milch animal herd. As crop production on 78 per cent of the agricultural land still depends on rain, it is prone to both drought and floods, rendering agricultural income uncertain for most farmers. Shackled to subsistence production as a result of a shortage of finance and credit facilities, these farmers become entangled in a strangling debt cycle. The combination of an unfavourable land-person ratio and fragmented landholdings make it difficult to support large families on crop income alone. It is not surprising that the small farmers and the landless labourers are more often than not victims of money-lenders and of natural calamities. Dairying, as a subsidiary source of income, is a real relief to most of these weaker groups in society. Often one or two milch animals enable these farmers to generate sufficient additional income to break the vicious subsistence agricultural-debt cycle.

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As in India, the reliance on low-cost and often-subsidized commercial imports as well as gifts seriously affects the development of dairying systems in many developing countries as they increase domestic demand for milk products and erode domestic-price incentives. As low-cost imports from advanced dairying nations depress domestic milk prices, it becomes uneconomical for local milk producers to invest in dairying, causing stagnation in production. This hampers breed improvement efforts, fodder production programmes, the manufacture of quality feed and other endeavours to improve productivity. For any country seriously interested in exploiting the potential of dairying, therefore, it becomes imperative to review and seriously consider policies that would promote dairy development activities by helping to establish independent and self-sustaining dairying systems.

Undoubtedly, the major challenge for the dairy sector in any developing nation is to increase milk production in order to meet the increasing demand resulting from the almost inevitable expansion of population and

presumably, growth of income. To meet this challenge, policies must become more market-oriented. The adoption of appropriate technology for production, procurement, processing and marketing - after the unique environmental, social, economic, political and cultural environment of the individual country has been considered - is an important aspect of dairy development. Those national governments and international institutions for whom the dairy sector is a major concern should accept the challenge and formulate policies that integrate and buttress the major functions of dairy development.

**Anand Model**

Milk procurement from the rural areas and its marketing in the urban areas was the major problem in Indian dairying at the time India gained independence. In one of the earliest urban milk supply schemes, Polsons – a private dairy at Anand – procured milk from milk producers through middlemen, processed it and then sent the milk to Bombay, some 425 km away. Bombay was a good market for milk and Polsons profited immensely. In the mid - 1940s, when the milk producers in Kaira asked for a proportionate share of the trade margins, they were denied even a modest increase. The milk producers went on strike, refusing to supply milk to Polsons. On the advice of Sardar Vallabhbhai Patel, a leader in India's independence movement, the milk producers registered the Kaira District Cooperative Milk Producers' Union, now popularly known as Amul, in 1946. The Kaira union procured milk from affiliated village-level milk societies. This was the genesis of organised milk marketing in India, a pioneering effort that opened a new vista for dairy development in the country.

Between 1946 and 1952, Amul's policy was directed towards obtaining monopoly rights for the sale of milk to the Bombay Milk Scheme. In 1952, it succeeded in achieving its purpose after the Government of Bombay cancelled the contract with Polsons and handed over the entire business of supplying milk from the Kaira district to Amul. However, as the Bombay Milk Scheme was committed to purchasing all the milk produced by the Aarey Milk Colony in Bombay, it would not take Amul's milk during the peak winter months. The disposal of this surplus milk posed difficulties for Amul, forcing it to cut down on purchases from its member societies, which affected members' confidence. The answer was the production of milk products; in 1955, a new dairy plant was set up at Anand to produce butter, ghee and milk powder.

A second dairy was built in 1965, and a product manufacturing unit was established in 1971 to cope with increasing milk procurement. In 1993, a fully automatic modern dairy was constructed adjacent to the original Amul dairy plant at Anand. Amul formed the basis for the Anand Model of dairying. The basic unit in this model is the milk producers' cooperative society at the village level. These cooperatives are organizations of milk producers who wish to market their milk collectively. Membership is open to all who need the cooperative's services and who are willing to accept the responsibilities of being a member. Decisions are taken on the basis of one member exercising one vote. No privilege accrues to capital, and the economic returns, whether profit or loss, are divided among the members in proportion to patronage. Each cooperative is expected to carry out the continuing education of its members, elected leaders and employees. All the milk cooperatives in a district form a union that, ideally, has its own processing facilities.

All the unions in a state are normally members of a federation whose prime responsibility is the marketing of milk and milk products outside the state. There is also a fourth tier, the National Cooperative Dairy Federation of India (NCDFI), which is a national-level body that formulates policies and programmes designed to safeguard the interests of all milk producers. Each tier of the Anand Pattern organisational structure performs a unique function: procurement and services by the cooperative; processing by the union; marketing by the state federation; and advancing the interests of the cooperative dairy industry by the national federation. Thus, the Anand Model has evolved into an integrated approach to systematic dairy development.

**National Dairy Development Board**

In October, 1964, on the occasion of the inauguration of Amul's cattle feed plant, the then Prime Minister of India, Lal Bahadur Shastri, spent the night as the guest of a village milk cooperative society near Anand. Impressed by the socio-economic changes brought about by the milk cooperatives, he expressed the desire for a national level organisation to replicate Anand Model dairy cooperatives throughout the country and to make available multi-disciplinary, professional dairy expertise to dairies in the public and cooperative sectors. Thus, in 1965, NDDB was registered under the Societies Registration Act, the Charitable Trust Act and the Public Trust Act. Consistent with its model and mandate, NDDB headquarters were established at Anand.

During the initial stages, NDDB was assisted financially by the Government of India, the Danish Government and by Amul. It also received aid from the United Nations Children's Fund (UNICEF) in the form of teaching material and equipment. In 1969, when the Government of India approved the Operation Flood Programme and its financing through the monetization of World Food Programme-gifted commodities, it was found that the statutes under which NDDBs was registered did not provide for handling of government funds. Therefore, in 1970 the government established a public sector company, the Indian Dairy Corporation. The IDC was given responsibility for receiving the project's donated commodities; testing their quality; their storage and transfer to use dairies; and receiving the dairies' payments. Thus, it served as a finance-cum-promotion entity while the entire Operation Flood technical support was provided by NDDB. To avoid any duplication in their activity or overlap of functions, the IDC and NDDB were eventually merged into a newly constituted NDDB by an Act of Parliament passed in October 1987. The Act designated the NDDB as an institution of national importance and accorded it the same autonomy of operation that it had enjoyed and which had been a major factor in its success.

**Operation Flood**

The strategy for organized dairy development in India was actually conceived in the late 1960s, within a few years after the National Dairy Development Board (NDDB) was founded in 1965. It rested on the Operation Flood Programme, which was conceived by the NDDB and endorsed by the government.

Operation Flood is a unique approach to dairy development. During the 1970s, dairy commodity surpluses were building up in Europe, and Dr. Verghese Kurien, the Founding Chairman of NDDB, saw in those surpluses both a threat and an opportunity. The threat was massive exports of low-cost dairy products to India, which, had it occurred, would have tolled the death-knell for India's staggering dairy industry. The large quantities that India was already importing had eroded domestic markets to the point where dairying was not viable. The opportunity, on the other hand, was built into the Operation Flood strategy. Designed basically as a marketing project, Operation Flood recognized the potential of the European surpluses as an investment in the modernization of India's dairy industry. With the assistance of the World Flood Programme, food aid in the form of milk powder and butter oil was obtained from the countries of the European Economic Community (EEC) to finance the programme. It was for the first time in the history of economic development that food aid was seen as an important investment resource. Use of food aid in this way is anti-inflationary, it provides a buffer stock to stabilize market fluctuations and it can be used to prime the pump of markets that will later be supplied by domestic production. The overriding objective of all aid is, or rather should be, the elimination of the need for aid. The use of food aid as an investment in the most effective way of achieving this objective.

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Operation Flood is a programme designed to develop dairying by replicating the Anand Model for dairy development, which has stood the test of time for almost half a century. The first phase of Operation Flood was launched in 1970 following an agreement with the World Food Programme, which undertook to provide as aid 126000 tonnes of skim milk powder and 42000 tonnes of butter oil to finance the programme. The programme involved organizing dairy cooperatives at the village level; creating the physical and institutional infrastructure for milk procurement, processing, marketing and production enhancement services at the union level; and establishing dairies in India's major metropolitan centres. The main thrust was to set up dairy cooperatives in India's best milksheds, linking them with the four main cities of Bombay, Calcutta, Delhi and Madras, in which a commanding share of the milk market was to be captured. In achieving that goal, the first phase of Operation Flood laid the foundation for India's modern dairy industry, an industry that would ultimately meet the country's need for milk and milk products.

The second phase of the programme was implemented between 1981 and 1985. Designed to build on the foundation laid in the first phase, it integrated the Indian Dairy Association-assisted dairy development projects being implemented in some Indian states into the overall programme. About US$150 million was

provided by the World Bank, with the balance of project financing obtained in the form of commodity assistance from the EEC. The current, third phase of Operation Flood aims at ensuring that the cooperative institutions become self-sustaining. With an investment of US$360 million from the World Bank, commodity and cash assistance from the EEC and NDDB's own internal resources, the programme envisages substantial expansion of the dairy processing and marketing facilities; and extended milk procurement infrastructure; increased outreach of production enhancement activities; and professionalisation of management in the dairy institutions.

**Technology Mission**

At the behest of the late Prime Minister, Rajiv Gandhi, India launched a number of Technology Missions to strengthen the basic infrastructure through a technology leap. Each mission is expected to search, identify and adapt the available technologies and apply them so that respective sectors would contribute significantly to the national growth and economy.

The NDDB having been vested with the responsibility to formulate and mount the mission on dairy development has proposed to consolidate achievement of the cooperative dairy sector using the infrastructure already established. It is expected that the Technology Missions would help accelerate the pace of increasing rural income and employment. The Mission would accelerate the adoption of modern technology to improve productivity, to reduce costs of operation and would ensure greater availability of milk and milk products. The Operation Flood programme would be dovetailed with the State Government's programme of animal husbandry and dairying, poverty alleviation programmes like the Integrated Rural Development Programme, research programme, process technology and product manufacture programme of the Central Research Institutes, the Agriculture Universities and the National Dairy Development Board.

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And now a target of 70 million tonnes of milk production has been set for AD2000 so as to average 200gm of milk per day per capita. To achieve this the efforts of Operation Flood and the Technology Mission on Dairy Development have been supplemented by technological interventions. A few areas identified are as follows:

- Application of embryo transplantation, embryo sexing, embryo microtomy and manipulative reproduction for improving indigenous breeds of cattle and buffaloes.
- Grain saving feeding system based on improving nutrient and energy content of ligno-cellulosic fodder straws with ammonia, urea and molasses. There is a need to develop large scale processes for treatment and conservation of green and fodder straws to meet threats from recurring droughts and floods.
- Use in animal feeds of single cell proteins and biological wastes after microbial upgradation.
- Plantation of multipurpose trees and grasses in complementary combinations to meet the fodder and fuel wood needs, so that cattle keeping does not destabilise the ecological balance.
- Application of bovine somatotropin – a synthetic growth hormone – for increasing milk production. It has been reported that the increase in milk is similar in cows with high genetic merits as those with low genetic merit.
- Production of monoclonal – antibody – drug combinations for treatment of diseases and cloned and synthetic vaccines which are safe, stable, effective, inexpensive and capable of being produced on a mass scale.
- Adaption energy of efficient technologies to process and package milk products.
- Development of non-process chemical stabilisation of milk for long distance transportation.
- Harnessing of nonconventional source of energy for use in dairy processes.

A synergy between the evolving technologies and the productive potential of the rural milk producer can certainly prove India as a slumbering gaint waking up. "If this gaint does wake up, if we do harness our resources", said Kurien, "no doubt the present order of international production - and international trade in agriculture commodities - would be vastly changed". And indeed India's

dairy sector is changing. In the 72nd Annual Session of the International Dairy Federation held during September, 1988, it was observed that in future the world dairy sector would be facing three major threats, namely adverse medical opinion on milk fat especially its role in increasing cholesterol in blood; role of somatoproteins which are likely to dramatically increase milk yield; and the increasing milk production in the developing countries.

### Delicensing the Dairy Industry

In June, 1992 under the new industrial policy of the Government of India, the India Dairy Industry was brought under the new policy of the delicensing. Subsequently a number of new private entrepreneurs have joined the dairy industry and many more are in the queue. Investment in any industry should always be welcomed and the dairy industry cannot be an exception. However, milk being the most important nutritional need of human beings and essential in nature, one should take such investment not merely for a good return but also as a commitment to the society. The investment oriented enterprises do have strength as cooperatives and should work in a collaborative pattern so that in the process possible synergies are explored and appropriate alliances between the cooperatives and the investment oriented enterprises are built.

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### Conclusions

Operation Flood may be considered the central event of twentieth- century dairying in India. An analysis of the lessons learned through the implementation of the programme should be useful for those involved in formulating dairy development policies and programmes for the developing nations of Asia and Africa.

The network of cooperative institutions created through the Operation Flood Programme now comprises 72,000 dairy cooperative societies in 170 milksheds, encompassing 8.4 million milk producer families. Average milk procurement by these cooperatives has now reached some 12.3 million kg per day, of which over 10.2 million litres are marketed as liquid milk, while the remainder is converted into products such as milk powder, butter, cheese, ghee and a wide range of traditional milk products. Milk-processing capacity of approximately 18.1 million litres per day, chilling capacity of 7.3 million litres per day and milk powder production capacity of 842 tonnes per day have been established through the programme.

One of the challenging aspects of dairy development in a tropical or subtropical country is the movement of milk over long distances. In Operation Flood, this has been made possible through the operation of about 140 insulated rail milk tankers, each with a capacity of 40,000 litres, supplemented by another 25 rail tankers of 21,000 litre capacity. Approximately 1,000 other insulated road milk tankers operate throughout the country as well. This has enabled the operation of a national milk grid, balancing regional fluctuations in milk procurement and demand- and-supply gaps resulting from concentrated production of liquid milk in selected milksheds. To balance seasonal variations in milk supply and demand caused by low milk production during the summer months, a large milk powder storage capacity has been created for buffer stocking.

The investment and achievements in modernizing the Indian dairy industry have had a major impact on milk production. Annual production, which had stagnated to between 20 million and 22 million tonnes during the 1960s, has steadily increased to around 63.5 million tonnes, an annual growth rate of about 5 per cent. Per capita availability of milk, which had declined consistently during the two decades between 1951 and 1970, dropping to 107g at the start of Operation Flood, is now 193 g per day despite a substantial increase in population. Had family-planning programmes achieved the same success as Operation Flood, the per capita consumption rate would be comparable to all but those of the leading dairying nations.

Commercial imports of dairy commodities were a regular feature in the 1950s and 1960s, comprising 50 to 60 per cent of the dairy industry's total through-put. Today, imports of dairy commodities are restricted to those donated by the EEC for implementing Operation Flood and their percentage of the total dairy through-put is negligible. All these developments have helped raise India to the rank of the second-largest producer of milk in the world, next only to the United States.

A number of programmes and policies have played a role in this success. Certainly, the introduction of modern technology, both at the farmer level and in the

processing of milk and products, has been important. Similarly, establishing an urban market has provided the stability necessary to encourage farmers to invest in increased milk production. The induction of professional managers to serve farmers has reversed the usual pattern of farmers as supplicants and officials as "benefactors". Perhaps most important, however, is the cooperative structure itself. By giving farmers command over the resources they create, Operation Flood has ensured that they received the maximum return from each rupee spent by consumers on milk and milk products, and it is this that has provided the incentive on which the growth of the dairy industry has been based.

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The success of Operation Flood has resolved many difficult issues relating to development. It has demonstrated how food aid can be used to enhance domestic production, if administered with care. It has also shown how technology can be harnessed so that neither the dependence on imported technology nor its capital intensity become counter-productive. Some of the dairy plants set up by NDDB during the implementation of Operation Flood are based on the latest technology and are comparable to those in advanced countries. The unique cooperative infrastructure with which NDDB works makes the adoption of technologies and the dissemination of knowledge relatively easy, and this has enabled Operation Flood to facilitate the application of modern technologies to enhance milk production.

After a long struggle, India has overcome a situation that, at least in some respects, may be similar to those prevailing in a number of Asian and African countries, and has built a modern dairy sector, responsive to the needs of milk producers. It has had to deal with a stagnant dairy industry in which cheap, subsidized imports were a disincentive to the farmers. It has had to overcome the negative effects of consumer-oriented programmes that managed to keep prices low for the urban elite while depressing the price of milk in rural milksheds. It has had to deal with the lethargy and bureaucratic orientation of state enterprise in dairying. While there are still challenge to be met, the foundation for an even stronger dairy industry is now in place.

The orderly growth of the Indian dairy industry is a critical goal. There is an imperative need to avoid uneconomic competition on a limited resource. More important is that it should not damage the finely tuned agricultural ecology that is so important to rural India. The dairy development plans and programmes in India must foresee - and prevent - any damage to the delicate balance of man, livestock and crops that is the core of the Indian agricultural eco-system. □

Stop worrying about quality, productivity, cost, and cycle time. Focus your energies on organizational performance improvement and all the rest will follow.

*Dr. H. James Harrington*

# Co-operative Dairying in India : Post Liberalisation Scenario

**A.A Chothani**

*Cooperative dairying in India is almost fifty years old and the Ventura has proved quite successful in uplifting the lot of the rural people. However, in the light of the emerging competition from the private sector and multi-nationals, the cooperative framework needs on urgent revamping to survive and flourish concludes the author.*

*A.A. Chothani is Managing Director, National Co-Operative Dairy Federation of India, Anand 388001*

Dairying in our country is a vocation of the masses. Unlike their counterparts in other parts of the world, our dairy farmers keep only one or two buffaloes; production by the masses as against mass production. About 70 per cent of the total 954 million population of India lives in villages. A large proportion of this population is landless and mainly owns an average herd of 1.6 dairy animals. A total number of 200 million cattle consisting of 160 million breed of cattle and 40 million of exotic and their crosses and 60 million buffaloes constitute India's herd of dairy animals. Dairy industry is an agro-based industry so much so that cattle-fodder and other feeds have a direct bearing on the agricultural products and largely depend on agricultural by-products and crop residues. Since India is an agricultural country, the dairy industry possesses bright prospects of development and expansion. Dairying in India is labour intensive whereas in developed countries it is capital intensive which means that in our country, lakhs of people, especially women, are gainfully employed in a business with great potential for increase in productivity.

## Current Scenario

Presently, India occupies the second position in the world map next only to USA for being the second largest milk producer in the world. The present milk production rate indicates that by the turn of the century India will be the largest milk producing nation in the world. India ranks next to New Zealand in low cost milk production which is because the cooperatives have built a dairy industry with the unshakable commitment that animal nutrition must be based on crop residues so that our cattle do not compete with humans for scarce resources. Whereas in the advanced nations such as the European countries, America, etc. milk is a subsidised agricultural commodity as the cost of milk production is very high. In these

countries, specialised dairy farming based upon fodder cultivation is followed. Another advantage for the dairy industry in India is that it has access to a large proportion of buffalo milk since the hot and humid climate of the country is suitable for buffaloes. Buffalo milk is richer in the total solids content as compared to cow's milk. Buffaloes are resistant to tick transmitted diseases such as Theileriosis and Anaplasmosis which cause severe anaemia in exotic animals. In addition, the Indian buffalo is a very efficient converter of roughages and other agricultural wastes which are the only feed resources available with the landless farmers in India. The last key element in our dairy industry is the market that it encompasses. Milk is consumed throughout the length and breadth of our land since it has been recognised as a complete food available in nature.

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The value of output in dairying is the largest compared to any other agricultural commodity. Milk production has tripled over the past two decades and has now become our second largest agricultural commodity. Indian dairying is characterised by a small land milch animal holding combination of rural producers, who depend on crop residues for producing not only milk but also bullock power. Cattle is their only tangible asset and the mainstay for their security. Dairying has showed enormous potentiality to improve the socio-economic status of the large percentage of rural population. Livestock development fits appropriately in the country's programme of increasing food protein, rural employment and equitable distribution. It helps in increasing crop production through making funds available for the purchase of essential inputs. e.g. seeds, fertilisers, pesticides etc. Thus, the contribution of livestock, especially the dairy and meat animals is rather unique. Livestock improvement is important since it enables farmers to increase their milk production and through increased milk or meat production, their income.

**Growth of Cooperatives**

In 1946, the foundation of milk co-operatives was laid with the organisation of the Kaira District Co-operative Milk Producers Union Ltd popularly known as "AMUL". At that time just 250 litres of milk was being handled. Now the union collects on an average 8.5 lakh litres milk daily in the peak season from 5.3 lakh members in over 954 village societies. The total annual turnover is over Rs 3200 million.

The Anand Pattern is a three-tiered organisational structure which links primary producer societies engaged in milk procurement to district cooperative unions engaged in the processing of milk and milk products. At the state level, the district unions are clustered together into a state level federation which is entrusted with the responsibility of marketing the output of the dairy unions. The village societies, the district unions and the state federations are managed by the elected representatives of the cooperatives. This system has been designated as "Anand Pattern Cooperative".

The collective interest of all the state federations is represented by the National Co-operative Dairy Federation of India Ltd (NCDFI) which was established in 1970 and is registered under the Multi-State Cooperative Societies Act. 1984. The state level dairy federations are the members of the NCDFI. NCDFI today is the apex body of 21 state cooperative milk producer's federations/apex union and 7 oilseeds growers' federations in the country with a grass root level membership of 98.79 lakh milk producers/oilseeds growers. These milk producers and oilseeds growers are members of nearly 74,625 village level cooperative societies which in turn are members of 189 district cooperative milk producers' unions/area oil unions.

The dairy co-operatives organised on Anand Pattern are single commodity co-operatives. The societies are responsive to the needs of members and as such provide not only a guaranteed market for the product but also inputs for enhancing production.

Anand Pattern means that the dairies are owned by farmers and not by the Government. They are managed by employees of farmers and not by bureaucrats deputed by the Government. They are sensitive and responsive to their needs. Their role is confined not just to the collection of milk but also extends to helping the farmer increase his production by improving the productivity of his dairy animals by providing inputs such as breeding facilities, feeds, veterinary health cover etc.

**Anand Pattern means that the dairies are owned by farmers managed by employees and not by bureaucrats. They are sensitive and responsive to their needs.**

At the behest of Shri Lal Bahadur Shastri, the National Dairy Development Board (NDDB) was created in 1965, to replicate the Anand pattern throughout India.

**Operation Flood**

To replicate the Anand Pattern, it was necessary that the NDDB have its own programme and funds. It was thus that the Operation Flood (OF) programme was evolved in 1970. OF in our country has been the largest rural employment programme. The launching of the programme has resulted in the accelerated growth of the dairy industry and creation of cooperative infrastructure-milk plants, distribution system and milk collection systems necessary to encourage and support growth in milk production.

OF aims at capturing a dominant share of the urban milk market, setting up a procurement network to link the milk producer cooperative societies in different milkshed areas with the urban dairy industry and to enhance and improve the milk production capacity of the dairy animals through various input services such as cross-breeding, veterinary services and auxiliary activities. The sole aim behind the OF programme has been to act as an agent for the socio-economic transformation of the weaker sections of the rural society.

OF has been carried out on the dairy commodity through aid and grants received from agencies like the World Food Programme (WFP) of the United Nation's Food and Agriculture Organisation (FAO), the European Economic Community (EEC), and the World Bank. The first phase of Operation Flood was from 1970 to 1981 and it involved a total outlay of nearly Rs 1,200 million, aimed to link 27 rural milkshed districts to the four metropolitan markets of Bombay, Calcutta, Delhi and Madras. The second phase of Operation Flood (OF) aimed at establishing a National Milk Grid linking around 155 districts with 147 major towns. In 1988, it was decided to launch Operation Flood III to cover imbalances that have remained after OF I and II which involved an outlay of Rs 6,806 million which was provided by the World Bank and EEC food aid.

OF has also strived towards creating a National Milch Herd on the basis of cross-breeding technology in the milk shed areas. The highlights of the OF programme are as follows:

*Milk Production and Consumption in India* : Under the OF programme, milk production increased from 20.1 million MT in 1970-71 to 60.8 Million MT in 1993-94 i.e. it has almost trebled. The per capita milk consumption has increased from 107 grams per day in 1970 to 186 grams per day in 1993.

*Milkshed coverage* : The number of milkshed covered has increased from 5 in 1970-71 to 170 in 1992-93. In the first phase of OF, 18 milksheds were covered. OF involves organised marketing of milk to diverse parts of the country. It encompasses development of procurement, processing and transport facilities in the milksheds.

*Farmer Members* : The wholehearted participation of the farmer members in the OF programme has played a pivotal role in its success. There has been a continuous upward trend in their participation from 2.78 lakh members in 1970-71 to nearly nine million members who manage over 69,000 cooperatives.

*Village milk producers' cooperatives* : Under OF, the number of village cooperatives has increased from 1588 in 1970-71 to over 69,000 in 1994-95.

**Cooperatives vis-a-vis Corporate Sector**

A co-operative is a form of economic organisation in which persons wilfully and voluntarily pool their resources on the basis of equality for the advancement of their economic interests. The guiding principle of a co-operative is 'self-help through mutual help' as their motto is each for all and all for each'. Common welfare through common action is their slogan. Cooperative dairying is the most outstanding form of agricultural co-operation. The co-operative dairy is an agency which carries on production, procurement, processing and marketing of milk and milk products on behalf of the producers who are unable to earn even marginal returns. The greatest strength of milk co-operatives is the individual small producer. The most fundamental factor underlying the cooperatives is upliftment of their people.

**The greatest strength of milk co-operatives is the individual small producer.**

A cooperative differs from a corporate in the sense that the former will not build a business by exploiting their fellow men i.e. the producers, the consumers. The main aim of dairy cooperatives is to accord priority to liquid

milk supply. The dairy co-operatives have not only ensured a remunerative return to the farmers but also a continuous supply of liquid milk to the consumers. Cattle feed factories have been set up to provide feed to the animals. Veterinary services are provided which include veterinarian's visits to each village at least once a week. The services can respond within four hours to any emergency call. Veterinarians not only cure a diseased animal, but show the farmers ways in which they can prevent disease. Artificial insemination is conducted to improve the breed of the animals. It is ensured that the farmers provide balanced nutrition to the animals so that the health and productivity of their cattle improves. The cooperative diaries accept milk from the cooperative milk societies at the rate at which it is produced by the society from the milk producer but it is doubtful that the dairies in the private sector would be procuring at the same rate. The cooperative dairies also procure milk from the remote village milk producer societies and pay the same rate for it. The dairies in the private sector prefer to procure milk only from places where the cost of procuring will be economical. Cooperatives have made a social commitment to supply liquid milk which the investor-oriented competitors i.e. the dairies in the private sector and the Multinational Corporations disdain as high risk, low return. Cooperative dairies have consistently striven to ensure that the consumer receives a product that is conducive or beneficial to their health i.e. hygienic, unadulterated safe and fairly priced. Deplorably, dairies in the private sector do not pay heed to hygiene and exhaust considerable effort tin finding ways to puzzle the customer with misleading packaging. While the cooperatives strive to observe the laws governing their activity, some private competitors are not quite as scrupulous in these matters.

Dairy cooperatives have given India a strong base for vertical integration linking the producer to the consumer and have the infrastructure and the opportunity to produce world class milk products.

### Emerging Scenario

With the New Economic Policy in 1991 which included the delicensing of the dairy industry, the Government set the pace rolling for a much freer and market oriented economy and the doors of the nation thrown open to foreign investment and technology collaboration.

The liberalisation policy has resulted in an acute shortage as too many people are chasing too few goods. More private units have sprung up in recent times. The new dairies coming up in the private sector are competing for every drop of milk and converting them in to value added products. The fundamental strategy of MNCs is to locate production where costs are the lowest. Cooperatives have encouraged production by the masses thereby supporting the economically weak farmers, whereas the MNCs encourage mass production and large farmers and not production by the masses.

**Cooperatives have encouraged production by the masses thereby supporting the economically weak farmers, whereas the MNCs encourage mass production and large farmers and not production by the masses.**

The cooperatives fear that the new entrants would take away the milk for high value-added products thus creating scarcity of liquid milk supplies for the average consumer. While the sole aim of the Multinational Corporation is to maximise the earnings per share, the cooperatives strive to strike a balance between improvement of the quality of life for the lakhs of farmer families by providing them a remunerative return for the milk supplied and ensuring a continuous supply of liquid milk to the consumers throughout the year. The new entrants in the private dairy sector want to thrive on years of effort put in by the cooperative dairies to build the necessary infrastructure for the dairy industry. It is necessary that the private dairies share the responsibility of ensuring an orderly growth of the dairy industry.

Indian Industry has, historically, operated in a protected environment. The licensing policy protected the dairy industry from both domestic and international competition. Till June 1991, regardless of the focus of the Industrial Policy Resolution in force, milk food processing industries (milk product manufacturing dairies) was in public interest under the control of the Union. This new policy abolished licensing under the Industries (Development and Regulation) Act, 1951 (IDRA) for milk food processing industries.

Even after the delicensing of the dairy industry, a matter worth commenting is the Central Government's rigid view that consumers primarily require liquid milk and their demand for value added milk products assumes a lower priority. Parliament and the Central Government have never imposed - since independence - licensing observances under the IDRA on any person establishing a factory that would receive and supply liquid milk without manufacturing any milk product.

After the dairy industry was delicenced under the IDRA, the Milk and Milk Product Order (MMPO) was promulgated in June 1992 under the Essential Commodities Act of 1955 by the Government of India. This is expected to impart some order and fairness to the process of liberalisation of the dairy industry as it lays emphasis on supplies of liquid milk rather than the manufacture of milk products and ensures that availability of liquid milk for the public is not jeopardised by undue conversion of milk into dairy products. The main objective of the MMPO is to bring about a qualitative upgradation and improvement in the standards of hygiene and sanitation in handling production, processing and marketing of milk and milk products and that the intermediaries between the producer and the consumer play a positive and important role towards safeguarding the interest of both these parties. Quality is the hallmark of success of any activity and the dairy industry is no exception. With the liberalisation policy of the government, the dairy processing units in the country need to gear up to improve the quality of processing of milk and dairy products.

The MMPO plays both a regulatory and promotional role. It attempts to promote healthy growth of the dairy sector by giving a new thrust to modernisation, technology upgradation and quality standards. In its regulatory role it provides a set of procedures to ensure processing of milk and dairy products in a hygienic manner. The MMPO represents the concerns of both the producers and the consumers. By promoting a systematic growth of the dairy industry, it would provide immense opportunities to the milk producers to expand their production base and increase their incomes.

**MMPO attempts to promote healthy growth of the dairy sector by giving a new thrust to modernisation, technology upgradation and quality standards.**

### Challenges to the Cooperatives

Cooperative Dairying in India is nearly 50 years old. Dairy cooperatives have proved that given the opportunity, the rural people rise to the occasion, prove their capability and engage in self-employment for their self-development.

Nearly 70 per cent of the organised dairying in our country is run by member owned and controlled dairy cooperatives. These dairy cooperatives after toiling hard for years, have made India the second largest milk producing nation in the world. A fact worth mentioning is that about 75 per cent of the milk producers who are small and marginal farmers and landless milk producers play an important role in the earnings of the dairy industry.

The cooperative dairy sector is not averse to the entry of big business houses and multinationals into the dairy sector but their entry represents a major challenge and a threat to them as they are not playing on a level playing field. The corporate or the private dairies operate under the Companies Act of 1956 which applies uniformly to all the private dairies in the county and also does not have un-called-for and baseless interference in the management of their business affairs. The dairy cooperatives are registered under their respective State Cooperative Acts and continue to suffer under a primitive, colonialist co-operative laws that permit supererogatory digressions into the affairs of their business. The big business houses and the multinationals can overcome innumerable obstacles in the areas of technology and finance whereas the cooperatives face a myriad of hurdles such as difficulty in access to corporate funds, working capital problems and the bias of the nationalised banks which are reluctant to treat them on the same preferential basis as is accorded to big business houses and MNCs. Cooperatives in India have been ridden with heavy government control — financial, managerial, administrative and regulatory. These co-operatives have managed to be self-dependent on these fronts leaving only regulatory and audit control to the government. It is very easy for a company to raise money to invest in the desired assets. On the contrary, in the case of a cooperative the approval of the Registrar of Cooperatives has to be taken while making investment. Besides, even the day - to - day decisions can be challenged by the Registrar, or by a cooperative department auditor.

### SWOT Analysis

Regardless of the challenges and the competition that lie ahead, let us examine the strengths and weaknesses, the opportunities and threats that face the dairy industry.

#### *Strengths*

*Availability of the main raw material i.e., milk is abundant*: Milk production in India has been increasing at an average rate of 4.5 per cent during the Eighth Plan and at the rate of 5 per cent during 1991-92, 1992-93 and 1993-94. Today India is the second largest milk producing nation in the world.

*Low cost of milk production* : Compared to the cost of milk production, the cost of processing is much higher. The cost of milk processing can be effectively minimised by proper capacity utilisation and by proper route planning which can greatly cut down the transportation cost involved in milk procurement.

*Demand-Supply gap of milk & milk products* : The major portion of milk production is domestically consumed, leaving a disposable surplus of 10 to 15 per cent to be procured and handled by the organised sector like the co-operatives, the government agencies and the private sector. While the demand for milk stays more or less same throughout the year, production grinds to a halt in summer following the seasonal calving pattern of the milch animals. Increase in the supply of milk is possible only after a time lag since cows and buffaloes are not machines, their productivity can only be increased by breed improvement through artificial insemination and by providing better feed, all of which require some time.

*Flexibility of product mix*: Flexible conversion of milk into various products enables easy addition of product lines. In the organised sector, in the product category, the production of milk powder occupies a dominant share. So far, the manufacture of traditional Indian dairy products has not been tapped by the organised sector.

### *Weaknesses*

*Perishability of milk - doubtful quality of milk*: Marketing is of key significance in dairy industry because of the perishable nature of the commodities.

*Scattered production*: Inefficiency in procurement of milk is the major lacuna in the present system. Only good logistics and proper infrastructure can lead to economical procurement.

**With the delicensing of the dairy industry, organised procurement by the cooperatives has been reduced since whatever is available is now being shared by many more units which is resulting in shortages.**

*Increasing competition* : With the delicensing of the dairy industry, a number of private units in the urban areas are procuring more milk than before. On the one hand, organised procurement by the cooperatives has been reduced since whatever is available is now being shared by many more units which is resulting in shortages.

### *Opportunities*

*Easy value addition* : Diversification into innovative value-added products such as cheese, butter, ghee, milk powder, ice-cream etc is easy which can ensure larger volumes and margin.

*Vast cooperative network*: The existing co-operative network can support the private sector also.

*Emerging consumerism* : Consumerism is growing fast among the urban population of our country which is expected to be between 350-400 million out of the total population of more than 940 million which will be about 1000 million at the end of 2000 AD.

*Export potential*: The advent of liberalisation and the signing of the GATT agreement has opened up avenues for export of our milk products.

### *Threats*

*Liberalisation and the entry of MNCs* : There has been a huge rush into the daily sector leading to over capacity and insufficient milk.

*The unorganised sector*: The unorganised sector poses a major threat since it procures a substantial portion of the milk produced.

### Conclusion : Concerns & Remedial Measures

The need of the hour is the liberalisation of the rules and regulations that are stifling the cooperative bodies. The cooperative dairies are not averse to the entry of multinationals. All they want is a level playing field which is not there due to the myriad controls on the cooperative sector. The cooperative dairies have to take into consideration the cooperative law even for minor decisions. A number of cooperative dairies have contributed greatly not only to the development of their milkshed but also towards the upliftment of the landless labourers and marginal farmers. One clear consequence of liberalisation in the dairy industry is the internationalisation of our competition at the cost of farmers.

**The need of the hour is the liberalisation of the rules and regulations that are stifling the cooperative bodies.**

Many who at one point of time strongly advocated a socialistic pattern of society are now staunch supporters

of market economy and have been talking about globalisation. As per market economy the resources are allocated not on the basis of justice, but on the basis of price irrespective of the fact that these are not consistent with the national goals. It is very paradoxical when even in the advanced countries the government takes steps to not only manage their economy but also to allocate resources and to protect their markets. We have to ensure that liberalisation is not just restricted to fulfilling the need of the elite class as we have been witnessing in the past few years. MNCs are preferring only lucrative areas where there is high profit margin and where it is possible to cloy our *creme de la creme*.

The following steps should be immediately taken up by the government:

*Need for a uniform policy on agriculture* : Agriculture still continues to be on the state list and there is no central legislation which can provide stimulus to agricultural development. Agriculture also included animal husbandry and dairying. The individual state governments continue to administer and legislate laws for governance of agriculture in their respective states. In a particular state itself, priorities assigned to the subject may change with the change in the government either at the centre or state level depending on the relationship between the two which in turn would affect the availability of funds from the centre for different agricultural development programmes. Also in a number of states, the governments may adopt some policy to please some lobby which in turn has adverse impact on the farmers; therefore it is not only necessary but imperative that the government announces a National Agricultural policy resolution. A level playing field needs to be provided to agriculture so that it can face the competition.

*Emerging competition in the dairy sector* : Milk is a limited resource since numerous factors such as the number of animals, their genetic potential, the availability of feed and fodder etc put a limit on the total milk that can be produced. New entrants seek to benefit from the decades of investing by the cooperatives. The cooperative dairy industry has mainly been instrumental for the increase in the amount of milk produced by providing various inputs such as veterinary health care services, improvement in the breed of the cattle through Artificial Insemination, better feed for the cattle e.g. production of Urea molasses block etc. With the delicensing of the dairy industry, there has been a mushrooming of private dairies without any regard to the availability of surplus milk to meet the new capacities being set up. Surplus milk processing capacity would lead to price wars which would benefit vendors and brokers but not the farmer. If this trend continues, the consequences will be detrimental to everyone. Quality and health standards should be adhered to ensure our credibility in the international market.

**The cooperative dairy industry has mainly been instrumental for the increase in the amount of milk produced by providing various inputs such as veterinary health care services, improvement in the breed of the cattle, better feed for the cattle.**

*Need to effectively enforce M&MPO* : M&MPO was brought in for the orderly and disciplined growth of the Indian dairy industry by maintaining emphasis on the supplies of liquid milk rather than the manufacture of milk products. Nonetheless, some important issues still to be effectively resolved under the M&MPO:

Any dairy can start or expand its business if it has made an application under the M&MPO. There have been instances where the dairy has still continued production even after the rejection of its application under M&MPO. There should be a mechanism which can ensure the dairy whose application under M&MPO is rejected is barred from carrying its operations any more or operations should be allowed only on being registered under.

Under the M&MPO 1992, only if the dairy has a handling capacity of more than 75,000 litres per day, it has to apply to the Central Government for registration, otherwise it has to apply to the state government. Therefore it is difficult to have a unified view of what is happening to the dairy industry.

Still the task of clearly demarcating the milk shed of each dairy unit has not been resolved which is necessary to ensure that each dairy unit takes necessary measures to enhance the production of milk in its milk shed area instead of thinning or weakening the share of another unit.

*Need for a level playing field* : In the organised dairy industry of our country, there are two large players — the cooperatives and the dairies in the private sector. The legislation governing the cooperatives in various states are repressive and restrictive. State interference in cooperatives is so widely prevalent that many co-operatives have become parastatal bodies and collapse when the external assistance is stopped. Cooperatives are not averse to the liberalisation process or to the entry of MNCs in the field of dairy industry. All they want is liberalisation of the rules and laws that stifle their growth.

*Implementation of the recommendations of the Chaudhary Brahm Perkash Committee* : The Cooperatives have been soliciting for reform in order that the cooperative movement may survive the present influx of the dairies in their sector and prosper also. The Cooperative Initiative Panel (CIP) has called for the enactment of multi-state cooperative legislation on the lines of the Companies Act. In 1992, the Chaudhary Brahm Perkash Committee proposed a Model Cooperative Act, an Act that would restore ownership and control of the cooperatives to their members. It not only encourages the practice of cooperative principles and respects the rights and the wisdom of members but also minimises the role of the Government. Some of the provisions of the existing Multi-State Co-operative Act which have been identified as being restrictive by the Brahm Perkash Committee which need to be amended are as follows:

- Unfettered power to the registrar of co-operatives to direct the societies to amend their by-laws
- Power of the government to nominate directors on the managing committees
- Power to the government to veto, annul or rescind resolutions
- Wide powers to registrars and state governments to give directives
- Provisions for supercession and suspension of management committees
- Automatic suppression of the management committees of credit cooperatives in case of repayment default by members
- Restriction on the term of office bearers
- Curbs on holding office in a number of co-operatives simultaneously
- Compulsory amalgamation and division of societies by the registrar.

Though the GOI has accepted the recommendations of the Chaudhary Brahm Perkash Committee and has promised to incorporate them in an amendment to the Multi-State Cooperative Societies Act, it has so far not implemented them. Andhra Pradesh Government has set a bold precedent for not only other states but also for the Centre to emulate by enacting the new Andhra Pradesh Mutually Aided Co- operative Societies Act, 95. This act grants substantial decision making autonomy to member-owned cooperatives.

*Amendment to the Companies Act to include registration of multi state cooperative companies* : A second initiative was that of the Department of Company Affairs which has drafted an amendment to the Companies Act that would enable the registration of Multi-State Cooperative Companies. This not only takes into consideration the principles of cooperation but considers them a prerequisite for registration. It is voluntary. In the US and New Zealand where Co-operatives dominate the dairy industry, these cooperatives are registered as companies, yet are equally committed to the principles and practice of cooperation.

**It has to be ensured that the economy does not unfold in a way that it caters only to the needs of the affluent sections of the society depriving the weaker and marginal farmers, violating the basic idea of sustaining the welfare of all.**

It has been almost four years since the liberalisation process was initiated by the Government in 1991 in the industrial and service sectors. Though the pace of reforms has slowed down, it is unlikely that there would be any going back. A matter of considerable distress is that the Government has so far not done anything in the areas of Agriculture and Cooperation. It is imperative that the Government does something concrete in these two areas so as to put the players in these two areas on a level playing field along with their counterparts in the private sector. The Government must understand that what is desired urgently is not an international economy that simply caters to the needs of the affluent people thereby creating patterns of consumption today that can be only met at great cost tomorrow. The success of the dairy cooperatives in making India self sufficient in meeting not only the demands of the country but also strengthening the position of the country on the export front is a testimony of the fact that by having faith in the capability of our people we can achieve self-reliance. The dairy cooperatives have built up the necessary infrastructure and brought the dairy industry to a stage where it can effectively compete in the world market. It has to be ensured that the economy does not unfold in a way that it caters only to the needs of the affluent sections of the society depriving the weaker and marginal farmers, violating the basic idea of sustaining the welfare of all. □

# Economics of Dairying in Rural Punjab — A Case Study

**D.K. Grover & S.K. Mehta**

*A study was initiated to examine various aspects of dairying and related characteristics on farms, where it was undertaken in small units along with the main agricultural activity. The cost-benefit analysis revealed that rearing milch cattle on the sample farms was not a profitable venture based on total cost considerations. There is enough scope to take up popularisation of suitable cross-breeding programmes and for development of more nutritive but economic feeding packages to increase the milk yield per milch cattle, concludes the study.*

*D.K. Grover & S.K. Mehta are Assistant Farm Economist and Senior Statistician, respectively in the Department of Economics and Sociology, Punjab Agricultural University, Ludhiana.*

In the changing scenario of global demands and needs, agricultural scientists are formulating new strategies to ensure sustainability of the entire farming system rather than increasing the production and productivity of an individual crop/commodity. The main emphasis of these new strategies is on diversification of crop farming and its integration with other suitable subsidiary enterprises. One such enterprise is dairying. Dairying leads to better utilisation of farm family labour during off season and provides fluid cash around the year. Since buffaloes and cows are the mainstay of dairy cattle on the farms in Punjab and contribute almost the entire milk production in the state, the economics of milk production for these cattle merits detailed study.

**The main emphasis of new strategies is on diversification of crop farming and its integration with other suitable subsidiary enterprises.**

Gupta (1985), Gill & Singh (1986), Bal et al (1989) and Grover et al (1992) have earlier conducted studies on milch cattle of various regions of Punjab. Gupta estimated the per litre cost of milk production at Rs 3.15 for buffaloes while Gill & Singh pegged it at Rs 4.24. Bal et al estimated the cost of production for buffalo's and cow's milk pooled at Rs 2.08 per litre. In the study conducted by Grover et al, the cost of production of milk was estimated at Rs 4.34 and Rs 5.05 per litre for buffaloes and cows respectively.

Most of these studies have been confined to the costs and returns of milk production when dairying is the primary enterprise. Scant attention has been paid to make an indepth study of the farms where dairying is undertaken in small units along with the main agricultural activity. The present study is an attempt in this direction.

Most of the earlier studies on the subject were based on data pertaining to a single agricultural year which may or may not be a normal year. In the present study, however, the results are based on the data for the triennium ending 1989-90 which, expectedly, would help in avoiding abnormal/biased inferences about dairy farming as a concomitant enterprise.

**Table 1:** Per cent distribution of farms according to number of milch cattle owned and farm size-group (Averages for the treennium ending 1989-90)

| Farm size-group | Per cent of farms with number of milch cattle owned | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Buffaloes) | | | | | | (Cows) | | | | | |
| | 0 | 1 | 2 | 3 | >3 | Total | 0 | 1 | 2 | 3 | >3 | Total |
| I | 7 | 28 | 38 | 17 | 10 | 100 | 72 | 22 | 6 | – | – | 100 |
| II | 1 | 16 | 38 | 31 | 14 | 100 | 67 | 29 | 4 | – | – | 100 |
| III | – | 6 | 35 | 38 | 21 | 100 | 59 | 31 | 8 | 2 | – | 100 |
| IV | – | 2 | 26 | 34 | 38 | 100 | 66 | 24 | 8 | 1 | 1 | 100 |
| V | – | 1 | 14 | 30 | 55 | 100 | 54 | 25 | 14 | 3 | 4 | 100 |
| Overall | 2 | 11 | 30 | 30 | 27 | 100 | 64 | 26 | 7 | 2 | 1 | 100 |

## Methodology

The data required for this study were taken from the "Farm Management Study in Bathinda District of Punjab" for the years 1987-88 to 1989-90, conducted by the Department of Economics and Sociology, Punjab Agricultural University, Ludhiana.

The sampling design of the study was a two stage stratified random sampling with the village as the primary unit and the operational holding as the ultimate unit. A total of twenty villages were selected for the present study. The operational holdings in each sample village were stratified into five size-groups viz. Group I (less than 3.95 cultivated hectares), Group II (3.95-5.97 cultivated hectares), Group III (5.97-8.20 cultivated hectares), Group IV (8.20-12.25 cultivated hectares) and Group V (12.25 cultivated hectares and above) and four holdings were randomly selected from each group of each selected village. Thus, a total sample of 400 holdings selected for intensive inquiry constituted 80, 81, 83, 82 and 74 holdings from Groups I, II, III, IV and V respectively. By and large, the same ultimate sampling units were retained during each of the three years of the study viz. 1987-88, 1988-89 and 1989-90. The required primary data were collected from these 400 respondents with the help of specially designed schedules through the survey method.

## Cost & Income Concepts Used

*Cost Concepts:* Cost A included expenditure on account of green fodders, roughages and concentrates fed to the cattle (farm produced as well as purchased), charges of hired labour for upkeep of the cattle, depreciation of the value of milch cattle and their sheds, and miscellaneous expenses. Cost B comprised all expenses under Cost A plus interest on the value of milch cattle and their sheds. Cost C was considered to be cost B plus the imputed value of family upkeep labour.

*Income Base :* Gross Income comprised the total money value of milk along with dung produced. Business income was considered to be gross income minus Cost A and Net income comprised gross income less Cost C.

## General Characteristics

*Distribution of farms according to milch cattle owned*: The distribution of sample farms according to milch cattle owned and farm size has been presented in table 1.

Nearly sixty per cent of the farms possessed two to three buffaloes whereas 27 per cent owned more than three buffaloes. On the other hand, about 64 per cent of the farms did not own even a single cow whereas nearly 33 per cent had one to two cows. The number of buffaloes per farm reflected an increasing trend with increase in farm size. In respect of cows, the majority of farms either did not own any cow or possessed one cow only irrespective of the farm size category.

**Table 2:** Number and value of milch cattle per farm (Averages for the triennium ending 1989-90)

| Farm size-group | Buffaloes | | Cows | |
|---|---|---|---|---|
| | Number | Value (Rs) | Number | Value (Rs) |
| I | 1.9 | 6842 | 0.3 | 784 |
| II | 2.5 | 9318 | 0.4 | 924 |
| III | 2.9 | 10108 | 0.5 | 1411 |
| IV | 3.2 | 12186 | 0.5 | 1256 |
| V | 3.9 | 15202 | 0.8 | 2664 |
| Overall | 2.8 | 10607 | 0.5 | 1378 |

*Average number and value of milch cattle per farm*: The average number and value of milch cattle owned per farm for different farm size categories (table 2) increased with an increase in farm size. On an average, nearly

three buffaloes worth Rs 10607 and one cow for every two farms valued at Rs 1378 per farm were possessed by the sample farms.

*Distribution of milch cattle by age* : A study of the distribution of milch cattle by age (presented in table 3) showed that about 75 and 65 per cent of the total population of buffaloes and cows, respectively, belonged to the age-group of five to nine years. About 12 per cent of buffaloes and 28 per cent of cows were in the age group of three to five years.

**Table 5:** Yield of milk per buffalo/cow per annum (Averages for the triennium ending 1989-90)

| Farm size-group | Yield per annum (litres) | |
|---|---|---|
| | Per buffalo | Per cow |
| I | 1277 | 787 |
| II | 1333 | 958 |
| III | 1309 | 949 |
| IV | 1248 | 994 |
| V | 1247 | 911 |
| Overall | 1280 | 926 |

**Table 3:** Per cent distribution of milch cattle by age and farm size-group (Averages for the treennium ending 1989-90)

| Farm size-group | Per cent of milch cattle owned in the age-group (years) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Buffaloes) | | | | | | (Cows) | | | | | |
| | 3-5 | 5-7 | 7-9 | 9-11 | >/11 | Total | 3-5 | 5-7 | 7-9 | 9-11 | >/11 | Total |
| I | 14 | 42 | 30 | 10 | 4 | 100 | 30 | 46 | 16 | 8 | – | 100 |
| II | 13 | 43 | 34 | 7 | 3 | 100 | 26 | 46 | 19 | 6 | 3 | 100 |
| III | 11 | 43 | 32 | 12 | 2 | 100 | 33 | 33 | 30 | 4 | – | 100 |
| IV | 11 | 42 | 34 | 10 | 3 | 100 | 22 | 48 | 28 | 2 | – | 100 |
| V | 13 | 41 | 33 | 11 | 2 | 100 | 28 | 43 | 21 | 8 | – | 100 |
| Overall | 12 | 42 | 33 | 10 | 3 | 100 | 28 | 42 | 23 | 6 | 1 | 100 |

*Proportion of dry and wet milch cattle* : The percentage of dry to total number of milch cattle maintained on the selected farms (table 4) showed that on an average 39 per cent buffaloes and 45 per cent cows were dry at a given point of time.

**Table 4:** Percentage of dry to total number of milch cattle owned (Average for the triennium ending 1989-90)

| Farm size-group | Per cent dry milch cattle to total number of milch cattle owned | |
|---|---|---|
| | Buffaloes | Cows |
| I | 35 | 34 |
| II | 36 | 41 |
| III | 40 | 52 |
| IV | 42 | 44 |
| V | 44 | 52 |
| Overall | 39 | 45 |

The percentage of dry cattle increased with an increase in the farm size both in the case of buffaloes as well as cows. The percentage of dry buffaloes varied from 35 in the smallest holding size-group to 44 in the largest holding size-group. The corresponding percentages were 34 and 52 in the case of cows.

*Yield of milk* : Due to limitations of the study, the estimates of milking average yields of buffaloes and cows could not be estimated. However, the average annual yields of milk per buffalo/cow for various farm size categories have been presented in table 5. An examination of these data did not reveal any definite relationship between yield per milch cattle and farm size.

The average annual milk yield of a buffalo ranged between 1247 and 1333 litres with an overall average of 1280 litres. In case of cows, the average annual milk yield per cow varied from 787 litres to 994 litres on various size-groups of holdings with an overall average of 926 litres.

*Disposal of milk and price received* : Dairy cattle on the sample farms were being maintained mainly to meet the family consumption rather than for sale. About 24 per cent of these farms sold milk which was about 12 per cent of the total volume of milk produced on these farms (table 6). The percentage of milk sold to total volume of milk produced varied from 10 to 17 on different farm size categories, the highest percentage being in the largest size-group of holdings.

**Table 6:** Percentage of farms selling milk and percentage of milk sold (Averages for the triennium ending 1989-90)

| Farm size-group | Total number of holdings | Per cent of holdings selling milk | Total milk produced during the year (ltrs.) | Per cent of milk sold |
|---|---|---|---|---|
| I | 83 | 22 | 225207 | 11 |
| II | 79 | 22 | 289827 | 12 |
| III | 84 | 25 | 350963 | 11 |
| IV | 83 | 22 | 375663 | 10 |
| V | 71 | 31 | 399920 | 17 |
| Overall | 400 | 24 | 1641580 | 12 |

The quarterly and annual average prices per litre of milk of buffaloes as well as cows in the study area have

been given in table 7. The average annual price per litre of milk of buffalo and cow worked at Rs 3.98 and Rs 3.35 respectively for the triennium ending 1989-90.

**Table 7:** Average price received per litre of milk during different quarters of the year
(Averages for the triennium ending 1989-90)

(Rs/litre)

| Quarter | Buffaloes | Cows |
|---|---|---|
| I | 3.85 | 3.32 |
| II | 4.15 | 3.23 |
| III | 3.92 | 3.40 |
| IV | 4.00 | 3.44 |
| Annual | 3.98 | 3.35 |

## Cost of Maintenance of Buffalo/Cow

The average total costs of maintenance per annum for a buffalo and a cow for the triennium ending 1989-90 along with the per cent break-up of the same into various items of expenditure have been exhibited in table 8.

*Labour cost*: The hired labour value was taken as the actual expenses borne by the farmers and the value of family labour was imputed at the corresponding wage rates prevalent at the point of time for casual labour in the sample villages.

*Miscellaneous expenses*: These included expenses like veterinary, water and electricity charges and were valued at the actual expenses incurred by the farmers.

*Depreciation on milch cattle*: For imputing the depreciation, the life of a buffalo or a cow was fixed at 13 years. The value of these cattle was assumed to appreciate in the ratio 1:3:5 for the first three years, constant for the fourth and fifth year and depreciate thereafter at the rate of 12.5 per cent per annum computed by the straight line method. No depreciation was allowed beyond 13 years of age. Buffaloes and cows above the age of three years only were considered as milk yielding.

**Table 8:** Per cent break-up cost of maintenance per annum for milch cattle (Average for the triennium ending 1989-90)

| Particulars | Buffalo | | | | | | Cow | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Farm size-group | | | | | | Farm-size-group | | | | | |
| | I | II | III | IV | V | Overall | I | II | III | IV | V | Overall |
| 1. Total variable costs | 75 | 76 | 76 | 76 | 76 | 76 | 82 | 84 | 81 | 83 | 81 | 82 |
| Green fodders | 20 | 20 | 21 | 20 | 21 | 20 | 20 | 22 | 21 | 22 | 24 | 22 |
| Roughages | 22 | 22 | 21 | 21 | 21 | 21 | 28 | 26 | 25 | 25 | 25 | 26 |
| Concentrates | 23 | 24 | 25 | 25 | 25 | 25 | 23 | 25 | 27 | 27 | 23 | 25 |
| Upkeep labour: | | | | | | | | | | | | |
| i. Family | 10 | 9 | 6 | 8 | 6 | 8 | 11 | 9 | 7 | 6 | 5 | 8 |
| ii. Permanent farm servant | – | 1 | 2 | 2 | 3 | 2 | – | 1 | 1 | 2 | 3 | 1 |
| iii. Total | 10 | 10 | 8 | 10 | 9 | 10 | 11 | 10 | 8 | 8 | 8 | 9 |
| Miscellaneous | – | – | 1 | – | – | – | – | – | – | 1 | 1 | – |
| 2. Total fixed costs | 25 | 24 | 24 | 24 | 24 | 24 | 18 | 16 | 19 | 17 | 19 | 18 |
| Depreciation on the value of buffalo/cow | 12 | 11 | 12 | 12 | 11 | 12 | 7 | 6 | 7 | 6 | 7 | 7 |
| Depreciation on the value of cattle shed | 1 | 1 | – | – | 1 | – | 1 | 1 | 1 | 1 | 1 | 1 |
| Interest on the value of buffalo/cow | 9 | 8 | 8 | 8 | 8 | 8 | 7 | 6 | 7 | 7 | 7 | 7 |
| Interest on the value of cattle shed | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 4 | 3 |
| 3. Total (1+2) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 4. Total cost (Rs) | 5433 | 5847 | 5749 | 5795 | 5785 | 5722 | 4217 | 4913 | 5208 | 4793 | 5489 | 4923 |
| Receipts (value of manure produced (Rs) | 69 | 67 | 70 | 72 | 75 | 71 | 69 | 67 | 69 | 72 | 77 | 71 |
| Net cost (Rs) (4-5) | 5364 | 5780 | 5679 | 5723 | 5710 | 5651 | 4148 | 4846 | 5139 | 4721 | 5412 | 4852 |

The following evaluation procedure was followed:

*Feed cost* : The feeds purchased from the market were valued at the actual expenses as reported by the respondents whereas owned farm produced feeds were evaluated at market prices prevailing in the selected villages.

*Depreciation on the value of sheds*: The depreciation on cattle shed was computed by the straight line method at two per cent and five per cent per annum in the case of pucca and kacha sheds respectively.

*Interest on fixed capital*: Owned fixed capital was considered to comprise the value of cattle sheds and

value of buffaloes/cows. Interest on owned fixed capital was worked out at a fixed rate of 12.5 per cent per annum, while the interest on capital borrowed for purchase of these fixed assets was taken as actual payments made by the respondents.

*Interest on working capital*: No interest on working capital was considered as there was a regular flow of income from milk which was utilised for the working expenses.

The net annual cost of maintenance of a buffalo (viz. total cost less value of dung produced) varied from Rs 5364 on the smallest farm size-group to Rs 5723 on the fourth farm size-group with an overall average of Rs 5651. An analysis of the per cent break-up of the cost revealed that green fodders, roughages and concentrates taken together accounted for about 66 per cent of the total average cost (Rs 5722) incurred annually on the maintenance of a buffalo. The other items of expenditure in order of their importance were depreciation on the value of a buffalo, upkeep labour and interest on the value of buffalo constituting nearly 12, 10 and 8 per cent, respectively, of the total cost. The distribution of total and net maintenance costs per annum did not exhibit any definite pattern in relation to farm size.

The average annual net maintenance cost of a cow for the triennium worked out nearly at Rs 4852. These costs showed an increasing trend with an increase in the farm size (barring fourth size group) and varied from Rs 4148 on the smallest holding size-group to Rs 5412 on the largest farm size-group. A perusal of the per cent break-up of the total cost per annum of a cow revealed that feeds (i.e. green fodders, roughages and concentrates taken together) accounted for the major portion viz. 73 per cent of the total cost (Rs 4923). The other important components of the annual total cost of maintenance of a cow in order of their relative importance were upkeep labour, interest and depreciation on the value of the cow which accounted for nearly 9, 7 and 7 per cent respectively.

## Cost of Production of Milk

The average costs of production per litre of milk for the triennium under reference according to different cost bases worked out separately for buffalo and cow have been shown in table 9.

**Table 9:** Cost of production per litre of milk based on different cost concepts (Averages for the triennium ending 1989-90)

(Rs)

| Farm size-group | Cost of production of buffalo's milk on the basis of cost | | | Cost of production of cow's milk on the basis of cost | | |
|---|---|---|---|---|---|---|
| | A | B | C | A | B | C |
| I | 3.25 | 3.75 | 4.17 | 4.30 | 4.66 | 5.27 |
| II | 3.56 | 4.05 | 4.45 | 4.13 | 4.60 | 5.05 |
| III | 3.64 | 4.16 | 4.45 | 4.42 | 5.02 | 5.41 |
| IV | 3.80 | 4.33 | 4.70 | 3.94 | 4.43 | 4.74 |
| V | 3.86 | 4.43 | 4.70 | 4.96 | 5.65 | 5.94 |
| Overall | 3.66 | 4.19 | 4.53 | 4.40 | 4.97 | 5.36 |

The average costs of production per liter of buffalo's milk estimated on all the three cost bases viz., A, B and C exhibited an increasing trend with increase in farm size. The average total cost (i.e. Cost C) per litre ranged from Rs 4.17 on the smallest farms to Rs 4.70 in the largest farm size-group with an overall average of Rs 4.53 in case of buffaloes. In case of cows, however, these costs did not exhibit any definite relationship with farm size. The total cost (i.e. Cost C) per litre of cow's milk varied from Rs 4.74 to Rs 5.94 on different farm size-groups with an overall average of Rs 5.36.

## Bulk-line Cost of Production of Milk

The average cost of production per litre of milk, generally, did not cover the major portion of total volume of milk produced, the majority of total number of milch cattle or the majority of total number of farms. With this end in view, the bulk-line costs of production per litre of milk according to three different criteria viz. covering 85 per cent of the total volume of milk produced; the total number of buffaloes/cows and the total number of farms to which these animals belonged, were worked out separately for buffaloes as well as cows. These are presented in table 10. The bulk-line costs of production per litre of buffalo's milk covering 85 per cent of milk produced, holdings and buffaloes were Rs 6.32, Rs 6.73 and Rs 6.80 respectively. The corresponding figures for cow's milk were Rs 7.60, Rs 9.08 and Rs 9.18 per litre respectively.

**Table 10:** Bulk-line cost of production of milk (Averages of the triennium ending 1989-90)

(Rs/litre)

| Milch cattle | Bulk-line cost covering 85 per cent of | | |
|---|---|---|---|
| | Milk produced | Holdings | Milch cattle |
| Buffalo | 6.32 | 6.73 | 6.80 |
| Cow | 7.60 | 9.08 | 9.18 |

## Returns per Buffalo/Cow

The returns per buffalo/cow reflected through gross income, business income and net income for various farm size categories have been presented in table 11. Based on Cost C, i.e. the total cost, on an average, a farm incurred a net loss of nearly Rs 630 per buffalo per annum. These losses exhibited an increasing trend with an increase in the farm size and varied from Rs 136 per buffalo per annum for the smallest holding size-group to Rs 796 for the largest farm size-group. The maintenance of a cow on these farms resulted in still higher losses per cow per annum. These losses varied from Rs 1473 for the smallest holding size- groups to Rs 2315 for the largest holding size groups with an overall average loss of Rs 1810 per cow per annum.

**Table 11:** Annual gross income, business income and net income per buffalo/cow (Average for the triennium ending 1989-90)

(Rs)

| Farm size-group | Buffalo | | | Cow | | |
|---|---|---|---|---|---|---|
| | Gross income | Business income | Net income | Gross income | Business income | Net income |
| I | 5097 | 844 | –136 | 2743 | –556 | –1473 |
| II | 5320 | 625 | –529 | 3330 | –705 | –1580 |
| III | 5221 | 503 | –526 | 3294 | –973 | –1914 |
| IV | 4990 | 296 | –805 | 3450 | –545 | –1342 |
| V | 4990 | 220 | –796 | 3173 | –1425 | –2315 |
| Overall | 5110 | 453 | –630 | 3220 | –926 | –1810 |

While looking at the returns based on Cost A (business income) which did not cover interest on the value of milch cattle and sheds and imputed value of family upkeep labour, the income turned out to be positive in the case of buffalo and varied from Rs 844 to Rs 220 on the smallest and largest holding size-groups respectively with an overall average income of Rs 453 per buffalo per annum. In the case of cows, even this business income did not turn out to be positive and farmers remained under losses. The per cow per annum losses varied from Rs 556 to Rs 1425 on the smallest and largest holding size-groups with an overall average loss of Rs 926. It showed that cow rearing is not an economical venture even if we ignore the cost on account of interest on value of milch cattle and cattle sheds and imputed value of family upkeep labour. This was mainly because of the poor yield of milk of milch cattle in general and of cows in particular. There is enough scope to improve the yield of these cattle by popularising suitable cross-breeding programmes and developing more nutritive but economic feeding packages.

**There is enough scope to improve the yield of cattle by popularising suitable cross-breeding programmes and developing more nutritive but economic feeding packages.**

This will go a long way in meeting the demand for milk by the masses and work towards the amelioration of the economic lot of the farming community of Punjab.

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# Techno-economic Considerations in Fluid Milk Processing

**D.K. Sharma**

*Liquid milk market depends on appropriate processing in view of the distances involved in our country. It is a matter of concern that organised dairy plants are processing only 5 per cent of the total milk production. The author analyses the technical and economic considerations involved and offers a few suggestions to safeguard the interests of the producers as well as the consumers.*

*D.K. Sharma is Sr. Scientist, Dairy Technology Division, National Dairy Research Institute, Karnal*

India is producing 56 million tons of milk per annum and is ranked as world's second largest milk producer after USA. The annual rate of growth in milk production is 5 per cent. At this growth rate it is expected that India's production would overtake that of the United States (67.4 million tons) by the turn of century.

India's per capita consumption of milk is not very high (65 kg/year) when compared with the world average (100 kg/year). The increase in milk production is remarkably high over the last two decades due to the concerted efforts like cross-breeding programmes, especially the Operation Flood.

The distribution of milk is not even among the Indian populace. Studies show that the top 10 per cent of population consumes 30 per cent of milk while the bottom 30 per cent manages with 10 per cent of milk. It is necessary to distribute the milk more evenly by linking the production centres (i.e. rural area) and the consumption centres (i.e. big cities). This is possible only if we are able to process milk in the most hygienic manner to increase its shelf-life and wholesomeness. Unfortunately milk marketing and distribution in the country is not well organized. It is still in the hands of small milkmen and vendors. These middlemen collect the milk from small and marginal farmers (keeping 1 or 2 milch animals) and sell it in nearby cities. The economics of such a home delivery system is tremendous. The profitability of immoral business lies in adulteration. These small milk vendors handle 85-90 per cent of the marketable surpluses of milk. They cheat the consumers by giving adulterated or skimmed milk, and at the same time pay a pittance to the producers. Due to such unhealthy competition in the market, the organized milk plants are able to handle only 10-12 per cent of the total milk production.

Organised milk processing is the only solution to feed the large populations in big cities and for providing market to rural milk producers at remunerative prices.

**Due to unhealthy competition in the market, the organized milk plants are able to handle only 10-12 per cent of the total milk production.**

### Milk Processing

The organized dairy plants are processing only 5 per cent of milk production for fluid milk marketing.

There are 275 liquid milk plants having an installed capacity of 20 million litres of milk per day. However, the average through- put is only 12.5 million litres/day (only 62.5 per cent capacity utilization). There has been a steady increase in the number of liquid milk plants from 190 in 1979-80 to 246 in 1990-91. Most of these plants are either in the public sector or in cooperative sectors and are run in an uneconomical manner incurring huge losses. The reason for such losses is that these plants are underutilized (run below their capacities) due to the non-availability of milk in lean (summer) season. Basic processing facilities are complementary in nature and their investment and operational fixed costs are high and this situation leads to high cost of milk processing which eats away the profit in a price competitive market.

On the other hand, the small unorganized sector, using indigenous technology and with unhygienic milk processing facilities is earning profits from the same market due to low processing cost. It is therefore, important to devise systems which can withstand milk fluctuations without affecting overhead charges and cost of processing. The fluid milk plant must be run at break-even-point even in unfavourable/ lean seasons. The management of dairy plants should be efficient and effective to earn profits. The plants must be managed by professional dairy technologists' to achieve such efficiencies. The malpractices in the unorganized sector must be stopped by effective implementation of the PFA regulations.

### Technological Considerations

Milk is collected from small and marginal farmers located in scattered villages. The payment for milk is done on the basis of fat and SNF test. The collection may be done by one of the three methods or their combinations; direct collection, cooperative societies, contractors.

The collected milk is chilled to less than 4°C before being sent to the main processing plant. Its mode of transportation may be tempo, truck or milk tanker. It is practically impossible to provide cooling/chilling facilities at every rural collection centres. To combat this reality, it is proposed to use some safe preservatives in raw milk (LP system of preservations) to increase its shelf-life. The technology is ready for its application. It is safe for use, but is yet to be cleared by legal authorities. Technically and medically the LP system of preservation is safe. It is rather essential to adopt this technology to avoid spoilage of large quantities (4-5 per cent) of total milk handled by the organized sector) of milk. The initial quality (Organoleptic, chemical and bacteriological) has to be good for its processing into wholesome and palatable processed milk with increased shelf-life.

Little can be done to improve the initial quality of milk after it is received at the dock of the main milk processing plant. The changes at micro and macro level which have occurred in raw milk cannot be completely reversed or masked. The milk processing plants, therefore, have to develop their own milk shed areas for producing clean and hygienic milk without adulterants and neutralizers. The system of development may be through cooperatives or direct involvement.

**Little can be done to improve the initial quality of milk. The milk processing plants, therefore, have to develop their own milk shed areas for producing clean and hygienic milk without adulterants and neutralizers.**

The milk received at the reception dock is then weighed, smelled and sampled. It is further chilled and stored in insulated tanks until processing.

The milk is clarified and standardized in to different types (double toned, standardized etc.) in a triprocess machine (cream separator). The standardized milk is pasteurized to kill all pathogenic bacteria and to increase its shelf-life (48-72 hours under refrigeration, 4°C). Plate heat exchanger type pasteurizers are used in large dairy plants which beat the milk to 74°C/16 sec. and chill it to below 4°C.

The pasteurized milk is stored in insulated tanks and packed automatically in polypacks taking all precautions to avoid post- pasteurization contamination. The automatic machines used for filling and scaling of milk

pouches are available indigenously. All other machines i.e. milk chillers, milk pumps, insulated S.S. tanks, cream-separators, pasteurizers, form-fill-seal machines etc. are also made in India. The quality standards of these machines are comparable with similar machines of the developed countries.

The schematic of fluid milk processing is shown in Fig. 1

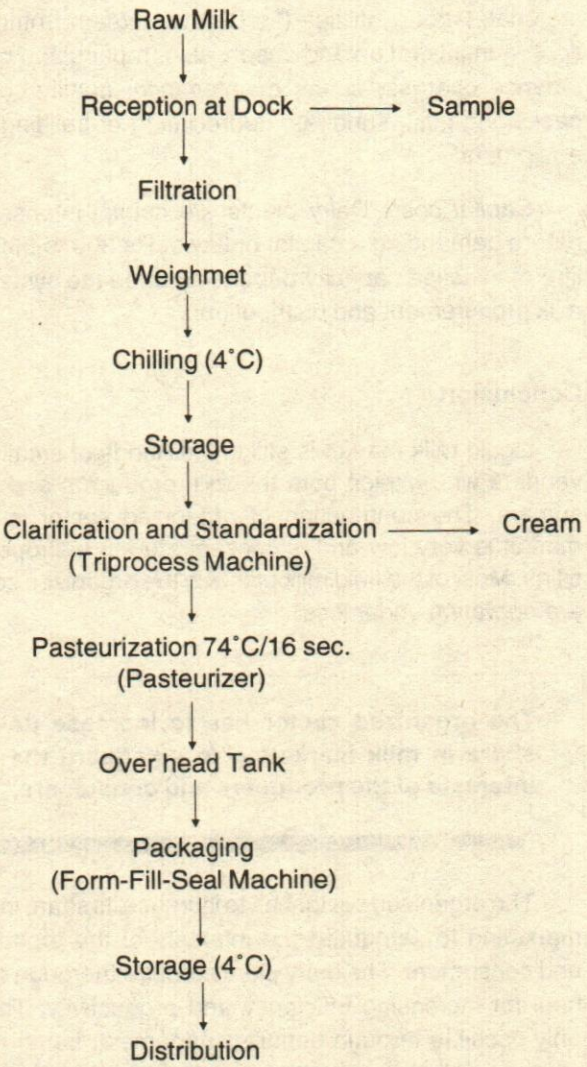



**Fig. 1:** Liquid Milk Processing Flow Chart

## Economic Considerations

Before going into the business of fluid milk processing one has to be sure about its economic feasibility. Based on technical constraints and realities, market situation and consumer preference (market research), one has to decide the level of production, break-even-point, selling price, and product-mix.

**Based on technical constraints and realities, market situation and consumer preference (market research), one has to decide the level of production, break-even-point, selling price, and product-mix.**

Some of the technical realities about milk are:

It is a good media for all pathogens to grow and therefore must be processed most hygienically and carefully and if possible automatically to avoid contamination.

It is a balanced food and some of the constituents are destroyed during processing. Therefore, exact and required processing is a must.

It is perishable and has to be preserved in the most wholesome form for a reasonable span of time.

Its flavour is delicate, and changes during processing. To avoid flavour changes, good initial quality of milk is to be ensured.

While assessing the economic and technical feasibility of a dairy plant project, the suitability or availability of following should be looked into.

*Location* : The location of a liquid milk plant should be near the market and should be connected by road/rail to the production centre/collection or chilling centres. The availability of good quality water and regular and cheap supply of electricity is necessary at location. The plant should be located in the city's industrial complex, as far as possible, to take the benefits of existing basic infrastructure.

*Effluent Disposal* : The plant should have a proper drainage facility either in municipal sewerage or nearby rivers after treatment.

*Building* : Building should be low cost and provide all possible facilities for avoiding aerial contamination and easy cleaning and good working environment (lighting, ventilation etc.)

*Milk procurement system* : The most efficient system of milk procurement is — the Cooperative Society system based on Anand Pattern. However, this system requires a thorough check-up before it can be recommended for a particular situation and location. Elements like honesty, cooperation and political immunity are key to the success of this system.

*Pricing of milk* : The milk should be priced on the basis of the two-axis pricing policy to encourage milk production and to discourage adultration. Extra 'bonus' must be given to milk with better bacteriological and hygienic quality. The neutralizers and adulterants must be tested occasionally and randomly.

*Dairy machines and equipment* : All machines and equipment required for liquid milk processing are manufactured in India. They should have been fabricated with sanitary designs for milk processing. The construction materials' should be non-reactive and non-corrosive. Machines made of stainless-steel (No. 304) with sanitary designs should be purchased from reputed manufacturers. Although similar machines are also available at 3-5 times less cost in market, these are not good in the long run.

*Economy in operation and energy audit* : Economy in the consumption of steam, water, electricity and reducing milk handling losses are key to increasing profits. The machines and processes must be such that consume energy most economically. The solar heater used for boiler feed water can effectively reduce the fuel consumption of the boiler upto 15 per cent. The recycling of condensate, regeneration units in the pasteurizer, use of proper pasteurization and cooling temperatures etc. can further conserve energy. Systems to save energy must be incorporated in all possible machines. This would reduce the cost of processing and increase the profits.

Another significant area of saving is the packaging machine which can save 2-3 per cent packaging material in big dairy plants. The bulk vending system is another economical way to distribute milk without incurring the cost of packaging. The system is effectively demonstrated by Mother Dairy, Delhi.

*Dairy managers and technical associates* : For running a fluid milk processing plant the manager must be qualified in dairy technology and should have thorough knowledge of the production, process technology and engineering, chemistry, bacteriology and management. Qualified technical persons must be trained to handle dairy business efficiently and effectively. Qualified manpower will lead this business to progress and profits.

*Cost of processing* : The cost of processing of fluid milk depends on the installed capacity, capacity utilization, management, energy auditing etc. This varies from plant to plant. The costs of processing are — raw material, labour, utilities (fuel, water, steam, refrigeration), administration and supervision, repairs and maintenance charges, stores maintenance, quality control packaging cost, sundries, depreciation of building and equipment.

*Capital cost* : Dairy plants are capital intensive in nature demanding a capital outlay of Rs 300 to 500 per litre of installed capacity depending upon the system of milk procurement and distribution.

## Conclusion

Liquid milk market is still in the hands of small milk vendors who exploit both the milk producers and consumers. The contribution of organized sector in milk market is very low and is concentrated in metropolitan cities. Most of the fluid milk plants in the organised sector are operating under loss.

**The organized sector has to increase its share in milk marketing to safeguard the interests of the producers and consumers.**

The organized sector has to increase its share in milk marketing to safeguard the interests of the producers and consumers. The dairy plants require thorough overhaul for increasing efficiency and productivity. This is only possible through better management, better technology, realistic economics, people's cooperation and professional will. □

# Cooperatives in Marketing, Processing & Export of Horticulture Produce

**B.C. Mathur**

*Though India ranks top in the area of horticultural production, our performance in processing and exporting of the produce is dismal. The author recommends several measures to be undertaken by the cooperatives so that marketing assistance and processing technology training can be imparted to the entrepreneurs in this sector.*

*B.C. Mathur is Chief Director (F & V), National Co-operative Development Corporation, 4 Siri Institutional Area, New Delhi 110 016.*

India, on account of varied soil and climatic conditions in different parts, turns out a wide variety of produce. The total cropped area in the country is about 180.36 million hectares out of which horticulture accounts for about 6.7 per cent. India is the largest producer of vegetables in the world and the second largest of fruits, after USA, accounting for about 103 million tonnes. The figure is likely to touch 110 million tonnes by the end of Eighth Five Year Plan with the various developmental measures being adopted. Data on the area, production and productivity of fruits and vegetables is given in tables 1 & 2.

**Table 1 :** Production of fruits in India

| Fruits | Area (Hectare) | Production (Tonnes) | Productivity (Tonnes/Hectare) |
|---|---|---|---|
| Banana | 396197 | 10459986 | 26.40 |
| Mango | 1136668 | 9223256 | 8.11 |
| Citrus | 369558 | 2979113 | 8.06 |
| Guava | 111851 | 1204310 | 10.77 |
| Apple | 191256 | 1168252 | 6.11 |
| Pineapple | 59436 | 858978 | 14.45 |
| Papaya | 47429 | 803602 | 16.94 |
| Grapes | 34010 | 653163 | 19.20 |
| Sapota | 30777 | 423143 | 13.75 |
| Litchi | 53561 | 260943 | 4.87 |
| Others | 774906 | 4920530 | 6.35 |
| All India | 3205649 | 32955276 | 10.28 |

**Table 2 :** Production of vegetables in India

| Vegetables | Area (Hectare) | Production (Tonnes) | Productivity (Tonnes/Hectare) |
|---|---|---|---|
| Potato | 1259922 | 20284373 | 16.09 |
| Onion | 380868 | 5718414 | 15.01 |
| Tomato | 308653 | 4849568 | 15.71 |
| Cabbage | 215865 | 4357048 | 20.18 |
| Cauliflower | 222436 | 4220853 | 18.97 |
| Okra | 281626 | 2486965 | 8.83 |
| Peas | 194150 | 1491974 | 7.68 |
| Others | 2239155 | 27596857 | 12.32 |
| All India | 5102675 | 71006052 | 13.91 |

Source : National Horticulture Board Gurgaon (1992-93)

### Production & Marketing Scenario

Government of India, a few years back appointed a Committee, heated by Dr. M.S. Swaminathan, to analyse all aspects of horticultural production and post harvest management and to suggest measures for planned development. The committee, among others, observed that about 25-30 per cent of fruits and vegetables produced goes waste as adequate attention is not being paid towards post harvest management. In the country, where majority of the people are undernourished, there is urgent need to control these losses in order to make available this quantity to the masses and to increase their nutritional standards. At present, per capita availability of fruits is only 40 gms and that of vegetables 120 gms per day, as against the requirement of 120 gms and 280 gms respectively, as per the nutritional standards recommended by Indian Council of Medical Research.

**25-30 per cent of fruits and vegetables produced goes waste as adequate attention not being paid towards post harvest management. In the country, where majority of the people are under nourished, there is urgent need to control these losses.**

The present marketing practice involves a number of intermediaries such as commission agents, wholesalers, sub - wholesalers, retailers, etc, resulting in the grower realizing hardly 30-40 per cent of the price paid by the consumer. The balance is shared by the intermediaries at different stages including a certain percentage of system wastage. Thus the consumer is paying two and a half to three times the price which the grower is actually realizing. There is, therefore, a distinct need for increasing the growers' share and evolving a suitable marketing system where both growers and consumers are benefitted. One of the solutions could be organization of growers' cooperatives for marketing, including retailing of the produce to avoid intermediaries.

The Government has accorded high priority to the horticulture sector by providing about Rs 1000 crores during the 8th Plan period. In consonance with the central policy, various state governments have also taken steps to boost production of horticultural crops. Hence, appropriate post harvest infrastructure needs to be created in the right earnest, lest the efforts for increasing the production go in vain.

**The Government has accorded high priority to the horticulture sector by providing about Rs. 1000 crores during the 8th Plan period.**

### Role of Cooperatives

*Marketing* : There are about 12 State/Central level societies and 275 primary marketing societies directly engaged in marketing of vegetables and fruits. However, there is no exclusive federation of fruit and vegetable cooperatives at the national level, for marketing of horticultural produce. This work is being undertaken by the National Agricultural Cooperative Marketing Federation of India (NAFED) in collaboration with affiliated State Federations and Primary Marketing Societies. NAFED handles a number of commodities like apple, grapes, mango, orange, onion, potato, ginger, etc. The cooperatives are able to handle only about 4-5 per cent of the total production. The total turnover of cooperatives in marketing of horticultural produce during the last three years, is given in table 3 which the state-wise position for the year 1994-95 indicated in table 4.

**Table 3 :** Fruits & vegetables marketed by cooperatives

| Year | Value (Rs in crore) |
|---|---|
| 1992-93 | 276.63 |
| 1993-94 | 362.10 |
| 1994-95 | 437.90 |

**Table 4 :** Fruits & vegetables marketed by cooperatives (1994-95)

| State | (Rs in crores) |
|---|---|
| Andhra Pradesh | 1.22 |
| Assam | 0.01 |
| Bihar | 0.15 |
| Gujarat | 52.42 |
| Himachal Pradesh | 4.66 |
| Haryana | 0.14 |
| Jammu & Kashmir | 0.08 |
| Karnataka | 37.03 |
| Kerala | 6.80 |
| Madhya Pradesh | 0.45 |
| Maharashtra | 50.00 |
| Manipur | 0.07 |
| Meghalaya | 0.06 |
| Nagaland | 0.01 |
| Orissa | 0.29 |
| Punjab | 0.14 |
| Rajasthan | 0.36 |
| Sikkim | 0.16 |
| Tamil Nadu | 15.88 |
| Tripura | 0.03 |
| Uttar Pradesh | 0.01 |
| West Bengal | 0.66 |
| Arunachal Pradesh | 0.40 |
| Total | 171.03 |
| NAFED | 266.87 |
| Grand Total | 437.90 |

Unless the cooperatives themselves take up retailing of fruits and vegetables, no substantial benefit can flow to the growers. The cooperatives have to undertake all the operations like collection, sorting, grading, packing and transportation of the produce and prepare it for retailing through their own outlets. This system will be useful in those cities and towns which are having larger population, say, about 7 lakhs or more.

**The cooperatives have to undertake all the operations like collection, sorting, grading, packing and transportation of the produce and retailing through their own outlets.**

A few cooperatives which are engaged in marketing or exporting horticulture produce have been turning out a performance worth emulating:

*HOPCOMS, Bangalore (Karnataka):* The Bangalore Horticulture Produce Marketing and Processing Society Ltd. (HOPCOMS) is handling about 140 tonnes of fruits and vegetables of its members per day. It is marketed through its 250 retail outlets spread over the Bangalore City and a few outlets in Mysore, Kolar, Mandya and Tumkur. Besides, about 20-25% of the produce is supplied to the institutional buyers. In this process the society is able to avoid the usual marketing channels of commission agents and wholesalers. Daily it fixes the retail price of each item at which the produce has to be sold. Of this price, about 70 per cent is paid to the growers. HOPCOMS Bangalore is also exporting fresh fruits. The society has exported 40.5 tonnes of fresh fruits to Malaysia, Canada, Germany and Singapore.

*The Nilgiris Vegetable Growers Cooperative Marketing Society Ltd., Udhagamandalam. T.N* : It is marketing vegetables of its members at Mettupalayam, foot hills of Nilgiris. The society has its own market yard where the vegetables are auctioned daily. Traders from various places participate in the auction. The society is handling Rs 70.00 lakhs worth of vegetables annually.

*Lahoul Potato Growers Coop. Marketing Society, Manali (H.P.):* The Society is operating in the land locked area Lahoul of Lahoul & Spiti Distt. It is handling about 60% of total production of patatio in Lahoul area which is used as seed in many parts. The other items are apple and off season vegetables like peas, cabbage, cauliflower, etc. Besides, it is also serving its members by distributing all their needs of consumer articles and inputs. Its annual turnover is around Rs 7.50 crores.

*Mahagrapes, Pune, Maharashtra:* The grape growers in areas such as Pune, Nasik, Solapur, Sangli and Satara in Maharashtra State have formed twenty-nine cooperatives with more than six thousand members. National Cooperative Development Corporation (NCDC) in collaboration with the State Government extended assistance to these cooperatives for creation of pre-cooling and cold storage facilities at the farm level, for export of grapes and other fruits. Air handling equipment for their units were imported by these societies from USA. This is essential for maintaining ultra high humidity in the cold storage chambers. Precooling helps in enhancing the storage life of the produce and maintaining the quality during long distance refrigeration transport. For example, it takes 2-3 weeks for the produce to reach U.K. from the society's storage facilities, and another 1-2 weeks before it reaches the consumer abroad.

20 Grape Growers' Cooperatives have created their own marketing organization, called Mahagrapes, which

is a partnership organization, registered under the Maharashtra State Cooperative Societies Act. With the guidance of the Maharashtra State Agricultural Marketing Board, Mahagrapes exported 420 tonnes of fresh fruits such as grapes, pomegranates, tomatoes and strawberries worth Rs 1.10 crores during 1994-95.

*Mahamango, Maharashtra*: Mango growers Cooperative of Maharashtra, have organized "Mahamango" on similar lines as Mahagrapes. It has a membership of 23 Primary Cooperatives and operates in the districts of Sindhudurg and Ratnagiri. It is setting up a modern mango handling unit at Kudal in Sindhudurg Distt. with a view to export the famous Alphanso mango by sea to Middle East, U.K. and other European countries. On a trial basis it exported 200 tonne of Mangoes valued at Rs 48 lakhs during the last season.

*Cannanore District Coop. Marketing Society, Cannanore (Kerala)*: The Society is handling fruits, mainly pineapples, and marketing the same at various terminal markets like Bombay and Bangalore. It is handling about 2500 tonnes of fruits and vegetables annually worth Rs 1.50 crore.

*NAFED New Delhi*: Government of India has designated NAFED as the canalising agency for export of onions. This has helped in increasing the unit value of exports while resulting in better foreign exchange earning to the country besides yielding higher price to the farmers. It also intervenes in the market whenever the prices tend to go below the cost of production. In the past under this scheme, it handled ginger, kinnow, onions, potato etc.

During 1994-95, NAFED exported 4.97 lakh tonne onions valued at Rs 256.75 crores. It also exported other fresh produce like grapes, pomegranates, apple, potato etc., valued at Rs 4.75 crores. Besides, it handled fresh fruits and vegetables worth Rs 5.37 crores, in the domestic market. It has acquired a shop in the New Azadpur market and is helping the fruit and vegetable cooperatives in marketing their produce.

### Processing

Processing of fruits and vegetables has not developed in the country to the desired extent, hardly 1 per cent of the total production is being processed, presently. The cooperatives also have not been able to make a significant impact in the processing field mainly on account of their limited scale. 33 processing units have been sanctioned in the cooperative sector out of which 30 units have been installed. These include units for processing of spices, honey and tapioca. The state-wise distribution is given in table 5.

**Hardly 1 per cent of the total production is being processed, presently. The Cooperatives also have not been able to make a significant impact.**

**Table 5 :** Cooperative processing units organised

| State | Units Organised |
|---|---|
| Andhra Pradesh | 2 |
| Assam | 1 |
| Himachal Pradesh | 5 |
| Karnataka | 1 |
| Kerala | 8 |
| Maharashtra | 2 |
| Manipur | 1 |
| Orissa | 1 |
| Punjab | 1 |
| Rajasthan | 2 |
| Tamil Nadu | 5 |
| Uttar Pradesh | 1 |
| West Bengal | 2 |
| Delhi (NAFED) | 1 |
| Total | 33 |

These units manufactured about 2700 tonnes of processed products during 1994-95 accounting for around Rs 12 crore. However, only two are exporting their processed products. During 1994-95, they exported products worth Rs 2 crore to Europe & Middle East countries.

*Prakash Cooperative Agro Industries, Sangli*: NCDC recently assisted this modern processing unit in Maharashtra based on tomato, mango, guava, etc. This unit is based on the state of the art "Bag in Box" technology imported from Italy. It has the capacity to process 10 tonne materials per hour and can process mango, tomato, papaya, guava etc. and pack in bulk aseptic packaging. During the year 1994-95 the unit exported 600 tonne processed products like mangopulp & banana-pulp valued at Rs 1.17 crore.

*Markfed Canneries, Jullundur*: The processing unit of Markfed Canneries Jullundur is having three lines viz. bottling, canning and dehydration of vegetables. It has

exported canned curried vegetables worth Rs 81.16 lakhs during 1994-95.

### Exports

While horticulture exports particularly of mango has been going for several decades, their potential for generating greater volumes of foreign exchange has only emphasized been in recent years. As a result this sector is showing a rising trend. The performance of horticultural exports is indicated in the following table:-

**Table 6 :** Export of fresh and processed fruits and vegetable

| | Quantity Exported in (MT) | | Value (Rs in crores) | |
|---|---|---|---|---|
| Year | Processed | Fresh | Processed | Fresh |
| 1992-93 | 95476 | 512995 | 205.92 | 347.07 |
| 1993-94 | 120522 | 475332 | 268.5 | 385.43 |

The share of the cooperatives in the total exports is miniscule. There is a need to increase this share by adopting suitable strategies for exports.

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### Role of NCDC

National Cooperative Development Corporation (NCDC) among promoting other activities, is also supporting fruit and vegetable marketing and processing cooperatives. It is extending financial and technical assistance for practically all the aspects of post harvest operations. Assistance is available for:

- Development of marketing including retailing
- Establishment of processing units
- Purchase of transport vehicles, including refrigerated transport
- Construction of godowns/sheds for storage of horticulture produce
- Establishment of cold storages including pre-cooling units.

The Corporation has so far sanctioned Rs 37.52 crores to 276 cooperatives for promoting marketing of fruits and vegetables. This includes infrastructure assistance to 33 cooperatives for export of fresh fruits. In the processing sector 33 units have been sanctioned to the cooperatives of which 30 have been installed. An assistance of Rs 8.60 crores has so far been sanctioned for processing activity.

Almost the entire cold storage capacity in the cooperative sector has been created with technical and financial assistance from NCDC. Upto 31.3.95, 247 cold storages with a capacity of 7.20 lakh tonnes (in terms of potato) have been organized in the cooperative sector, out of which 232 cold storages with a capacity of 6.60 lakhs tonnes have been installed. An assistance of Rs 77.15 crores has been provided by NCDC for construction of cooperative cold storages. Most of the cold storages are meant for potato. A few are multicommodity, particularly those which are in the metropolitan towns.

### Future Strategy

Cooperatives should endeavour to develop close linkages with their members and build their faith in the institution. They may provide services such as distribution of fertilisers, seeds, planting materials insecticides/pesticides, etc. for increasing horticultural production, on the one hand, and develop an efficient system for collection, marketing and storage of their horticulture produce, on the other.

Cooperative processing units generally face problems in the marketing of processed products. They also lack professional management. Hence, they are unable to compete with the private sector. Cooperatives should either take up processing on a small scale mainly to cater to the local areas or on large scale whether they can afford professional management to run the unit.

Cooperatives should give emphasis on the marketing of the fresh produce of their members. Initially this could be on a consignment basis in terminal markets to gain the requisite experience, Subsequntly, they should organize retailing of fruits and vegetable in cities having a population of more than 7 lakhs and also explore the possibility of sale to institutional buyers. HOPCOMS model could be emulated for this purpose.

**Cooperatives should give emphasis on the marketing of the fresh produce of their members.**

Cooperatives lacking in requisite information on business strategies can visit good working societies. Training of the Managers of marketing and processing cooperatives as also of their functionaries should be a continuous process. NCDC is extending assistance for this purpose.

Cooperatives should assess the potential of setting up export oriented fruit and vegetable projects based on mangoes, grapes, pomegranates etc. and may formulate project proposals for assistance.

They should endeavour to have professional management for supervising their business operations.

It is hoped that with the assistance rendered by NCDC with its various schemes, the cooperatives will set up an efficient post harvest management infrastructure for handling of fruits and vegetables and carve a niche for horticultural produce. □

Everyone can take part in a team. The aim of a team is to improve the input and the output of any stage. A team may well be composed of people from different staff areas. A team has a customer.

Everyone on a team has a chance to contribute ideas, plans, and figures; but anyone may expect to find some of his best ideas submerged by consensus of the team; he may have a chance on the later time around the cycle. A good team has a social memory.

At successive sessions, people may tear up what they did in the previous session and make a fresh start with clearer ideas. This is a sign of advancement.

*W. Edwards Deming*
*Out of the Crisis*

# Fruit & Vegetable Processing Industry: Present Status & Future Prospects

**S.B. Maini & J.C. Anand**

*Fruits, vegetables and their products not only improve the quality of the diet but also provide essential ingredients like vitamins, minerals, carbohydrates, dietary fibre etc. They also exhibit a high potential for generating employment in rural areas. Because of high productivity and value, they provide much better economic returns per unit area compared to cereal crops and are hence a good source of foreign exchange earnings. The article analyses the Indian horticultural scenario and presents a few recommendations.*

*S.B. Maini is from the Division of Fruits & Horticultural Technology, Indian Agricultural Research Institute, New Delhi - 110012. J.C. Anand is Consultant, Post Harvest Food Management, New Delhi.*

Endowed with diverse agro-climatic conditions such as tropical, subtropical, arid and temperate, India holds a unique position for growing a wide range of fruits and vegetables like mango, citrus, banana, guava, papaya, grape, onion, potato, brinjal, cauliflower, okra, tomato etc. In fact, there is hardly any fruit or vegetable which cannot be grown in India.

According to FAO production year book, 1994, India is the scond largest producer of fruits and vegetables after China and its share in world production is about 9 per cent in fruits and 13 per cent in vegetables. It produces 65 per cent of world's mango and 11 per cent of world's banana and 12 per cent of world's onion. It produced about 24 million tonnes of fruiits and 36 million tonnes of vegetables in 1984-85 which rose up to 33.235 and 65.1 million tonnes respectively in 1993-94. The area covered for fruits and vegetables in 1993-94 was 3.3 million hectare for fruits and 5.10 million hectares for vegetables. The percentage of total production of major fruits and vegetables is given in tables 1 & 2.

**Table 1:** World situation and India's rank in fruit and vegetable production (1994) 000'mt

| Commodity | World | India | Rank |
|---|---|---|---|
| Apple | 48890 | 1238 | |
| Banana | 52584 | 7900 | 8th |
| Grapes | 56392 | 750 | 1st |
| Mosambi | 58731 | 2100** | 17th |
| Mandarin | 9991 | – | |
| Mango | 18450 | 10000 | 1st |
| Cabbage | 40250 | 3300 | 3rd |
| Cauliflower | 10888 | 4800 | 1st |
| Onion | 32546 | 3400 | 2nd |
| Potato | 265436 | 15000 | 6th |
| Tomato | 77540 | 5029 | 5th |
| Green peas | 4376 | 268 | 4th |
| Pineapple | 11832 | 820 | 5th |

** Both including mosambi and mandarin

World fruit production - 388 M.T.

World vegetable production - 486 M.T.

**Table 2:** Percentage of total production of major fruits and vegetables in India (1992-93)

| Fruits | % | Vegetables | % |
|---|---|---|---|
| Mangoes | 28 | Potato | 28 |
| Banana | 32 | Onion | 8 |
| Grapes | 2 | Tomato | 7 |
| Pineapple | 3 | Cabbage | 8 |
| Apple | 4 | Cauliflower | 6 |
| Guava | 4 | Okra | 3 |
| Citrus | 7 | Peas | 2 |
| Others | 22 | Others | 39 |

Total production of fruits 328.93 lakh tonnes
Total production of vegetables 715.77 lakh tonnes

Based on the nutritional requirement for a projected population of about 1000 million by 2000 A.D., the National Commission on Agriculture has fixed a target of 45 million tonnes of fruits and 104 million tonnes of vegetables.

Fruits and vegetables are highly perishable commodities and due to lack of adequate post harvest handling facilities and proper infrastructure in our country, post harvest losses due to spoilage are very high. Actual post harvest losses have been estimated to be as high as 25-30% of the value of the produce. At this scale, the post harvest losses are Rs 6000 to Rs 7000 crores per annum. Even if 10% of this could be saved by converting them into processed products at peak production season, there will be a saving of Rs 650 crores to the horticultural wealth of the country. But the fruit and vegetable processing industry at present is utilizing only about 1.3 per cent of total production for processing, as against the performance of other countries — Malaysia (83%), Philippines (78%), Brazil and USA (70%).

## Export of Fresh Fruits & Vegetables

The total value of export has increased from Rs 65.7 crores in 1982-83 to Rs 265 crores in 1991-92 (tables 3 & 4). The strength of this sector lies in fresh mangoes and onions. Export of mangoes has increased in value from Rs 3.84 crores in 1978-79 to Rs 46 crores in 1992-93. Export of onion has increased from Rs 13.7 crores to Rs 173 crores. As for the composition of farm exports, of $3.26 billion in 1992-93, fruits constitute 23.5 per cent of the export basket, vegetable 6 per cent and processed foods 18.4 per cent.

**Table 3:** Export of fresh fruits and vegetables from India

| Year | Quantity ('000 tonnes) | Value (Rs millions) |
|---|---|---|
| 1982-83 | 242.8 | 656.7 |
| 1983-84 | 217.8 | 735.5 |
| 1984-85 | 343.0 | 973.6 |
| 1985-86 | 318.0 | 926.7 |
| 1986-87 | 318.9 | 1030.6 |
| 1988-89 | 294.4 | 1274.5 |
| 1991-92 | 420.0 | 2650.5 |

APEDA had commissioned a study in 1991 to determine the export potential of selected horticultural products in India taking into account the level of current exports, various constraints faced by the exporters, various market demands and India's competitiveness vis-a-vis other suppliers. It was estimated that the country could achieve export of over Rs 850 crores by 1996-97 (table 4).

**Table 4:** Export of fruits and vegetables and their products

| | 1991-92 | | 1996-97 | | 2000 | |
|---|---|---|---|---|---|---|
| Commodity | Qty* | Value* | Qty* | Value* | Qty* | Value* |
| Fruits | 45 | 59 | 187 | 365 | 355 | 693 |
| Vegetables | 375 | 206 | 530 | 415 | 705 | 552 |
| Processed fruits and vegetables | 45 | 107 | 130 | 345 | 247 | 656 |

* Qty. in 1000 tonnes
* Value in Rs crores

## Role of Fruit & Vegetable Processing Industry

Fruit and vegetable preservation industry is the very backbone of the horticulture industry as it takes care of gluts and all possible wastes that occur in spite of improvements in the distribution and marketing of fresh produce. It can always fetch an additional income to the grower and help in stabilizing the prices and providing economic returns. Hence, indigenous fruit and vegetable processing industry should be encouraged and developed.

**Preservation industry is the very backbone of the horticulture industry as it takes care of gluts and all possible wastes.**

Export of processed fruit and vegetable products to earn valuable foreign exchange is regarded as a major

spin-off benefit and the government has already recognised it as one of the major thrust areas for augmenting the country's exports. Realising the importance and potential of fruit and vegetable processing and other processed food products, a separate Ministry has been created in the Union Government.

### Present Status

As can be seen from table 5, the progress of the industry has been quite tardy but it got a boost after 1990 with more number of industries coming up. It may be due to the formation of Ministry of Food Processing and other incentives given to the industry by lowering the taxes and duties. As on 1993, there were 4132 units with an installed capacity of 12.60 lakh tonnes. But the capacity utilization was as low as 44.4 per cent with production of 5.59 lakh tonnes. This is mainly due to the seasonal nature of the industry on the one hand and the lack of diversification and aggressive marketing on the other.

**The capacity utilization was low mainly due to the seasonal nature of the industry and the lack of diversification and aggressive marketing.**

**Table 5:** Licences, installed capacity and production of fruit and vegetable products in India (thousand tonnes)

| Year | Licences | Installed capacity | Production |
|---|---|---|---|
| 1981 | 1996 | 275 | 90 |
| 1982 | 2327 | 300 | 137 |
| 1983 | 2512 | 330 | 120 |
| 1984 | 2625 | 379 | 140 |
| 1985 | 3093 | 405.0 | 179.2 |
| 1986 | 3137 | 447.0 | 161.5 |
| 1987 | 3213 | 558.0 | 197.6 |
| 1988 | 3367 | 599.0 | 231.2 |
| 1989 | 3629 | 708.0 | 245.0 |
| 1990 | 3846 | 894.0 | 280.0 |
| 1991 | 3925 | 950.0 | 360.0 |
| 1992 | 4057 | 1108.0 | 469.0 |
| 1993 | 4132 | 1260.0 | 559.0 |

Maximum number of processing units are in the home scale (43%) minimum being in large scale (9%) sector. About 14% are relabellers. However, it is interesting to note that the large scale units contribute to about 70% of total production. Majority of these units (about 95%) are in the private sector, the balance being distributed among the public and cooperative sector. As far as the location of these units is concerned, the maximum (41%) are in the western region followed by Northern (28%), Southern (22%) and Eastern (9%) (tables 6 & 7).

**Table 6:** Distribution of FPO licences in India (1994)

| Categorywise | % | Regionwise | % |
|---|---|---|---|
| Large scale | 9 | Western | 41 |
| Small scale | 18 | Northern | 28 |
| Cottage scale | 17 | Southern | 22 |
| Home Scale | 43 | Eastern | 9 |
| Releabeller | 14 | | |

**Table 7:** Break up of FPO licences in India as on 1.1.1994

| State | Number | State | Number |
|---|---|---|---|
| Andhra Pradesh | 252 | Punjab | 175 |
| Assam | 23 | Rajasthan | 90 |
| Bihar | 53 | Sikkim | 2 |
| Gujarat | 224 | Tamil Nadu | 385 |
| Haryana | 143 | Tripura | 3 |
| Himachal Pradesh | 81 | Uttar Pradesh | 415 |
| Jammu & Kashmir | 80 | West Bengal | 260 |
| Karnataka | 230 | A & N Islands | 1 |
| Kerala | 327 | Arunachal Pradesh | 2 |
| Madhya Pradesh | 93 | Chandigarh | 29 |
| Maharashtra | 817 | D & N | 6 |
| Meghalaya | 11 | Delhi | 245 |
| Manipur | 7 | Goa, Daman & Diu | 140 |
| Nagaland | 4 | Mizoram | 2 |
| Orissa | 22 | Pondicherry | 10 |

The breakup of the production of various processed products of the industry from 1985-93 is shown in table 8. The production of RTS beverages has continuously increased from 17.8 thousand tonnes to 152.1 thousand tonnes showing an eight fold increase. It can be attributed to the introduction of tetrapack system in the country and its convenience. Moreover, the consumers are becoming more health conscious and consequently the fruit juice based beverages are gaining more popularity.

**Table 8 :** Breakup of production for various processed products

(000 tonnes)

| Products | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|
| RTS beverages | 17.8 | 24.5 | 59.4 | 91.3 | 105.0 | 126.4 | 131.9 | 36.0 | 152.1 |
| Canned and Bottled fruits and vegetables | 13.1 | 12.6 | 11.7 | 9.0 | 8.7 | 8.5 | 14.0 | 19.0 | 22.8 |
| Jam, squashes and syrups | 38.0 | 34.9 | 24.8 | 31.1 | 26.5 | 26.0 | 28.2 | 42.6 | 45.8 |
| Pickles, preserves and chutneys | 22.9 | 22.1 | 22.2 | 23.9 | 22.3 | 20.9 | 39.2 | 52.4 | 64.6 |
| Dehydrated fruits and vegetables | 2.0 | 2.1 | 1.5 | 1.5 | 1.8 | 2.6 | 5.4 | 8.5 | 12.2 |
| Frozen fruits and vegetables | 2.4 | 0.9 | 1.7 | 1.3 | 2.7 | 4.0 | 9.0 | 31.3 | 46.0 |
| Tomato products | 8.8 | 9.5 | 8.5 | 11.5 | 15.6 | 17.1 | 29.2 | 35.4 | 43.2 |
| Canned and crystalized fruits | 3.5 | 3.8 | 5.0 | 5.2 | 5.2 | 4.3 | 6.5 | 11.0 | 16.8 |
| Vinegar, sauces and miscellaneous products | 4.0 | 5.9 | 5.5 | 8.1 | 7.2 | 7.0 | 7.1 | 8.3 | 9.0 |

## Export of Processed Products

The export of fruit and vegetable products from India is presented in tables 9 & 10. It increased from Rs 22.56 crores in 1980-81 to Rs 62.4 crores in 1982-83 and then decreased to Rs 49 crores in 1986-87, slightly increased to Rs 51.7 crores in 1988-89 and in 1991-92, it was 107 crores. These fluctuations in export are attributed to the changing situation in the international market and buying mood of the importing country.

**Table 9:** Trend in export of fruit and vegetable products from india

| Year | Quantity (Metric tonnes) | Value (Rs millions) |
|---|---|---|
| 1980-81 | 29,966 | 225.6 |
| 1981-82 | 42,100 | 325.5 |
| 1982-83 | 70,026 | 624.0 |
| 1983-84 | 38,351 | 369.8 |
| 1984-85 | 60,910 | 569.1 |
| 1985-86 | 65,043 | 582.8 |
| 1986-87 | 46,993 | 489.3 |
| 1987-88 | 38,120 | 391.3 |
| 1988-89 | 42,974 | 516.7 |
| 1991-92 | 45,000 | 1070.0 |
| 1992-93 | 95,476 | 2059.3 |

**Table 10:** Export of processed fruits and vegetables

| Year | Dried and preserved vegetables | | Mango pulp | | Pickles and chutneys | | Other processed fruits and vegetables | |
|---|---|---|---|---|---|---|---|---|
| | Qty | Value | Qty | Value | Qty | Value | Qty | Value |
| 1990-91 | 25.7 | 40.65 | 19.5 | 27.07 | 8.4 | 12.77 | 14.0 | 22.59 |
| 1991-92 | 30.5 | 63.98 | 23.2 | 37.95 | 11.0 | 26.28 | 15.3 | 29.56 |
| 1992-93 | 45.1 | 85.99 | 27.5 | 58.34 | 10.1 | 28.65 | 12.8 | 32.95 |

Value : Rs in Crores
Qty : 1000 M.T.

Export, product wise and destination wise is shown in table 11. Fruit juices and pulps followed by pickles and chutneys and dehydrated vegetable dominate the export list. Majority of export products are based on mango fruit only. Among the vegetable products, canned green pepper, dehydrated onion and garlic dominate. Hence, there is vast scope for production and export of processed products based on other fruits and vegetables.

**Table 11:** Export of processed fruits and vegetables items and major destinations

| Item | Main components | Major destination |
|---|---|---|
| Fruit juices/jams | Juice of mango/pineapple/orange | USSR |
| Canned fruits | Mango pulp/guava pulp/and others | USSR, YAR, S. Arabia, F.R.G., U.A.E. |
| Canned vegetables | Canned tropical vegetables, green pepper in brine | UK, USA, S. Arabia, F.R.G., U.A.E. |
| Dehydrated vegetables | Dehydrated onion and garlic | USSR, Japan, UK, F.R.G. |
| Pickles and chutneys | Pickles and chutneys from mango/others, mango slices in brine | UK, S. Arabia, U.S.A., U.A.E. |

The international trade in preserved fruits and vegetables consists largely of juices, nectors, juice concentrates, canned pineapple, canned pulps, canned and dehydrated vegetables. There is further scope for augmenting exports with respect to tropical fruit juices, pulps and their concentrates based on other fruits like guava, papaya, pineapple and Banglore grapes, canned and dehyrated tropical vegetables, tomato paste etc. Sufficient capacity for production of fruit juice and pulp concentrates and tomato paste has been built up of late in the country.

**There is scope for augmenting exports with respect to tropical fruit juices, pulps and concentrates canned and dehydrated tropical vegetables, tomato paste etc.**

International trade in vegetable consists of onions, carrot, mushrooms and leeks and major suppliers of these commodities to Western Europe are USA, Egypt, Romania and Netherland. The soup industry is their largest user followed by Institutional Catering Sector. India's export of dehydrated onion and Garlic in 1992-93 was 1868 mt. valued at 6.15 crores and 97 mt. valued at 0.28 crores respectively.

Mango pulp is the major tropical fruit pulp in international trade and the major varieties exported from India are the Alphonso and Totapuri. Phillipines. Haiti, Honduras, Costa Rica and Brazil are the other suppliers. Alphonso pulp is preferred for its flavour, colour and taste and is ideal for use in Yoghurt, ice-creams etc. Guava pulp is also gaining in popularity but the industry prefers the pink variety available only from Australia and South Africa.

**Constraints**

The fruit and vegetable processing industry in India is faced with some major constraints:

**The main reasons for low average yield are the small size of the orchards, poor efficiency, old heterogenous populations of trees showing considerable variation both in respect of quality and yield, low yielding varieties, multiplication from plants of unknown pedigree, ad-hoc package of practices and technology stagnation.**

*Below par Horticultural Development*: No doubt, from a subsistence level of horticulture 4-5 decades ago, India has emerged on the horticultural map of the world but the present production of fruits and vegetables falls short of the dietary requirements of our increasing population. Overcoming high losses in post harvest management of horticultural crops and increasing productivity of fruits and vegetables crops can help mitigate this situation to some extent. Our yields of fruits work out to less than 10 M.T./ha which is one of the lowest in the world. For instance, in citrus the average yield works out to about 8-10 M.T. compared to 17-30 M.T./ha in countries like Spain, Italy and Japan. Similarly yield of pineapple works out to about 15-20 M.T./ha as against 60-70 M.T./ha obtained in countries like Phillipines, Ivory Coast and Hawaii. The main reasons for this very low average yield are the small size of the orchards, poor efficiency, old heterogenous population of trees showing considerable variation both in respect of quality and yield, low yielding varieties, multiplication from plants of unknown pedigree, ad-hoc package of practices and technology stagnation.

The resultant high cost of the raw material now only makes it difficult for the products to be competitive in the world market but also contributes substantially to the high price which has to be paid by the domestic consumer for these products.

The problem of low productivity is further accentuated by the absence of suitable varieties used by the processing industry. For dehydration purposes, our white onion cultivars have a T.S.S. of about 15 per cent as compared with 24-28 per cent in Egypt. Our tomato cultivars fall short of T.S.S. of 6 per cent as obtained in Italian and Greak tomatoes. We have yet to bring smooth Cayenne variety of pineapple having cylindrical shape, shallow eyes and relatively small core preferred by canning industry.

The lack of processing varieties is mainly due to their low and uncertain demands as compared with regular commercial varieties. For example, the processing industry utilizes only 1.0 per cent of the total production of mangoes, 1.3 per cent of pineapples, 2.0 per cent of apples, 1.0 per cent of tomatoes and 0.4 per cent of onions.

*Poor Domestic Demand*: It is a fallacy to imagine that any industry can be developed on the basis of exports alone. In fact, particularly in the case of processed fruit and vegetables industry, domestic demand has given a boost to the growth in several countries abroad and exports have been the off-shoot.

In India, the demand for fruit products has been sluggish due to a variety of factors including prohibitive costs, lack of traditional taste suiting the dietary habits of Indian consumers, low priority accorded to such items in

the apportionment of disposable income and year-round availability of fresh fruits and vegetables. It may not be incorrect to say that the fruit and vegetable processing industry remains virtually divorced from the mass consumers within the country.

High cost of processed products can be attributed to expensive raw-materials' high cost of packaging, low capacity utilisation, high incidence of taxes and duties, low scale of production, poor conversion rates, high spoilage etc. Whereas cost of processed products is several times the cost of fresh material in India, it is either comparable or even less than fresh fruit costs in other countries as reflected in the price trends of orange juice and fresh orange in Florida.

**High cost of processed products can be attributed to expensive raw-materials' high cost of packaging, low capacity utilisation, high incidence of taxes and duties, low scale of production, poor conversion rates, high spoilage etc.**

*Shortage of Working Capital* : The present state of technology of the industry needs to be updated. Both the production techniques as well as packaging practices are, by and large, obsolete except in certain units. Aseptic packaging is the latest technology in the food processing industry. Since this system is highly capital intensive, not many units would be capable of going in for this system. Only through upgradation of our technology can we meet the high quality standards of products required for exports.

*Ineffective publicity and promotion* : Except in a limited way in the recent past, the fruit and vegetable processing industry has done little so far to stimulate dormant domestic demand through a sustained publicity campaign and promotion particularly in the context of the 'media explosion' which has occurred in recent years. The impact of publicity on the sale promotion of certain products like 'Frooti' 'Mazza', Chavan Prash', potato wafers, pickles and tomato sauce under various trade names is very well recognised to make these products a house-hold word. The sale promotion efforts of synthetic beverage manufacturers and products like 'Rasna' is a case in point.

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*Lack of standardization and quality control* : Sale of our processed products inside the country and abroad has suffered considerably due to the poor and inconsistent quality standards of our products. Mango products which are our best bet are invariably based on different varieties of mangoes used at different stages of maturity resulting in wide variations in the finished products. This is the reason why the importers are now insisting on purchasing bulk packs, to standardise different products on their own before marketing to the consumers. There are reports of rejection of several Indian consignements of different products on the basis of quality parameters.

**Recommended Strategy**

A new orientation needs to be given to the fruit processing industry to upgrade nutrition, minimise post-harvest losses, ensure remunerative returns to the growers, increase employment avenues in the countryside and generate foreign exchange earnings. The efforts called for to achieve some of these objectives are as follows:

*Increasing Productivity of Raw Material* : To ensure higher productivity in fruits and vegetables, steps to be taken include supply of planting material and quality seeds, high density planting, economising on fertilizer and water use, staggering production and harvest, using appropriate plant protection measures and better post harvest management. All these measures have helped to increase the productivity level in grapes, pineapple, banana, tomato and onions. In the absence of appropriate distribution system, increasing production often proves counter-productive by increasing losses and bringing lower returns to the peril of growers. The oft repeated story of potato, onions and garlic gluts is a pointer in that direction.

*Contract Growing* : Contract growing of fruits and vegetables which has been successfully worked outside, has not been properly exploited in our country. This can

work to the benefit of both the growers and processors. Captive plantation around the processing units can be organised which can save on expensive packaging and transport and guarantee supplies of raw material at optimum maturity. Wherever possible, the practices of ripening and grading of fruits can be practised in the field to discard massive proportions of residues and stagger raw material supplies to the processing factories.

**Captive plantation around the processing units can be organised which can save on expensive packaging and transport and guarantee supplies of raw material at optimum maturity.**

*By–products* : The edible portions in most fruits and vegetables vary between 50-70 per cent. Instead of transporting fruits like mango, tomato, citrus over long distances, it may be more appropriate to carry pulps and concentrates. This will save in transport cost and also help economic exploitation of residues into value added by-products.

*Cost Distribution* : The cost of distribution of fruits and vegetables, including the cost on preparation, packaging, transport, marketing, retailing and control systems is 5-9 times the production cost. The type of handling system envisaged for the future by horticulture industry should be integrated distribution which will optimise all the components of distribution to obtain the maximum benefit.

*Production Diversification* : There is excessive dependence on mango based products. Export market outlets for these items being limited, the growth of the industry will be adversely affected with a narrow product range. Products from some minor indigenous fruits, like Phalsa, Jamun, Kokum, Aonla, Bael, Hadhad should be promoted as 'health foods' as the therapeutic properties of some of these fruits have long been exploited by the indigenous systems of Indian medicine, like 'Ayurveda'. We now find herbal beverages as articles of international trade in partial substitution of tea and coffee.

*Plant Pigments* : With the ban on the use of coal tar dyes in several countries, India offers a great potential for extracting and supplying natural pigments in different hues and colours as the country possesses a large diversity of coloured fruits, flowers and other plant materials. A start has already been made in this direction.

*Public Policies* : Guaranteed export promotion drive, especially in agricultural products, is largely based on sound public policies. Government should keep a continuous watch on the compatibility of Indian products in foreign countries and come forth with instant remedial measures in terms of incentives, subsidies, duty-reliefs and freight concessions to maintain the economic viability of Indian products.

*Organised Promtion* : Over-seas promotional campaigns to boost Indian products are very expensive and beyond individual's budgetary resources. Publicity blitz needs to be launched by agencies like APEDA to promote trade marks, designs by distributing attractive folders, increasing press relation activities in individual countries through cultural programmes etc. This will go a long way to add an exotic touch to the sales efforts of our products.

Having identified the relative strength and weaknesses of Indian fruit and vegetables industry, the time is now ripe to retreat from endless seminars and deliberations and move to an integrated action plan for fruit and vegetable processing of which exports should form a major component. Let National Horticulture Board screen the various recommendations made at seminars and workshops, draw up the priority list of the action to be taken and pursue the recommendations with concerned institutions and government departments, set targets in terms of resources and time frame. This alone will ensure a bright future for the horticulture industry.

**Future Prospects**

The demand for the processed fruit and vegetable products is likely to increase tremendously during the next decade due to the following perceptible trends:

Increase in urban population at 4.2 per cent annually concomitantly creating more demand for processed products. By 2000 A.D., our population is expected to reach about 1000 million by which time about 326 million people will be living in urban areas.

The changing social pattern has created nuclear families. This has altered the role of women who have to earn to meet their rising family demands. The housewife is no more a traditional cook. This results in the increase of working female population to nearly 120 million.

It is reported that atleast 20 per cent of the urban and 5-10 per cent of the semiurban and rural population already has buying power comparable to that of advanced countries.

Energy and household labour becoming costly and changing food habits have increased the demand for convenience products.

Increase in urban catering establishments with high premium on time necessitating ready-to-cook and ready-to-serve foods.

Doubling of foreign tourist arrival by 2000 A.D. to 3.0 million per annum.

The rapid growth of TV coverage (80% of population) and the advertisements influencing the consumers to go for processed products. Hence, more convenience foods, both traditional and nontraditional, ready to cook and ready to eat are required to be developed for domestic market.

The 1991-92 union budget altogether exempted sauces, ketchup, jam, jellies, juices, canned fruits, dried vegetables etc. from excise duties. Increased direct foreign investment from 51 to 100% in equity and general policy has helped the horticulture processing industry substantially. □

Most ailing organizations have developed a functional blindness to their own defects. They are not suffering because they cannot resolve their problems but because they cannot see their problems.

*John Gardner*

# Potential & Profitability of Paddy Processing in Punjab

**Rajinder Singh & Ashok Kumar**

*Rice is the staple diet of most of the people in the world. Due to its versatility and nutritional value, its demand is increasing all over. The article analyses the status of paddy processing in Punjab and recommends upgradation of technology to improve quality and enhance exports.*

*Rajinder Singh & Ashok Kumar are Professor-cum-Head and Asstt. Research Engineer respectively in the Department of Processing & Agricultural Structures, Punjab Agricultural University, Ludhiana.*

India is one of the largest producers of paddy in the world accounting for about 117 million tonnes of paddy per annum, next only to China (table 1) and Punjab is a major state contributing to the production of rice in India (table 2). Punjab has a geographical area of only 5.03 million hectares out of which 4.21 million hectares is under crops. Fifty one percent of the kharif cropped area is under paddy alone. Total market arrival of paddy in Punjab, for the year 1994-95 was 95 lakh tonnes out of which 80 per cent was procured by government agencies and the rest by the rice millers (Sodhi, 1995). Punjab with a mere 1.5 per cent of cropped area is contributing 9.23 per cent to the total rice production of India, and more than 42 per cent to the central pool.

**Table 1:** World paddy production

| Countries | Rice production (thousand M Tonnes) | | | |
|---|---|---|---|---|
| | 1990-91 | 1991-92 | 1992-93 | 1993-94 |
| World total | 518008 (100.00) | 521041 (100.00) | 521418 (100.00) | 518739 (100.00) |
| China | 189331 (36.55) | 183810 (35.28) | 186220 (35.71) | 177700 (34.26) |
| India | 111448 (21.51) | 116532 (22.37) | 108926 (20.89) | 117012 (22.56) |
| Indonesia | 45178 (8.72) | 44680 (8.58) | 48231 (9.25) | 47700 (9.20) |
| Bangladesh | 26781 (5.17) | 27378 (5.25) | 27513 (5.28) | 27003 (5.21) |
| Vietnam | 18818 (3.63) | 21933 (4.21) | 21530 (4.13) | 22121 (4.26) |
| Thailand | 17192 (3.32) | 20400 (3.92) | 19917 (3.82) | 18485 (3.56) |
| USA | 7081 (1.37) | 7142 (1.37) | 8149 (1.56) | 7081 (1.36) |
| Pakistan | 4898 (0.95) | 4865 (0.93) | 4674 (0.90) | 5926 (1.14) |

Note : Figures in parenthesis show percentages to world production

Source : Sabharwal, (1995)

**Table 2:** Rice production in major states of India

| State | Rice production (thousand M tonnes) | | | |
|---|---|---|---|---|
| | 1990-91 | 1991-92 | 1992-93 | 1993-94 |
| W. Bengal | 10437 | 11954 | 11733 | 8000 |
| Uttar Pradesh | 10260 | 9411 | 9615 | 10500 |
| Andhra Pradesh | 9654 | 9249 | 8557 | 6442 |
| Punjab | 6535 | 6755 | 7002 | 7446 |
| Tamil Nadu | 5782 | 6596 | 6537 | 4828 |
| Madhya Pradesh | 5738 | 5249 | 5432 | 5565 |
| Orissa | 5275 | 6660 | 5388 | 5726 |
| India total | 74291 | 74678 | 72592 | 79010 |

Source : Sabharwal, (1995)

## Crop Productivity

The technology of crop production determines to a large extent, its productivity, cost of production and profitability. In general, higher the productivity lower is the cost of production and higher the profitability. A study (Jain & Garg, 1995) on the change in production and productivity of paddy in the major rice producing countries of Asia in 1972 and 1990 (table 3) shows that except for Pakistan, all developing countries have registered a significant increase in productivity. A small increase in productivity of paddy in Japan is probably due to the fact that Japan had already reached a high level of productivity in 1972 and made only a marginal increase thereafter. On analysing the comparative cost of cultivation of paddy in major rice producing states of India during 1986-87 (table 4), Punjab is found to be technically as well as economically the most efficient producer compared to the other states of India. Productivity of paddy is directly related to the modern inputs of seeds, fertilizer, insecticide, irrigation and machine labour. Judicious use of human labour and high growth in rice productivity have been responsible for growth in labour productivity.

**Punjab is found to be technically as well as economically the most efficient producer of paddy compared to the other states of India.**

## Procurement of Paddy

Every year the government announces minimum support price for different varieties of paddy and procures huge quantities during the post harvest season through a large number of purchase centers. Agencies such as Markfed, Punsup and Ware Housing Corporation purchase and stock paddy on behalf of the Food Corporation of India (FCI) as per specifications. Mandi Board provides the necessary marketing facilities for which it charges the market fee. During the last decade Mandi Board has upgraded the marketing technology by installing 88 mechanical handling units in 34 mandis of Punjab (Grover *et al.*, 1995). Each such unit has a handling capacity of 200 bags of wheat or 140 bags of paddy per hour. These units save farmers time, reduce grain losses, improve grain quality, provide higher rates to the farmers, multiply space utilization and reduce congestion in the mandi. More such units are necessary to make their effect visible.

**Table 3:** Production and productivity of paddy in major rice producing countries of Asia in 1972 and 1990

| Country | Production (million metric tons) | | | Production (kg/hectare) | | |
|---|---|---|---|---|---|---|
| | 1972 | 1990 | % change | 1972 | 1990 | % change |
| Bangladesh | 15.1 | 29.5 | 95.36 | 1568 | 2783 | 77.49 |
| China | 116.6 | 188.6 | 61.75 | 3252 | 5734 | 76.32 |
| India | 58.9 | 110.5 | 97.61 | 1605 | 2644 | 64.74 |
| Indonesia | 19.4 | 44.5 | 129.38 | 2430 | 4320 | 77.78 |
| Japan | 15.5 | 12.9 | –16.78 | 5864 | 6220 | 6.07 |
| Pakistan | 3.5 | 5.2 | 48.57 | 2365 | 2445 | 3.38 |
| Phillipines | 4.4 | 9.2 | 109.09 | 1414 | 2772 | 96.04 |
| Asia total | 282.4 | 480.1 | 70.01 | 2340 | 3652 | 56.07 |

Source: Jain& Garg, (1995)

**Table 4:** Comparative cost of cultivation of paddy in major rice producing states of India 1986-87

| State | Yield (qt.1/hectares) | Cost of production in rupees | |
|---|---|---|---|
| | | Per hectare | Per quintal |
| Punjab | 56.71 | 7390.21 | 129.23 |
| Andhra Pradesh | 80.15 | 6681.70 | 148.44 |
| Tamil Nadu | 39.17 | 7042.65 | 160.96 |
| West Bengal | 27.15 | 4687.98 | 139.45 |
| Uttar Pradesh | 74.68 | 3557.40 | 122.51 |
| Madhya Pradesh | 13.36 | 2565.83 | 162.02 |

Source: Jain & Garg, (1995)

Depending upon the government policies, the rice millers purchase 20-65 per cent of the market arrivals of paddy. The procured paddy is invariably stored in the CAP stores by the millers as well as the FCI because the godown space is already occupied by wheat and extremely inadequate or no space is available for paddy

storage (Anonymous, 1995). These stores are for short-term storage upto 6-8 months. But in practice storages continue for 1-2 years causing a great deal of quantitative as well as qualitative losses. During milling, the percentage of broken increases much beyond the prescribed limits resulting in avoidable controversies between the FCI and the millers which has an adverse effect on the paddy growers. It is high time that the specifications of paddy and milled rice are made bearing in view the ground realities and price structure offered. It goes without saying that higher price needs to be offered for better quality rice.

**It is high time that the specifications of paddy and milled rice are made bearing in view the ground realities and price structure offered.**

## Rice Milling

There are about 7000 rice milling units in Punjab (Sehgal *et al.*, 1995) which include 4000 hullers, 500 mini rice mills, 2500 modern rice mills and 2 high capacity integrated plants.

To assess the adequacy of rice milling capacity in the state, Rangi (1995) estimated effective as well as engineering capacities of rice mills and the marketed surplus of paddy in different years (table 5). Engineering capacity has been estimated on the basis of 22 hours of milling for 205 days in a season of 7 months. Effective capacity is based on 2 shifts (16 hours per day) for 150 working days in a season with 80% efficiency. It shows that the engineering capacity in the state was much higher than the raw material (paddy) available. However, the attainable effective capacity fell short of the market arrivals by as high as 17.3 per cent during 1978-79 and 11.7% during 1994-95.

Food Corporation of India is the nodal agency for the procurement of foodgrains. It lays down the specifications for the procurement of various varieties of raw paddy from the mandis. A major portion of the procured paddy is custom-milled from private mill owners. FCI also fixes its own specifications for custom-milled rice. The procurement price as well as the price of the milled rice (either levy rice or custom-milled rice) is also fixed by the government (table 6). Every year the rice millers protest against inadequate raise in the price of the levy or custom-milled rice and do not purchase raw paddy which adversely affects the growers. Since free-market forces are not allowed to play, a number of malpractices crop up. As a result, almost all the rice millers pay illegal gratification to the officials of procurement agencies for acceptance of their levy rice or custom-milled rice (Rangi, 1995). This is in addition to quality cut of Rs 500/wagon to show honesty. Sometimes even damaged paddy (unfit for human consumption) has been purchased by some dishonest millers and delivered to the procurement agencies after mixing it with the new crop. Substandard rice in under-weighed bags are delivered, resulting in a bad reputation for Punjab rice. Hence Punjab rice encounters a poor demand even within the country leading to ever increasing carry-over stocks in the state.

**Since free-market forces are not allowed to play, a number of malpractices crop up.**

**Table 6:** Procurement of paddy and selling rates of levy rice fixed by Govt. for 1994-95 and 1995-96.

| Variety | Procurement price (Rs/qt1) | | Selling rate of levy rice (Rs/qt1) | |
|---|---|---|---|---|
| | 1994-95 | 1995-96 | 1994-95 | 1995-96 |
| PR 106 | 380 | 395 | 671.85 | – |
| Pusa | 360 | 375 | 633.40 | 651.00 |
| IR 8 | 340 | 360 | 572.55 | – |

Source : Gupta, 1995

**Table 5:** Market arrivals and seasonal milling capacity of rice in Punjab.

| Year | No. of Rice Mills/ shellers | Installed capacity tonnes/hr | Engineering capacity (lakh tonnes) | Effective capacity (lakh tonnes) | Market arrival (lakh tonnes) | Effective capacity as % of market surplus col 4/col 5 |
|---|---|---|---|---|---|---|
| 1975-76 | 399 | 475 | 21.42 | 13.68 | 14.75 | 92.7 |
| 1978-79 | 887 | 1235 | 55.70 | 35.57 | 42.99 | 82.7 |
| 1982-83 | 1204 | 1793 | 80.86 | 51.64 | 55.52 | 93.0 |
| 1985-86 | 1531 | 2362.5 | 106.55 | 68.04 | 70.71 | 96.2 |
| 1989-90 | 1655 | 2843.3 | 128.23 | 81.88 | 83.20 | 98.4 |
| 1994-95 | 1585 | 2398.5 | 130.72 | 83.48 | 94.14 | 88.7 |

Source : Rangi, 1995

## Milling Recovery

Per cent milling yield of paddy is the estimate of quantity of total milled rice that can be produced from one hundred units of paddy. To determine the milling yield, a clean sample of paddy is shelled to remove hulls from the kernels. The brown rice is then milled to remove the bran and the embryos. The endosperm in the form of whole or broken kernels is separated from bran and embryos. Generally hulls form 20-22 per cent of paddy. Bran and embryos constitute 8-10 per cent. Thus from a given sample of paddy, the milled rice is about 70% per cent which is further separated into brokens and whole grain with the help of sieving machines. Thus if from a sample of 100 g of paddy, 70 g of milled rice is obtained 20 g of which is broken, then head rice recovery or yield is 50 g or 50 per cent of paddy.

The head rice recovery may vary from as low as 25 per cent to as high as 65 per cent depending upon variety, maturity, environmental factors such as temperature and humidity during ripening, post harvest handling, drying and storage, and, machine factors such as single or multistage operations and type of shellers.

Rice varieties are generally classified on the basis of their length, shape and length-width ratio (table 7). Preference for different classes varies enormously from region to region across the world. The highest quality markets usually demand slender to medium widths. Bold grain is usually discriminated against because it breaks during milling. Long grains usually break the least. Total milled rice of intermediate or bold grain is usually slightly higher than that of slender types and the reverse is true for head rice yield.

**Table 7:** Classification of grain length and shape of brown rice.

| Designation | Length (mm) | Shape | Length/width ratio |
|---|---|---|---|
| Extra long | 7.50+ | Slender | 3.0+ |
| Long | 6.61–7.50 | Medium | 2.1–3.0 |
| Medium | 5.51–6.60 | Bold | 1.1–2.0 |
| Short | –5.51 | Round | –1.1 |

Source : Bharaj & Gagneja, (1995)

Grain appearance is largely determined by endosperm opacity, the amount of chalkiness (white belly or white center) and the condition of the eye. The starch granules are less densely packed in chalky areas as compared to translucent areas. Thus grains with chalkiness are more prone to breakage during milling.

Punjab, Haryana, Western Utter Pradesh and Jammu and Kashmir are potential areas for cultivation of Basmati rice (Bharaj & Gagneja, 1995). Within each state, areas of a group of farmers in different blocks/districts should be identified for cultivation of a particular Basmati variety. Some important characteristics of a few Basmati varieties are reproduced in table 8. To obtain high yield and good quality of grains, purity of crop stand should be ensured by using pure seeds of recommended varieties of Basmati rice from seed producing agencies of high repute only.

**To obtain high yield and good quality of grains, purity of crop stand should be ensured by using pure seeds of recommended varieties of Basmati rice from seed producing agencies of high repute only.**

**Table 8:** Some characteristics of important Basmati varieties.

| Character | Basmati 386 | Basmati 370 | Basmati 385 | Pusa Basmati |
|---|---|---|---|---|
| Plant height | 180 | 165 | 142 | 104 |
| Duration (days) | 155 | 145 | 134 | 141 |
| Lodging score | 9 | 9 | 7 | 5 |
| Tillers/$m^2$ | 285 | 277 | 234 | 273 |
| Grains/panicle | 141 | 140 | 210 | 168 |
| 1000 grain wt. of paddy(g) wt. of paddy/$m^2$ (g) | 23.29 | 20.09 | 19.80 | 22.76 |
| 1000 grain wt. of milled rice (g) | 19.50 | 15.05 | 15.54 | 16.40 |
| Grain L/B ratio of paddy | 5.32 | 5.18 | 5.00 | 5.15 |
| Grain L/B ratio of brown rice | 1.73 | 1.79 | 1.73 | 1.65 |
| Cooking time (minutes) | 14.00 | 14.00 | 13.00 | 14.00 |
| Grain length of cooked rice | 12.06 | 12.06 | 12.00 | 12.02 |
| Millled rice recovery (%) | 65.17 | 67.78 | 63.97 | 64.54 |
| Head rice recovery (%) | 55.82 | 56.35 | 50.45 | 51.38 |
| Grain appearance | Trans-lucent | Trans-lucent | Trans-lucent | Trans-lucent |
| Grain shape | long slender | long slender | long slender | long slender |
| Aroma | Mild | Strong | Strong | Mils |

Source : Bharaj & Gagneja, (1995)

## Parboiling & Milling Technologies

Paddy can be milled as raw paddy or as parboiled paddy. During parboiling, scented varieties usually lose their favour and aroma and hence are not parboiled in general (Ali & Pandya, 1974). The process of geletiniza-

tion, during parboiling, glues the micro fissures developed in the rice kernel due to hydrothermal changes during the post maturation period. Modern method of parboiling by hot soaking and steaming of paddy in suitably designed parboiling tanks and mechanical drying system increases the total yield of rice by atleast 1 per cent and head yield by 10-20 per cent depending upon the variety. It also provides nutritionally-rich rice and better quality bran. It can even salvage partially damaged paddy which otherwise could not be milled as raw paddy (Ali, 1991).

The milling technologies used for processing of paddy are huller mills, huller-cum-sheller mills, modern rice mills, integrated rice mills and mills using solvent extractions milling process. In raw milling, modern rice mills yield 2.5 per cent more, over huller-cum-shellers and 6.6 per cent more, over huller mills and in case of parboiled paddy, the figures are 3.3 per cent and 8.2 per cent respectively (Sehgal *et al.*, 1995). The huller units give an yield of total rice (60-65%) and head rice (40-45%) besides producing husk-bran mixture which has little value. These mills are being modernised for getting higher total yield (70- 72%) of rice and completely separated by-products which could be further effectively utilized. An integrated rice mill has all the advantages of a modern rice mill in addition to making optimum use of all the by-products. Such a system can have a modern rice mill, a furfural plant, a power generation plant, edible oil extraction plant, an animal-feed plant and a cement plant to fully utilise the by-products. It has to be of a large size and capacity as Agro-Tech (India), Budhewal, or Oswal Agro Furane (Ltd), Dhuri with milling capacity of 40 tonnes/hr or 120 tonnes/hr respectively. The solvent extraction milling (SEM) process (Lynn, 1966) involves softening of bran layer before the kernels are subjected to wet milling in the presence of a rice oil-hexane miscella. In addition to milled rice, by-products of SEM process include crude rice oil and defated bran. In this case shelling has to be 100 per cent for effective results. Shelled rice is treated with 0.5 per cent warm rice oil and is held for a period of 2-4 hours to allow the rice oil to permeate the bran membranes and soften them. Afterwards it is subjected to bran removal with rice oil-hexane miscella in a rice pearler where in and out flow of miscella is regulated at a controlled temperature. The miscella acts as a washing and rinsing medium to aid in flushing the bran from the rice endosperm, and, as a conveying medium for continuously transporting the removed bran away from the rice. Miscella also acts as lubricant and prevents rise of rice temperature leading to minimising of breakage. Rice is then rinsed with additional hexane on vibrating screens. The solvent adhering to rice is removed by super heated hexane vapour followed by inert gas. Rice is then sized, graded and packaged using conventional rice mill equipment. SEM rice is whiter, more attractive, has lower fat content, longer storage life and increases total and head rice yield by 2 and 10 per cent respectively in addition to directly producing crude rice oil and defated bran.

## Export Potential

India has the largest area (29 per cent of the world) under paddy and is the second largest producer (22.56 per cent) of paddy in the world, second only to China (34.26%), yet it ranks only sixth in the export of rice (table 9) with just 5.16 per cent during 1994. On the other hand Thailand produces only 3.56 per cent of the world production of paddy, but shares 27.12 per cent of the world trade. However, the yield level in India is below the world average of 35.5 qtls/hectare whereas the highest yield is 84.1 qtl/hectare in Australia followed by China with 56.8 qtls/hectare (Sabharwal, 1995). Thus there is large scope for increasing the yield and exports of rice from India. Recognising this fact, the Government of India has rightly identified rice as the major thrust item for exports. Export of Basmati and non-Basmati rice are freely allowed without any restrictions. Indian Basmati rice, because of its delicate fragrance and high quality, has found a ready market in countries like Saudi Arabia, UAE, Baharain, Kuwait, Oman and Qatar.

**Table 9:** Major rice exporting countries of the world

| Country | Rice exports (thousand M Tonnes) for the year | | | |
|---|---|---|---|---|
| | 1991 | 1992 | 1993 | 1994 |
| Thailand | 3988 (33.07) | 4776 (33.92) | 4798 (32.49) | 4200 (27.12) |
| USA | 2197 (18.22) | 2106 (14.96) | 2641 (17.88) | 2600 (16.79) |
| Vietnam | 1048 (8.69) | 1914 (13.59) | 1800 (12.19) | 2100 (13.56) |
| Pakistan | 1297 (10.76) | 1358 (9.64) | 937 (6.34) | 1200 (7.75) |
| China | 689 (5.71) | 933 (6.63) | 1374 (9.30) | 1500 (9.69) |
| India | 711 (5.90) | 596 (4.23) | 625 (4.23) | 800 (5.17) |
| World trade | 12059 (100.00) | 14081 (100.00) | 14769 (100.00) | 15487 (100.00) |

Note : Figures in parenthesis show percentage of world trade.
Source : Sabharwal, (1995)

**Export of Basmati rice has been growing steadily but that of non-Basmati rice has been declining, probably because of the abolition of minimum export price of Basmati rice and also due to higher domestic prices which makes India uncompetitive in the world market.**

India and Pakistan are the exclusive producers of aromatic Basmati rice which is sold at a premium. Export of Basmati rice has been growing steadily but that of non-Basmati rice has been declining, probably because of the abolition of minimum export price of Basmati rice and also due to higher domestic prices which makes India uncompetitive in the world market. The quality of Indian long grain rice (non-Basmati) is quite good. The importer normally lays down his own specifications for exports which are followed by the exporters. The AGMARK has fixed specifications for the export of Basmati and non-Basmati rice (table 10) for the guidance of Indian exporters.

**Table 10:** AGMARK specifications for export of basmati & non-Basmati varieties.

| Grade Designation | Special characteristics (Max. tolerance limits)% by weight | | | | |
|---|---|---|---|---|---|
| | Foreign matter | Brokens & frequents | Admixtures including red grains | Damaged discoloured & chalky grains | Moisture |
| Special | 0.5 | 5.0 | 10.0 | 1.0 | 14.00 |
| A | 1.0 | 10.0 | 15.0 | 2.0 | 14.00 |
| B | 2.0 | 10.0 | 20.0 | 3.0 | 14.00 |

Source : Sabharwal, (1995)

At present Indian non-Basmati rice is not fetching as good a price as the American long grain rice or Thai rice does. It is due to the fact that the milling standards in India are poor in comparison to those of USA and Thailand. Modernization of Indian rice industry is necessary to enable India to have a better product image abroad.

New markets such as South Korea, Japan and South Africa need to be explored by launching new promotional policies. Indian exporters much understand the psychology of the importers and present their rice in ever pleasing, handy and attractive packages, complete with details of ingredients and recipes for making tasty dishes.

## Conclusions

Punjab is the most technically and economically viable state in India for the cultivation of Basmati as well as non-Basmati rice. As basmati rice varieties yields are about 2.5 to 3.0 times lower than semi dwarf high yielding rice varieties, the support price may be fixed 2.5 to 3.0 times higher than that of fine and superfine varieties of rice. This will encourage the farmers to increase area under Basmati. To fully tap the vast potential for export of Basmati as well as non-Basmati rice, it is essential that their yields be increased substantially to lower the unit cost of cultivation. Processing technology needs to be upgraded alongwith a change in the mind set of millers and concerned government agencies to establish pride of place for Indian rice brands in the world market. The concepts of integrated rice milling as well as solvent extraction milling systems of correct size should be encouraged to make effective use of all by products, reduce the processing costs and improve overall quality with more effective quality controls to make Indian rice more competitive in the global market. Contract farming by big export houses may ensure purity of crop with highest quality at competitive price which is an essential ingredient in world trade.

**Contract farming by big export houses may ensure purity of crop with highest quality at competitive price which is an essential ingredient in world trade.**

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Management in authority will take pride in their adoption of the new philosophy and in their new responsibilities. They will have courage to break with tradition, even to the point of exile among their peers.

*W. Edwards Deming*
*Out of the Crisis*

Feature

# Oriental Wisdom & Western Leadership

**Hans H. Hinterhuber**

*Effective leadership and followership, needed for peak performance and radical change, appear to belong more to the emotional domain than to the cognitive domain of thinking, selecting, and willing. The paper starts with an oriental parable showing how to operate in the emotional domain in order to make change happen. A western cognitive model is then presented evidencing the tasks an effective leader cannot delegate. In an increasingly complex world, added-value leadership has to integrate both the eastern wisdom related to the emotional domain of satisfaction, stress, and control and the western cognitive domain. From this combination new leadership tasks emerge: second level observation or self-remembering, ethical reflection, giving orientations, structuring, dynamizing strategies and actions, and appropriate handling systems.*

*Hans H. Hinterhuber is Professor, Department of Management, University of Innsbruck, Innsbruck, Austria*

*Only a mouse finds its hands full with a couple of grains. Small desires do not behove you. Commit yourself to a lofty target worthy of you. Be convinced that you will succeed.*

Mahabharata

The following parable (adapted from Hazrat Inayat Khan, 1960, and Zundel, 1986) at first sight has nothing to do with leadership. It is a very old story, of Sufi origin, and tells us of a sultan who wanted to hear a very famous bard. Following the customs of his time, he gives order for the bard to come to the palace and demonstrate his art. The servants of the sultan, however, come back with the message that the bard is not interested in coming to the court. The sultan then looks for the advice of a dervish; the dervish agrees to help the sultan. At first, nothing happens. Whenever the sultan asks when the bard would appear, the dervish answers that the time has not yet come. Many months pass, during which the sultan again and again asks for the bard and gradually masters his impatience, and eventually the dervish declares that now the time has come.

"Bring him to my palace" orders the sultan. But the dervish answers: "Sir, this is not the right approach. We have to meet him". The sultan and the dervish set out, visit the bard in his house and are very well accepted. The bard, however, even now is unwilling to give a demonstration of his art. The dervish suddenly begins to intone the famous song of the bard, it sounds very good to the sultan. The bard listens, his interest has been roused. As soon as the dervish has finished his song, the bard begins to sing - incomparably. The sultan has never heard a more beautiful and perfect song.

## Lessons to be Learned

*Always and in every thing strive to attain at the same time what is useful for others and what is pleasant for oneself.*

Nasreddin

As with all Sufi stories, this parable also can be interpreted in many ways. If you wish, you can see in it a metaphor for the mysterious and difficult way to enlightenment. But you can also see in it the description of the basic pattern of effective leadership and engaged followership.

The sultan wants to achieve something quickly; this is the classical situation of a leader. "Leaders see what others cannot. Somehow, they develop an understanding of what is possible — a desired state of affairs" (Taylor, 1995). They want to achieve quickly. They give orders. The sultan does not worry about the effects his order will produce. He has a vision that is attractive to him and he is surprised that his servants are incapable of performing activities that lead in the desired direction.

The sultan has to wait and show patience; he begins to understand how difficult the conditions of human action are and that the direct strategy — a simple order gets stuck and does not lead to achieving the vision — a typical entrepreneurial experience. Without lengthy repetition of the same, a clear and inspiring vision and a shorter term mission statement, without tiring commitment to action, nothing happens. Napoleon used to say: "The only valid rhetoric formula is repetition". Therefore, the first lesson to be learned from the story is: Effective leadership and engaged followership need **patience and concentration upon a vision**, whether it is a new product or service, a better way of life, improving the common good, or something reflective of the organization's purpose. For political leaders, the vision can be a state of affairs which is attractive to those who are governed: employment opportunities, affordable housing, food and water, safety, or the absence of corruption. No matter the contexts, the vision remains on the horizon of the future and represents a challenge to the resources of the organization involved (Taylor, 1995).

All successful entrepreneurs and strategists have been masters in repeating and communicating a vision. Patience means communicating the vision in a way that it becomes shared and co-created with those who have to participate in achieving it. The leader must be able to wait until a suitable environment for the solution to a problem or for moving towards the vision can be found, or until the market is mature for a new service or product.

**The leader must be able to wait until a suitable environment for the solution to a problem or for moving towards the vision can be found, or until the market is mature for a new service or product.**

The second lesson to be learned from the story is that every entrepreneurial action needs the **right timing**. In order to be successful, the strategy or a "grand manoeuvre" has to be initiated at the proper time.

In the parable, the dervish appears to be the helper and consultant of the sultan. He has his own understanding of the requirements of the situation and of the ways of perform activities that lead to the desired goal. A more modest and at the same time more difficult way of leadership becomes evident: First, not a master plan, elaborated in all details, but a person who at the right time takes part in evolving the strategy. Second, listening appears to be one of the most important communication skills of the leader. The leaders generally believe they have or must have all answers. Effective leadership is dependent upon active listening to the right persons.

The right person — the dervish in the parable — is a totally independent person. It must have not been easy for the sultan to let the dervish take control and act freely, since he apparently didn't perform anything useful. In a similar way, it is difficult for modern leaders to accept the autonomy of their engaged followers or consultants who as long as their tasks last, become effective leaders. Since they have the same opportunities as the leader to access needed information, they add value only if - they act within mutually agreed upon directives or guidelines and are not degraded to being receivers of orders. A leader must **trust** the people with whom he or she works.

**A leader must trust the people with whom he or she works.**

But there is still another interesting factor. Only certain people are capable of exploiting opportunities for entrepreneurial action in a conscious or instinctive way. The question remains open whether the right person leads to the right strategy - as Jack Welch, CEO of General Electric puts it - or whether the situational development, created with the help of many persons, makes a leader out of a man or woman in a given position.

The third lesson to be learned is : Leadership needs the **right people**, where "right" is very difficult to define with respect to entrepreneurial talent and personal performance. The sultan as an effective leader empowers the dervish to perform at his best. This includes open two way communication, joint analysis of the problem, active listening, and giving satisfaction by accepting innovative ideas. Effective leaders win the hearts and minds of their followers.

Coming back to the parable, we see that it was not the bard who came to the sultan, but the dervish who brought the sultan to the bard. The lesson is clear: the leader is the antithesis of a detached strategist. Bossidy, CEO of Allied Signal, like GE's Welch, serves as his own chief operating officer. Both love to dig deep. Almost every week they visit one or more of their many business units. "A strategist divorced from operations", says Bossidy, "is an incomplete person. You make far better judgements doing both" (Tully, 1995, p. 46). In business, no leader will be successful if he gives orders top down. Added- value leadership, as H. Maucher, CEO of Nestle puts it, requires enabling followers to understand the organization of today and to motivate people to reshape or recreate it in a way which is in line with a shared vision; this means taking into consideration the place where the strategy has to be executed, the attitudes of the people who have to be involved in line with the strategy, and the right timing.

**"We measure the effectiveness of the true leader, not in terms of the leadership he exercises, but in terms of the leadership he evokes; not in terms of this power over others but in terms of the power he releases in others; not in terms of decisions made, events completed, but in terms of growth in competence, sense of responsibility, and in personal satisfactions among participants.**

Bob Galvin, CEO of Motorola, puts it thus: "We measure the effectiveness of the true leader, not in terms of the leadership he exercises, but in terms of the leadership he evokes; not in terms of this power over others but in terms of the power he releases in others; not in terms of the goals he sets and the direction he gives, but in terms of the plans of action others work out for themselves with his help; not in terms of decisions made, events completed, and the inevitable success and growth that follow such released energy, but in terms of growth in competence, sense of responsibility, and in personal satisfaction among participants. Under this kind of leadership it may not always be clear at any given moment just who is leading. Nor is this important. What is important is that others are learning to lead well." (Jick, 1993, p. 112).

One of the most impressive aspects of the parable refers to the **method** used by the dervish. He does not simply invite the bard to sing his song, but he uses an indirect method. Indeed, in strategy the roundabout way very often is the shortest way to the goal. The dervish himself sings, very good for those who do not know the real song, but not perfectly. Maybe, he stimulates the vanity of the bard. However it may be, the bard answers the imperfection with perfection.

Here we touch one of the most difficult problems in leadership. Entrepreneurial action is not the direct way from a state of affairs *A to B*, from vision to a desired outcome. The dervish, who understands his role in the shared vision, anticipates the reaction of the bard in his strategy. In business the leader has to create a "learning" climate where all managers, employees, and consultants can anticipate a variety of critical factors in order to satisfy all key stakeholders (Hinterhuber, 1995b).

**Entrepreneurial action is not the direct way from a state of affairs *A to B*, from vision to a desired outcome.**

There are no sure ways for implementing change; managing change is an open process. From all the conditions of successful change management which have been discussed — patience, the right timing, the right place, the right people — the last condition — the method — is the most difficult.

The view on leadership expressed by the metaphor influences its content: it emphasizes graduality and openness, it does not know final solutions or a maximum, but an imperfect and gradual approach towards an optimum which later on may look completely different. The metaphor teaches **humility**. The roots of sound leadership, indeed, are in ideals: moral principles (such as justice and beneficence), high-minded values (loyalty, integrity, consideration for others), and selfless service (Donnithorne, 1993).

If the parable is a metaphor for the difficult way to enlightenment, one can say that the way to added-value leadership is not less difficult.

### The Tasks a Leader Cannot Delegate

*A leader is one who goes after his own light*

Rumi

The metaphor teaches us that there are tasks as leader cannot delegate.

The first task a leader cannot delegate is the formulation of **vision**. The vision is a future desired state of affairs, not too far in the future as to appear topic, and not too near to the present as to be a goal; it must represent a challenge and give a meaning and a direction to all people involved in the organization. The vision of the president of a European Technical University is to create the conditions that enable one or more of its research staff to win the Nobel Prize. The vision gives a sense of purpose, a reason for being, it is a shared guiding philosophy which helps motivate and enables a large, scattered work force to deploy their best energies for implementing the strategy in whose formulation they have been involved. The vision of Steve Jobs, the co-founder to Apple, was to make a contribution to the world by making tools for the mind that advance human kind.

Dr. Heinrich v. Pierer, CEO of Siemens, defines his vision as follows: "I envisage a flexible organization, supported by openminded employees, who set the required standards for themselves and for the company and actively help in making the necessary changes".

The leader's first responsibility is not to decide or to direct but to create a vision which can be shared by all managers and employees, enabling them to give their best energies to the organization. All good visions have therefore an economic as well as a spiritual content. The economic content refers to the needs of Society the firm is going to fulfill, the spiritual content to something which transcends reality. If the vision finds the right interpreters and people in the organization, it operates like a "bacillus syntheticus", integrating the efforts of individuals, functions, business and regional units to exploit new opportunities and/or to control badly calculated risks for the benefit of the stakeholders of the firm.

**The leader's first responsibility is not to decide or to direct but to create a vision which can be shared by all managers and employees, enabling them to give their best energies to the organization.**

The second task that cannot be delegated to others is the formulation of the **corporate policy and strategy**. Following Carl von Clausewitz, the great Prussian military philosopher, the primacy of corporate policy over strategy means that the leader has to define the stakeholders — customers and markets, employees, shareholders and financial community, suppliers, society and environmental needs, and partners in strategic networks — the corporate strategy and the SBU strategies have to satisfy. The mission statement which translates the corporate policy, is nothing else than the explicit specification of the qualitative and quantitative goals the company is going to achieve with respect to all key stakeholders. The mission is therefore easier to define than the vision, because it has a finish line — all followers need to be able to know when they have achieved the goal.

The strategy is the way to create value for all key stakeholders. There are many definitions of strategy. The best definition of strategy, applicable to all fields of human endeavour, stems from the Prussian general Helmuth von Moltke:" "Strategy is the evolvement of the original guiding idea according to continuously changing circumstances" (Hinterhuber/Popp, 1992). In our times and in business terms, the original guiding idea is the core competencies of the company. It is the task of the leader to contribute to developing these core competencies at the corporate level and exploiting them in the business units for sustainable competitive advantages. His prime responsibility is making the company a world leader in the core competencies required for enabling its business units to satisfy its key stakeholders better and/or faster than the competitors or other reference companies can do. In order to steer the company as a whole towards satisfying all key stakeholders, the leader, obviously, needs a **strategic control system**, monitoring all components of strategic management.

The third task a leader cannot delegate is designing an **effective organizational structure** in line with the strategies at corporate and business unit level and **selecting the right managers** for formulating and implementing them. Since the execution of strategies depends on individuals and teams, motivating and rewarding good performance are critical issues requiring the leader's involvement.

The fourth task that cannot be delegated regards managing **corporate culture** and **corporate identity** to successfully implement the strategies at corporate and business unit level. The leader's "prime responsibility is not to decide or direct" - as Bob Galvin, CEO of Motorola puts it - "but to create and maintain an evocative situation, stimulating an atmosphere of objective participation, keeping the goal in sight, recognizing valid consensus, inviting unequivocal recommendation, and finally vesting increasingly in others the privilege to learn through their own decisions" (Jick, 1993, pp. 112-113). Corporate culture is what creates spontaneous homogeneity within employees and managers. The responsibility a leader cannot delegate is to make the culture of the organization evolve in the direction defined by the vision, the corporate policy and the grand strategy of the company. Corporate identity is the image with which the company wishes to be seen by the outside world. Top management can learn from Rumi who says: "Appear as you be; be as you appear". A conceptual overview of the tasks an effective leader cannot delegate is provided in Figure 1 (Hinterhuber & Krauthammer, 1994).

*Strategy is nothing else than the application of good common sense, and this cannot be taught*

Helmuth von Moltke

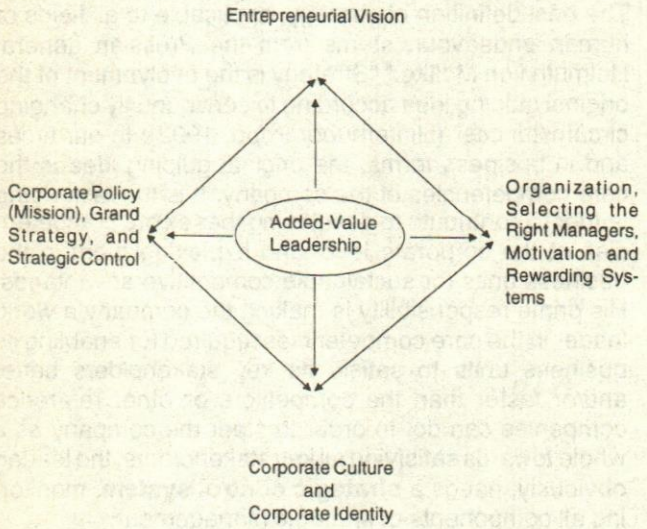



**Fig.1:** Functions of Added-Value Leadership

We are progressively entering a complex world which can be identified by the following indicators (Feneuille, 1995):

*Instability and unpredictability.* The future has always been unpredictable, but we are now constantly faced with rapid, sometimes violent changes of a random and uncertain nature. In such a situation, the search for hypothetical states of equilibrium or at least for predictable and controllable trends is bound to fail.

*Globality.* The systemic aspect of any organization is more important than its various analytical components. In global systems, processes are not linear by nature and there is no evident relation between the consequences of cooperative efforts and initial causes.

*Adaptability.* Complex systems like organizations are much richer than simple systems. Thanks to feedback loops and non- linear effects they are able to learn and to adapt themselves to the changing environment.

If instability and unpredictability are basic characteristics of our world, then any planning process has to chance to be successful. Under behavioral, constructionistic and systemic aspects, the primacy of planning, the principle of rational decision making and the existence of an objective reality are not valid any more (Stahl, 1995). Firms are formally organized, but non-trivial operating social systems, which challenge traditional leadership.

Being unable to predict the future means that a company or a business unit has to prepare for a variety of situations which cannot be anticipated. Helmuth von Moltke defined strategy as "a system of expedients ad hoc", in order to take advantage of unforeseen opportunities and/or to limit the losses due to badly calculated risks. In nature and in business, complex adaptative systems develop a certain degree of redundancy both in resources and in processes in order to ensure the best possible adaption to the environment. Business Process Reengineering and Lean Management can sometimes be the best ways to kill healthy companies, if they undermine their strategic reverses (Hinterhuber, 1995a).

These trends and developments have a profound impact on leadership. Figure 2 shows a strategic management model (Hinterhuber, 1995 a), evidencing the leadership tasks that cannot be delegated - vision, corporate policy, strategy and strategic control (the feedback loop), organization, and corporate culture and identity, and the new leadership functions required in an increasingly complex world. These new leadership functions are as follows (Stahl, 1995):

*Orientation* means not only giving a direction through challenging, meaningful and concrete images of the future, but also excluding opportunities and areas of entrepreneurial action not in line with the vision, through generalized and internalized regulations and directives.

The better the orientation of the firm through a shared vision and an enabling corporate culture, the greater will be the freedom for initiative action of the managers and employees.

*Interpretation*, according to constructivism, has different meanings:

- since reality cannot be discovered, but has to be continuously invented, the leadership challenge is to make the organization open for new impulses, from wheresoever they may come, to create values for all stakeholders
- to continuously create new knowledge in a differential way with respect to the competitors in order to

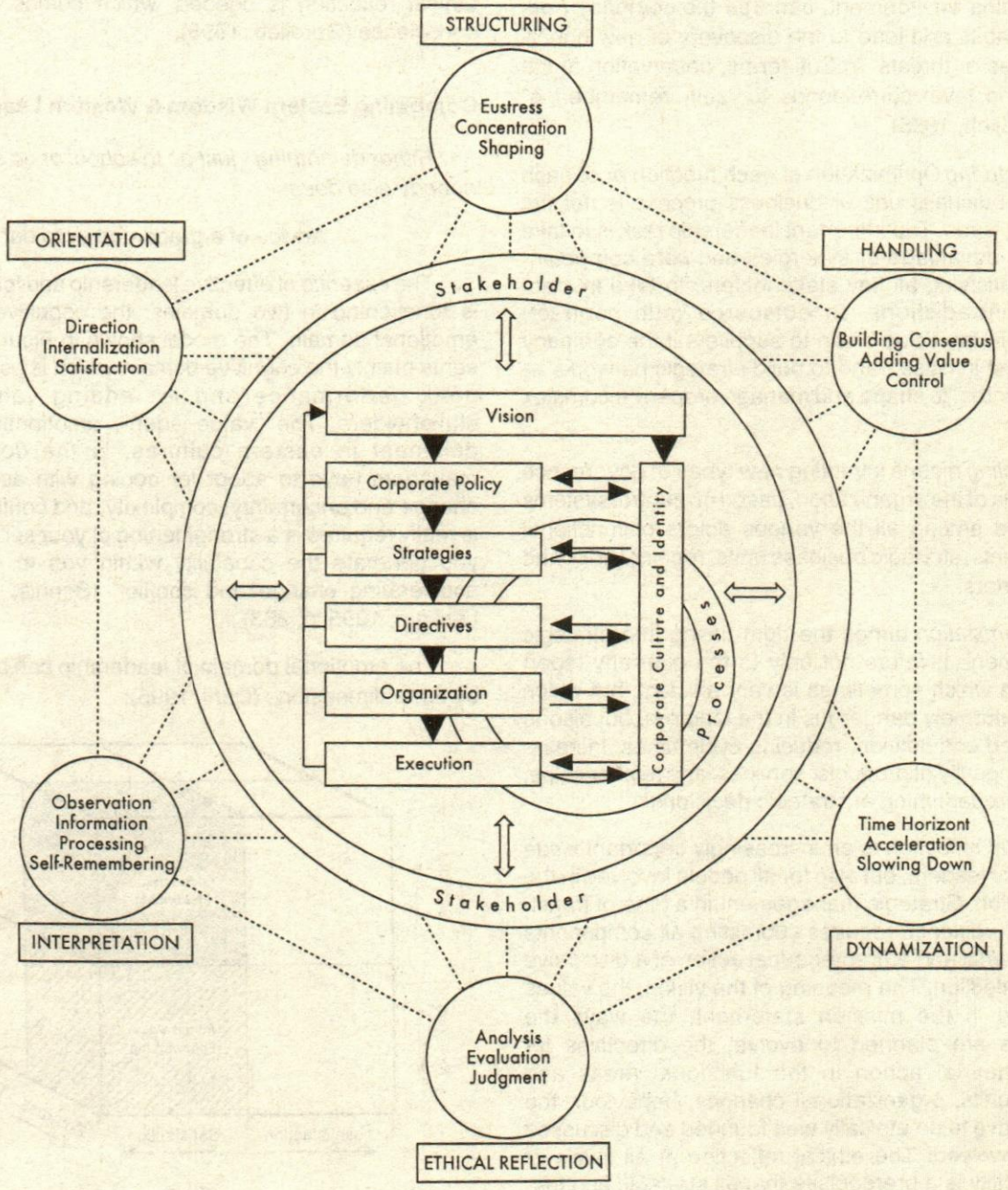



**Fig.2:**

improve the competitive positions of the business units and the company as a whole

- interpretation refers not only to the observation at the first level, i.e. observation of facts, trends and critical issues, but more to the observation at the second level, i.e. the observation of observations from a "helicopter" point of view; observing the behaviour on oneself and the unit in the context of the whole company, its stakeholders, competitors and surrounding environment, can free the company from old habits and lead to the discovery of new opportunities or threats. In Sufi terms, observation at the second level corresponds to "self- remembering" (Gurdjieff, 1985).

*Structuring* Optimization of each function or of each strategic business unit or business process is not the important issue. The important leadership task is to take complete advantage of synergies and core competencies in satisfying all key stakeholders, to take into account contradictions, to outsource (sub contract) activities in the value chain to suppliers if the company is not "best in class", and to build strategic networks — in other words, to shape and manage properly a complex system.

*Handling* means inventing new types of governance at all levels of the organization, based on control systems distributed among all the various actors of functional departments, strategic business units, regional units and headquarters.

*Dynamization* brings the right timing into strategic management. It refers not only to the quarterly report syndrome which sometimes is very efficient, but which can be extremely dangerous in the long run, but also to time-based competition, reducing cycle times, increasing the longevity of products, services, and relationships, and the proper timing of strategic decisions.

*Ethical reflection* is an increasingly important issue not only for leaders, but also for all people involved in the organization. Strategic management in a time of transition and turbulence requires submitting all components of managerial and entrepreneurial action of a discursive ethical reflection. The meaning of the vision, the values contained in the mission statement, the ways the strategies are planned to evolve, the directives for entrepreneurial action in the functional areas and regional units, organizational changes, behaviour, the actions have to be ethically well-founded and discussed with all involved. The ethical reflection at all levels of responsibility is a prerequisite that all strategic and tactical decisions are consequently taken and in tune with the expectations of all key stakeholders. Promoting ethical reflection in the organization means that top management takes seriously its responsibility for the future of this planet. There is however a very severe limitation to the ethical reflection. To the extent that it is increasingly difficult to foresee the consequences of entrepreneurial action, the idea of the ethical responsibility weakens. How can a leader be made responsible for the consequences which he or she could not foresee? There is no sure answer to this question. For real life, however, an ethical reflection is needed, which comes only from conscience (Gurdjieff, 1995).

## Combining Eastern Wisdom & Western Leadership

*Either do nothing - just go to school or do something nobody else does*

Advice of a grandmother to her grandson

The essence of effective leadership and followership is functioning in two domains: the cognitive and the emotional domain. The model shown in Figure 2 represents mainly the cognitive domain which is essential for peak performance and for adding value to all stakeholders. The "value-laden", emotional domain, dominant in eastern cultures, is the domain top managers have to adopt for coping with accelerating change and uncertainty, complexity, and conflict. "What is really required is a strengthening of your self, whereby you generate the capability within you to cope with accelerating change and conflict" (Bennis, Parikh, & Lessem, 1995, p. 363).

The emotional domain of leadership can be defined by three dimensions (Dahl, 1995):

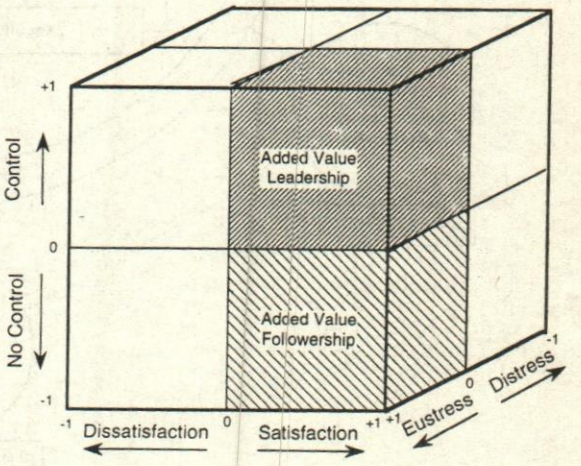



**Fig.3:**

satisfaction, control, and stress, using coordinates from –1 to +1 in this three-dimensional space (Fig. 3). Using this definition, the effective leader is in control, is (eu) stressed and satisfied. Coming back to our metaphor, we see that the effective leader is not only the sultan, but also the dervish; in fact, according to Dahl, the top goals of effective leaders are:

- Counselling the advising people
- Improving the execution of projects and programs
- More efficient, streamlined work processes
- Better responsiveness to customers and their request
- Motivating people

All these goals refer to the **emotional domain** of human behaviour. The emotional domain is involved with the action, or the change itself. People change when they are involved, engaged, enthusiastic, and committed — all these states are found in the parable. Virtually all western education is oriented towards improving the **cognitive domain** — thinking, judging, and willing. "The cognitive domain is central to performance improvement, because it is through our thinking, judging, and willing processes that we arrive at the goals and objectives we desire, and the strategy to reach them.... But performance improvement requires change. And change, unfortunately, occurs mostly in another domain — the affective domain" (Dahl, 1995, p. 14).

The sultan in our parable is the effective leader as the engaged follower — he is (eu)stressed, satisfied, but not always in control. Indeed, "every leader is a follower. No one commands an organization without restraints. For every leader, no matter how 'supreme', there is always a higher authority who must be answered" (Donnithorne, 1993, p. 19). An engaged follower is (Dahl, 1995):

Impressed, Thankful, Fascinated, Loved, Surprised, Respectful, Awed, Overwhelmed.

The dervish as the effective leader is not the one who does everything. He makes it possible for the others to do or to be — he makes it possible for the sultan to achieve his vision and to reach enlightenment. The dervish knows very well how to motivate and how to help others do or be. This is the emotional domain of change. He is also the one who has a good sense of knowledge about all the things that should be done.

The effective leader is the master of his limits; he or she is above the situation, is detached and does not identify himself with his emotional and cognitive capabilities. Identification would mean not mastering these capabilities. Effective leaders and followers are masters of themselves who continuously win small but important victories over themselves.

**The effective leader is the master of his limits; he or she is above the situation, is detached.**

### Reactive and Proactive Leadership

*The first camel stops the rest of the caravan and the last camel gets a beating*

Arabian proverb

At a turning point in history, not less important as today's, two leaders emerge, whose contrary behaviour will remain symbolic for all times: Cato and Julius Caesar. Cato personifies the old and dying Rome. He knew the decay of the old structures, he saw the decadence of his time, in him lived the greatness of the past, and his heart languished for a greater future. But his rigid intellect could not conceive any other greatness than that of the past. Also Caesar loved his country and understood the rottenness of his time; he also was filled with the glory of the past and wished it to come back. But Caesar understood something which Cato did not: he understood that the greatness of Rome was not bound on transient forms. For him, the spirit of Rome as eternal, but not the Roman republic. Hew understood that the old, though it be venerable, was not viable any more. He had the courage to move on graves into the future. Cato died with his time, as its last and most significant incarnation, being remembered only as an antiquated Roman of the last century B.C., without any significance for life. On the contrary Caesar became the symbol for a new era; he was more than a Roman, more than a child of his time, indeed more than his own person. He lives and will live on.

The essence of leadership is seeing the big picture, recognizing a multiplicity of perspectives, and assimilating all of them (Donnithorne, 1993).

## Conclusion

*A really great man is known by three signs: generosity in the design, humanity in the execution, moderation in success*

Otto von Bismarck

Effective leadership means mastering two domains: the cognitive domain and the emotional domain. The cognitive domain covers thinking, judging, and willing processes preceding action like strategy formulation, elaborating directives for SBU, regional or functional managers, oranizing, etc. The emotional domain is involved with the action, or the change itself. Change occurs mostly in the emotional domain.

The lessons to be learned from the parable — patience and concentration on a vision, the right timing, the right place, selecting the right people, thrust, humility, engaged but detached involvement, commitment — refer to the emotional domain. There are however other lessons in the parable which refer to the cognitive domain: the method used by the dervish, his strategy, the way he organized the meeting with the bard, and his musical mastery. The parable — the oriental wisdom — emphazises the emotional domain which is involved with action; integrating the emotional domain with western thinking, judging, and willing, and understanding how to operate in both domains is to know how to create peak performance and to make change less difficult.

**Integrating the emotional domain with western thinking, judging, and willing, and understanding how to operate in both domains is to know how to create peak performance and to make change less difficult.**

Leadership is a state of constant learning and of creating an atmosphere where all followers can deploy their best energies for the implementation of the strategy they have contributed to formulate. Every leader is also a follower who has to report to key stakeholders. For effective leaders and followers there is no time to be wasted making excuses for not performing, no time to lose covering up old tracks. "There is only time to do the job - for success" (Donnithorne, 1993, p. 26)

## Acknowledgement

The author is grateful to the late Dr. Zundel for the interpretator of the metaphor in the parable.

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Feature

# Parents, Prejudice & Productivity

**Albert A. Blum**

*As the 1996 election approaches in the United States, politicians are focusing more attention on two problems with which they feel the public is dissatisfied — a decline in family values and affirmative action programs. Commentators often issue self-righteous platitudes parading as facts concerning these two problems and blame everything that is wrong with the United States on the breakdown of the family and the launching of the affirmative action program approximately three decades ago. They claim that both have had deleterious effects on productivity. How justified is this?*

*Albert A. Blum is Professor, Department of Management, New Mexico State University. Box 30001, Dept. 3 DJ. Las Cruees, New Mexico 8803-8001 USA. An earlier and shorter version of this article appeared in the Las Cruees Sun News.*

The breakdown in family values has caused many commentators to bemoan its impact on violence, marriage, honesty, and so forth. These are justifiable concerns. One effect, not usually discussed however, is the family breakdown's supposed negative impact on productivity. Book after book, article after article, training program after training program have echoed each other in teaching managers a variety of theories that are supposed to motivate workers to produce more and faster. Gimmick after gimmick is offered by consultants to the gullible and often desperate managers who seek the golden grail of increased productivity. But managers will not be able to realise the fruit of increased motivation and productivity for their workers unless their employees become more receptive to these management programs. One barrier to this receptivity has been their family's attitude toward their work.

## Family Values

Families in some cultures are indeed more receptive and can help us understand better the relationship between familial values and productivity. In the United States, for example, there have been studies to see which ethnic groups do best at education and later on in employment. These indicate that Jewish and Japanese ethnic groups are relatively more successful than their counterparts. And the reasons are not far to seek. Both the Japanese and Jewish folk and family culture emphasize and create social and family pressure on the children to work hard and to do well in school since they believe education is important and the key to later success and self-satisfaction. Stories thus abound in the United States about Jewish mothers and the pressures they put on their children to succeed in school. ("David," a Jewish mother says to her college-age son, "you have a free choice. You can go to Harvard University and become and doctor or you can stay home and be a bum and I will die of a heart attack.")

On the other hand, it is also true that those ethnic groups whose family values reflect negative experiences with schools as fortresses of failure whose walls they cannot breach tend to carry that negative feeling over to the factory where they are, therefore, less productive than their peers.

There are two important lessons to be learned from these examples. For people to be motivated to work hard, it helps: if the culture supports such goals and if the workers' "significant others" (parents, siblings, wife, children, close friends) are also sympathetic to the goal of hard work and productivity. In the absence of these cultural pressures, managers can use every technique suggested in the host of books dealing with productivity and motivation and the gains secured may still be minimal.

In many countries, platitudes about the need for productivity are issued but corrupt, exploitative, manipulative and lazy political, business and union leaders make a mockery of the pressure for more output. In countries like Japan and Singapore, however, the national culture is most supportive and conducive to motivating employees to be productive. Everyone in Singapore, for example, seems to be aware of the need to be more productive. Special government organizations focus on it; training programs are organized to facilitate it. And because of relatively full employment and the safety valve of foreign workers, one factor that sometimes hampers motivation to increase productivity elsewhere — namely, the feat that increased productivity will result in fewer jobs — is not immediately relevant to Singapore.

**In many countries, platitudes about the need for productivity are issued but corrupt, exploitative, manipulative and lazy political, business and union leaders make a mockery of the pressure for more output.**

But even if national norms are clearly present to make workers receptive to the message of increased productivity, is there echoing support from family, friends, and fellow workers? In most countries, very little attention is paid to making sure that these groups positively reinforce the productivity message and that is because we do not think about the issue, except when fellow workers are concerned. But the active support, particularly of family, is essential if workers are to be more productive. At least, the family should not provide a negative message.

**The active support, particularly of family, is essential if workers are to be more productive.**

*Ensuring Family Support*

What can firms do to increase family support? The first thing is to be aware of the problem and to think about it as they plan a program to enhance productivity. For example, many training programs to increase productivity take place during the evenings or on Saturday afternoons or Sundays or are held at a distant location. Does the management really believe that a wife and two children are going to be enthusiastic about the husband being away for a period of time so that she has to take care of the children again (perhaps on her days off from work) and the children have to wonder where their father always is? (The story would be the same if the working wife were at a seminar). If it is necessary to have the program at a distance or when the worker would not normally work, the firm ought to consider what to do to secure the support of the family, not its resentment. And just thinking about the problem will provoke certain answers.

Second, there is no blueprint available on how to integrate the family into company goals since each firm and its culture differ. But one way to secure some alternative ideas about what can be done is to brainstorm. Two type of brainstorming should be pursued. The first is to secure ideas from managers (and employees) as to what they feel should or could be done. The second, and more difficult but less important, is for them to try to place themselves in the roles of the spouses and children and then brainstorm as to what these family members might want from the firm. Better still, if one can arrange it, is to have some spouses in. After the session, one can evaluate which ideas are most promising and carry them out and see what happens.

As a result of such brainstorming they may come up with a host of ideas, besides the popular ones of child care centers and flextime. One may be to invite the spouse to the final session (including dinner) of the productivity training program. Another may be letters or other forms of communication to the family. Still another

may be parental leaves for fathers in addition to those for mothers. Or the company may invite the employees' children to take a tour of the workplace so that what their parents do when they are at work may have some meaning to them. Years ago, many of us as we grew older, worked sides-by-side with our parents so we could identify with what they were doing at work. Now, children frequently have no real contact with their parents' job. How then can they identify with the parents' motivation to succeed at work? Since the spouse or the child barely knows what the father does at work, how can the father, for example, have the pleasure (and the increased productivity that should result) that comes with his seeing his child's or spouse's pride in his success at increasing productivity at work? These are just samples of what might be forthcoming and the results in increased productivity would be worth the effort.

Employees surely can be motivated to work productively by the managers at the workplace. The workplace is not an island, isolated from the mainland. The employees' mainland are the cultures of their corporations and their communities. Managers can do little about the national culture except through their important role in society but they ought to understand its implications. They can do more, however, about the family than what they are doing at present. And, of course, managers can and must do more at the workplace as part of their corporate culture. They can do a good job there if, first, they seek not to manipulate employees but really to motivate; if, second, they consider motivation from where the employees are, not solely from where the managers want them to be; and, third, if the benefits from increased productivity are really shared with their employees and with their families. Then, families and firms may be able to move forward together toward a more productive company and culture.

**They consider motivation from where the employees are, not solely from where the managers want them to be.**

### Affirmative Action

There are those who point to affirmative action programs (quotas for the under privileged) as standing in the way of increasing productivity no matter how well the family behaves. Talk to a manager in any country that has an affirmative action program and he will often complain about the lack of growing productivity of his workforce and blame affirmative action programs which he claims has forced him to hire less qualified workers.

It should surprise no one that because of past poor education, inadequate training, and negative self-images forced upon Blacks by the dominant white population through years of disgraceful discrimination, the hiring of black employees through affirmative action programs should often result in a decline of productivity. Therefore, if the society wants to enforce affirmative action schemes for the under privileged, it has to be ready to pay the price of lower productivity for a period of time while it tries to close the gap between Black and Whites' skills. This surely would be only a partial payment back for the profits made from the earlier exploitation of Blacks.

**If the society wants to enforce affirmative action schemes for the under privileged, it has to be ready to pay the price of lower productivity for a period of time while it tries to close the gap between Black and Whites' skills.**

It also should surprise no one that the young white worker who did not get the job he wanted to, that the Black had secured, would become bitter over what he felt was an unjust act since he feels he had not discriminated against Blacks; his parents and grandparents had. These are both incredibly difficult problems with which a society has to deal, but there are hopeful ways of dealing with them. One way, of course, is to improve the training and education of Blacks but unfortunately, experience shows that education can take a long time and we are not sure of how to accomplish this goal. For example, I once directed a study of all the government-sponsored research done between 1962 and 1972 in the United States dealing with worker training and education (much of which focused on training of minorities). Perhaps sardonically, I concluded that the research either was not very good or no one had paid any attention to it, since unemployment at the end of the period was greater than when the research program had started.

There has been at least one reported success - the Head Start Program in which children from disadvantaged families receive preschool education so that they could start school with more skills than they would

have otherwise. Moreover, Head Start involved the families of the children who were in the program, a fact too often ignored but which is most important. A colleague and I did a study of training in Detroit, Michigan, where the majority of the population is black. We discovered that the most successful training programs involved not only the persons to be trained but also their significant others - mainly, their family and their peers. Training programs for adults run in same school buildings where the adults' children or younger siblings were going to school and helped change attitudes positively for both the groups. They began to view the school building no longer as a fortress of fear and failure as mentioned earlier but as a location for learning, love, and success.

But such programs take time. It takes a long time for a Head Start product to get into the labor market. But the key to better reception and success is that the initial financial help must come from the more affluent white community through its tax dollars and commitments. Long term change, however, also requires the involvement of the black family and leaders to help provide meaningful and realistic goals from black youth. This is why it is disturbing to read newspaper stories about representatives of South Africa's African National Congress who after promising to give a speech or to be at a meeting, often fail to show up or do so extremely late. They must be busy but they are poor models for young black children who see that their leaders think it permissible not to carry through on commitments made. In the United States, training with disadvantaged people, who have had a history of failure at work, often includes teaching them proper procedures at work. And one such procedure is punctuality. Disadvantaged young people will continue to be failures at the workplace if they do not learn the importance of good work habits. These can best be learned through emulation of their peers, parents, and political leaders.

**Good work habits can best be learned through emulation of their peers, parents, and political leaders.**

The failure of an ANC speaker to fulfill his commitments does not help his young followers learn these skills. And "African" time (and I have heard the term used all over the world — for sample, "Mexican" time — to explain a lack of punctuality) may work on a farm (I doubt it), but it surely does not work in a factory or office and that is where a rising standard of living will come to South Africans and Americans - black or White.

The debate over affirmative action should not result in either side believing itself to be right since both sides have made mistakes in handling discrimination and since each side has to alter its behaviour. Otherwise, meaningful concerns about past and present discrimination and its negative impacts on productivity will be ignored. Instead of taking baby steps forward, we will follow the pied pipers of prejudice and platitudes and not realize the potential of increased productivity that a nondiscriminatory society makes available to us. □

Feature

# Corporate Planning Practices in Indian Industries — A Survey

**B.S. Sahay, Prem Vrat & P.K. Jain**

*The paper makes a modest attempt to gain insight in to the corporate planning practices followed by the industries in India. The experience is likely to be useful in devising a suitable methodology for corporate planning and modelling thereof. Accordingly a survey was conducted in oil, petrochemical and fertiliser industries in India. The survey diagnoses the gap between the theory and practice in the context of Indian industries particularly the core sector e.g. oil, petrochemicals and fertilisers through samples from all over the country.*

*B.S. Sahay is Sr. Dy. Director, National Productivity Council, 7/155 Swarup Nagar, Kanpur 208 002. Prem Vrat is Professor of Industrial Engineering, Department of Mechanical Engineering and P.K. Jain is Professor of Finance, Department of Management Studies, both from Indian Institute of Technology, New Delhi 110 016.*

That corporate planning practices are vital for the survival and growth of any company needs no emphasis. Literature reveals that corporate planning is now practised on a worldwide basis and continues to grow rapidly. The methodology has been adopted and adapted virtually by all large and small companies of the industrially developed countries (Grinyer & Noburn, 1974; Hussey 1984; Krijinen, 1977 & Steiner 1979). While efforts have been made in India by some big and established companies to develop corporate plans, still very little is available in literature (Dutt, 1983; Nambudiri, 1974; Ramachandran et al, 1982 and Sahay, 1994). Hence a study was attempted to assess the level of corporate planning in Indian companies.

## Methodology

Organisations are hard pressed for time to provide quantitative information for any type of survey questionnaires seeking statistical data. Moreover, these data are published in the balance sheet and other documents. Also majority of the questionnaires are quantitative based. Hence, it was decided to develop a qualitative based detailed questionnaire (Ackoff 1981; Corfield, 1984) to get the required information from different corporate enterprises from oil, petrochemicals and fertiliser industries under the purview of the survey.

The questionnaire was in three parts: general information on the organisation in terms of activity, line of business and background; information about corporate planning practices followed including corporate planning techniques; and financial practices and policies of the organisation.

## Analysis of Feedback

The survey questionnaire was mailed to Chief Executives/ Managing Directors of 101 organisations covering oil, petrochemical and fertiliser sectors.

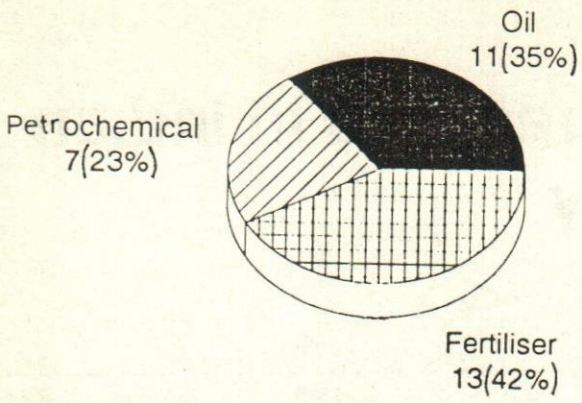



**Fig. 1:** Sectorwise Feedback Received

The analysis is based on the responses received from 31 corporate enterprises out of 101 as shown in fig. 1 Statistically, it may appear to be inadequate. However, given the type of information (generally considered confidential by the organisations), it was difficult to seek responses from a sizeable number of organisations. The 31 responses were collected after making more than one personal visit and holding a series of detailed discussions with the practising Corporate Planners and Chief Executives of the organisations. Major thrust of the discussion was the problems encountered by them not only at the time of preparation of the corporate plan but at the time of implementation also.

### Profile of the Respondent Organisations

The response was markedly better from public sector organisations which constituted nearly three-fifths (58%) of the total sample, the private sector accounting for the balance (42%). Fertiliser sector has the maximum representation (42%) followed by oil (35%) and petrochemicals (23%).

All organisations, save two, indicated corporate planning as a regular activity in their organisations. It started in late 1950s and early 1960s in a few organisations. Nearly three-fifths of the sample companies have corporate planning as a separate department in their organisations with an average manpower of 7 (minimum 2 and maximum 12). The petrochemical industry has the highest average manpower (8) and fertiliser the lowest (4); oil occupies the intermediate position (5). While three-fifths of the organisations have separate corporate planning departments, only 16% indicated that corporate planning activities are looked after by planning department. Nearly one fourth (26%) of the organisations indicated that these plans are formulated by an ad-hoc committee formed by the top management. The committee is represented by functional heads of planning, if any, production, projects, marketing, finance, materials, human resource development (HRD) etc.

Chief Executives and top management are mainly responsible for formulating and developing corporate plans as shown in table 1.

**Table 1:** Degree of participation in formulating corporate plan

| Position of Personnel | Percentage degree of participation | | | |
|---|---|---|---|---|
| | High | Medium | Low | Nil |
| Board of Directors | 29 | 35 | 7 | 30 |
| Chief Executives | 77 | 16 | 7 | – |
| Top Management | 78 | 19 | 3 | – |
| Middle Management | 26 | 64 | 6 | 4 |
| Operating Management | 10 | 32 | 39 | 19 |
| Outside Consultant | 3 | 23 | 23 | 51 |

As per survey analysis, more than three-fourths (77%) of the chief executives and top executives are responsible for devising corporate plans whereas only slightly more than one fourth (29%) of the Board of Directors are actively involved in this activity. This finding seems to be in contrast with the popular belief that the Board of Directors are likely to have the maximum say in formulating the corporate plans.

Active participation of middle management in devising corporate plans is only 26%, whereas for detail working on the corporate plan their involvement is attributed at around 64%; operating management has the least say (9%). It may, therefore, be reasonably concluded that the planning is down the Indian organisations.

Another notable finding of the survey is that, growing consultancy practices and professionalism notwithstanding, it continues to be at low key so far as planning aspect is concerned. There seems to be two weighty reasons for it. First, corporate plan is a confidential document and should be developed by the management and not by any outside agency. Secondly, insiders of the organisation understand the vision of the management better than any outside consultant. In view of these factors, organisations are of the view that outside consultant should be involved in devising corporate plans only to seek their expert opinion, if required.

In India, objective setting process is generally top-down, though this involves cooperation between top management and functional heads. Organisations set their objectives regarding sales, profits, rate of return, market share, employment etc. The major thrust of the organisations in setting corporate objective is to increase

the return on investment (65%) followed by increase in the sales turnover (55%) and maximisation of profit (51%). In fact, many organisations have indicated more than one objective.

**In India, objective setting process is generally topdown, though this involves cooperation between top management and functional heads.**

Two-fifths (42%) of the organisations, mostly from public sector, have their objectives, *inter-alia*, as improving the economy of the nation, serving the mankind and improving the quality of worklife etc.

Corporate planning objective(s) of the organisations under survey are depicted in Fig. 2.

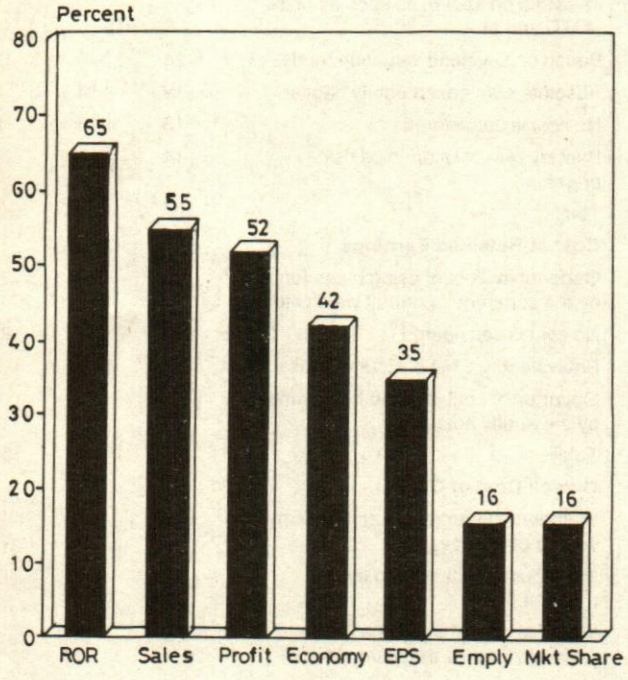



**Fig. 2:** Corporate Planning Objectives of Organisations

Legend:

| | |
|---|---|
| ROR | - To increase in rate of return on investment |
| SALES | - To increase sales turnover |
| PROFIT | - To maximise profit |
| ECONOMY | - To improve the economy of the nation |
| EPS | - To increase earning per share |
| EMPLY | - To provide maximum employment |
| MKTSHARE | - To attain certain per cent of market share |

While the highest level of approving authority of corporate plan is normally the chief executives of the organisation in concurrence with the board of directors in case of private sector, the approving authority in the case of public sector organisations is the concerned Ministry of the Government of India.

Only half of the sample organisations expressed inability in setting up joint venture projects or in expanding overseas. Similarly, three-fifths (58%) of the organisations are unwilling to expand their business overseas. It is definitely a good sign that a considerable number (65%) of organisations consider their employees as assets and do not foresee any constraint in expanding their area of work.

Of late, liberalisation in the industrial policy has given a boost to these sectors to over come the conventional syndrome of external constraints.

In a majority of the organisations (58%), capital expenditure is planned ahead for 2 to 5 years whereas in one fourth of the organisations (26%), capital expenditure planned for 5 to 10 years. It is surprising to note that though oil, fertiliser and petrochemicals are core sectors requiring strategic long range planning, only 16% of the organisations have responded that they plan capital expenditure for more than 10 years.

Nearly two-thirds of the sample organisations take less than 6 months to prepare the corporate plan whereas the remaining organisations, (excepting two which have reported that their corporate planning is a continuous process without quoting any specific time period), take more than 6 months to carry out this exercise. *Inter-se*, one fourth of these organisations take more than a year to devise the plan.

There are a large number of techniques available and used for making decisions in the corporate planning process/ forecasting. Survey reveals that some organisations are using more than one technique. Technological forecasting technique seems to be most popular and is used by more than 70% of the organisations while 43% either prefer computer simulation or econometric models. 23% use models that incorporate probability theory followed by decision tree analysis (20%), decision matrix (13%) and system dynamics (10%). However, no organisation uses game theory for modelling corporate plans. 27% reported that, apart from above mentioned techniques, trend analysis, input-output matrices, extrapolation, statistical forecasting are also used for devising corporate plans as shown in Fig. 3

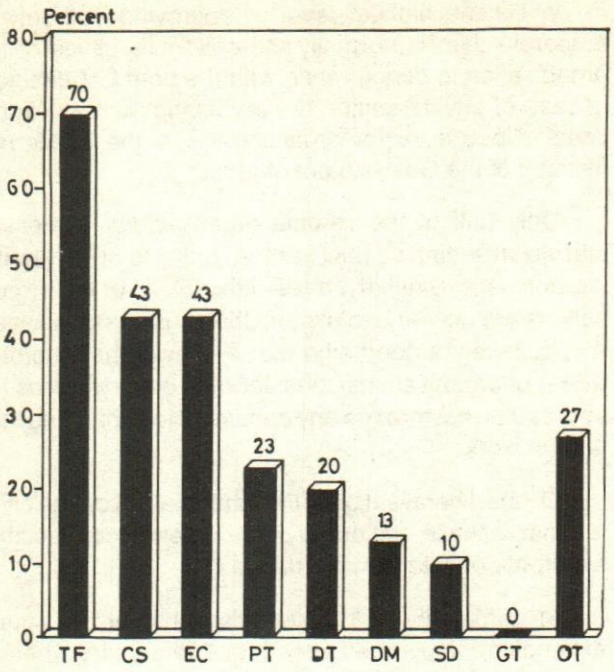



**Fig. 3:** Corporate Planning Techniques used in Indian Organisations

Legend:

| | |
|---|---|
| TF | - Technological Forecasting |
| CS | - Computer Simulation |
| EC | - Econometrics |
| PT | - Probability Theory |
| DT | - Decision Tree Analysis |
| DM | - Decision Matrix |
| SD | - System Dynamics |
| GT | - Game Theory |
| OT | - Others |

The majority of the organisations (90%) include forecast of customer requirements in their corporate planning activities. However, only 67% correlate forecasted customer requirement with the capabilities of their organisations.

More than four-fifths (83%) of the organisations have reported that it is important to consider forecast of future restrictive conditions. These are influenced by factors external to the organisation and over which it has limited control.

Most of the organisations (93%) formulate corporate plans in financial terms and two-thirds carry out evaluation of their divisions/departments in financial terms.

The survey also reveals that most of the organisations (89%) accord priority of manufacturing targets followed by personnel (77%), and research and development (70%).

**Most of the organisations (89%) accord priority of manufacturing targets followed by personnel and research and development.**

## Financial Aspects

The cost of capital is the most vital ingredient in financial decision making. The outcome of the survey on cost of capital (equity, retained earnings and overall) is summarised in table 2.

**Table 2:** Basis of determining cost of capital (equity, retained earnings and overall)

(Figures are in percentage)

| Particulars | Total | Public | Private |
|---|---|---|---|
| **Cost of Equity Capital** | | | |
| Primary rate of return available to investors on securities such as units of UTI and NSC | 24 | 19 | 5 |
| Based on Dividend valuation model | 24 | 5 | 19 |
| Absolute sum based equity capital | 19 | 14 | 5 |
| No cost is considered | 19 | 10 | 9 |
| Primary rate of return plus risk premium | 14 | – | 14 |
| Total | 100 | 48 | 52 |
| **Cost of Retained Earnings** | | | |
| Opportunity cost of using these funds by the company (external yield criteria) | 50 | 28 | 22 |
| No cost is considered | 33 | 11 | 22 |
| Equivalent to Cost of Equity Capital | 11 | 6 | 5 |
| Opportunity cost of using these funds by the equity holders | 6 | – | 6 |
| Total | 100 | 45 | 55 |
| **Overall Cost of Capital** | | | |
| Weighted average cost of long term source of finance | 50 | 10 | 40 |
| Cut off point established by the management | 25 | 15 | 10 |
| Marginal cost of additional funds raised to finance the expenditure | 15 | 5 | 10 |
| Historical rate of return | 10 | 5 | 5 |
| Total | 100 | 45 | 55 |

The findings are based on the responses received from only half of the corporate enterprises regarding the question of cost of equity capital practised in their organisations; the nonresponding companies reported that these things are confidential in nature and expressed their inability to provide the required information in the case of private sector corporate enterprises whereas

public sector enterprises felt that they have little say on these factors, as these are basically governed by the concerned Ministry and the Governments.

Significantly, one fifth of the total sample companies virtually (equal from public and private sectors) do not consider any cost for calculating cost of equality capital as it is the most difficult and controversial to measure. Out of these responses, one-fourth (24%) of organisations considered cost of equity capital equivalent to either primary rate of return available to investors on securities such as units of Unit Trust of India (UTI) and National Saving Certificate (NSC) or as calculated by dividend valuation model.

While most of the public sector enterprises prefer primary rate of return as the mode of determining the overall cost of capital (Ko), private sector enterprises prefer weighted average cost of long term sources of finance as the basis of determining Ko.

(represented equally by both private and public) consider the cost of retained earning equivalent to the cost of equity capital.

Significantly, half of the organisations calculate the overall cost of capital based on weighted average cost of long term source of finance. This is in conformity with sound tenets of finance theory. This practice is predominantly followed by the private sector enterprises (40%). In contrast, only 10% public sector enterprises have adopted this procedure. The cut-off point established by the management as the basis for determining overall cost of capital (Ko) is adopted by one fourth of the corporate enterprises (15% of public sector enterprises and 10% of private sector enterprises).

An important aspect of capital budgeting for any project is the incorporation of risk and uncertainty into investment decision process. The trade-off between risk and profitability would have a bearing on the investors of

**Table 3:** Methods adopted by sample corporate firms to incorporate project risk

(Figures in percentage)

| Approaches to incorporate Project risk | Always | | | Frequently | | | Infrequently | | | Never | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | G | P | T | G | P | T | G | P | T | G | P | T | G | P | T |
| Shorter payback period for risky projects | 26 | 13 | 39 | 13 | 13 | 26 | 4 | – | 4 | 13 | 18 | 31 | 56 | 44 | 100 |
| Higher cut off rate for risky projects' | 5 | 13 | 18 | 14 | 18 | 32 | 9 | – | 9 | 27 | 14 | 41 | 55 | 45 | 100 |
| Measurement of expected variation in return | 11 | 22 | 33 | 8 | 13 | 21 | 4 | – | 4 | 34 | 4 | 42 | 57 | 43 | 100 |
| Sensitivity Analysis | 25 | 27 | 57 | 14 | 11 | 25 | 7 | – | 7 | 11 | – | 11 | 57 | 43 | 100 |

G - Public Sector Enterprises

P - Private Sector Enterprises

T - Total

Likewise, the survey portrays that one third of the organisations (11% belonging to public sector enterprises and 22% to private sector firms) do not consider any cost of retained earnings. Apparently, retained earnings may appear to carry no cost since they represent funds which have not been raised from outside. The contention that retained earnings are free of cost, however, is not correct as they involved opportunity benefits sacrificed/foregone by equity shareholders by allowing corporate enterprises to use these funds.

Two-thirds of the respondent companies take into account the cost of retained earnings. The cost of retained earnings equivalent to opportunity cost of using these funds by the organisation is the most commonly used measure for the purpose. This is very much in line with the theoretical postulate. 11% of the organisations

the organisation before and after acceptance of a specific proposal. As shown in table 3, sensitivity analysis approach is used by the majority of the organisations (57%) followed by shorter payback period for risky projects (39%) and measurement of expected variation in return (33%). Higher cut-off rate for risky projects in their investment decision process is also used by nearly one-fifth (18%) of the business firms.

Post-completion audit to control financial aspects of capital expenditure and investment is done in more than three - fourth (77%) of the organisations in line with their corporate policies and programmes.

Preference for equity is evident in the capital structure consideration of sample companies. It is manifest in that nearly three-fifths (58%) of the organisations prefer

high equity base and one-third (31%) medium equity base. More than half (56%) of the organisations have observed that the reason for high equity base is the flexibility in paying dividends. *Inter- se*, public sector enterprises have shown greater inclination for equity (table 4). It may perhaps be ascribed to the fact that equity capital by them is generally considered cost free as there is no mandatory obligation for them to make payment of dividends. In contrast, payment of interest on debt reduces their profits.

As far as the type of debt is concerned, sample firms show preference for long-term debt to short-term debt. This is true both for private and public sector enterprises.

Besides, virtually all organisations (96%) are satisfied in dealing with financial institutions in matters such as appointment of nominee directors, use of convertibility clause (not in vogue now), other terms of loan agreement etc. and revealed that loans are generally released by financial institutions as and when required.

It is of interest to have an idea about the time-lag involved in releasing the funds. Nearly two-thirds (62%) of the organisations (29% from public sector and 33% from private sector) indicated that financial institutions normally take 3 to 6 months to release the funds. Nearly 29% of the organisations from public sector and 24%

**Table 4 :** Preference for Equity or Debt in Designing Capital structure of the sample companies

(Figures in percentage)

| Equity/Debt | High | | | Medium | | | Low | | | Nil | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | G | P | T | G | P | T | G | P | T | G | P | T |
| Equity base | 35 | 23 | 58 | 22 | 19 | 31 | 4 | 4 | 8 | 3 | – | 3 |
| Debt-long term | 14 | 5 | 19 | 29 | 33 | 62 | 10 | – | 10 | 9 | – | 9 |
| Debt short term expected variation in return | 10 | 5 | 15 | 15 | 20 | 36 | 20 | 10 | 30 | 20 | – | 20 |

G - Public Sector Enterprises
P - Private Sector Enterprises
T - Total

Another important aspect of enquiry is to ascertain various funding avenues to meet financial requirements. Obviously, it is expected that organisations will be relying on more than one source, keeping in view the large requirements. That is precisely what the survey also reveals. *Inter-se*, the public sector organisations have shown marked preference for retained earnings (68%) followed by financial institutions (64%) and capital market (55%). The situation is just the reverse in the case of private sector organisations.

Both public and private sectors have prefer to have funds from financial institutions, vis-a-vis, raising on their own from capital market because of convenience, flexibility, no flotation costs and less time involved in getting funds from financial institutions.

**Both public and private sectors prefer funds from financial institutions, vis-a-vis, raising on their own from capital market because of convenience, flexibility, no flotation costs and less time involved in getting funds from financial institutions.**

from private sector expressed that this time period varies between 6 to 12 months. In case of some organisations the time period involved was less than three months.

As far as working capital financing is concerned, two-thirds of the sample firms rely on long term sources to meet such requirements. This is in tune with sound principles of financial management as it is basically a permanent requirement and not a short term one. However, it is a matter of concern that one third of the organisations are adopting the policy of financing from short term sources.

It is surprising to note that a sizeable number of organisations (primarily from public sector) have observed that reliance on bank credit as a source of financing working capital has remained unaffected as a result of Tandon Committee recommendations. On the contrary, 35% of the organisations (majority of which are from public sector) reported that reliance on bank credit as a source of financing working capital in fact has increased. Private sector firms seem to be affected by the Tandon Committee recommendations, these organisations reported that decrease in bank credit for

working capital purposes is compensated through public deposits, issuing equity shares and convertible debentures.

Finally, current ratio is the widely used measure (52% of the organisations) for assessing working capital norms; other measures used in this regard are working capital to sales (29%) and working capital to total assets (10%). The firms do not seem to be following a pragmatic and sound approach towards determining working capital requirements. It involves determination of each segment of working capital (cash, inventories, debtors, creditors, etc.) separately.

### Facets of Corporate Planning

Table 5, presents the opinion of practising corporate planners/chief executives pertaining to various facets of corporate planning practices followed in India. From the facts contained in the table the following conclusions can be deduced.

**Table 5:** Summary of survey opinion pertaining to various facets of corporate planning practices followed in Indian organisations.

| Sl. No | Facets | Agree (%) | Undecided (%) | Disagree (%) |
|---|---|---|---|---|
| 1. | Corporate planning is a must in any company. | 100 | – | – |
| 2. | The purpose of Corporate Planning is | | | |
| | a) to develop long range objectives | 100 | – | – |
| | b) to change the direction of the company, | 61 | 16 | 13 |
| | c) to accelerate growth and improve profitability | 87 | 13 | – |
| | d) to guide divisions and R & D personnel in developing new products, | 78 | 16 | 06 |
| | e) to develop a frame of reference for budgets and short range operating plans, | 84 | 13 | 03 |
| | f) to pick-up pace of a tired company | 64 | 29 | 07 |
| | g) to gain control of operations | 81 | 19 | – |
| | h) to provide a road map to show where the company is going and how to get there. | 81 | 19 | – |
| | i) to coordinate & integrate company's total management system | 81 | 19 | – |
| | j) to foresee opportunity and threats that lie ahead of a company | 100 | – | – |
| | k) to appraise company's strengths and weaknesses. | 100 | – | – |
| 3 | It is useful in developing realistic current information about the competitors. | 83 | 10 | 07 |
| 4 | Corporate planning highlights key issues and helps to establish appropriate priorities for dealing | 100 | – | – |
| 5 | It provides a basis for measuring the performance of entire company and its major parts. | 87 | 07 | 06 |
| 6 | Corporate planning is useful in developing creditable medium and short term plans to implement strategies so as to achieve goals. | 93 | 07 | – |
| 7 | It provides a forum for sharing divergent views about the changing environment | 76 | 17 | 07 |
| 8 | Which of the different approaches to corporate planning is mostly used? | | | |
| | a) Top-down | 77 | 23 | – |
| | b) Down-top | 06 | 23 | 13 |
| | c) Combination of two | 32 | 03 | 03 |
| 9 | Computer models are very useful for corporate planning. | 71 | 13 | 16 |
| 10 | An effective planning system can be designed and introduced only after top management has a clear understanding of corporate planning. | 84 | 13 | 03 |
| 11 | Top management consistently rejects the formal planning mechanism by making intensive decision which conflicts with formal plan. | 29 | 29 | 42 |
| 12 | Although corporate planning is supposed to reduce uncertainty it also can increase it. | 39 | 32 | 39 |
| 13 | Corporate Planning cannot get a company out of current crisis. | 46 | 12 | 42 |
| 14 | Many managers are not willing to realise weakness of company in devising plans | 65 | 16 | 19 |
| 15 | Lower level managers often go along with the ideas of their superior even though in their own mind they have better ideas. | 65 | 22 | 13 |
| 16 | It helps in highlighting conflicts in the compnay such as those between divisions and head office and among divisions | 58 | 03 | 39 |
| 17 | It is dangerous to spend too much time on the plan to and too little on the planning. | 68 | 13 | 19 |

All organisations agree that corporate planning is a must in every organisation; 81% of the organisations have strongly advocated this.

A majority of organisations (84%) agree that the purpose of corporate planning is to develop long range objectives.

About 60% of the organisations agree that the purpose of corporate planning is to change the direction of the company; about one fourth of the respondents disagree with this contention; 16% respondents are undecided. Similarly while most of the respondents (87%) feel that the purposes of corporate planning is to accelerate growth and improve the profitability of the organisation, 13% are undecided.

Majority of the respondents agree that the purpose of corporate planning is to guide divisions and R & D personnel. While 16% are undecided about their opinion, 6% strongly disagree with this.

84% of the organisations find that corporate planning helps in developing a frame of reference of budgets and short range operating plants. Only 64% organisations endorsed that it helps to pick-up pace of the operations; 7% of the organisations disagree with the latter part.

Almost all the organisations observed that corporate planning practices are quite useful particularly for appraising company's strengths and weaknesses on the one hand and to foresee opportunities and threats that lie ahead on the other. In fact, more than three-fourth of the respondents strongly agree with these facets.

**Corporate planning practices are quite useful particularly for appraising company's strengths and weaknesses and to foresee opportunities and threats that lie ahead.**

81% of the organisations agree that corporate planning provides a road map to company's directions. This also helps in coordinating and integrating total management system to gain control of operations.

All top managements agree that corporate planning highlights key issues and helps to establish appropriate priorities for dealing with them. 55% strongly agree with this assertion. 83% of them agree that it is useful in developing realistic current information about the competitors. 93% organisations feel that corporate planning is useful in developing credible medium and short term plans to implement strategies so as to achieve goals.

It is alarming to note that more than one fourth (29%) top management consistently rejected the formal planning mechanism by making intensive decisions which conflicts with the formal plan. Probably this is one of the main reasons for the slow introduction of corporate planning practices in India. This statement is supported by 84% of the respondents, who agree that an effective planning system can be designed and introduced only after top management has a clear understanding of corporate planning, 68% of respondents strongly agree with this.

About 40% of the respondents disagree that although corporate planning is supposed to reduce uncertainty it also can increase it. Further, they feel that it cannot get a company out of the current crisis. However, while more than 40% feel just otherwise, 24% are undecided.

In as much as 65% of the organisations, managers are not willing to realise the weakness of their organisations in divising plans. It is also reported that most of the lower level managers often go along with the ideas of their superiors even though in their own mind they have better ideas.

Corporate planning systems vary from organisation to organisation depending on a variety of factors e.g. environmental conditions, organisational size and complexity, age, top management values and styles, initial trigger for the commencement of planning etc Variations in the corporate planning systems across organisations may be found first in the top management's basic approach to corporate planning. Survey reveals that many organisations use more than one approach. While top-down approach is used by 32% of the organisations, only 6% use down top approach. However, the combination of these two approaches is very common and used in as many as 77% of the organisations. Broad objectives, policies and strategies may be arrived at through a dialogue and sharing divergent views about the change of the environment between the top management and divisional heads. This is supplemented by two thirds of the organisations.

58% of the respondents also feel that it helps in highlighting conflicts in the organisation such as those between divisions and between head office and divisions.

A variety of management science tools are used by the corporate planners. 71% of organisations feel that

computer models are very useful for corporate planning. However 16% of the organisations do not agree with this. Lastly, 68% of the corporate planners feel it is not useful to spend too much time on the plan to plan and too little on the planning.

## Concluding Remarks

Corporate planning activities started way back in late 50s and early 60s in core sectors like oil, petrochemical and fertiliser of Indian corporate sector. It has had a positive impact on their performance and is considered as a regular activity in these organisations. Survey reveals that it has significant bearing on both public and private sectors in appraising their strengths and weaknesses on the one hand and to foresee opportunities and threats that lie ahead on the other. It is strongly felt by these sectors that corporate planning and long range planning provide a road map to show where their company in particular and nation at large are going and how to achieve the desired mission and objectives. Chief executives have the maximum say in divising the corporate plan which is contrary to the popular belief that the board of directors have maximum influence. Survey presents some alarming observations. It has been found that one-fourth of the top management of Indian industries consistently reject the formal planning mechanism by making decisions which conflict with the formal plan.

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Things which matter most
must never be at the mercy of things which matter least.

*Goethe*

Feature

# Environmental Factors for Strategy Formulation

A.M. Shah

*Environmental scanning is an essential component of an effective strategy formulation process. Based on available literature and the data collected from 61 companies this paper identifies relevant environmental factors for strategy formulation, to enable companies to direct their scanning efforts to the analysis of the relevant environment only. While approving the choice of segments like market supplier, technology, economic and regulatory sectors, the author recommends that more attention has to be paid to international factors in the present context.*

*A.M. Shah is Reader, Department of Management Studies, University of Kashmir, Srinagar - 190006.*

Today business organizations are facing a complex turbulent and rapidly changing environment which affects their form, behaviour and fate. On the one hand they have to secure inputs (capital, labour, raw material and equipment) from evolving, uncertain and imperfect markets. On the other hand, they have to satisfactorily dispose of their outputs to customers whose own needs and resources are in flux and who typically have alternative options for having their needs fulfilled. In this highly competitive and volatile scenario the survival of an organization is becoming tougher. The uncertainty of the different forces in play have changed the rules of the game for most industries, and companies have had to adopt appropriate plans to deal with these changes. This calls for a detailed environmental analysis for identification of opportunities and threats for formulating effective strategies.

## Analysis of Business Environment

Analyzing the environment as a whole is impossible, since it is too complex and interconnected. Therefore, the environment should be decomposed into different segments. Literature reflects two conceptions of the organizational environment: the first is the task environment, which is broadly defined as all aspects of the environment potentially relevant to goal setting and goal attainment (Dill, 1958). It is defined by customers, suppliers, competitors and regulatory agencies and represents external contingencies to which the business unit must respond (Pfeffer & Salancik, 1978). The other conception which emphasizes the importance of large corporate systems is the institutional environment which includes societal, demographic, economic, political and international elements (Scott, 1987). Khandwalla (1977) and Jauch, Osborn and Glueck (1980) have also identified similar environmental segments.

**The task environment is all aspects of the environment potentially relevant to goal setting and goal attainment.**

Business environment may also be viewed as a multi-dimensional construct (Duncan, 1972; Lawrence and Lorch, 1967). Organizational theory has established several specific environmental dimensions, which include dynamism (Dess and Beard, 1984; Thompson, 1967); complexity (Child, 1972; Dess and Beard, 1984, Mintzberg, 1979; Thompson, 1967), hostility (Miller and Friesen, 1978; Mintzberg, 1979), and bargaining power (Kim and Lim, 1988). While environmental complexity and dynamism have been closely linked to the information uncertainty, (Lawrence and Lorsch, 1967; Thompson, 1967), the hostility has been tied to the resource dependence (Aldrich, 1979; Pfeffer and Salancik, 1978). Bargaining power depicts the interactive relations between a task environment and an organization (Kim & Lim, 1988). In a different framework but capitalizing on business environment, Cowen and Middaugh (1990) point out that external environment has four major characteristics that affect planning and control system design: dynamism (rate of change in the market), heterogeneity (market expectations and diversity), hostility (competitive pressures, governmental regulation etc.) and technology employed (method of providing goods and services). The focus on the various dimensions of the environment has become increasingly important due to their far reaching implications and impact on the business strategy.

**External environment has four major characteristics that affect planning and control system design: dynamism (rate of change in the market), heterogeneity (market expectations and diversity), hostility (competitive pressures, governmental regulation etc.) and technology employed.**

Mintzberg (1973) defines strategy as a patterned stream of decisions, which focus on a set of resource allocations that are employed in an attempt to reach a position consistent with a firm's environment. The role that strategy plays in aligning a business with its environment has received considerable attention in literature (Andrews, 1971; Ginsberg & Venkatraman, 1985; Hambrick & Lei, 1985; Hofer & Schendel, 1978) However, the review of the existing research on environment and organizational strategy reveals that there is not sufficient empirical evidence to show the relationship between environmental factors and the strategy of Indian companies particularly after liberalization of the Indian economy. But there is a strong conviction that it is the fit between the organizational strategy and the environmental dimensions that leads to better organizational performance. Therefore, organizations need to scan their environment continuously for designing the strategies which can achieve the most favourable match between the environment and organization. However, the environment comprises a large number of factors under the dimensions of its several sectors. It is useless to analyze those factors which are irrelevant for strategy formulations. Therefore, a study was attempted to find out those environmental factors which are relevant for strategy formulation, so that scanning efforts of organisations are directed to the analysis of these factors only.

## Research Methodology

A comprehensive questionnaire was sent to 125 companies selected purposively to cover a wide cross section. However, only 61 of them returned the completed questionnaire out of which 49 were from domestic and 12 from multinational companies.

On the basis of a survey of literature, a list of various environmental factors assumed to be of relevance for strategy formulation was prepared and included in the questionnaire for examination. In all, 133 factors were identified under the dimensions of eight environmental sectors/segments (table 1). The factors included under the rubric of different environmental sectors ranged from 11 to 25.

**Table 1:** Total number of factors included in each environmental sector.

| Environmental Sector | Number of factors included |
|---|---|
| Economic | 21 |
| Political | 14 |
| Regulatory | 18 |
| Market | 25 |
| Suppliers | 19 |
| Technology | 12 |
| Socio-cultural | 11 |
| International | 12 |
| Total | 133 |

Respondents were asked to rate environmental factors as most relevant, relevant, less relevant or irrelevant on the following basis:

Most relevant - If the environmental factor strongly and directly influences the company's business strategy and/or its performance.

Relevant - If it indirectly influences the company's business strategy and/or its performance.

Less Relevant - If the influence was negligible.

Irrelevant - If the environmental factor does not have any impact.

Score was computed by assigning weightages 3,2,1 and 0 respectively. Level of relevance of each environmental sector was computed by taking the averages of the levels of relevance of the environmental factors grouped under that sector. The environmental segments were ranked on the basis of average relevance score. Coefficient of rank correlation was used to study the degree of similarity between the ranking scheme of domestic and multinational companies.

## Results and Discussion

Table 2 presents the levels of relevance attached to the environmental sectors by companies under study. Market, supplier and Technology sectors are reported as the most relevant sectors for strategy formulation by 78.69 per cent, 70.49 per cent and 67.21 per cent companies respectively. 18.03 per cent to 24.59 per cent of them identified these sectors as relevant. A small number of respondents ranging from 3.28 per cent to 8.20 per cent reported these sectors as less relevant. Economic and regulatory sectors were categorized as most relevant by 21.31 per cent and 16.39 per cent, relevant by 65.57 per cent and 63.93 per cent and less relevant by 13.12 per cent and 19.68 per cent companies respectively. None of the companies reported market, supplier, technology, economic and regulatory sectors as irrelevant. The resultant average score was closer to most relevant in case of market, supplier and technology segments. In case of economic and regulatory sectors, it was near to relevant category. The other environmental sectors viz, political, socio-cultural and international are assigned considerably low importance by majority of the companies. 59.02 per cent to 63.93 per cent of them reported these segments as less relevant and 21.31 per cent to 29.50 per cent rated them as irrelevant. The resultant average score in all these sectors was near to less relevant category depicting thereby the low importance given to these factors in strategy formulation. This may be because, social and political factors affect the companies performance indirectly and are also difficult to predict. The lower relevance attached to international sector reveals that the majority of the companies are hardly interested in internationalization of their businesses. However, in the light of the liberalization and globalization of the Indian economy, it would be better for them to initiate efforts in this direction as early as possible.

**Table 2:** Levels of relevance attached to environmental sectors

| Environmental Sectors | Sample Response (N=61) | | | | Average Relevance score |
|---|---|---|---|---|---|
| | Most Relevant | Relevant | Less Relevant | Irrelevant | |
| Economic | 13 (21.31) | 40 (65.57) | 8 (13.12) | – – | 2.08 |
| Political | – | 10 (16.39) | 36 (59.02) | 15 (24.59) | 0.95 |
| Regulatory | 10 (16.39) | 39 (63.93) | 12 (19.68) | – – | 1.96 |
| Market | 48 (78.69) | 11 (18.03) | 2 (3.28) | – – | 2.75 |
| Supplier | 43 (70.49) | 14 (22.95) | 4 (6.56) | – – | 2.59 |
| Technology | 41 (67.21) | 15 (24.59) | 5 (8.20) | – – | 2.59 |
| Socio-cultural | | 9 (14.75) | 39 (63.93) | 13 (21.31) | 0.93 |
| International | | 7 (11.48) | 36 (59.02) | 18 (29.50) | 0.82 |

Note : Figures within parentheses represent percentage to total.

Table 3 depicts levels of relevance attached to environmental factors. 22 factors grouped under the dimensions of five environmental sectors were considered as most important for strategy formulation by majority of the companies. Those environmental factors which were considered as irrelevant or less relevant by majority of the companies were not included in the table for further analysis. The table indicates that marketing factors are accorded highest importance by almost all the companies. The percentage of companies reporting these factors as most relevant ranged from 67.21 per cent to 91.81 per cent. Among the marketing factors, buying behaviour occupies the top position with 91.81 per cent score, followed by competitors' price 86.88 per cent, customer needs 80.32 per cent and competitor's plans 77.05 per cent. The average relevance score was near to the most relevant category in all the marketing factors, signifying thereby the importance in strategy formulation. This may be mainly due to the changing needs and mix of consumers and the sources, strategies and intensity of competition, which have forced the companies to

devote more meticulous and sophisticated attention to interpreting the signals from their consumers and their competitors. Of late Indian companies have started laying greater emphasis on identification of customer needs and wants to render full satisfaction.

**Marketing factors are accorded highest importance by almost all the companies.**

**Table 3** : Levels of relevance attached to environmental factors.

| Environmental Sectors | Respondents' view (N = 61) | | | Average Relevance score |
|---|---|---|---|---|
| | Most Relevant | Relevant | Less Relevant | |
| **Economic :** | | | | |
| –economic policies—physical, fiscal and monetary | 11(18.03) | 38(62.30) | 12(19.67) | 1.98 |
| – Interest rate on borrowings from banks & financial institutions | 19(31.15) | 39.(63.93) | 3(4.92) | 2.26 |
| – Conditions for borrowing from banks and financial institutions | 12(19.67) | 43(70.49) | 6(9.84) | 2.09 |
| – Corporate taxation | 10(16.39) | 40(65.58) | 11(18.03) | 1.98 |
| **Regulatory:** | | | | |
| – Policies related to licensing | 8(13.12) | 42(68.85) | 11(18.03) | 1.95 |
| – Policies related to development of industries | 10(16.39) | 39(63.93) | 12(19.68) | 1.96 |
| – Policies related to liberalization of imports | 13(21.31) | 38(62.30) | 5(8.19) | 2.04 |
| – Policies related to exports | 9(14.75) | 37(60.66) | 15(24.59) | 1.98 |
| **Market:** | | | | |
| – Customer's buying behaviour | 56(91.81) | 5(8.19) | – | 2.91 |
| – Customer needs | 49(80.32) | 12(19.68) | – | 2.80 |
| – Competitor's plans | 47(77.05) | 11(18.03) | 3(4.92) | 2.72 |
| – Competitor's price | 53(86.88) | 8(13.12) | – | 2.86 |
| – New substitutions | 42(68.85) | 14(22.95) | 5(8.19) | 2.60 |
| – Marketing channels | 41(67.21) | 16(26.23) | 4(6.56) | 2.60 |
| **Supplier:** | | | | |
| – Availability of raw material | 57(93.44) | 4(6.56) | – | 2.93 |
| – Price of raw material | 35(57.38) | 21(34.43) | 5(8.19) | 2.49 |
| – Availability of energy used | 41(67.21) | 16(26.23) | 4(6.56) | 2.60 |
| – Availability of finance | 39(63.93) | 15(24.59) | 7(11.48) | 2.52 |
| **Technology:** | | | | |
| – Technology Developments | 39(63.93) | 14(22.95) | 8(13.12) | 2.50 |
| – Competitor's Technology | 46(75.41) | 9(14.75) | 6(9.84) | 2.66 |
| – Availability of new technology | 36(59.02) | 21(34.42) | 4(6.56) | 2.52 |
| – Cost of new technology | 43(70.49) | 16(26.33) | 2(3.28) | 2.67 |

Notes 1 : Irrelevant factors have been ignored

2 : Figures within parentheses represent percentage to total.

Table 3 also depicts that under the supplier segment, availability of raw material has been rated as the most relevant factor by 93.44 per cent companies followed by availability of energy used by 67.21 per cent, availability of finance by 63.93 per cent and price of raw material by 57.38 per cent. Respondents ranging from 6.56 to 34.43 per cent reported these factors as relevant while only 6.56 to 11.48 per cent of them rated these factors as irrelevant. The average relevance score was near to most relevant category in case of the factor availability of raw material (2.93) while it was on the higher side of relevance category in case of other factors (range 2.49 to 2.60). This reveals that majority of the companies attached significant importance to supplier factors also while formulating their strategies. The data (table 3) also indicates that the percentage of companies reporting technology factors as most relevant ranged from 59.02 to 75.41 per cent. 14.75 to 34.42 per cent of the companies placed these factors under the relevant category and only 3.28 to 13.12 per cent identified them as less relevant. The average relevance score ranged from 2.50 to 2.67 in case of technology factors. This reveals that the companies under investigation are exhibiting aware-

ness and concern towards technology factors. This may be mainly due to the severe competition emerging in the Indian markets and the technology upgradation needed by the Indian companies to improve their quality and productivity.

A further examination of table 3 reflects that under the economic environment, four factors were identified as relevant for strategy formulation by majority of the companies. 16.39 to 31.15 per cent of the companies reported these factors as most relevant and 62.30 to 70.49 per cent rated them as relevant. The average relevance score of economic factors ranged from 1.98 to 2.26, meaning thereby that majority of the sample considered these factors as relevant and not most relevant. Table 3 also shows that the companies viewing regulatory factors as most relevant, relevant and less relevant ranged from 14.75 to 21.31 per cent, 60.66 to 68.85 per cent and 8.19 to 24.59 per cent respectively. The resultant means in case of regulatory factors was closer to relevant category ranging from 1.95 to 2.04. As compared to market, supplier and technology environments, economic and regulatory factors were assigned less importance by the respondents. Majority of the companies rated economic and regulatory factors as relevant and not most relevant. This could be mainly because, after liberalization the Indian economy has stabilized and the economic and regulatory policies are predictable and to a large extent favour industrial development. Most of the economic and regulatory policies which proved detrimental to the industrial development in India in past have been changed/relaxed and there has been a sharp change of direction in Indian economic, Industrial and trade policies in the last four years.

**Table 4**: Average relevance score and ranking of environmental factors.

| Environmental Sector | Domestic Companies | | Multinational Companies | | Overall | |
|---|---|---|---|---|---|---|
| | ARS | Rank | ARS | Rank | ARS | Rank |
| Market | 2.69 | 1 | 2.81 | 1 | 2.75 | 1 |
| Supplier | 2.60 | 3 | 2.64 | 2 | 2.62 | 2 |
| Technology | 2.67 | 2 | 2.51 | 3 | 2.59 | 3 |
| Economics | 2.18 | 4 | 1.08 | 5 | 2.08 | 4 |
| Regulatory | 1.91 | 5 | 2.01 | 4 | 1.96 | 5 |
| Political | 0.99 | 6 | 0.91 | 7 | 0.95 | 6 |
| Socio-Cultural | 0.98 | 7 | 0.88 | 8 | 0.93 | 7 |
| International | 0.71 | 8 | 0.93 | 6 | 0.82 | 8 |

Co-efficient of rank correlation between domestic and multinational companies = 0.88, ARS = Average relevance score

In order to assess the importance attached to the environmental sectors by domestic and multinational companies table 4 presents the ranking of environmental sectors. The table demonstrates that market sector occupies the top position in the ranking scheme of both types of companies. Domestic companies assigned second rank to technology sector while multinationals gave it third rank. This may be because domestic companies must be in the process of technology upgradation while multinationals have already adopted advanced technology. Supplier environment is accorded second rank by multinationals but domestic companies assigned it third tank. Regulatory segment was ranked fourth by multinationals while domestic companies ranked it fifth. Economic sector is ranked fourth by the domestic companies but multinationals ranked it fifth. The other environmental sectors viz, political, socio-cultural and international sectors were given low importance by both the groups of companies. However, domestic companies ranked them as 6th, 7th and 8th respectively while multinationals ranked them 7th, 8th and 6th. International sector was ranked 6th by multinationals while domestic companies ranked it 8th. Thus, it may be observed that the ranking scheme of the domestic and multinational companies are not very different. Both the groups of companies assigned first five ranks to market, supplier, technology, economic and regulatory factors and gave considerably low importance to other sectors. The coefficient of rank correlation between the two types of companies comes out to be 0.88. This reveals that there is a high degree of similarity between the ranking scheme of domestic and multinational companies. In the overall ranking scheme, marketing sector occupies the top position (1st rank) followed by supplier (2nd) technology (3rd) economic (4th) and regulatory sector (5th). The political, socio-cultural and international factors were ranked 6th, 7th and 8th.

## Conclusion

The results of the study indicate that five environmental sectors viz., market, supplier, technology, economic and regulatory were considered as most relevant for strategy formulation by majority of the companies. 22 environmental factors were found relevant for strategy formulation under the dimensions of these five sectors. The resultant average relevance score was near to most relevant category in case of market, supplier and technology factors while it was closer to relevant

category in case of economic and regulatory factors. The overall analysis reflects that the factors related to customers, products, competition, raw material and technology receive the highest importance in the strategy formulation process of the companies. The high relevance accorded to these factors is appropriate because consumer orientation and innovation are fast becoming the key ingredients to success.

The political, socio-cultural and international factors were assigned considerably low importance by majority of the companies because their influence is felt only indirectly through changes in other environmental factors. However, Indian companies can not afford to attach low importance to international factors now, because of globalization of the Indian economy. Progressively fierce local and international competition is emerging in India and Indian companies will have to learn to manage in a more competitive environment. While survival and growth in the domestic markets would obviously be the first priority for them, they should also examine various strategies for planning their invasion into foreign markets. This calls for a detailed probate into those environmental factors which can help in developing strategies coherent with the global vision. A study of this nature systematically selecting a large sample may prove to be of great help to Indian companies in internationalizing their business.

**Indian companies can not afford to attach low importance to international factors now, because of globalization of the Indian economy.**

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# New Materials Programme in Developing Economies — Policy Imperatives

**S. Suresh Kumar & K.G. Satyanarayana**

*The arrival of advanced materials capability is leading to an acceleration in the rate of materials and product invention and innovation, more rapid obsolescence of products and processes, and reduced life cycles. This paper dwells on the policy imperatives for building up industrial capabilities embracing the necessary multi-disciplinary and trans-material approach enabling the developing economies to learn from the development trends abroad and adapt to the new situation by planning for the transition.*

*S. Suresh Kumar is Scientist-Coordinator, Planning & Policy Research Unit and K.G. Satyanarayana is Adviser (Materials) and Senior Scientist in the Regional Research Laboratory (CSIR), Trivandrum.*

From time immemorial, materials have played a key role in various sectors vis-a-vis societal development. Man has always looked for better materials for performance, leading to the general trend of greater knowledge intensity of material usage or less material per unit of output, or for a given product. This has made possible the advent of new materials which can perform many functions optimally resulting in improved performance as compared to conventional materials, in the context of new techniques/technologies. Such materials are sometimes called "Advanced Materials" (AMs). These along with a synergic combination with informatics play a catalytic role in industrial restructing, reorientation of patterns of investment and employment and commerce

**Table 1:** AMs, processes & functions

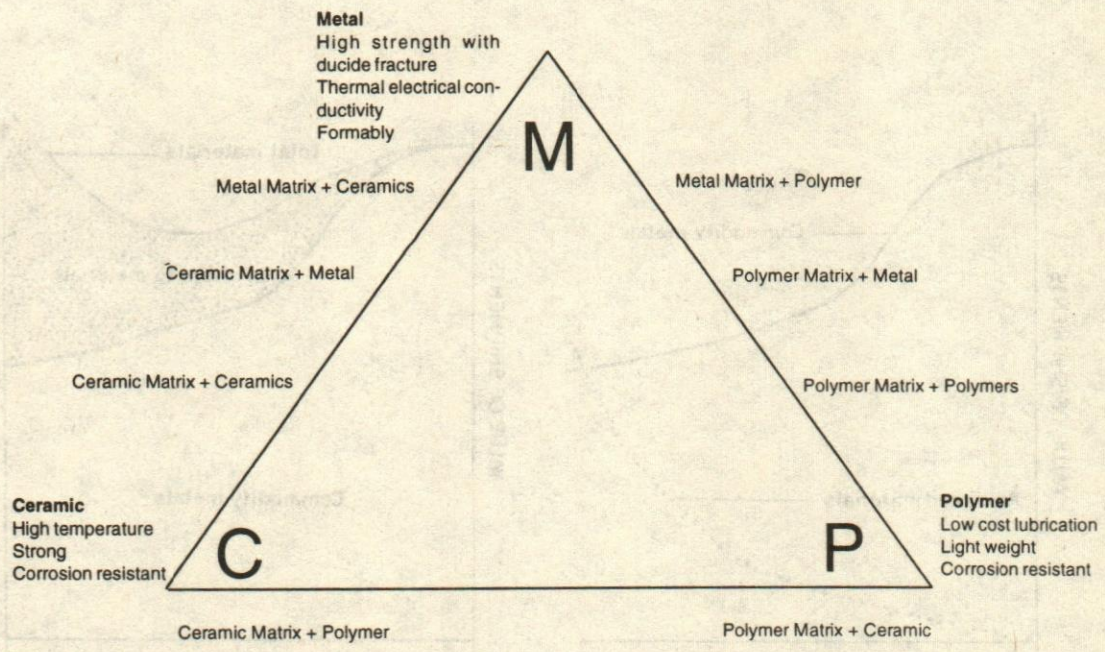
| |
|---|
| Advanced Materials |
| New metallic materials comprising new high strength alloys/ shape memory alloys/ferrite single crystals/RE magents etc. |
| Advanced (fine) ceramics comprising engineering ceramics, Electronic ceramics, industrial sensors, high temperature ceramics etc. |
| New polymers consisting of engineering plastics, optical polymers, LCP, special rubbers etc. |
| Composites consisting of PMC/MMC/CMC and intermetallics. |
| Targetted End Users |
| Aerospace |
| Defence |
| Chemical industry |
| Medical instruments |
| Consumer goods |
| Processes |
| Fine powder technology including nano sized powders obtained through chemical and vapour phase route/ spray atomization etc. |
| Near net shape manufacturing processes including injection moulding/semi solid processing/magneto hydrodynamic casting (MHD) strip casting etc. |
| Use of CAD/CAM/CIM for higher yields with lower processing times. |

in many of the developed nations. AMs thus promise major contribution to the national prosperity and better quality of life and will have important consequences for the developing countries such as India (which are primary producers of base materials), particularly with respect to materials development programme and related technological policies (Fig. 1 & Table 1).

**What are AMs**

What precisely are AMs? Despite a number of definitions that are available for AMs depending on individual perception, the one mostly acceptable seems to be that "AMs are those technologically intensive materials developed to fulfill increasingly sophisticated product specifications in order to satisfy the necessary conditions required for the establishment of a new economic cycle" (UNIDO, 1990). The scientific and engineering basis of materials today is such that it is possible not only to improve the processing and properties of existing materials but also to design new materials so as to develop combination of properties for specific applications. The capability to manipulate properties and achieve tailor-made performance characteristics lies at the core of the materials revolution. This will have profound effects on national technologies in respect of competitiveness and industrial productivity. Development of these AMs and the advanced processing techniques (APT) used to produce them together constitute "Advanced Materials Technology" (AMT). AMT offers the possibility for an inversion in the logic of production of materials in the sense that the focus shifts from material input to specifications of output and capabilities in technology content. For example, polymer and composites substituting steel in cars/aircrafts lead to lighter weights and higher performance, optical fibres replacing copper wires in telecommunication lead to better performance and lower energy consumption etc (Souza, 1988). New technologies that utilize the new materials have also emerged.

**"AMs are those technologically intensive materials developed to fulfill increasingly sophisticated product specifications in order to satisfy the necessary conditions required for the establishment of a new economic cycle".**




Source : Alcoa, Position Paper from the 10th Diennial Conference on National Materials Policy

**Fig. 1:** Advanced material systems

Long term structural changes are taking place with the process of AMs aimed at establishing a new pattern of production and consumption of materials tailored to national technologies and fulfilling sophisticated functions and applications. For example, in a developing country like Korea, high tech industries such as semiconductors, computers developed in eighties resulted in increased domestic market for the required AMs, from 0.7 million in 1984 to 2 billion in 1990 (UNIDO, 1990). This is expected to grow to $ 6.7 billion by 2000 A.D. Of this, market size for fine ceramics is about $ 1-7 billion in 2000 compared to $ 0.5 billion in 1984. Under this, there are about 62 fine ceramic industries in the production line with about 18 for ferrites, 15 in insulators, 10 in semiconductors. Market Forecasts for Advanced Materials in Japan are given in Table 2.

Similarly consumption of certain metals such as steel, aluminium and copper has declined over the years as indicated by the following: steel: from $ 90 million to GDP in 1978 to $ 78 m in 1982-83; aluminium; 2 m to 1.8 m and copper; $1.75 m to $ 1 m. Accordingly the share of commodity metals has declined vis-a-vis advanced materials (Fig. 2).

**Table 2**: Advanced and conventional material production in Japan

| | 1983 $ million | 1990 forecasts $ million | Growth 1983-90 (%) |
|---|---|---|---|
| Advanced materials | | | |
| Fine Ceramics | 1,670 | 6,315 | 19 |
| New Polymers | 1,800 | 4,210 | 13 |
| (Engineering Plastics) | 1,100 | 2,736 | 14 |
| New Metals | 710 | 2,315 | 18 |
| (Amorphous Metals) | 12 | 147 | 42 |
| Composites | 105 | 631 | 29 |
| (Carbon Fibres) | 63 | 160 | 14 |
| Total | 4,285 | 13,471 | 18 |
| Conventional Materials | | | |
| Steel | 67,676 | 80,000 | 2 |
| Non-ferrous | 29,200 | 35,790 | 3 |
| Ceramics | 36,324 | 44,210 | 3 |
| Chemicals | 80,955 | 101,052 | 3 |
| Textiles | 33,945 | 40,000 | 2 |
| Pulp and Paper | 29,730 | 34,526 | 2 |
| Total | 277,830 | 335,578 | 3 |
| Advanced materials as % of conventional materials | 1.5 | 4.0 | |

Source : Dubaralc (198( ) : "Advanced Materials: The Silent Revolution", OECD Observer, 158, June-July, p.9.

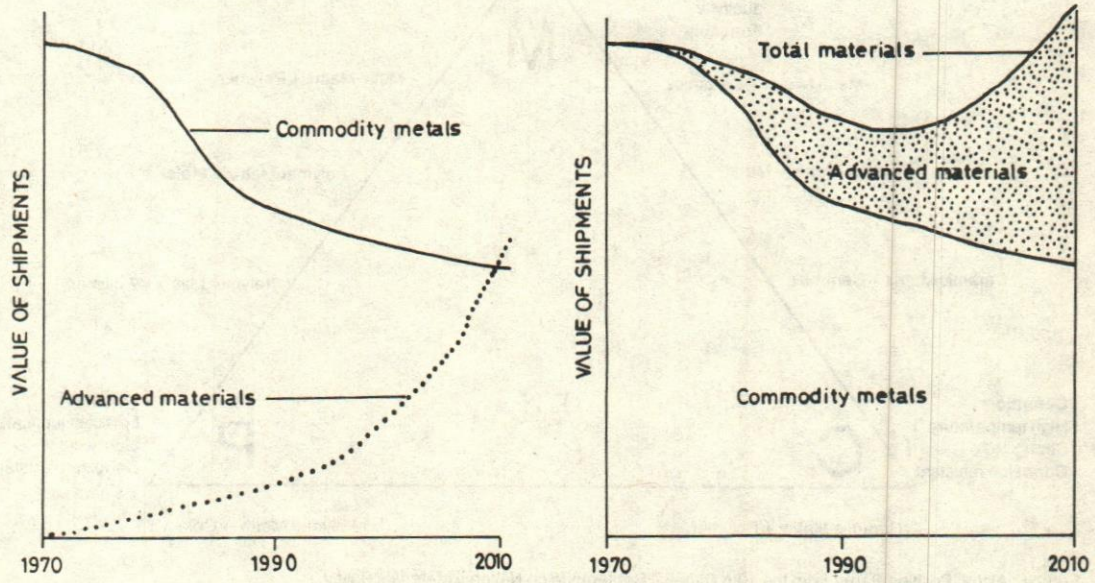
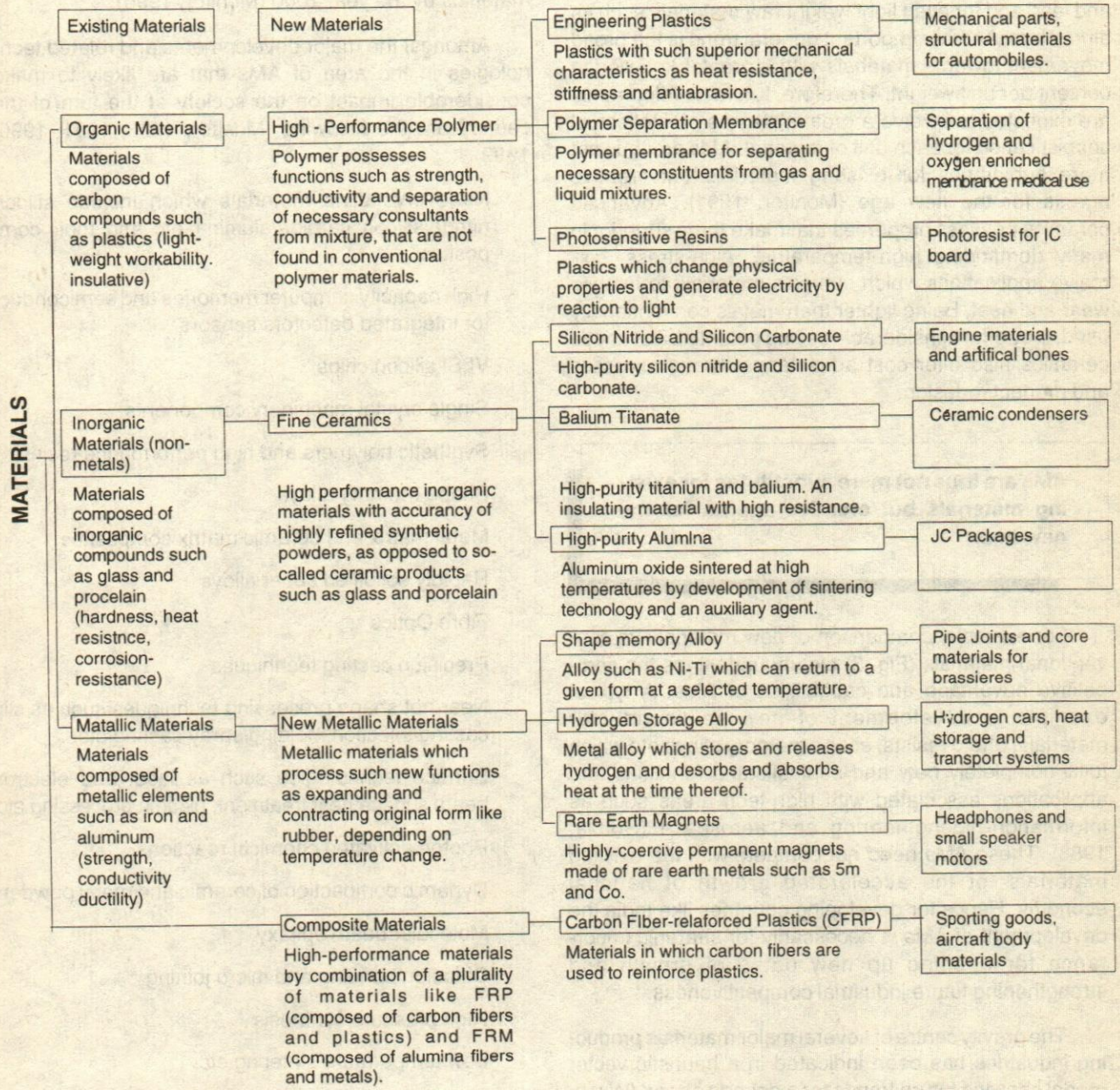



**Fig. 2 :** Transition from a Metals Economy to a Materials Economy.
*Source : Souza, (1988)*

The importance and significance of policy issues are highlighted by the fact that the development and diffusion of AMs in Japan and US have been accelerated solely through explicit and implicit policy measures aimed at achieving revolutionary advances in material science and engineering so as to provide new materials with a competitive advantage for national technology (Perez, 1983). For example, cutting tools made of carbon steel during 1990 showed a speed of 10 m/min; while recent advances made through high speed steels have taken speeds to more than 200 m/min. This has helped in enhancing the productivity considerably. Another example is in the development of turbojet engine materials to operate at 1200°C (Monitor, 1988). For every 150°C temperature increase, there results a 20 percent increase in engine thrust and a substantial economy in




Source : K. Takeda, Basic Industries Bureau, MITI.

**Fig. 3**: Existing and New Materials

fuel. Thus R&D efforts have been focussed on the development and use of appropriate advanced materials aimed at improving specific industrial competitiveness.

### Development of AMs and APTs

The need for energy conservation has led to process and product changes resulting in a reduction in consumption density for major metals like iron, copper, zinc and lead and for even light weight raw materials such as aluminium. Another important general trend is the broad movement towards materials with a greater knowledge content per unit weight. Therefore, future developments are expected to involve a greater degree of intellectual sophistication for each unit of material. AMs are thus not mere substitutes for existing materials but creative agents for the new age (Monitor, 1991). Advanced ceramics possess properties that make them superior in many demanding high-temperature, high-stress, corrosive applications which subjects materials to intense wear and heat. Being lighter than metals conventionally used, they offer considerable saving potential. Advanced ceramics also offer cost advantages through process and product redesign.

**AMs are thus not mere substitutes for existing materials but creative agents for the new age.**

For example, comparison of new materials vs conventional materials (Fig. 3) clearly underlines the competitive advantage and capabilities of AMs. A typical example is development of new semiconductor materials, photo resists, shape memory alloys etc which fulfill completely new and sophisticated functions and applications associated with high-tech areas such as information-bioengineering and aerospace (Souza, 1988). These AMs need not compete with the existing materials for the accelerated growth of national economy. Hence for developing countries like India the development of AMs is necessarily for strategic importance for opening up new paths of growth and strengthening future industrial competitiveness.

The gravity centre of several major materials producing industries has been indicated in a heuristic vector model showing future trends for a decade ahead (Wyatt, 1987). According to this, older industries such as steel and cement have limited possibilities for the introduction of drastically new technologies, while highly specialized and advanced steels such as high strength low-alloy steels have a bright future. On the other hand, high temp./wear resistant metals such as carbides/ nitrides/oxides and light metals such as aluminium, titanium and even plastics will have better opportunities in future. For example, about 65 percent of body panels in subsonic airplanes will be made of composite materials by the year 2000 (Monitor, 1990).

Amongst the major developments and related technologies in the area of AMs that are likely to make considerable impact on the society at the turn of the century are the following (Monitor, 1988, 1991, 1990, 1992).

Nano crystalline materials which include silicon nitride/silicon carbide/alumina etc and their composites

High capacity computer memories and semiconductor integrated detectors/sensors

VLSI silicon chips

Single crystal machinery components

Synthetic polymers and high performance resins

Shape memory alloys

Metal matrix and ceramic matrix composites

Rapidly solidified super alloys

Fibre Optics

Precision casting techniques

Near net shape processing techniques such as slip casting/injection molding/spray casting etc.

Surface technologies such as laser and electron beam surface heat treatment, plasma processing etc.

Photon activated chemical reactions

Dynamic compaction of ceramic and metal powders

Molecular beam epitaxy

Diffusion bonding and micro joining

High pressure synthesis

Low temperature sintering etc.

Computer aided design/manufacturing/integrated manufacture (CAD/CAM/CIM) etc.

## Trends and Market in AMs

It is estimated (Monitor, 1990; Wyatt, 1987) that the world market scale for AMs alone is $ 25 billion (with 1981 as base). With more promise in the future for a quantum leap in the development of AM and innovative manufacturing processes in the industrialized world, the market scale for existing materials that can be put to use for new products is about $ 24 billion. The market scale for intermediary products due to the production inducement effect is about $ 56 billion; the market scale for products employing AMs is about $ 200 billion and the total sale is estimated to reach about $ 365 billion.

Growth of world market for AC powders is given as 65 percent between 1988-95 (Monitor, 1991). Sales of structural ceramics (cutting tools, wear resistant crucibles for metal melting and armour for military applications etc) grow by 15 per cent per annum during 1990-2000. Table 3 shows growth expected in AC by 2000 with annual growth during 1985-90 and 1990-2000.

**Table 3:** Worldwide advanced ceramic market projection

| Industry | 1985 ($M) | 1990 ($M) | 2000 ($M) |
|---|---|---|---|
| Automotive | 53 | 634 | 5700 |
| Electronic | 1708 | 3740 | 11360 |
| Integrated optics | | 1 | 111 |
| Advanced energy systems | | | 360 |
| Cutting tools | 14 | 92 | 500 |
| Other industrial | 80 | 225 | 690 |
| Other aerospace | 20 | 30 | 65 |
| Bioceramics | | 10 | 30 |
| Total | 1875 | 4732 | 11818 |

It is estimated that world market for AC will be $14 billion with USA alone accounting for $ 5 billion with a compounded annual growth rate of 8 percent to total 11 billion by 2000 (constant prices). Largest AC market is in electronic applications such as capacitors, substrates, IC packages etc. Predicted annual growth rate is 7 per cent (from $3-8 billion in 1989 to $ 8 billion in 2000). Structural applications including wear parts and cutting tools will increase by 9 percent per annum from $ 1-2 billion to $ 3 billion. However, there is difficulty for any one company to develop and bring AC to market and hence joint ventures are being explored.

International joint ventures must be aimed at assisting the development of domestic technological capacity and skills in a dynamic context through acquisition of foreign technology and regional collaboration in research, training, standards and education. A major feature of the global corporate environment in materials is the growing internationalization, merger and acquisition, licensing agreement and joint ventures. The research and development costs of new materials and the scientific and engineering expertise in design, manufacturing and testing calls for large, integrated, research intensive, organizational settings and arrangements. Thus materials production in future is likely to be dominated by global corporates achieved through internationalization, mergers and acquisitions. Some economies with appropriate level of development of productive forces may have the opportunity as well as the need to enter into joint ventures directly with companies engaged in advanced materials production in industrially advanced countries. Other countries may more usefully build upon their existing technological and traditional materials strength by entering into collaborative agreements with firms and institutions in other developing countries in their region. Countries need to closely examine the potential benefits of engaging in joint ventures and licensing agreements with either large multinational corporations or smaller specialized firms from developed countries in areas related to their existing resources and strength. A particular feature of the materials revolution is the importance of the small company accounting for flexible specialization and production for small market segments. Such joint ventures would assist the efforts for forward integration and diversification of the export sector, enhance the skills, scientific capacity and managerial and technological know how in a range of primary and manufacturing sector, assist the penetration of foreign markets, enable the economy to accumulate experience in the use of new materials production (Wyatt, 1987, Kaounider, 1991).

**International joint ventures must be aimed at assisting the development of domestic technological capacity and skills.**

By their very nature as intermediate inputs, advanced materials can enter virtually every production process and emerging products. AMs contain the potential for reorganizing many fields of production and effecting inter-firm and inter-industry linkages. For example, as part of a national scientific and industrial strategy, domestic, traditional, glassware and ceramic producers can be assisted to move to advanced ceramic production in the long run with the combination of enhanced domes-

tic skills and acquisition of foreign technology. In the US ceramic market, the trend is towards vertical integration and more acquisitions and mergers to consolidate the position. However, in Japan, the main mechanism for market penetration is for firms to seek joint ventures. Acquisitions, joint ventures and licensing agreement have also become common in the European ceramic market. A point of obvious significance to developing economies is the interesting fact that the US composite industry has resorted, right from the beginning, to the licensing of basic technology from foreign firms; this constitutes an important mechanism for transfer of production and distribution rights for products. On the other hand, European firms have entered the US market through acquisition and joint ventures. Japan is one of the leaders in international joint ventures. The number of joint ventures is over 25 in Japan (and nearly 35 for the whole of Europe) (Lastres, 1990; Choi, 1983). Interest remains the highest in emerging 'plastic' technologies for such ventures, with metals and electronics as strong contenders, particularly, in developing countries.

### Changing Technology Scene : Policy Aspects

In view of their unique characteristics based on information intensive technique, AMs have been changing the technology scene of the world. Many of the knowledge-driven advances in Materials Science can be channelled towards development needs. Examples are rapidly solidified structures, sprayed and vapour-deposited materials, nano-phase materials with controlled interfaces and properties, surface processed materials and mechanically alloyed materials. They are fast replacing conventional materials, techniques and applications in production processes. In many of the modern-day industries particularly from the aerospace, automotive, communication, informatics, and military sectors, traditional materials have reached their limits in sophisticated applications. There is a need for new materials in these industries. This has encouraged and promoted research into new advanced materials and emerging technologies for application and commercialisation purposes. Advanced materials and techniques are largely utilised at present in high-technology growth sectors. Advanced materials with superior properties enter as intermediate inputs in aircrafts, microelectronic devices, cars, telecommunication equipment, military hardware etc. Developments in material science and engineering will facilitate innovations in technologically advanced sectors, providing for international competitiveness. The high-tech industries promote the AMT base in their respective countries. However, these developments are not continuous with the developments in the traditional materials sector. AMs constitute a discontinuity in terms of material evolution in that they require new types of inputs, processes and technology, industrial structures, organizational patterns and product characterisation. This calls for appropriate policies aimed at establishing new patterns of production and consumption of materials.

**In view of their unique characteristics based on information intensive technique, AMs have been changing the technology scene of the world.**

Distinctively, in the area of AC for high temperature applications the following trends have been projected (Monitor, 1991; Wyatt, 1987). Amongst the ceramic materials, $Si_3N_4$ based materials can be used upto 1250°C (which may be extended upto 1440°C) while monolithic SiC (upto 2000°C) has better performance at high temperature but exhibits low fracture toughness (FT) (5 MPa $\sqrt{m}$). Composite technology as applied to ceramics can improve FT upto 10-15 MPa $\sqrt{m}$ at high temperatures to overcome the design limits of the monolithics. There would be improvement of processing techniques through better understanding of the basic mechanism involved in sintering, high temperature deformation, coating cohesion. There are possibilities for the development of a new range of particulates with controlled morphology and chemical compatibility with matrices such as $Si_3N_4/SiC$; all of these have great implications for appropriate processing equipment and instrumentation as well as production planning, calling for policy facilitated changes.

A number of research projects with high future impact have been identified and a number of R&D collaborative programmes chalked out by various committees under the Commission of European Committees such as BRITE/EURAM/EUREKA etc. (Monitor, 1989).

The development of structural ceramics activity in USA and Japan has been planned in such a way that commercialization should go hand in hand with technological development, particularly for major programmes.

A multi organization sponsored Japanese National Gas Turbine Project has been initiated in 1988 with a total budget of $ 114 m for a period of 9 years; a 100 KW ceramic gas turbine for passenger cars and a ceramic engine for 300 KW cogenerator system are under development under this programme (Monitor, 1991).

An examination of the overall growth pattern in AMs shows that this sector is separating more and more from the dynamic axis of industrial growth. This would pose greater threat for the use of demand for conventional materials (Choi, 1983). Developing countries such as India are slow in realizing the need for adopting similar strategies to take the benefits of new frontiers of technology along with the dangers posed to the primary commodities produced by them. In fact, this has greater relevance in planning the materials programmes of a developing country like India. In view of the increasing dependence on knowledge based sophisticated processing aspects of AMs with potential implications for industrial energy and natural resource management policies, development strategies based on export oriented production of traditional ores/metals or alloys and other materials have become obsolete. The advantages due to plentiful mineral resource availability, cheap energy and labour is diminishing.

### AMs and Diffusion Dynamics

A definition of the advanced materials should address the question of why they are important for the recent developments in world economy and how they are to be introduced in the market. These materials are developed to satisfy sophisticated and specific needs in response to the new requirements of market evolution or else as the result of scientific and technological advances. The recent changes are not what constitute incremental innovations in terms of material evolution. The transition to new materials development is guided by considerations of gains in competitiveness and hence effected through policies aimed at opening up new areas of economic growth which help in gaining competitiveness at the national and international market. Advanced materials have been developed in accordance with the objectives emphasized by the new mode of world production introduced in the late seventies in industrialy advanced countries and aimed at effecting savings in raw materials, energy and labour inputs, while adding flexibility to the production processes. Several branches of manufacture in industrialized countries are undergoing considerable restructuring accompanied by a transformation of production technologies. Changing structure calls for improvements in the materials front leading to a faster diffusion of advanced materials within manufacturing industry. The advanced materials sector is thus emerging as a major new technology transforming the process and production base of several industries. This will have an impact on product and process innovations, manufacturing technologies and resource-based industries, thus giving further impetus towards technological and organizational transformation of industry.

**Advanced materials have been developed in accordance with the objectives emphasized by the new mode of world production.**

Advances in materials and techniques imply obsolescence of existing materials also. In this sense the impact of AMs is directly related to the long term changes in the techno-economic paradigm. Some of the recent advances and changes in terms of materials evolution are in the nature of radical innovation, which (combined with incremental innovations) results in far reaching changes in both technical and organizational modes lending support to the current techno-economic restructuring. As the literature concerning long waves indicates, each period has been associated with the development of some industrial sectors and also some group of materials (Dosi, 1984). The age of steam power was associated with the development of coal and iron industries. The spread of railway system was closely linked to the steel industry. Throughout the 20th century, the period of prosperity has been connected to the upsurge and consolidation of the car and electricity industries which were strongly linked to the birth and development of the oil, chemical and metal industries. In the same way, the development of advanced materials has been associated with world's new production cycles led by information technology and affecting and reorganising the whole industrial basis as well as contributing to synergic and novel perspectives on developments. These can, therefore, be understood as knowledge and technology intensive materials developed to fulfill the sophisticated product specifications to satisfy necessary conditions for the establishment of a new economic cycle. One result of the recent advance is that the new materials are competing with traditional materials. For example, new polymers and composites with sophisti-

cated mechanical functions are competing with materials in structural applications. Advanced ceramics are proving superior in applications requiring thermal, magnetic and electronic functions.

The advent of advanced materials constitutes a major discontinuity. With the establishment of a new pattern of production and consumption of materials, this is playing an important role in the process of industrial restructuring. As already mentioned the recent changes are not incremental and rise from strategies adopted outside the traditional material sector. For example, very few metal producers in the US and Europe have shown interest in or the capability of entering this new and high tech sector. But the contrary is true in Japan where the development of advanced materials has been one of the national priorities backed by a Government policy for industrial restructuring. The development, design and production of advanced materials rely on the use of information intensive techniques and the required new patterns of work and industrial organisation. For example, inflexible mass production has become increasingly unsuitable in conditions of product differentiation, consumer sophistication and fast technological changes. The new plants designed to produce advanced materials are operated by 'multi skilled' labour force and make 'multi materials', utilising advanced informatics.

In this sense, the material evolution is leading to a long term structural change that can be characterised as a 'trans materialization' of production (Lastres, 1990; Suresh Kumar, 1990). This is particularly true since there is a constant decline in the use of materials due to miniaturization, decreasing the requirements of materials needed by industrial processes. A considerable saving of materials has been effected by information technology also.

There is a well defined trend towards the process of advanced materials being used as substitutes for basic metals. For example, some polymers and composites are deployed in the car industry and optical fibres displace copper wires in telecommunications. The advent of AMs goes beyond the process of materials substitution. Opportunities are open for the development of entirely new materials. Therefore, perhaps the most important aspect relating to the development of these advanced materials is the fact that they have been seen as a necessary and strategic issue in terms of opening new paths of growth and strengthening new industrial competitiveness. In this respect, the best example is Japan which has evolved specific action oriented policies towards the development of advanced ceramics focussing on building up new capabilities and establishing new patterns of production and consumption of materials comprehensively in selected areas. The current scenario thus presented them with an opportunity to establish a new technological and economic leadership in such a pervasive area. To a lesser extent, this is also true for US and Europe where policies have evolved from national perspectives on new materials of choice and preference for effecting global competitiveness and marketing campaign successes. Specific actions at micro-levels are derived from a macro level of such policy options and imperatives. The developing economics have a lot to benefit from these experiences abroad.

The total amount of investment for R&D in Korea is expected to increase to 5 percent of GNP in the early 2000s. R&D investment is sought to be given to materials-related technology, for which 30 percent of the national R&D project funds would be allocated. Grouping under the fine chemicals, biotechnology, new materials and manufacturing processes, the major chunk of the funds (as high as 25 to 30 percent) is expected to be devoted to new materials related activities.

**Policy Issues**

It has been found from experience that small scale research carried out by a principal investigator with a small team is a cost-effective measure to innovation; at the same time, it has also been widely appreciated that large multi-disciplinary teams are more effective for addressing industrial problems.

At the governmental level jointindustry - university - national laboratory efforts have to be planned for in a complementary manner and with selected duplication to generate healthy competition.

A balanced national programme for resource facilities, research laboratories and other regional facilities should be developed. Materials centres in developing countries can, through national and international efforts, promote cooperation between disciplines and between laboratories and develop into specialised institutions in specific fields. The centre should provide a mechanism for several parts of the technical infrastructure to come together such that an atmosphere is created for quick development and communication of the results of research. The separateness in science and technology in research institution in most developing countries call for such centres to combine these components in a

common endeavours, with industrial inputs also factored in, so that such materials centres can function as catalysts of industrial change. In addition, training of scientists and industrial personnel can be combined in such an endeavour with funding the intellectual support from academic centres, government and industry. Such a coordination and integration will help to develop the competitiveness of industry in the third world. There has to be a stronger coupling between needs and opportunities. For this, people who understand applications based on new materials or incremental improvements in current materials and processes have to be involved in the structuring of applied programmes. This alone can bring about the much needed understanding and cooperation among those who generate knowledge and those who apply it.

**A balanced national programme for resource facilities, research laboratories and other regional facilities should be developed.**

Research laboratories have a central role to play in any joint university-industry-government effort. This alone can bring about greater link up between the scientific and engineering aspects as well as stronger industry-university interaction. Research laboratories can also facilitate the formulation and dissemination of broad and large-range goals that go beyond the strict confines of programmatic or disciplinary boundaries.

Besides the crucial role of the national laboratories, the government also has a critical facilitatory role to play in areas such as building consensus in such topics as evolving research opportunities, identification of barriers to development, broad efforts to overcome bottlenecks and personnel development to meet the challenges abroad. For example, emphasis has to be given at both graduate and undergraduate levels to develop new courses and new text books broadening the intellectual foundation in general. Only the government can effectively promote industry consortia or academy-lab-industry joint programmes.

Technology Forecast (TF) and information dissemination help to identify material problems of the future vis-a-vis competitiveness and industrial production. Government policy is also an important consideration in effecting fruitful technology transfers from abroad. Technology Transfer (TT) negotiations are important since no country can be self-sufficient in technology.

It is not enough that we have a national body for data building up, coordination and diffusion. State level forums have a vital role to play in facilitating effective interactions with small business and pilot centres attached to universities/research centres. There can be a separate apex body to coordinate the activities of these state level forums with S&T industry and energy ministries.

Thus the Government has a role in:

- Building consensus among the parties involved so as to evolve research opportunities, identify barriers to development and prepare an action plan for an attack on deficiencies.
- Promoting cooperative interactions by creating of joint forums/programmes.
- Identifying industrial needs through effective TF programmes.
- Communicating industry needs for evolution of appropriate action programmes and balancing various programmes related to AM development and diffusion by bringing together the various groups involved, and enhancing communication, interaction and coordination among the various sectors affected by materials science and engineering.
- Setting up a central organization to stimulate the market introduction of AMs for high technology products and to encourage international trade through collaborative efforts in the development of data base, test methods etc including standardisation; such a body can collaborate with similar international bodies such as VAMAS set up by seven countries to help in standardisation of new materials, irrespective of variations due to local materials and test methods so that a reference criteria is met for competition in the area of AMs internationally.

It is hence strongly recommended to create a separate Council on New Materials for National Technology, spelling out the Governmental role and facilitating the other roles.

## Conclusion

Vast changes are being brought in the emerging scene of Materials Science and Engineering due to

advanced materials development programmes of the developed nations. This has wide-ranging impact on the developing economies. The entire production-consumption and resource utilization patterns are undergoing a restructuring that heralds in a new techno-economic paradigm based more on tailor-made applications rather than on physical factor endowment. Unless developing countries like India adopt a long-term plan as a policy measure on this front, the competitiveness of national technologies will be seriously hampered. Developing countries will need to be increasingly integrated in the world economy. The installed capacity in various fields may be subjected to rapid product and process obsolescence, without indigeneous capacity to respond technologically to changes in materials. This calls for implementation of joint schemes and collaborative arrangements for a knowledge-base attack on remodelling the traditional materials sector and also to forge ahead on the front of advanced materials. The government, national laboratories and materials forums have a vital role to play in this regard.

**Unless developing countries like India adopt a long-term plan as a policy measure on this front, the competitiveness of national technologies will be seriously hampered.**

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Feature

# Productivity Measurement in Health Care Service

**Omprakash K. Gupta**

*This study examines the issue of productivity measurement in the service sector with specific reference to one major segment namely the health care services. As health care costs began to rise dramatically in 1960s, productivity became a magic word in the health care industry. The challenge of productivity soon became a challenge of measurement. In this context, the study reviews traditional methods of productivity measurement used in the service sector and health care industry. In addition to surveying pertinent literature, interviews have been conducted with hospital management personnel involved in measuring the productivity of their employees and facilities as well as others who consult in this area. Finally, conclusions and recommendations are presented of the future of productivity measurement in the health care industry.*

*Omprakash K. Gupta is from the Indiana University Northwest, Division of Business and Economics, 3400 Broadway, Gary, IN 46408-1997.*

Productivity measurement in the United States has received considerable attention in the past decade from the media, business and public policy makers. Much of this renewed interest is attributable to concerns over declining rates of productivity growth in this country compared to the rest of the industrialized world. Many of the methods for measuring productivity in the industrial sector of the economy have been in use for many years and have been continually refined along with improvements in information gathering and processing technology.

The traditional approach of measuring productivity is to calculate it as a ratio by dividing quantity of output by quantity of input or inputs required to achieve the output. A typical method, and probably the most universal approach for making international comparisons, measures the number of units produced per direct labour hour presented in terms of gross domestic product (Packer, 1983).

## The Service Sector

The service sector offers some of the greatest opportunities for productivity improvement while at the same time presenting some of the greatest challenges. The ability to more accurately measure service sector productivity is extremely important in assessing the economic vitality and progress mainly because of the sheer size of the service economy in the United States. In 1986, of the 1.2 million new jobs created, more than 80 percent were in the service sector alone (Ross & Shaw, 1987), Recent studies (Lee & Schniederjans, 1994) show that service industries employ more than 77 percent of U.S. workers, whereas manufacturing represents only 18 percent of total employment. Furthermore, approximately 90 percent of new jobs ae created in the service sector.

Though the United States still lags behind many industrialized nations, there has been a remarkable improvement in the manufacturing sector. Unfortunately the service sector has shown almost negligible growth, and with its increasing share in the economy, it has contributed to declining growth in overall productivity. Various other studies also indicate that there is a great need and potential for improving productivity in the service sector and that initially, positive results would be relatively easy to achieve. Estimates for improvement range from 9 to 10 percent, translating into significant bottom line increases (Ross & Shaw, 1987).

Despite the consensus that enormous service sector productivity gains can be realized there has been little in the way of practical implementation of the methods espoused in the literature. This is due to one major problem. Measurement of output by service workers is not at all easy and the expense to pin-point the actual costs of inputs can be prohibitive. Many managers cannot readily define a service worker's output in absolute terms, requiring more subjective definitions that are open to varying interpretations. In addition, most hospitals do not have the necessary systems in place to capture the required cost information to compute measures of productivity.

In health care, though inputs are tangibles such as equipment, supplies, facilities, and human labour, the outputs are intangible (Jordan, 1994). The outputs are affected by patient acuity that cannot be easily quantified. A simplistic solution to this problem was proposed by Omachonu & Nanda (1989) where they suggested that outputs and inputs should be defined in monetary terms. Despite the difficulty involved in defining and measuring the elements of input and output in the service sector it is imperative that the problem be solved for two reasons. First, because increasing productivity is paramount to improving profitability and remaining competitive. Second, because methods to improve productivity can not be implemented unless some baseline exists against which to develop a plan for action and control performance.

**Methods to improve productivity can not be implemented unless some baseline exists against which to develop a plan for action and control performance.**

While there is a wealth of literature on the subject of productivity in the service sector, many authors offer only generalized or incomplete solutions to the problem. For instance, DeFuria & Shimshak (1988) outline four criteria necessary to evaluate performance in the health care industry. These are productivity, effectiveness, efficiency and quality. They define these criteria and draw some debatable and puzzling conclusions. For example, they describe the health care industry as "high customer contact" defined as one "characterized by the extensive physical presence of the customer in the system." From this they conclude that "high contact systems should seek to maximize *effectiveness* while low contact systems should seek to maximize *productivity*." The supporting logic suggests that high customer contact systems are inherently limited in their ability to achieve productivity and therefore it should be abandoned as a goal in such systems.

There are a number of problems with this approach. First, the authors treat effectiveness and efficiency as separate from the issue of productivity when, in fact, most managers would recognize them as components of the total productivity equation. That is, by implication, managers and other employees must use available resources efficiently and effectively to be more productive than a competing firm. Conversely, it is hard to imagine high productivity with low efficiency and effectiveness. Second, even "high customer contact" businesses need to find ways to measure and improve productivity, for reasons alluded to earlier. Therefore, while offering suggestions for measuring performance in the health care industry, the authors seem to conclude that focussing on productivity in this sector of the service economy is futile and they fail to offer a solution to the productivity problem for high customer contact organisations.

### The Health Care Industry

Nowhere in the service economy is the need for reliable methods of measuring and improving productivity more pressing than in the health care industry and for hospitals in particular. According to Grandfield (1992), the improvement of nursing productivity is a key function of first-line nurse supervisors. She argues that productivity management must synchronize the organizational goals of quality health care at reasonable costs, with the professional goals of independence of judgement in professional practice. A combination of skyrocketing health care costs, increased competition for providing services and changes in various methods of health care delivery have changed the way hospitals operate and compete.

**Nowhere in the service economy is the need for reliable methods of measuring and improving productivity more than in the health care industry.**

Traditional approaches to productivity measurement in health care use full-time equivalents (FTEs) and productive equivalents (PEs) as indicators of inpatient operational productivity. The only modification to this measure was in the late 1960s when the use of outpatient hospital services increased dramatically. An adjustment was made to account for this trend by calculating FTEs per adjusted occupied bed as an enhanced productivity indicator. The computation for this adjustment is shown in table 1. This adjustment factor was an attempt to account for the increasing amount of hospital revenue that was coming from outpatient services, not properly reflected in previous FTE calculations based mainly on inpatient revenue.

**Table 1 :** Comparison of FTEs per adjusted occupied bed to actual

| | | |
|---|---|---|
| Total FTEs | 1,000 | Assume 200 occupied beds average |
| FTEs related to inpatients | 800 | Inpatient Revenue 90 percent |
| FTEs related to outpatients | 200 | Outpatient Revenue 10 percent |

$$\frac{1{,}000 \text{ FTEs}}{200 \text{ Beds}} = 5.0 \text{ FTEs per occupied bed}$$

Inpatient related:

$$\frac{800 \text{ FTEs}}{200 \text{ Beds}} = 4.0 \text{ FTEs per occupied bed}$$

Outpatient has the other 200 FTEs.
Adjusted occupied beds = 200/.9 = 222
But with FTEs per adjusted occupied bed:

$$\frac{1{,}000}{222} = 4.5 \text{ FTEs per adjusted occupied bed}$$

Alternatively,

$$\text{Adjusted occupied beds} = \frac{\text{Total revenue}}{\text{Inpatient revenue}} \times (200) = \frac{100\%}{90\%} \times 200 = 222 \text{ Adjusted occupied beds}$$

Source : Hospital & Health Services Administration, August 1987, p.387

Serway, Strum & Haug (1987) identify three major changes that have influenced the way hospitals deliver health care and medical services that have, in turn, demanded changes in the way hospitals measure productivity. This thorough and exhaustive study examines these changes in the light of traditional health care productivity measures (namely, FTEs per adjusted occupied bed) and offers specific recommendations for alternative approaches. The analyzed ten months of actual data from four hospitals in a multi-hospital system based in Los Angeles.

*Operational/Definitional Factors*

The first factor influencing productivity measurement in attributed to operational differences in the way hospitals are managed and differences in formula definition that tend distort the use of FTEs as a productivity measure. It is important to note that the use of FTEs per adjusted occupied bed as a measure of productivity stems from the recognition of labour as the largest portion of total expenses related to health care delivery. Operational problems stem from changes in the way hospital organizations are structured. Increased use of shared services, contract employees and consultants, hospital affiliates on the payroll and skill-mix changes all serve to distort the true costs associated with providing services in typical FTE measurement.

For instance, with respect to skill-mix changes, a hospital can hire two technicians to assist a pharmacist less expensively than hiring two pharmacists. The pharmacy is more productive, providing the same or greater amount of services at less cost. From an FTE standpoint, however, more hours have been used to do so, increasing FTEs and indicating lower productivity when, in fact, productivity has really improved. This is because FTEs measure service outputs versus labour inputs and tend to ignore expense monitoring. The primary definitional problems that distort FTE calculation include defining occupied beds, properly accounting for and measuring revenue, (to be discussed next), and the premise on which the occupied bed adjustment is based.

*Alternative Payment System*

The second major influence is the manner in which hospitals are compensated for their services, specifically the transition to diagnostic related groups (DRGs), or prospective payment plans. Hospitals now receive a fixed amount of revenue for providing a service related to a specific DRG. The implication for hospital management and productivity measurement has been an increased emphasis on controlling expenses associated with delivering services for each DRG. Productivity of labour, in this sense, is defined with respect to the amount of revenue brought in. Therefore, according to Serway et al., (1987) "the productivity focus should be expanded beyond FTE usage to expense management, through the review of patient acuity and clinical practice patterns and cost control of expenses." This has been the missing element of FTE calculation.

**"The productivity focus should be expanded beyond FTE usage to expense management, through the review of patient acuity and clinical practice patterns and cost control of expenses."**

Expense monitoring should also be captured on a per patient day basis because with DRGs the trend is toward shorter hospital stays. This means that more services are delivered in a shorter period of time, distorting productivity measured by FTEs alone. Detailed expense monitoring will allow the management to determine if the delivery of service per patient day is stable or changing and thus make decisions regarding the extent of labour usage needed. The extent by which to decrease or increase the amount of labour, however, is much less clear.

The service sector faces a similar dilemma as the manufacturing sector of finding the optimum point between leveling the work force to meet demand or constantly changing the size of the work force to *chase* actual demand. The decision is basically related to concerns regarding hiring and layoff costs, morale considerations as well as the costs associated with being understaffed (or being out of stock, in the case of manufacturing).

The important point here is that productivity is also related to the issue of capacity utilization. That is, there are certain economies of scale associated with a greater number of services provided i.e., more services being consumed in one day by the same staff. Typical FTE calculations alone will not account for this aspect of productivity.

**Productivity is also related to the issue of capacity utilization, there are certain economies of scale associated with a greater number of services provided in one day by the same staff.**

*Capitated Health Plans*

The third major influence on productivity measurement has been the rapid emergence of capitation or prepaid at risk pans for providing medical and health care services. These include health maintenance organizations (HMOs), preferred provider organizations (PPOs) and comprehensive medical plans (CMPs). The management challenge here is, again, one of accurately monitoring and assigning appropriate costs to the level of service provided. This becomes difficult under capitation plans because the revenues are not directly realized when the services are provided. Under such plans, there is a promise to provide services purchased on a predetermined, prepaid financial arrangement.

The risk for the cost of delivery under capitation plans is placed directly on the provider. The commitment to provide patients with service remains a liability of the provider to deliver at some future date, much like checking account deposits are a liability of a bank. For this reason, careful managing of revenues (received in advance) and gaining control of operational expenses are a necessity.

Each of these influences have collectively demanded that hospitals take a hard look at their internal operations and implement systems to accurately account for expenses by more directly relating them to revenue produced where possible. These influences challenge the validity of FTEs per adjusted occupied bed as the single indicator of productivity.

**Alternative Productivity Measures**

To supplement FTEs, Serway *et al.* (1987) recommended a number of important financial ratio measures that are "urgently needed" in light of the factors influencing hospital operations. These include ratios of :

Total operating expenses/net patient revenue

Capitation expenses/net capitation revenue

Productive and non-productive salary expense/net patient revenue

Productive FTE expense/net patient revenue

Productive FTE expense/adjusted patient day

The authors contend that productivity, defined as "how much output for a unit of input," can be adequately measured by such financial ratios. Table 2 shows an example of these ratios calculated with sample data. The results of these measures provide an expanded view of operational efficiency, and hence productivity, beyond standard FTE measurement.

tivity decrease. Thus, by using several measures, the productivity of one dollar of productive labour expense seems to have decreased, despite the initial conclusion of stability via FTE measurement alone.

### Implementing Alternative Productivity Measures

Meeting the challenge of generating alternative productivity indicators is ultimately a cost accounting issue. This is evident in the light of our original definition of productivity as the ratio of output divided by corresponding inputs. Cost accounting necessarily plays a major role in the management's ability to determine the profitability of the output by carefully identifying and analyzing the actual costs involved to produce them. Cost analysis has long been recognized and applied in

**Table 2 :** Alternative prodctivity measures — example data

| | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. |
|---|---|---|---|---|---|---|
| FTEs per adjusted occupied bed | 4.36 | 6.408 | 4.806 | 4.806 | 5.073 | 5.34 |
| Adjusted patient days | 6,582 | 6,063 | 6,776 | 6,907 | 6,210 | 6,586 |
| Total operating expense/net patient revnue | $4,593,000 / $4,947,000 | $4,502,000 / $4,751,000 | $4,875,000 / $5,041,000 | $4,988,000 / $5,157,000 | $4,514,000 / $4,647,000 | $4,972,000 / $4,714,000 |
| Percentage | 92.8% | 94.7% | 96.75% | 96.75% | 97.15% | 105% |
| Ratio captiation expenses/net captiation revenue[1] | $190,217 / $258,804 | 141,788 / 287,953 | 149,970 / 333,132 | 448,948 / 382,228 | 369,520 / 382,639 | 361,667 / 384,596 |
| Percentage | 73.49% | 49.24% | 45.02% | 117.0% | 96.57% | 94.0% |
| Ratio prod. and nonprod. salary expense/net patient revenue | $2,471,033 / $4,947,000 | 2,406,814 / 4,761,000 | 2,414,372 / 5,041,000 | 2,512,626 / 5,157,000 | 2,175,617 / 4,647,000 | 2,335,692 / 4,714,000 |
| Percentage | 49.9% | 50.7% | 47.9% | 48.7% | 46.8% | 49.5% |
| Ratio productive FTE expense/net patient revenue[2] | $2,001,948 / $4,947,000 | 1,925,278 / 4,751,000 | 1,924,190 / 5,041,000 | 2,124,570 / 5,157,000 | 1,912,536 / 4,647,000 | 2,058,948 / 4,714,000 |
| Percentage | 40.47% | 40.5% | 38.2% | 41.2% | 41.2% | 43.7% |
| Ratio productive FTE expense/patient day | $2,001,948 / $6,582 | $1,925,278 / $6,063 | $1,924,190 / $6,776 | $2,124,570 / $6,907 | $1,912,536 / $6,210 | $2,058,948 / $6,586 |
| Productive FTE expense per adjusted patient day | $304.15 | $317.54 | $283.97 | $307.60 | $307.97 | $312.62 |

Notes: 1. Provides the contribution margin by product line
2. Productive FTE expense includes contract employment, regular, overtime and called-back hours worked by salaried employees.

Comparing the results of December and January, we find that FTEs indicate that productivity has remained stable at 4.806. Indeed, total operating expenses as a percent of net patient revenues also remained stable for the same period at 96.7 percent. The results of the other indicators, however, tell a different story. The ratio of capitation expenses to net capitation revenue jumped significantly. Overall salary expense to revenue showed a decrease in productivity, as did productive FTE expense to net patient revenue. Further examination of records showed that the hospital gives management raises in December, accounting for some of the productivity decrease. Thus, by using several measures, the productivity of one dollar of productive labour expense seems to have decreased, despite the initial conclusion of stability via FTE measurement alone.

the industrial sector but, according to Possett (1980), executive vice president of Sebrite Mortgage Company and a CPA, such an approach has been "only infrequently applied in the service sector".

**Cost accounting necessarily plays a major role in the management's ability to determine the profitability of the output by carefully identifying and analyzing the actual costs involved to produce them.**

The difficulties with the accounting in the service sector are similar to those experienced in the manufacturing sector, although much more pronounced. That is, correctly identifying the real "cost drivers" associated with revenue produced is a major management challenge in the services industry. Ideally, one would be able to draw direct cause and effect relationships between all of the expenses involved in providing a service and the revenue produced by the activities. This is especially difficult in today's hospital environment with the use of contract labor, shared services between hospital departments and skill mix changes, among other reasons previously discussed. This atmosphere makes the cause and effect determination between revenues and expenses less clear and often subject to arbitrary allocation methods that may mask or distort the true productivity of a given hospital department.

**The difficulties with the accounting in the service sector are similar to those experienced in the manufacturing sector, although much more pronounced.**

"The standard costing process," states Mr. Possett (1980), "facilitates management's evaluation as to whether or not the economic activity of the enterprise is being carried on efficiently." Mr. Possett suggests that, to begin with, management must recognize, define and think about the detailed breakdowns of work activity in the firm and, he notes, this will require a significant research investment on the part of the company. Mr. Possett began by studying his own company with the initial objective of finding one all encompassing productivity measure, which he termed an "omni-measure." This objective was quickly discovered to be unrealistic.

Much like the hospital study, Sebrite Mortgage Company is a firm with a high degree of customer contact involved in providing its service. This means that the major resource input, employees, are subject to uneven work pressures throughout the day and a single productivity measure is inadequate. Mr. Possett acknowledges that for this reason his firm needed to measure productivity "by several bench marks to gain insight and judgement on pricing." This notion confirms the conclusions reached by the hospital study which recognized the need for alternative productivity measures beyond FTEs. This conclusion also rejects the findings of DeFuria and Shimshak that measuring productivity in "high customer contact" businesses is not plausible or attainable.

**The major resource input, employees, are subject to uneven work pressures throughout the day and a single productivity measure is inadequate.**

In a personal interview, a senior executive of a large compensation and benefit consulting firm in the United States confirmed that, "the cost accounting system is crucial" to accurately measure health care productivity. He recommends that for internal costing purposes the accounting system should be tied to a flexible budgeting approach using "reliable standard that are based on DRGs." Flexible budgeting is a method to adjust a budget for differences in volume while using the same standard unit costs.

Cost standards should be DRG based because this is where fixed amount of revenues come from. The logic follows that if expenses incurred are tied to some other revenue base, profitability and productivity results will not be as useful for management decision making and control purposes. This, of course, requires that the accounting systems require a certain degree of sophistication to capture all of the information necessary for comprehensive profit and productivity measurement.

In another interview, the manager of budgets and reimbursement of a large hospital in Indiana agreed that productivity analysis is useful and expressed concern regarding the ability of even the most sophisticated cost accounting systems to provide all of the needed data. She thought that there are too many variables involved in providing health care services that can cause a problem with accurately attaching every expense to the activity that produced the revenue. The causal relationship between expanses and the revenue is not always clear cut, and therefore one must be careful in their interpretation of expense to revenue ratios. A typical hip replacement surgery was referred to demonstrate this point. Attempting to standardized costs and routines based on a physician performing a typical surgical procedure is very difficult. In the case of hip replacement, a physician may prefer to use a hip that costs between $6,000 and $7,000 with a lifetime guarantee because this is what he or she has used in the past, while a hip that costs half as much, with a 25 year guarantee, will do the job just as well for most elderly patients. In order to develop cost standards for this procedure, physicians must analyze the situation and select a hip replacement that, according

to established standards, best meets the patient's needs rather than making a selection based on personal preference. In addition, if the hip replacement patient comes in with multiple medical problems that require treatment at the same time, this will serve to further cloud the standard cost picture. In this case, the cost base or standard used will have to accommodate other medical services administered in addition to the hip replacement. For these reasons, she found that standard costing is a difficult concept to implement in a hospital environment.

Because of cost allocation difficulties due to organizational structure factors and skill mix variability mentioned above, she maintains that "physician practice patterns must be analysed as well." This is necessary, she insists, because physicians ultimately "control the admission and discharge process" for various medical services and this ultimately affects the total cost of services. "Physician practice patterns" in this respect refer to the ability and willingness of physicians to conform to the standards set forth by the government established DRG system. This is currently a problem at her hospital, and is directly related to a lack of commitment on the part of the Board of Directors to insist that physicians operate within and comply with a DRG based environment. This situation can create a "political climate" and affect the results of productivity enhancement measures. She believes "flexible budgeting is realistic" and that DRG based cost standards make sense but DRG standards may not be appropriate for every hospital. One consideration is the hospital's actual "Medicare base" as a percentage of total revenue. It also depends on the probability that the state of Indiana will shift to a DRG based Medicaid disbursement plan as other states have done, thereby making DRG based revenues a larger proportion of total revenue.

**"Physician practice patterns must be analysed as well." Because physicians ultimately "control the admission and discharge process" for various medical services and this ultimately affects the total cost of services.**

Finally, it was stated that implementation of an accounting system to track productivity measures can be very difficult for hospitals that have not operated under such methods before. At her hospital, implementing the budgeting process itself is very time consuming because it is a learning process for everyone involved. The education process is especially difficult for those workers who are actually involved in providing medical services and have never been exposed to or operated under budgetary conditions before. The ultimate benefits are however worth the effort and that they will be necessary for future survival in the health care industry.

**Implementation of an accounting system to track productivity measures can be very difficult for hospitals.**

## Conclusions

The issue of productivity measurement in the service economy is a difficult one to resolve, as feasible and accurate methods of measurement have either not been perfected or simply do not exist. Most managers and experts agree, however, that there is ample room for improvement in this growing portion of the economy. Many service sector businesses, such the health care industry, have sought ways to measure productivity out of necessity to survive in an increasingly complex and competitive environment.

For the health care industry in particular, not all of the measures outlined and recommended in this paper and in the literature are available for comparative analysis across facilities. More importantly, not all these measures are captured or even available within many hospitals due to a lack of appropriate accounting tracking systems. Where productivity measures are documented, traditional measures such as FTEs per adjusted occupied bed or adjusted patient day are no longer appropriate because productivity involves more than efficiently using labour alone. To look only at productive FTE expenses neglects the changes in revenue and medical care delivery brought about by per capital programs with reduced patient days and shorter stays. Thus, the traditional measures must be complemented with more expansive ratios that will capture related expense measures as well.

**Traditional measures such as FTEs per adjusted occupied bed or adjusted patient day are no longer appropriate because productivity involves more than efficiently using labour alone.**

Old rules of thumb for measuring productivity in hospitals are no longer appropriate in the light of new payment approaches and other operational and organizational innovations. The recognition of the need for productivity measurement, cost determination and the commitment of resources to satisfy the need will come slowly to some and, regretfully, they will be the followers.

Indeed, the days have passed when productivity measurement in the service sector can be ignored because of the myopic view that it is too difficult or impossible to accomplish. As the United States continues to add service sector jobs relative to manufacturing employment, new and innovative ways must be devised to implement cost controls and standards for improvement. Otherwise the country will risk losing key service industries to foreign competition just as has been done in key manufacturing industries.

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The truth? You want to hear Americans do it better than anybody else.

They're kicking our butts. And that ain't luck. That's the truth. There's your truth. Sure, the great old American do-or-die spirit. Yeah, it's alive, but they got it.

*Hunt Stephenson*
*Gung Ho*

Feature

# PSU Disinvestment: Concepts & Practices in India

**Nand Dhameja**

*Disinvestment is seen to be the panacea to cure all the evils dogging public sector enterprises. The author elaborates on the principles involved in this practice and cautions that the exercise is bound to be useless if the government does not lay down a policy for the use of funds realised on disinvestment for the development and rehabilitation of the concerned enterprise*

*Nand Dhameja is professor in the Indian Institute of Public Administration, New Delhi 110 002*

**Privatisation : Origin**

Privatisation which is said to have originated from Great Britain, where the then Prime Minister sold public enterprises to private individuals, has made inroads in more than 100 countries and "it is hard to find a country without privatisation programme, or a sector of activity not susceptible to private management if not ownership." (World Bank Policy Research Bulletin, 1993. Also see Kikeri Sunita et al, 1994; Ramamurthy Ravi, 1991). A conservative estimate of the number of public enterprises privatised exceeds 15,000 and hundreds of billion dollars have been realised by privatisation in various countries.

The Industrial Policy (Statement of Industrial Policy, 1991) announced by the Government of India in 1991, as a part of economic reforms, laid-down a new approach towards public enterprises by which the public sector was to play its rightful role in evolving socio-economic scenario of the country. Government holdings in selected Public Sector Units (PSU) were to be disinvested with the objective to provide further market discipline to the performance of public enterprises. The Finance Minister in his budget speech to the Parliament stated that in order to raise resources, encourage wider public participation and promote greater accountability, upto 20 per cent of Government equity in selected public sector undertakings would be offered to mutual funds, investment institutions in the public sector and also to the workers in these firms. The Government later on also decided to disinvest upto 49 per cent of the shares of PSUs, with the target disinvestment of Rs 2,500 crore, Rs 3,500 crore, Rs 3,500 crore and Rs 4,000 crores for the years 1991-92, 1992-93, 1993-94 and 1994-95 respectively. Target for the year 1995-96 is Rs 7,000 crore.

## Disinvestment: Conceptual Aspects

Why to disinvest? Which PSU to disinvest? What is the mechanism of disinvestment? What are the possible steps of disinvestment?

*Objectives*

Disinvestment of share holding of PSUs by the Government may be in response to the demands of the various financing or donor agencies, and/or a part of economic reforms pursued. Objectives are always with respect to time frame: immediate objective of disinvestment may be to mop up resources, or a long-term objective may be to enhance efficiency and improve the performance of PSUs and to realign with the developments in the industrial and economic policy pursued by the government. Rangarajan Committee (1993) appointed by the Government to advise and make suggestions and recommendations on various aspects relating to disinvestment of shares in PSUs has laid-down the following as the broad objectives of disinvestment:

**Immediate objective of disinvestment may be to mop up resources, or a long-term objective may be to enhance efficiency and improve the performance of PSUs and to realign with the developments in the industrial and economic policy pursued by the government.**

As an immediate objective to mop up resources of non-inflationary character to meet the budgetary needs which include requirements of development activities and social obligations.

To subserve, in the medium term, the overall fiscal objective of gradually reducing the fiscal deficit and bringing about a positive over-all impact on future liabilities and income flows to government.

To improve the overall economic efficiency by bringing about a more competitive atmosphere with emphasis on the cost and quality of product and service to the customers of public enterprises.

To enhance the efficiency of individual enterprises by imparting a new dynamism in the management of these enterprises through diversification of ownership and control and larger and freer access to the expanding capital markets in India.

To realign the extent of ownership, control and regulation in different activities consistent with the technological needs and developments in industrial policy.

*Selection & Limits*

Selection of PSUs for disinvestment is linked with the objectives. For mobilising resources, it is the profitable ones which are selected. However, it has to be in accordance with the overall economic and industrial policy as PSUs in the core areas and of strategic importance are normally to remain with the government and not opened up to the private sector (Dhameja, 1991). Sale of loss making PSUs is a cumbersome process, as it involves decision relating to its financial restructuring and other socio-economic considerations of deployment of human and other resources. To sum,

**PSUs in the core areas and of strategic importance are normally to remain with the government and not opened up to the private sector.**

- "To build up confidence in a programme of divestiture, it is advisable to start with some easier cases. The enterprises that lend themselves to rapid divestiture are profitable, nationalised companies in attractive industries with good medium-term prospects. Private companies that have been nationalised because they were unprofitable are more difficult to divest unless profitability has been restored and sustained. And preparing corporations that have always been in the public sector for divestiture takes time — sometimes several years. A programme of divestiture may therefore include the rapid divestiture of easy cases and the preparation for sale of more complex candidates later." (Coopers & Lybrand, 1991).

On the overall consideration that target level of disinvestment be consistent with industrial policy, the Rangarajan Committee (1993) recommended that:

- Percentage of equity to be disinvested should be generally under 49 per cent in industries reserved for the public sector and over 74 per cent in other industries.

- In sectors other than those reserved for public sector, the government should justify its continued holding of equity on considerations as an investor and not as owner. The government may hold more than 26 per cent of the total equity in enterprises with outstanding prospects, but the investment would need to be justified on the basis of growth potential and the scope of larger realisation and not on the basis of desirability of government control. The effort should, therefore, be to disinvest the holding at the best available price at the opportune time.

- The desirable level of public ownership may be reached with greater advantage to the PSU concerned and the government by expanding the equity base through public offering than disinvestment.

*Methods*

Disinvestment can be done by offering the shares to the financial institutions or to the public. Sale of shares to financial institutions can be either by auction or at a fixed price. For auction disinvestment, selected banks and financial institutions are invited to bid for tenders as per the laid-down norms, who in turn offload the shares purchased in the stock market. This process of disinvestment does not lead to broad basing the equity holding pattern of PSUs until the shares are listed on a stock exchange and are available to the public thereafter. This process of private placement of shares is relatively less cumbersome, involves less administrative expenses and results in higher realisation. However, there is a need to guard against consortium formation by bidders, and requires competitiveness among bidders. It raises a question: Will this process of disinvestment through financial institutions, not lead to transfer of shares to another government institution, when banks and financial institutions are government institutions?

**Auction disinvestment does not lead to broad basing the equity holding pattern of PSUs until the shares are listed on a stock exchange and are available to the public thereafter.**

Alternatively, disinvestment of shares to the public through the stock market commonly termed as public floatation, as normally followed by private sector companies, involves high publicity and other floatation expenses and net proceeds often are not so attractive. Direct sale to public through stock market requires fixation of share prices, is followed for bigger sale aiming at wider share ownership, so as to avoid cornering of shares by a few investors. The two principal conditions for a public floatation to succeed, are: a developed capital market to absorb the offer of shares; the PSU having a record of profitability and good prospects of maintaining it, so that it is attractive to potential investors. Further, such a mode of disinvestment requires publicity expenses, involves administrative problems of screening, the numerous applications received, large number of which may not be a serious offer. It may also be possible that the shares may go unsubscribed which may defeat the whole purpose of the exercise. Public floatation method has been followed for the sale of shares of public enterprises in U.K. Disinvestment can also be in the form of trade investment or 'Buy out deals' under which shares are sold as a process of negotiation to organisations, domestic or foreign, engaged in similar business. This form is suitable for industries of specialised nature like, telephone or telecommunication, electricity generation, airlines. It fetches the best price, though ownership is not broad based. This form of disinvestment is also followed in situations where the two conditions namely, a developed capital market, and the PSU being attractive enough for public floations, are not fulfilled.

Disinvestment by offering shares to the workers cooperatives is well accepted in practice and was followed in certain cases in UK. However, the share sale offer to employees has to be made attractive.

Another mode of disinvestment followed in various Eastern European countries like Hungary and Argentina has been by means of issuing 'vouchers' to the citizens, which provide entitlement for a certain number of shares against a specific price. However, there are certain restrictions for transfer of the shares by the investors to guard against cornering of shares by a selected few.

Under the 'piggy back method' of disinvestment, the Government simultaneously approaches the stock market alongwith the PSUs, when they float a public issue. This method increases the size of the issue and thus the excess supply of the scrip in the market is likely to affect the premium. However, it is reported to be quicker and less expensive.

To regulate the practice of cornering of the shares or creation of private sector monopolies resulting from disinvestment of shares, the government may hold a

'Golden Share' (as followed in UK) carrying a veto power without requiring any investment. Alternatively, the scheme of 'Hardcore Shareholders' as prevalent in France, may be followed, under which shareholders are supposed to maintain a long term stake in privatised firm. The Rangarajan Committee (1993) considered the concept of 'Golden Share' and felt that there may be constitutional problems of discrimination and suggested 26 per cent ownership wherever such control was necessary. (Also see Dhameja, 1993).

**To regulate the practice of cornering of the shares or creation of private sector monopolies resulting from disinvestment of shares, the government may hold a 'Golden Share' carrying a veto power without requiring any investment.**

*Implementation*

The process of disinvestment discussed above and illustrated in Fig. 1 entails clarity, of objectives, identification of PSUs, preparing of the PSUs, adopting appropriate mode of disinvestment. Preparing of the PSU concerned refers to conversion of departmental organisations, or statutory corporations into joint stock companies; restructuring of its capital structure in terms of commercially acceptable debt-equity ratio; restructuring of its manufacturing and infrastructure facilities may be injecting funds called 'green dowry'[1] and creating awareness of the strengths of the enterprise.

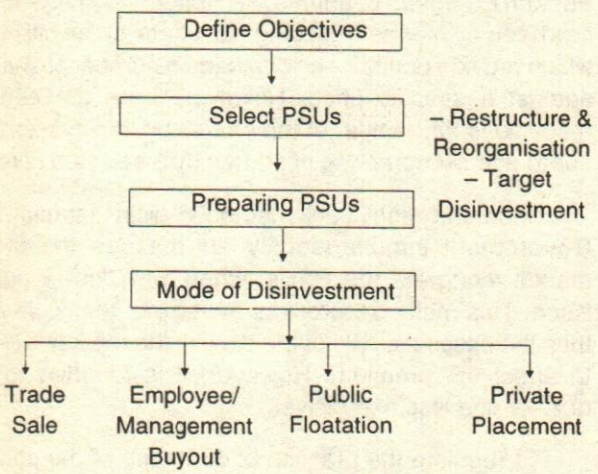



**Fig. 1:** PSU Disinvestment Process

For disinvestment by inviting tenders, Minimum Reserve Price (MRP) of shares offered for sale must be laid-down in advance. Similarly, for public floatation or for private placement, the share prices have to be fixed, since these shares have never been traded earlier in the market. Three possible methods of valuation of shares adopted are:

- Net Asset Value (NAV) indicates the value of the assets, but not the profitability or income to investors
- Profit Earning Capacity Value Method (PECV) is based on the profit actually earned or anticipated.
- Discounted Cash Flow Method (DCF) reflects the expected income flows to the investors.

Pricing of shares for disinvestment purposes should be more to reflect investor perception of the worth of the enterprise rather than the cost of assets to the enterprise. The following circumstances need to be assessed while fixing value of shares, particularly for PSUs (Rangarajan Committee, 1993):

- Whether the PSUs have been focussing more on discharging economic and social responsibilities indicated by the government rather than on projecting profitability to the investor
- Whether the book value of land and other facilities provided to the PSUs are reflected at lower than market value
- If the financing norm and debt-equity structure has not necessarily been based on commercial principles
- Gains or losses of PSUs in the past may have been due to the effects of administered prices; or recent policy measures may affect the immediate business prospects of some of the PSUs
- Whether heavy investment has been made in projects under construction or expansion programme undertaken by the PSUs
- Whether efforts have not been made to project the strengths of PSUs in the public eye and in the market.

The Rangarajan Committee (1993) recommendations as regards share valuation are as follows:

[1]For privatisation of Water Authorities in UK, the government injected funds called green dowry to cover third party debt and to help pay for environment improvement (Dhameja, 1993).

- Discounted Cash Flow Method, though the most difficult one, has greatest relevance.
- An explicit assessment of the scope and limits for selling non- income generating assets (land or buildings) and rationalising labour force (voluntary retirement scheme etc.) should be made.
- Government policies affecting future profitability (such as disappearance or guarantees of off-take or guaranteed rate of return) and their implications on the economic efficiency may have to be spelt out.
- Influence of social constraints in the past working of the PSUs and the extent of benefit accruing due to provision of certain under priced facilities like land should be captured and presented. Likewise, costs of projects under construction should be evaluated on a realistic basis and presented while reckoning the intrinsic worth of the PSUs.

Lastly, disinvestment is a complex long drawn exercise, and an apex level autonomous agency like a separate privatisation Ministry or High Level Board should be established to plan, coordinate and implement disinvestment policies. Other issues relating to disinvestment are: whether disinvestment should be an annual budgetary exercise or to lay down objectives with respect to time frame-should it be to meet routine expenses or to meet fiscal deficit or be a part of planning process to introduce competitiveness and market forces so as to improve the performance of PSUs?

## PSU Disinvestment in India

*PSUs Selected for Disinvestment*

The Department of Public Enterprises (DPE) under the Ministry of Industry, having the task of collection, evaluation and maintaining information relating to the working of PSUs, was involved with the exercise of disinvestment of shares of selected PSUs alongwith the concerned PSUs, their Administrative Ministries and Ministry of Finance. PSUs selected for disinvestment included profitable units other than from the power sector, or of strategic and defence importance. Accordingly, PSUs excluded for disinvestment were those under construction stage or of insignificant size, or having Net Asset Value (NAV) per share either negative or less than the face value, or non-profit organisations falling under Section 25 of Companies Act, or those functioning in power generation/transmission sector, or in which shareholding of the government was below 60 per cent, or those engaged in production of goods of strategic nature or for defence purposes. (Report of C & AG, 1993).

Thirty-one PSUs were selected for disinvestment in the first phase of 1991-92 and these were profitable ones in the areas of petroleum, fertilizers, chemicals, computers and communication, electronics, and heavy engineering enjoying virtual monopoly and were mainly the 'cash cows' with 'star performance'. Disinvestment in subsequent years comprised shares of companies amongst these 31 companies, supplemented with three more companies during 1992-93 and seven more during 1994-95. In short, so far shares of 41 companies have been offered for disinvestment in various phases during 1991-92 to 1994-95. List of these companies is given in table 1.

The selected PSUs for disinvestment however, included companies listed on the stock exchange (like, Cochin Refineries and Andrew Yule) which were to be disinvested at market prices directly to mutual funds and investment institutions, or companies whose exclusion from the proposed disinvestment was earlier suggested by the companies concerned or by their ministries. Their low profitability was expected to improve or better expansion prospects were envisaged on decontrol or deregulation. The other reason for exclusion was that some enterprises (like IPCL, CRL, AYL) were planning to raise funds directly from the market by issue of shares and their proposed disinvestment thus would result in government shareholding falling below 51 per cent. For example, for fertilizer companies (like NFL, and FCTL) profitability reflected by the accounts for the year 1990-91 was low; SAIL suggested that share valuation methods did not reflect the real value of their share prices which were likely to improve in future due to steel decontrol and modernisation of plants; share prices of HZL were expected to increase on attainment of full scale commercial production in a year or two.

During the first round in 1991-92, the shares were sold by grouping into 825 bundles, each bundle consisting of shares of nine PSUs, three from each category of 'very good', 'good' 'average'. The categorisation was on the basis of their net asset value (NAV) and for a Rs 10 share, the NAV for the above three categories were above Rs 50; between Rs 20-25, and below Rs 20, respectively. Net asset value reflected the net worth adjusted for accumulated losses, miscellaneous expenditure not written off, and contingent liabilities and was based on the balance sheet figures without considering

**Table 1**: Disinvestment of Central Government Enterprises

| | 1991-92 | | | 1992-93 | | 1993-94 | 1994-95 | | 1995-96 |
|---|---|---|---|---|---|---|---|---|---|
| | Dec '91 | Feb '92 | Oct '92 | Dec '92 | Mar '93 | | Oct '94 | Jan '95 | |
| Andrew Yule Co. | XX | | | | | | | | |
| Bharat Petroleum Corpn. | XX | XX | XX | XX | | | | | XNA |
| Bharat Heavy Electricals | XX | XX | | X | XNA | XX | | | |
| Bharat Electronics | XX | | | | | XX | | | |
| Bongaingaon Refinery | XX | XX | | XX | XNA | X | | | |
| Bharat Earth Movers | XX | | | | | XX | | | |
| Cochin Refineries | XX | XX | | | | | | | |
| CMC | XX | | | | | | | | |
| Dredging Coprn. of India | XX | | | | | | | | |
| Fertilisers & Chemicals, Tra. | XX | | | XX | α | | | | |
| Hindustan Petroleum Corpn. | XX | XX | XX | XX | | XX | | | XNA |
| Hindustan Cable | XX | | | | | | | | |
| HMT | XX | XX | XX | X | XNA | | | | |
| Hindustan Photo Films | XX | | | | | | | | |
| Hindustan Zinc | XX | XX | XX | XX | XNA | | | | |
| Hindustan Organic Chem. | XX | XX | | | | | | | |
| Indian Petrochemicals | XX | XX | | | | | | | |
| IRCC | XX | | | | | | | | |
| ITI | XX | | | XX | XNA | | | | |
| MTNL | XX | XX | | | XNA | XX | X | | XNA |
| Madras Refineries | XX | | | | | | | | |
| MMTC | XX | | | | | | | | |
| National Aluminium Co. | XX | XX | XX | XX | XNA | XX | | | |
| National Fertilisers | XX | | | XX | XNA | | XX | | XNA |
| Neyveli Lignite | XX | XX | XX | XX | XNA | | | | |
| Rashtriya Chem. & Fert. | XX | | XX | XX | α | | | | |
| STC | XX | XX | | XX | | | | | |
| Shipping Corpn. of India | XX | XX | | | | | XX | | |
| SAIL | XX | XX | XX | XX | XNA | | XX | | XNA |
| Videsh Sanchar Nigam | XX | XX | | | | | | XX | XNA |
| Metal Scrap Trading Corpn. | α | | | | | | | | |
| BALCO | | | | | α | | | | |
| NMDC | | | | | XNA | | | | |
| Hindustan Copper | | | | | XNA | | | | XNA |
| Container Corpn. of India | | | | | | | XX | | |
| EIL | | | | | | | | XX | XNA |
| ONGC | | | | | | | XX | | |
| GAIL | | | | | | | | XX | XNA |
| IOL | | | | | | | XX | XX | |
| ITDC | | | | | | | | XX | |
| Kudremukh Iron | | | | | | | | XX | |

Symbols Signify:

| | |
|---|---|
| XX | PSU offered & Disinvested |
| α | PSU offered But No Bid |
| X | PSU offered Bids below Reserve Price & Not Accepted |
| XNA | PSU offered Bid Response Not Available |

current values of land, buildings and machinery. The shares were sold through the process of bidding for bundles of shares to public sector financial institutions and mutual funds who in turn were allowed to offload the shares later in the market to ensure wider holding of the ownership of the shares.

Bids were received for 533 bundles, and 406 bundles valuing Rs 1,427 crores for 51.62 crores shares were accepted. In the second round of 1991-92, 16 PSUs (comprising petroleum, refineries, heavy engineering, etc.) out of 31 PSU (offered earlier) were selected for disinvestment with the expectation that the desired amount could be raised. The fifteen PSUs not considered for disinvestment included fertilizer companies with the expectation that their prices would appreciate during the next year with the likely reduction in subsidies on fertilizers. These shares were regrouped in 120 bundles on the categorisation basis adopted earlier and the reserve price of each bundle was fixed at Rs 10.08 crore and was indicated in the notice inviting tenders from 36 public sector financial institutions and mutual funds. Bids received from institutions for 120 bundles for 35.6 shares for Rs 1,611 crores were accepted. Details are given in table 2.

During the first two phases in 1992-93, shares of 8 PSUs and 12 PSUs respectively were sold and these were amongst the PSUs selected for disinvestment the previous year. In the third round, three other companies, not considered for disinvestment earlier, (viz BALCO., NMDC, Hindustan Copper) were also included. During the first phase of 1992-93 (October 1992) 12.89 crore shares of eight companies were sold and Rs 682 crore was realised. This was against the offer of 39.29 crore shares and receipt of bids worth Rs 2100.8 crore. Similarly, for the second phase during 1992-93 (December 1992), 31.06 crore shares of 12 companies were sold and Rs 1,184 crore was realised as against the offer of 46.27 crore shares of 14 companies and receipts of bids for Rs 1,798 crore. In other words, bids for two companies namely BHEL and HMT being below the minimum reserve price (MRP) were not accepted. Again for the third phase during 1992-93 (March 1993), 53.87 crore shares of 15 companies were offered for disinvestment, there was no bid for three companies (namely BALCO, FACT and RCF). Out of Rs 935.2 crore worth of bids received, 95 per cent were below the Minimum Reserve Price (MRP) and bids for only 1.01 crore shares were accepted, Rs 53.87 crore being realised. The distinct features of the disinvestment during 1992-93 were that private bidders were also allowed to bid for shares, and the minimum bid size was reduced from Rs 1 crore to Rs 12 lakh over the third phase.

**Table 2:** Disinvestment of PSU shares

| | 1991-92 | | | 1992-93 | | | | 1993-94 | 1994-95 | | | 1995-96 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dec '91 | Feb '92 | Total | Oct '92 | Dec '92 | Mar '93 | Total | | Oct '94 | Jan '95 | Total | |
| No. of PSU - Offered | 31 | 16 | – | 8 | 14 | 15 | – | 7 | 7 | 6 | – | 15 |
| – Disinvested | 30 | 16 | – | 8 | 12 | NA | – | 6 | 6 | 6 | – | NA |
| Target Sale (Rs Crore) | 1250 | 1250 | 2511 | NA | NA | NA | 3500 | 3500 | NA | NA | 4000 | 7000 |
| Actual Realisation (Rs Crore) | 1427 | 1611 | 3038 | 681.95 | 1183.3 | 46.73 | 1912 | 2290.7 | 2231 | 398 | 2629 | NA |
| Shares Offered (No - Crore) | NA | NA | – | 39.29 | 46.27 | 53.87 | 139.4 | 25.77 | 34.59 | NA | NA | – |
| Shares Sold (No - Crore) | 51.62 | 35.6 | 87.22 | 12.87 | 31.06 | 1.01 | 44.94 | 11.37 | 4.5 | NA | NA | – |
| No. of Bidders | 9 | 19 | – | 39 | NA | 21 | – | – | – | – | – | – |
| Bid Size - Minimum | One bundle | One bundle | – | Rs 1 Crore | | Rs 1 lakh | | | | | 2500 | 25,000 |
| Bidders Included | Public Sector Mutual Funds, Insurance, Cos & Banks | | | Also Private Agencies | | | | Also FIIs | | | | – |
| No. of Bundles/Bids Received | 533 bundles | 120 bundles | | 286 bids | 225 bids | 174 bids | | NA | | | NA | – |
| Average Price Per Share Realised (Rs) | 27.65 | 45.25 | 34.83 | 53.0 | 38.1 | 46.2 | | 42.5 | 201.5 | 495.8 | – | – |

During 1993-94, 25.77 crore shares of 7 PSUs amongst those disinvested in earlier years, were offered, with the target realisation of Rs 2,500 crore. 11.37 crore shares of 6 PSUs were sold and Rs 2290.70 crore realised; bids for shares of Bongaigaon Refinery and Petrochemicals Ltd. were not accepted as these were lower than the reserve price fixed for the scrip. Approved foreign institutional investors (FII), in addition to the public sector financial institutions, mutual funds and private sector agencies were invited to submit their tenders, each having a minimum price of Rs 25,000.

During the year 1994-95, disinvestment was made in two phases by offering shares of 7 and 6 PSUs respectively, with the target realisation of Rs 4,000 crores. These companies were among those whose shares were disinvested in earlier years, and 7 new companies were added to the list. Amount realised was Rs 2,231 crore and Rs 398 crore in two phases during October 1994 and January 1995. Bids received for Mahanagar Telephone Nigam Ltd. were not accepted as they were below the minimum reserve price fixed.

*Response & Under Pricing of Shares*

What had been the response to the Government offer of sale of shares of PSUs? This can be assessed in terms of number of companies and shares offered, number of bidders, number of bids received and accepted.

During the year 1991-92, Rs 3,038 crores was realised on disinvestment of shares against the target of Rs 2,500 crore, while for the year 1992-93, the corresponding figures were Rs 1,866 crore and Rs 3,500 crore, respectively. The number of shares sold during the two years were 87.22 crore and 43.93 crore, respectively, with the average price realised per share being Rs 34.83 and Rs 42.48. Amounts realised during the years 1993-94 and 1994-95 were Rs 2,290 crore and Rs 2,629 crore, respectively. The targets in the corresponding years were Rs 3,500 crore and Rs 4,000 crore. In short, Rs 9,870 crore has been realised in the last four years by disinvestment of shares of about 39 PSUs.

During 1991-92, shares of 31 PSUs, as stated earlier, were to be disinvested in lots of 9 PSU selected randomly with the target to sell 20 per cent of the share capital to public sector financial institutions, banks and mutual funds. Of these the shares of one PSU namely, Metal Scrap Trading Corporation remained unsold. Of the total realisation of Rs 3,038 crore during 1991-92, approximately 26 per cent (Rs 800 crore) was realised from the sale of shares of three PSUs namely BPCL, HPCL and SAIL.

During 1992-93, disinvestment was made in three rounds with the target realisation of Rs 3,500 crore by offering 139.43 crore shares. The actual amount realised was Rs 2,391 crore by selling 45 crore shares; the response was not encouraging, as for a number of companies no bids were received for disinvestment, and sale could not be made for some other companies due to their bids received being below the minimum reserve price fixed. Of the total amount received on disinvestment, approximately 58 per cent was from that of MTNL. or 96 per cent was from disinvestment of shares of MTNL, HPCL and BHEL and all the shares planned for disinvestment for MTNL, HPC, BHEL, BEM were sold. However, the shares for BRPL and NALCO were not found attractive and for the former the bids received were below the reserve price (See table 3).

**Table 3**: Disinvestment during 1993-94

| | Total No. of Shares | | | | Per Share | |
|---|---|---|---|---|---|---|
| | Offered (Crore) | Sold (Crore) | Amount Realised (Rs Crore) | Average Realisation (Rs) | Market Price (Rs) | Minimum Price Realised (Rs) |
| Bharat Electronics | 0.88 | 0.331 | 47.17 | 142.5 | 150 | 132 |
| BEM | 0.15 | 0.15 | 48.27 | 321.79 | NA | 310 |
| BHEL | 2.692 | 2.692 | 301.34 | 111.93 | 117 | 100 |
| HPC | 0.447 | 0.449 | 563.11 | 1254.14 | NA | 1200 |
| MTNL | 7.80 | 7.744 | 1330.80 | 171.87 | 185 | 155 |
| NALCO | 11.60 | 0.003 | 0. 01 | 320.0 | NA | NA |
| BRPL | 2.20 | – | – | – | – | – |
| Total | 25.7694 | 11.3699 | 2290.7 | 201.59 | – | – |

Notes:

1. Shares of BRPL were offered for Sale (2.2 crore) but were not sold as bids were below the Reserve Price
2. Minimum Reserve was fixed by the Government on the Recommendations of IDBI and ICICI
3. Most of the deals were close to the prevailing market price.

For the year 1994-95, 34.59 crore shares of seven companies were offered, these included four companies (namely, MTNL, NFL, SAIL, SCI) listed on stock exchanges. Of these, 4.5 crore shares of six companies were sold and Rs 2231 crore realised. Shares of MTNL were not disinvested as the bids received were below the minimum reserve price. Approximately 90 per cent of the disinvestment proceeds were from the sale of two

petroleum companies namely, ONGC and Indian Oil Corporation (both unlisted companies), while Container Corporations of India. Shipping Corporation, NFC, and SAIL were amongst the least attractive (Details in table 4).

**Table 4**: Disinvestment – October 1994

| | Total No. of Shares | | Amount Realised on Sale (Rs Crore) |
|---|---|---|---|
| | Offered (Lakh) | Sold (Lakh) | |
| Containers Corp. of India | 129.88 | NA | 99.72 |
| IOC | 184.905 | NA | 1026.14 |
| ONGC | 68.57 | NA | 1044.14 |
| MTNS* | 300.00 | – | – |
| NFL* | 490.58 | NA | 29.99 |
| SAIL* | 1992.945 | NA | 22.54 |
| Shipping Corp. of India* | 282.30 | NA | 28.33 |
| Total | 3459.18 | 450.00 | 2231.00 |

* Indicates Share Listed

Note: Shares of MTNL were offered for Sale but were not sold as bids were below the Reserve Price.

**Table 5**: Company distribution : PSU share disinvestment

| 1991-92 | |
|---|---|
| % of Capital Disinvested Class Intervals | Number of Companies |
| 20% of Capital | 14 |
| 10 – 19.99 | 4 |
| 5 – 9.99 | 6 |
| 1 – 4.99 | 5 |
| < 1 | 2 |
| | 31 |
| TARGET DISINVESTMENT 20%, of Capital | |

The percentage of share capital disinvested as against the target disinvestment of 20 per cent during 1991-92, is shown in table 5. Only for fourteen companies, disinvestment was as targetted, while for six companies disinvestment was between 5 to 10 per cent of share capital and for seven companies, below five per cent. Similarly for the second round of 1992-93 (December 1992) only for five companies (against 12 in total) target 5 per cent of capital was disinvested, while for four companies disinvestment was below 1 per cent of share capital (break-up in table 6). In other words, the disinvestment during 1991-92 and 1992-93 was much below the target.

**Table 6**: Company distribution : PSU disinvestment – 1992-93

| | 1992-93 - 2nd Phase 1992 December |
|---|---|
| % Disinvested Class Intervals | Number of Companies |
| 5% of Capital | 5 |
| 2.5 – 4.9 | 1 |
| 1 – 2 | 2 |
| < 1 | 4 |
| | 12 |
| TARGET DISINVESTMENT: 5% of Capital | |

Further, as on December 31, 1994, Government of India holdings were more than 75 per cent in 28 companies and only in 11 companies, the Government holding was between 50 to 75 per cent, of the latter for petroleum companies, government shareholdings were: MRL (52 per cent), CRL (55 per cent), HPCL (62 per cent), IOC (88 per cent), BPCL (69.6 per cent), BRCL (74.6 per cent) (table 7). It indicates the extent of disinvestment of petroleum companies. In other words, maximum amount realised on disinvestment has been from petroleum companies and telephone and engineering companies. For example, of the total realisation of Rs 9870 crore so far, about 55 per cent has been from the disinvestment of only five companies viz BPCL, HPCL, SAIL, ONGC, MTNL.

**Maximum amount realised on disinvestment has been from petroleum companies and telephone and engineering companies.**

**Table 7**: Frequency distribution of government holdings in percentages for companies selected for disinvestment

| Govt Holding as on 31/12/94 | No. of Companies |
|---|---|
| 100 | 4 |
| 95 – 99.9 | 9 |
| 90 – 94.9 | 4 |
| 75 – 89.9 | 11 |
| 65 – 74.9 | 4 |
| 50 – 64.9 | 3 |
| Total | 35 |

* Excludes BALCO, MSTC

The practice of disinvestment has been, inviting bids for the share after fixing the minimum reserve price for each script (or each bundle during 1991-92) and laying down the minimum bid amount which, as mentioned, has

reduced over the years. The Government has not laid down the minimum number of shares offered for sale and there has been no underwriter, as was the practice in UK, who would subscribe to the shares, if there had been no bid above minimum reserve price. As a result, the Government accepted the bids above reserve price and at times shares disinvested had been at different prices in the same round of disinvestment, and amount realised has been much below expectation. This is despite the fact that the bids had been opened to private agencies during 1992-93 and approved FIIs and NRIs during 1993- 94.

There was lack of planning and preparatory work and no efforts were made towards publicity for disinvestment of shares particularly in the early rounds. For example, for the first round during 1991-92, shares reserve price was fixed after the announcement of disinvestment inviting bids (bids were invited on December 10, 1991 while prices were fixed on December 14). Further, to quote from the C&AG Report, 1993 the Government had asked financial institutions, like the Unit Trust of India (UTI) who were the prospective buyers, to do their own valuation of shares of PSUs for which purpose they were advised to obtain information from the PSU concerned. No efforts were made to generate widespread investor enthusiasm among FIIs/MFs about the PSUs shares to encourage a good response from these institutions.

**There was lack of planning and preparatory work and no efforts were made towards publicity for disinvestment of shares.**

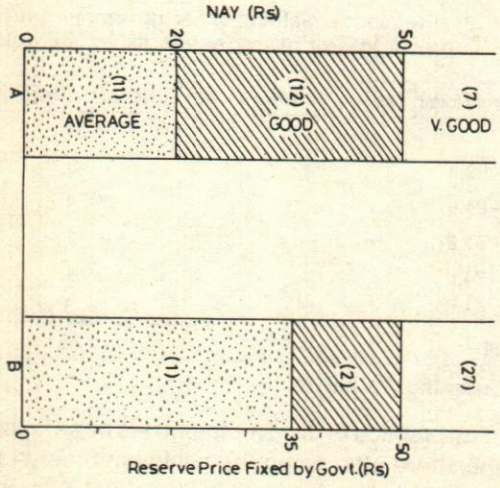



**Fig. 2:**

During 1991-92, categorisation of shares as 'very good', 'good' and 'average' on the basis of NAV did not consider other financial criteria and macro economic parameters and the reserve price fixed for shares did not conform to the above classification. (fig. 2). For a number of shares, reserve price fixed was relatively higher while the shares were categorised as average. For example, BRPL, HZL, MTNL were categorised as 'average' while their reserve price fixed rated them much better (table 8). Similarly, number of companies categorised as 'average' and 'good' were 11 and 12 respectively, while only three PSU had reserve price below rupees 50.

**Table 8**: Classification of disinvested companies

| Name of PSU | Classification by Govt on NAV Basis | Reserve Price Fixed by Govt. Rs |
|---|---|---|
| MTNL | Average | 57.00 |
| BRPL | Average | 55.00 |
| HZL | Average | 85.00 |
| MRL | Good | 65.00 |
| HMT | Good | 46.00 |

PSU share price once fixed was refixed on the advice of consultants and was further reduced after the receipt of the bids as no bid could have been accepted at the fixed reserve price. Accordingly, shares were later evaluated only with reference to the CCI formula (Changing the earlier decision of not applying CCI formula) with a capitalisation rate of 10 per cent. The C&AG Report (1993) gives an estimate that the unjustified reduction in the reserve prices in response to lower bids received resulted in under-realisation of receipts aggregating to Rs 3442 crore to the Government and an unintended transfer of wealth to the buyers.

The reserve price of Rs 10.08 crore for each bundle for the second phase during 1991-92 was based on the valuation of shares of each of the 16 PSUs done by ICICI. According to the C&AG Report (1993), the following parameters were not considered while fixing the reserve price:

- Profitability projections made by the PSUs
- Major changes contemplated by the PSUs in the future plans
- Any further major restructuring of the PSUs
- Impact of decontrol of steel on the profitability of SAIL

The Report concludes. "The Reserve Prices thus recommended were not based on relevant factors and were much lower than the reserve prices of shares of PSUs originally fixed."

Despite allowing private agencies and FIIs to bid for shares of PSUs disinvestment, the response had been dismal, there was lack of competition in bidding and for approximately 50 per cent of bids received in value, there was only one bidder (table 9). UTI had been the biggest bidder, followed by LIC and GIC in every disinvestment and approximately two-thirds of the shares disinvested have been acquired by UTI. To refer to C&AG Report, this indicated unequal bidding power of the institutions/mutual funds and the obvious corollary was that a couple of institutions had virtually dictated the prices.

**Table 9**: Competitiveness of bidders – 1991-92

| | Bids Received | | |
|---|---|---|---|
| | Number | Value (Rs Crore) | Value in % |
| Single Bidder | 509 | 2848.17 | 49.8 |
| Multiple Bidders (Four Bidders) | 474 | 2869.17 | 50.2 |
| Total No. of Bidders : 28 | 983 | 5717.34 | 100 |

The average price per share realised has, no doubt, improved over the years, it was lowest during 1991-92; price fixed originally was further reduced after the receipt of the bids as no bid could have been accepted at the fixed reserve price. Underpricing of shares, particularly, in the initial stages of disinvestment, had been a world wide phenomenon. Sale of British Telecom in U.K. was underpriced, as per the estimates by Vickers and Yarrow (1988), to the extent of 1295 million pounds the total undervaluation of all PSUs privatised, being approximately 3 billion pounds.

In respect of disinvestment of PSUs shares in India, the first estimate of under-realisation was by the C&AG Report (1993). The C&AG Report gives an estimate that the unjustified reduction in the reserve prices in response to lower bids received resulted in under-realisation of receipts aggregate to Rs 3442 crore to the government.

**Unjustified reduction in the reserve prices in response to lower bids received resulted in under-realisation of receipts.**

Vaidya (1994) has estimated the extent of underpricing of PSU shares by following the Vickers and Yarrow (1988) method, modified for the change in share prices over the period. The underpricing is estimated by comparing the average price realised with the price on the first day of listing on stock exchange adjusted for the movement in the share price index. Estimates of underpricing indicate the loss of revenue and these are given in table 10. Underpricing of shares during 1991-92 was to the extent of Rs 2633 crore for disinvestment of shares for Rs 3038 crores; the loss of revenue works out to be 86 per cent. As against this, the loss of revenue in subsequent disinvestments was relatively lower. On an average, for the disinvestment of shares during the three years, 1991-92 to 1993-94 for Rs 7194 crore, the underpricing was by Rs 3529 crore which works out to be 49 per cent. It is evident from table 10 that the extent of underpricing reduced with experience or by changing the practice of disinvestment of shares in bundle to individual shares.

**Table 10** : Estimate of underpricing of shares and loss of revenue

| Year | Actual Realisation | Extent of Underpricing or Revenue Lost | (Rs in Crore) Revenue Lost % |
|---|---|---|---|
| 1991-92 | 3038 | 2633 | 86 |
| 1992-93 | | | |
| October 1992 | 682 | 319 | 47 |
| December 1992 | 1183 | 486 | 41 |
| 1993-94 | 2291 | 91 | 4 |
| Total | 7194 | 3529 | 49 |

Source : Vaidya (1994)

### Macro-Economic Effects

Disinvestment of equity holdings by the Government, has been a part of the Industrial Policy announced with the objective of raising resources and providing further market discipline to the performance of public enterprises. How far would the present policy to disinvest upto 49 per cent of share capital of PSUs not reserved for public sector encourage wider public participation or bring in market discipline in the performance of public enterprises? Disinvestment has been confined to 39 PSUs and of these, as shown in table 7, only in 25 per cent cases, government holding has come below 70 per cent, the possibility of market prices affecting the working of the PSUs is not clearly visible. Alternatively, it may be argued that in a number of PSUs disinvested, competition from other private enterprises, also trading such

shares on stock exchanges and their prices would be an indicator of management performance. Further, pressure on the PSU's managements to rely on internal and external sources for their financial requirements, rather than on central budgetary allocations, may have a positive impact on the performance. However, shares of PSUs, though listed on the stock exchange, are not actively traded and thus do not enjoy a high degree of liquidity. Thus the practice of sale of a small fraction of shares does not result in privatisation of PSUs or bring in positive effects like managerial autonomy, or the introduction of market forces of privatisation. Bhagwati and Srinivasan Report (1993) on India's Economic Reforms, states that "sale of fractional equity to the private sector in enterprises that continue to be essentially owned and managed by the public sector cannot address the efficiency question meaningfully." However, the approach along with the restructuring of PSUs has been endorsed by the Committee to promote eventual privatisation.

**Sale of fractional equity to the private sector in enterprises that continue to be essentially owned and managed by the public sector cannot address the efficiency question meaningfully.**

Economist (1995) Weekly from London, in their Survey of India while reporting on the Government of India's claim that its policy of selling small bunches of shares in the more profitable public sector companies, will improve their efficiency, refer to an internal government document that shows that some bureaucrats do not agree with this view. "Partial disinvestment of equity in the public sector enterprises fails to address the efficiency problems..., it has no impact on ownership, control and management....., it has been used more as a fiscal tool in order to raise cash to finance the government deficit, rather than to improve the efficiency of enterprises' operations..... There is also the danger that such an approach can be a temptation to privatise badly and to postpone the more difficult but much needed longer term fiscal reforms."

Sale of shares in India has been mainly to public sector mutual funds/ investment companies and banks, and it virtually resulted in cornering of shares by UTI, though a small fraction was acquired in later years by private agencies and foreign institutional investors. UTI has been participating in every bid and has the highest share in the shares sold. During 1991-92, the year of heavy underpricing of shares, it bought 70 per cent of the total disinvestment of Rs 3038 crore, similarly, from the disinvestment in later years, UTI acquired more than two-thirds of the shares sold. This raises two broad issues. Due to the extent of underpricing of shares, there has been unintended transfer of government wealth to the buyers, leading to dissipation of public money and increase in inequality of wealth distribution in favour, particularly of unit holders of UTI, GIC and other mutual funds. Further, acquisition of shares by UTI, GIC, LIC and public sector mutual funds has resulted in transfer of government shareholdings to other government agencies, though such agencies mobilise funds from private individuals but are virtually controlled and managed by the government.

Sale of PSU shares amounts to receiving of money in exchange for claim for the future income stream. In order that the sale yields a net benefit to the economy, the amount realised on disinvestment plus the present value of future tax revenue should be greater than the present value of the net future income stream expected from the shares disinvested (Shirelay & Nellis 1991). On the other hand, if the sale proceeds fall short of the present value of income stream foregone, though it improves current liquidity position, the net wealth of the government falls and there is a transfer of wealth to the successful bidders. It amounts to frittering away of nation's wealth and increases inequality of wealth.

**In order that the sale yields a net benefit to the economy, the amount realised on disinvestment plus the present value of future tax revenue should be greater than the present value of the net future income stream expected from the shares disinvested.**

How are the proceeds from disinvestment used? PSUs represent the wealth and capital assets of the government and use of disinvestment proceeds for financing of fiscal deficit reflects it as a revenue receipt, thus the whole exercise of disinvestment has been a conversion of capital assets into revenue receipt. Though a small proportion of the total realisation so far of Rs 9870 crore on PSU shares disinvestment has been

transferred to National Renewal Fund (NRF) for the development of employees of PSUs, there is a need to laydown a policy for the use of funds realised on disinvestment for the development of public enterprises and also rehabilitation and restructuring of loss making public enterprises. Bhagwati and Srinivasan Report (1993) addresses the issue of the treatment of the sale proceeds from the disinvestment of PSU shares by the government as revenue receipts to reduce the current budget deficit. Is this a wise decision, or, should the proceeds be used to retire debt? According to the Report, the government is avoiding such a principled choice and is in fact taking the easy way out of not raising revenues or cutting expenditures or both, by pretending that these sales proceeds are revenue. The report recommends following the Mexican example and assigning the proceeds from equity sales in public enterprises exclusively to retiring the accumulated debt. This would enable us to reduce quickly the burden of interest payments which afflict the budget, while putting pressure on the government to push ahead with necessary fiscal reforms in regard to both taxation and expenditures. It would be pertinent to refer to Maharashtra Government's decision to disinvest 51 per cent of the shareholding in the SICOM. The Unique feature of the State Government's decision is that "the entire proceeds from the disinvestment of its shares has been deployed by the Government in the company as an interest free readjustment loan for a period of five to seven years." This reflects the recognition of the changing financial and economic scenario in the country and enables SICOM to operate effectively in a highly competitive environment.

**There is a need to laydown a policy for the use of funds realised on disinvestment for the development of public enterprises and also rehabilitation and restructuring of loss making public enterprises.**

Disinvestment so far has been an annual budget exercise and has been mostly used to meet fiscal deficit, an immediate and short term objective and is just like 'selling of family jewels to meet family expenses.' Why is disinvestment a part of annual budgeting? A five year plan of disinvestment would be a step towards reorientation of the working of PSUs, their performance measurement, and could be linked to the capital market developments.

Primary as well as secondary capital markets need to be strengthened to provide liquidity and stability to the securities disinvested. The quantum of disinvestment during a period should be commensurate with the size and growth of the capital market. Change of labour laws, and the creation of institutions to ease the adjustment of labour problems, have to be considered.

So far, disinvestment has been of those PSUs which had virtual monopoly and were cash cows and had star performance. Should not more PSUs be added to the list of PSUs opened for disinvestment? Should not the target disinvestment for different categories of PSUs be laid down? Further, about one-fourth of the central PSUs are chronically sick and an equivalent number is engaged in providing services, or are at various stages of development, requiring strategies for their financial restructuring and plan for disinvestment of their shares.

Lastly disinvestment as a business proposition would require preparatory work to highlight the strong points of PSUs and to generate widespread investment enthusiasim among investors and institutional investors. The mode of disinvestment and pricing of shares have to be determined. Is disinvestment the responsibility of the concerned PSU, or the concerned Ministry and/or DPE? Setting up of a separate Ministry or a Professional Body, like in other countries, to be concerned with the planning and implementation of disinvestment task, would be the first step in the right direction.

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Sometimes when I consider what tremendous consequences come from little things...
I am tempted to think ...
there are no little things.

*Bruce Barton*

Feature

# Growth & Structural Changes in the Manufacturing Sector in Gujarat

**Hina Sidhu**

*The Government of Gujarat has been announcing various policies conducive for the development of industrial sector in the State. Gujarat has emerged as one of the most industrialised states in India.*
*Industrial development in Gujarat, over the period of time, has brought about major shifts in the relative importance of different industries in the State economy.*
*The analysis reveals that there is almost one-to-one correspondence between the capital intensity and value added in most of the industries. Therefore, the modernisation of process technology is inevitable to increase the level of productivity, concludes the author.*

*Hina Sidhu, is Lecturer of Economics, School of Social Sciences, Gujarat University, Ahmedabad 380 009.*

Gujarat was carved out as an autonomous State in 1960. Since then the State Government has formulated various policies along with emphasis on the development of infrastructural facilities in order to accelerate industrial development. Gujarat has emerged as one of the most industrialised states in India. In 1990-91 the share of Gujarat in the manufacturing sector in terms of total number of factories was 10.02%, fixed capital 11.36%, total capital employed 10.54%, no. of persons employed 8.77%, value of output 10.3% and value added 8.63%.

The new economic policy of the Government of India announced in July 1991 has provided a boost to the industrial sector in Gujarat as the infrastructural facilities available in the State are adequate to attract investments from the private sector. Besides, the policy incentives of the Government of Gujarat ranging from provision of tax concessions, subsidies and special incentives to set up units in the identified backward areas have been designed to give a fillip to industrial development. The State has been flooded with large number of investment proposals which according to official estimates amount to about Rs 96000 crore (Indian Express, 27th Anniversary Special, 1995).

Time series data for this study was obtained from ASI summary tables of factory as well as census sector units and deflated with suitable price indices. The analysis, at constant prices, covers four dimensions viz., inter-state comparison, growth of factory sector and census sector units, structural changes in the factory and census sector units, and industry-wise factor productivities and output elasticities in the factory as well as census sector units.

### Inter-State Comparison

Analysis (table 1) shows that the state is losing its pioneer position in the country's industrial scenario.

During 1980-91 although the share of Gujarat in capital investment had recorded a marginal increase, there was significant drop in her share in employment and value added.

**Table 1:** Contribution of Gujarat, Maharashtra and Tamil Nadu to industrial development in India – ASI factory sector (Fig. in %)

| Indicator | Year | Tamil-nadu | Maha-rashtra | Gujarat | All India |
|---|---|---|---|---|---|
| No. of Factories | 1980–81 | 10.76 | 16.20 | 11.70 | 100.00 |
| | 1985–86 | 12.44 | 14.90 | 10.29 | 100.00 |
| | 1990–91 | 13.41 | 14.20 | 10.02 | 100.00 |
| Fixed Capital | 1980–81 | 7.36 | 16.9 | 10.48 | 100.00 |
| | 1985–86 | 9.71 | 15.94 | 11.39 | 100.00 |
| | 1990–91 | 8.38 | 17.42 | 11.36 | 100.00 |
| Capital Employed | 1980–81 | 8.92 | 18.77 | 10.35 | 100.00 |
| | 1985–86 | 10.38 | 17.52 | 10.99 | 100.00 |
| | 1990–91 | 9.25 | 19.36 | 10.54 | 100.00 |
| Employees (No.) | 1980–81 | 10.33 | 18.10 | 9.72 | 100.00 |
| | 1985–86 | 11.80 | 16.62 | 9.47 | 100.00 |
| | 1990–91 | 12.06 | 16.00 | 8.77 | 100.00 |
| Value of Output | 1980–81 | 10.98 | 23.78 | 11.97 | 100.00 |
| | 1985–86 | 10.88 | 22.36 | 11.34 | 100.00 |
| | 1990–91 | 10.27 | 22.72 | 10.30 | 100.00 |
| Value Added | 1980–81 | 10.43 | 26.19 | 10.26 | 100.00 |
| | 1985–86 | 10.43 | 26.19 | 9.98 | 100.00 |
| | 1990–91 | 11.51 | 23.32 | 8.63 | 100.00 |
| **Annual Growth Rate (%)*** | | | | | |
| No. of Factories | 1965–78 | 4.09 | 3.90 | 6.66 | 4.79 |
| | 1980–91 | 2.99 | –0.18 | –0.44 | 1.11 |
| Fixed Capital | 1965–78 | NA | NA | NA | NA |
| | 1980–91 | 9.42 | 9.76 | 9.01 | 8.30 |
| Capital Employed | 1965–78 | 0.72 | 6.24 | 11.16 | 4.56 |
| | 1980–91 | 7.38 | 7.79 | 7.76 | 7.22 |
| Employees (No.) | 1965–78** | 3.00 | 3.97 | 4.21 | 3.50 |
| | 1980–91 | 1.92 | –3.79 | –0.87 | 0.07 |
| Value of Output | 1965–78 | 8.18 | 3.20 | 8.48 | 6.54 |
| | 1980–91 | 7.09 | 7.11 | 5.98 | 7.48 |
| Value Added | 1965–78 | 5.81 | 5.11 | 6.58 | 5.03 |
| | 1980–91 | 7.68 | 6.29 | 6.26 | 7.04 |

* Annual Growth for the period 1980-91 was computed with regression equation $L_n Y = a + bt$
Growth rares for the period 1965-78 were obtained from PG Pathak, in Gujarat Economy, edited by DT Lakdawala (1983).
** Workers; NA = Not Available

The sluggish growth of industrial activities in Gujarat during 1980-91 becomes a matter of concern when one views an appreciable growth attained during 1966-78, which was higher than Maharashtra and Tamil Nadu. However, during the 1980's Tamil Nadu has progressed much faster than Gujarat and Maharashtra in terms of growth in the number of factories, employment and value added. In fact, Gujarat has lost the second position to Tamil Nadu.

The analysis also shows that during 1980-91 part of the fall in the growth of factories as well as employment in Gujarat and Maharashtra was caused by a decline in the reporting factories. However, due to modernisation and/or expansion of existing factories and setting up of comparatively large size plants, the capital investment has recorded significant growth.

During 1980-91 Tamil Nadu registered an annual growth of 7.68% in value-added, which was higher than in Gujarat (6.26%) and in Maharashtra (6.29%). Lower growth in value-added against increased capital intensity in the manufacturing sector in Gujarat and Maharashtra have resulted in the decline in capital productivity in most of the industries. Besides, the increased capital intensity has also affected the generation of employment opportunities. Therefore, the identification of industries having high potential for employment augmentation and value additions is important for the formulation of promotional policies.

**Identification of industries having high potential for employment augmentation and value additions is important for the formulation of promotional policies.**

### Major Industries in ASI Factory Sector

Industrial development in Gujarat has brought about major shifts in the relative importance of different industries in the state economy. For example, the textiles industry which was the highest contributor to net value added in the state until 1980-81, lost the first rank in 1981-82 and second rank in 1987-88 (table 2). On the other hand, chemicals has emerged as an important industry. It has recorded a steady increase in all the major development indicators and its share in total value added by the industries in Gujarat has almost doubled during 1980-91. In fact chemicals has overtaken the textiles industry in 1981-82 in case of contribution to net value added. However the contribution of chemical industry to the employment was very low (14.86%) compared to capital investment (46.64%) and value added (41.93%). The textiles industry, on the other hand, has continued to play a key role in the absorption of industrial workers. However, the share of textile workers in total employment in the ASI factory sector has declined from 39% in 1980-81 to 23% in 1990-91.

The electrical industry has emerged,since 1987-88, as the second largest in terms of its share in value added

**Table 2:** Industry-wise share in the manufacturing sector in Gujarat : ASI factory sector (Fig. in %)

| Industry | Year | No. of Factories | Capital Employed | No. of Workers | No. of Employees | Output | Value Added |
|---|---|---|---|---|---|---|---|
| Food Products | 1980–81 | 10.80 | 7.57 | 10.30 | 10.51 | 13.02 | 5.55 |
| | 1985–86 | 9.18 | 6.38 | 10.15 | 10.14 | 11.14 | 5.48 |
| | 1990–91 | 9.50 | 5.94 | 10.46 | 10.82 | 13.91 | 7.91 |
| Textile | 1980–81 | 15.22 | 16.24 | 39.87 | 39.29 | 20.11 | 30.77 |
| | 1985–86 | 11.63 | 13.10 | 26.95 | 26.63 | 14.41 | 17.02 |
| | 1990–91 | 10.34 | 8.12 | 25.39 | 22.59 | 10.98 | 13.37 |
| Wood & Wood Products | 1980–81 | 2.34 | 0.13 | 0.61 | 0.67 | 0.25 | 0.28 |
| | 1985–86 | 1.95 | 0.13 | 0.44 | 0.49 | 0.15 | 0.20 |
| | 1990–91 | 2.06 | 0.19 | 0.43 | 0.44 | 0.23 | 0.20 |
| Paper & Paper Products | 1980–81 | 3.61 | 1.72 | 2.49 | 2.50 | 1.70 | 2.31 |
| | 1985–86 | 3.91 | 1.92 | 2.72 | 2.75 | 1.67 | 1.36 |
| | 1990–91 | 4.63 | 2.28 | 2.89 | 2.95 | 2.09 | 2.22 |
| Rubber & Rubber Products | 1980–81 | 4.30 | 12.97 | 1.73 | 1.76 | 16.73 | 8.57 |
| | 1985–86 | 5.03 | 5.23 | 2.25 | 2.31 | 13.91 | 5.28 |
| | 1990–91 | 6.07 | 7.03 | 3.09 | 3.31 | 11.83 | 5.69 |
| Chemicals & Chemical Products | 1980–81 | 7.86 | 36.17 | 10.19 | 10.18 | 20.26 | 22.41 |
| | 1985–86 | 10.09 | 42.61 | 13.31 | 13.21 | 30.13 | 37.51 |
| | 1990–91 | 10.67 | 46.64 | 13.31 | 14.86 | 34.70 | 41.93 |
| Non-Metallic Mineral Products | 1980–81 | 10.51 | 2.78 | 6.86 | 6.95 | 2.68 | 4.02 |
| | 1985–86 | 13.02 | 5.68 | 9.06 | 9.17 | 3.05 | 4.86 |
| | 1990–91 | 12.07 | 5.60 | 8.70 | 8.29 | 3.55 | 4.85 |
| Basic Metal & Alloys | 1980–81 | 5.47 | 3.12 | 3.60 | 3.64 | 5.18 | 3.96 |
| | 1985–86 | 6.74 | 4.32 | 5.15 | 5.19 | 4.85 | 3.32 |
| | 1990–91 | 6.69 | 2.63 | 3.97 | 3.95 | 5.18 | 2.98 |
| Metal Products | 1980–81 | 6.61 | 1.54 | 2.30 | 2.36 | 1.70 | 2.01 |
| | 1985–86 | 6.45 | 1.34 | 2.60 | 2.68 | 1.58 | 2.00 |
| | 1990–91 | 5.59 | 2.44 | 3.22 | 3.24 | 1.92 | 2.10 |
| Electricals & Electrical Products | 1980–81 | 14.29 | 8.30 | 9.69 | 9.76 | 8.01 | 10.69 |
| | 1985–86 | 16.40 | 8.03 | 11.01 | 11.11 | 8.52 | 12.23 |
| | 1990–91 | 16.05 | 9.11 | 10.46 | 12.00 | 11.13 | 13.41 |

(13.41%). Although the share of non-metallic mineral products in the number of factories is 12%, it has very low share in capital investment (below 7%), employment (8-9%) and value added (3-5%). In case of rubber, basic metal & alloys and metal products industries, each industry accounted for about 7% in the number of factories and around 3% in employment. However, their shares in value added ranged between 3% and 4% except rubber & rubber products which contributed in the range of 4% - 13% during the period 1980-91. Table 2 shows that the level of employment is higher in the food products, textiles, chemicals & chemical products and electrical industries. Therefore these industries are important when the objective is to augment employment opportunities.

In fact, chemical industry has emerged as a catalyst to the industrial economy of Gujarat. However, since the chemical units release pollutants in the air as well as ground, this industry has created serious environmental hazards in the areas of its concentration, particularly Ahmedabad, Baroda and Bharuch. Therefore, preventive actions must be initiated to keep the level of pollutants within reasonable limits.

**The level of employment is higher in the food products, textiles, chemicals & chemical products and electrical industries. Therefore these industries are important when the objective is to augment employment opportunities.**

### Major Industries in the ASI Census Sector

In the census sector also, the cotton textiles and chemicals are the dominating industries. In 1986-87 they together accounted for about 26% of total units, 45% of

total employment and 82% of total net value added of the census sector units in Gujarat (table 3). Chemical industry has been the main focus because of high profit margins. The share of chemical industry in the net value

**Table 3:** Industry-wise share in the manufacturing sector in Gujarat : ASI census sector (Fig. in %)

| Industry Code | Industry | Year | No. of reporting Factories | Fixed Capital | Productive Capital | Employees | Emolument | Output | Value Added |
|---|---|---|---|---|---|---|---|---|---|
| 20-21 | Food Products | 1975–76 | 9.95 | 6.42 | 6.22 | 8.49 | 4.15 | 14.51 | 1.97 |
| | | 1980–81 | 14.02 | 6.91 | 6.61 | 10.21 | 5.22 | 10.98 | 3.42 |
| | | 1986–87 | 10.53 | 4.64 | 5.79 | 9.84 | 6.61 | 11.69 | 2.04 |
| 22 | Mfg. of Beverages Tobacco & Tobacco Products | 1975–76 | 2.54 | 0.14 | 0.50 | 0.67 | 0.15 | 0.45 | 0.16 |
| | | 1980–81 | 3.57 | 0.30 | 0.87 | 1.29 | 0.46 | 0.83 | 0.42 |
| | | 1986–87 | 3.69 | 0.25 | 0.24 | 1.40 | 0.67 | 0.70 | 0.12 |
| 23 | Mfg. of Cotton Textiles | 1975–76 | 29.39 | 19.57 | 24.25 | 53.84 | 57.79 | 40.31 | 23.85 |
| | | 1980–81 | 24.39 | 16.82 | 16.67 | 46.98 | 48.45 | 25.74 | 21.77 |
| | | 1986–87 | 14.93 | 11.93 | 10.58 | 29.76 | 30.17 | 16.76 | 7.31 |
| 24 | Mfg. of Wool, Silk & Synthetic Fibres | 1975–76 | 5.14 | NA | NA | 3.73 | 3.28 | NA | NA |
| | | 1980–81 | 8.67 | 5.31 | 5.39 | 5.92 | 5.17 | 6.73 | 3.69 |
| | | 1986–87 | 9.90 | 7.57 | 7.83 | 10.75 | 8.13 | 9.47 | 2.70 |
| 26 | Mfg. of Textile Products | 1975–76 | 0.94 | 0.15 | 0.10 | 0.42 | 0.00 | 0.27 | 0.06 |
| | | 1980–81 | 2.55 | 0.23 | 0.27 | 1.04 | 0.25 | 0.50 | 0.27 |
| | | 1986–87 | 2.40 | 0.30 | 0.38 | 2.08 | 0.91 | 0.76 | 0.29 |
| 27 | Mfg. of Wood & Wood Products | 1975–76 | 0.80 | 0.05 | 0.11 | 0.22 | 0.11 | 0.13 | 0.07 |
| | | 1980–81 | 0.63 | 0.01 | 0.03 | 0.13 | 0.05 | 0.05 | 0.04 |
| | | 1986–87 | 0.51 | 0.01 | 0.02 | 0.08 | 0.05 | 0.02 | 0.01 |
| 28 | Mfg. of Paper & Paper Products | 1975–76 | 2.67 | 2.59 | 2.40 | 2.00 | 1.84 | 1.75 | 1.08 |
| | | 1980–81 | 2.46 | 1.02 | 1.03 | 1.97 | 1.85 | 1.40 | 1.23 |
| | | 1986–87 | 3.93 | 1.69 | 1.46 | 2.67 | 2.82 | 2.56 | 0.57 |
| 29 | Mfg. of Leather & Leather Products | 1975–76 | NA | NA | NA | NA | NA | NA | NA |
| | | 1980–81 | NA | NA | NA | NA | NA | NA | NA |
| | | 1986–87 | 0.04 | 0.02 | 0.02 | 0.02 | 0.04 | 0.02 | 0.003 |
| 30 | Mfg. of Rubber, Plastic Petroleum & Coal Products | 1975–76 | 1.87 | 0.30 | 0.38 | 0.53 | 0.37 | 0.52 | 0.25 |
| | | 1980–81 | 2.12 | 31.72 | 28.11 | 1.90 | 4.14 | 27.96 | 10.30 |
| | | 1986–87 | 3.58 | 2.69 | 5.48 | 1.45 | 2.15 | 16.66 | 4.08 |
| 31 | Mfg. of Chemicals & Chemical Products | 1975–76 | 7.88 | 56.60 | 49.47 | 8.91 | 13.02 | 22.94 | 62.03 |
| | | 1980–81 | 9.35 | 26.01 | 27.27 | 9.67 | 14.22 | 8.37 | 45.70 |
| | | 1986–87 | 11.24 | 53.59 | 51.82 | 14.59 | 23.67 | 23.43 | 73.81 |
| 32 | Mfg. of Non-Metallic Mineral Products | 1975–76 | 11.96 | 2.75 | 3.41 | 5.07 | 3.63 | 3.97 | 2.15 |
| | | 1980–81 | 9.11 | 2.33 | 2.40 | 4.50 | 3.53 | 3.00 | 2.03 |
| | | 1986–87 | 11.20 | 6.84 | 5.40 | 6.17 | 4.22 | 3.25 | 1.23 |
| 33 | Basic Metal & Alloy | 1975–76 | 3.41 | 2.77 | 2.01 | 2.49 | 2.11 | 3.47 | 0.85 |
| | | 1980–81 | 3.95 | 2.51 | 2.65 | 2.84 | 2.48 | 4.47 | 1.99 |
| | | 1986–87 | 7.07 | 3.45 | 2.70 | 5.07 | 3.98 | 5.10 | 1.14 |
| 34 | Mfg. of Metal Products & Paper Except Machinery & Transport Equipment | 1975–76 | 3.47 | 1.73 | 1.78 | 1.43 | 1.16 | 1.83 | 0.91 |
| | | 1980–81 | 3.08 | 0.73 | 0.80 | 1.52 | 1.24 | 1.11 | 0.88 |
| | | 1986–87 | 3.18 | 0.72 | 0.84 | 1.90 | 1.50 | 1.12 | 0.29 |
| 35 | Mfg. of Machinery, Machine Tools & Parts Except Electrical Machinery | 1975–76 | 8.75 | 4.57 | 6.07 | 5.87 | 5.84 | 5.64 | 3.47 |
| | | 1980–81 | 6.75 | 3.75 | 4.55 | 5.83 | 6.07 | 4.91 | 4.19 |
| | | 1986–87 | 7.43 | 3.42 | 3.89 | 6.26 | 6.54 | 4.74 | 2.68 |
| 36 | Mfg. of Electrical Machinery, Apparatus & Appliances | 1975–76 | 2.81 | 1.04 | 1.67 | 2.18 | 2.11 | 2.31 | 1.24 |
| | | 1980–81 | 2.46 | 1.23 | 1.89 | 2.46 | 2.66 | 2.76 | 1.89 |
| | | 1986–87 | 3.26 | 1.38 | 2.07 | 3.09 | 3.34 | 3.35 | 1.64 |
| 37 | Mfg. of Transport Equipment & Parts | 1975–76 | 1.94 | 0.23 | 0.38 | 0.88 | 0.76 | 0.11 | 0.56 |
| | | 1980–81 | 2.55 | 0.64 | 0.79 | 1.99 | 2.37 | 0.21 | 1.40 |
| | | 1986–87 | 2.08 | 1.18 | 1.07 | 2.29 | 2.47 | 0.50 | 1.46 |
| 38 | Other Mfg. Industries | 1975–76 | 1.54 | 0.30 | 0.36 | 0.51 | 0.29 | 0.31 | 0.18 |
| | | 1980–81 | 1.49 | 0.26 | 0.31 | 0.47 | 0.32 | 0.29 | 0.32 |
| | | 1986–87 | 1.69 | 0.19 | 0.28 | 0.72 | 0.48 | 0.49 | 0.27 |
| 97 | Repair Services | 1975–76 | 4.94 | 0.79 | 0.89 | 2.75 | 3.38 | 1.47 | 1.16 |
| | | 1980–81 | 2.84 | 0.21 | 0.34 | 1.30 | 1.46 | 0.69 | 0.47 |
| | | 1986–87 | 3.34 | 0.12 | 0.15 | 1.86 | 2.29 | 0.37 | 0.35 |

added increased from 62% in 1975-76 to 74% in 1986-87. Cotton textiles industry continued to play a key role in the absorption of industrial labour although its share has declined significantly from 58% in 1975-76 to 30% in 1986-87. Other industries which are steadily emerging as important to Gujarat economy are food products, manufacture of wool, silk and synthetic fibers and machinery and machine tools. Table 3 shows the industry-wise share of census sector units in important indicators.

Although the share of food industry in the fixed capital, productive capital and value of output has declined during 1975-87, its share in net value added has registered a marginal increase. High value additions and various tax concessions applicable to the agro-processing units have attracted the private houses and the multinationals to set up agro processing units in Gujarat.

The woolen textiles registered a steady increase, while the reverse has occurred in cotton textiles. The share of non-metallic mineral products, basic metals & alloys, metal products, machine tools and electrical machinery and transport equipment industries have remained almost stable.

An important observation from tables 2 and 3 is that the textiles and chemical industries will continue to play a dominant role in the industrial economy of Gujarat. Besides, the food products industry is emerging as another important contributor to employment and resource (value added) generation in recent years. Rubber products and electrical products are the other industries which are gaining importance in terms of their contribution to employment and/or industrial output.

**Textiles and chemical industries will continue to play a dominant role. Besides, the food products industry is emerging as important contributor to employment and resource (value added) generation in recent years.**

### Growth of Factory Sector Units

Analysis at the aggregate level (table 4) shows that the factory sector units attained a significant growth in capital investment (7.76%) and value added (6.26%) eventhough there was a decline in industrial units (–0.44%), and employment (–0.87%). The growth in capital investment was highest in non-metallic mineral products (15.35%), followed by wood products (12.06%) and metal products (10.90%). Lowest growth was registered in the textiles (0.87%).

**Table 4:** Industry-wise annual growth of major development indicators in Gujarat during 1980-91: ASI factory sector (Fig. in %)

| | No. of Factories | Capital Employed | No. of Workers | No. of Employees | Output | Value Added |
|---|---|---|---|---|---|---|
| Food Products | –2.93 | 5.80 | –2.90 | –1.85 | 7.12 | 8.64 |
| Textiles | –4.23 | 0.87 | –7.63 | –6.92 | –0.41 | –3.35 |
| Wood & Wood Products | –2.38 | 12.06 | –3.18 | –2.56 | 7.76 | 2.17 |
| Paper and Paper Products | 0.87 | 7.29 | –0.73 | 0.31 | 6.85 | 3.39 |
| Rubber & Rubber Products | 3.23 | 1.82 | 5.10 | 6.27 | 1.01 | 10.70 |
| Chemicals & Chem. Products | 2.25 | 10.49 | 2.16 | 3.69 | 11.29 | 12.55 |
| Non-Metallic Minaral | 0.73 | 15.35 | 0.43 | 0.51 | 8.40 | 6.74 |
| Basic Metal & Alloy | 2.66 | 6.90 | –0.15 | 0.75 | 6.54 | 3.29 |
| Metal Products | –1.08 | 10.90 | 2.73 | 3.56 | 8.12 | 8.21 |
| Electricals & Electrical M | 0.56 | 8.89 | 1.43 | 3.16 | 10.62 | 8.79 |
| All Mfg. | –0.44 | 7.76 | –2.26 | –0.87 | 5.98 | 6.26 |

In rubber and rubber products, employment increased by 6.27% against 3.23% in capital investment which indicates increase in labour intensity. However, the marginal productivity of labour has declined which apparently is due to deepening effects of employment. The decline in marginal productivity does not mean a fall in the average productivity. This is apparent from the indices of factor productivities which reveal that both the capital as well as labour productivities registered positive growths during the period 1980-91.

In textile industry, the employment declined by about 7% per annum which might have been caused by retrenchment of employees due to the closure of unviable and/or modernisation of existing units. Wood & wood products and food products were the other industries which recorded decline in employment. The inference is that these industries are in the transitory phase of switching over from the traditional to improved technologies. The increased investment in the aforesaid industries was mainly for the upgradation of process technology.

The growth of output was highest in the chemicals (11.29%) followed by electricals (10.62%), non-metallic mineral products (8.40%) and metal products (8.12%). In the rubber industry, however, the growth of output was very low (1.01%).

Value added recorded highest growth in the chemicals (12.55%) followed by rubber (10.70%), electricals (8.79%), food products (8.64%) and metal products (8.21%). On the other hand, the net value added in the textile industry declined by 3.35% per annum during 1980-91.

Textiles, chemical & chemical products, electrical & electrical products, rubber & rubber products, food products, and non-metallic mineral products are the major industries in Gujarat. During 1980-91 the textiles industry, which was the traditional giant experienced recessionary conditions while chemicals and rubber products industries emerged as the sunrise industries in terms of growth in the number of units, employment and value added.

### Growth of Census Sector Units

The data for the years 1975-76 to 1986-87 has been taken into account for computation of growth rates. Data for the year 1974-75 was not considered due to clubbings of certain groups with other industry groups. The data for the year 1987-88 was ignored because of reduced coverage of the ASI census sector.

Table 5 shows that like factory sector units, the census sector units also recorded highest growth in capital investment (11.62%) followed by value added (10.63%), and output (9.76%). Similarly there was a decline in employment (–12.97%). The fall in employment brought about almost proportionate decline in the wage bill (–12.33%).

The analysis at the disaggregate level shows highest growth in the number of reporting factories in rubber (12.49%) followed by basic metal and alloys (12.09%) and the manufacture of textiles products (11.26%). The textiles industry recorded a decline of 0.72% per annum in the number of reporting factories.

Growth in capital investment was highest in rubber & rubber products (22.36%) followed by beverages & tobacco products (18.24%), textiles products (17.57%) and transport equipment (17.71%). The analysis shows that in all the industries, except paper & paper products, manufacture of metal products and repair services, the

**Table 5 :** Industry-wise annual growth of major development indicators in Gujarat during 1975-87: ASI-census sector (Fig. in %)

| Industry code | No.of Reporting Factories | Fixed Capital | Productive Capital | Workers* | Employees | Wages & Salaries* | Emolument | Output | Value Added |
|---|---|---|---|---|---|---|---|---|---|
| 21-22 | 4.78 | 8.08 | 9.83 | –8.02 | 2.69 | –3.08 | 8.70 | 6.29 | 8.14 |
| 22 | 8.47 | 18.24 | 2.35 | –10.68 | 7.47 | 3.65 | 15.53 | 12.54 | 1.03 |
| 23 | –0.72 | 6.04 | 1.50 | –18.35 | –4.70 | –17.78 | –1.43 | 1.21 | –1.93 |
| 24 | 9.64 | 11.91 | 11.40 | –0.04 | 9.83 | –1.05 | 11.09 | 3.35 | 2.22 |
| 26 | 11.26 | 17.57 | 23.00 | 7.19 | 14.87 | 12.87 | 12.54 | 21.46 | 24.00 |
| 27 | 3.47 | 4.74 | 1.31 | –6.99 | –3.94 | –0.08 | 3.08 | –6.59 | –6.47 |
| 28 | 9.03 | 5.81 | 6.72 | –4.64 | 4.12 | –3.61 | 8.20 | 9.79 | 6.33 |
| 29 | Data for most of the years are not available | | | | | | | | |
| 30 | 12.49 | 22.36 | 28.84 | 2.18 | 9.51 | 6.22 | 16.52 | 39.25 | 26.80 |
| 31 | 9.42 | 13.70 | 14.36 | –4.64 | 5.69 | –1.85 | 10.95 | 13.51 | 14.18 |
| 32 | 7.07 | 20.98 | 16.28 | 5.26 | 4.98 | 6.25 | 7.02 | 7.88 | 3.67 |
| 33 | 12.09 | 13.72 | 15.92 | 1.27 | 9.07 | 1.85 | 11.96 | 13.61 | 10.42 |
| 34 | 5.87 | 1.21 | 2.37 | –6.07 | 2.53 | –6.32 | 4.90 | 4.82 | 0.08 |
| 35 | 4.63 | 7.11 | 6.08 | –7.72 | 2.49 | –6.25 | 6.10 | 8.22 | 6.97 |
| 36 | 8.69 | 13.38 | 12.40 | –4.09 | 4.63 | –3.11 | 8.11 | 11.47 | 10.02 |
| 37 | 4.84 | 17.71 | 14.84 | 1.64 | 10.00 | 5.48 | 15.26 | 15.66 | 12.80 |
| 38 | 7.17 | 8.22 | 9.95 | –0.78 | 5.03 | 1.56 | 9.28 | 9.65 | 11.33 |
| 97 | 1.06 | –7.69 | –5.91 | –11.81 | –3.25 | –12.75 | –1.33 | –3.54 | –1.74 |
| All Mfg. | 5.50 | 11.62 | 11.18 | –12.97 | 1.06 | –12.33 | 4.51 | 9.76 | 10.63 |

*Growth Rate for the period 1976-87.

growth in capital investment was higher than the number of reporting factories. This indicates the setting up of capital intensive and/or expansion of existing plants. In the repair & services industry, on the other hand, investment in fixed capital declined by 7.69% per annum against an increase of 1.06% in the number of units indicating the adoption of labour intensive technology or setting up of smaller size plants.

Growth in employment was highest in the textile products (14.87%) followed by transport equipment (10%), wool, silk & synthetic textiles (9.83%) and rubber & rubber products (9.51%). On the other hand employment registered a decline of 4.70% per annum in the cotton textiles, 3.94% in wood & wood products and 3.25% in repair services.

Highest growth in the value added was recorded in the rubber & plastic (26.80%) and textile products (24%). The other industries which registered higher growth in value added were chemicals and chemical products (14.18%), manufacture of transport equipment (12.80%), other manufacturing industries (11.33%), basic metal & alloys (10.42%) and manufacture of electrical machinery & apparatus (10.02%). On the other hand, the value added declined by 6.47% per annum in the wood & wood products, 1.93% in cotton textiles and 1.74% in the repair services industries.

## Estimation of Structural Ratios

Structural ratios are used to understand specific queries such as cost of employment generation, factor intensity and factor productivity etc. With a view to examine the changes in the structural ratios over the period of time, the period under study was divided into two phases. For the factory sector units, the first phase is from 1980-81 to 1984-85 and the second phase from 1985-86 to 1990-91. Similarly, for the census sector units, the first period is from 1974-75 to 1980-81 and the second phase is from 1981-82 to 1986-87. A comparative analysis of the two phases for the factory as well as census sector units was done.

## Structural Ratios of Factory Sector

Table 6 shows that the level of capital intensity has undergone considerable changes over the period of time. In the capital intensive, rubber & chemical industries average capital intensity in the latter has in-

**Table 6 :** Industry-wise important structural ratios in the ASI factory sector units in Gujarat

| Industry Code | Year | Capital Invested per | | No. of Employees per Factory | Output per Unit of Capital (Rs.) | Output per Employee (Rs.) | Value-Added per Unit of | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Employee (Rs. '000) | Factory (Rs. '000) | | | | Capital (Rs.) | Output (Rs.) | Employee (Rs.) |
| 20-21 | 1980–85 | 432 | 26680 | 62 | 3.43 | 1483 | 0.25 | 0.07 | 108.49 |
| | 1985–91 | 661 | 43490 | 66 | 3.72 | 2458 | 0.29 | 0.08 | 194.47 |
| 23 | 1980–85 | 265 | 44759 | 169 | 2.27 | 602 | 0.48 | 0.21 | 126.53 |
| | 1985–91 | 430 | 59320 | 138 | 2.08 | 897 | 0.37 | 0.18 | 159.31 |
| 27 | 1980–85 | 167 | 2305 | 14 | 2.50 | 418 | 0.46 | 0.19 | 77.43 |
| | 1985–91 | 382 | 4179 | 11 | 2.06 | 734 | 0.28 | 0.12 | 98.40 |
| 28 | 1980–85 | 484 | 17934 | 37 | 1.62 | 786 | 0.31 | 0.19 | 149.60 |
| | 1985–91 | 689 | 28793 | 42 | 1.60 | 1101 | 0.24 | 0.15 | 162.44 |
| 30 | 1980–85 | 2981 | 79370 | 27 | 3.61 | 10758 | 0.18 | 0.05 | 524.25 |
| | 1985–91 | 2118 | 67198 | 32 | 3.59 | 7608 | 0.38 | 0.11 | 800.16 |
| 31 | 1980–85 | 1978 | 152760 | 77 | 1.45 | 2874 | 0.26 | 0.18 | 518.03 |
| | 1985–91 | 2995 | 250472 | 84 | 1.41 | 4211 | 0.28 | 0.20 | 841.65 |
| 32 | 1980–85 | 818 | 38370 | 47 | 1.31 | 414 | 0.27 | 0.15 | 84.93 |
| | 1985–91 | 694 | 28591 | 41 | 0.95 | 659 | 0.19 | 0.20 | 131.69 |
| 33 | 1980–85 | 545 | 25327 | 47 | 2.55 | 1388 | 0.29 | 0.12 | 159.76 |
| | 1985–91 | 763 | 32888 | 43 | 2.43 | 1851 | 0.24 | 0.10 | 184.30 |
| 34 | 1980–85 | 400 | 9647 | 24 | 1.97 | 788 | 0.35 | 0.18 | 139.35 |
| | 1985–91 | 581 | 17810 | 31 | 1.75 | 1017 | 0.33 | 0.19 | 189.05 |
| 35 | 1980–85 | 579 | 22332 | 39 | 1.82 | 1052 | 0.40 | 0.22 | 229.89 |
| | 1985–91 | 789 | 34486 | 44 | 2.08 | 1640 | 0.41 | 0.20 | 320.78 |
| All Mfg. | 1980–85 | 603 | 38520 | 64 | 2.05 | 1238 | 0.32 | 0.16 | 194.59 |
| | 1985–91 | 995 | 60479 | 61 | 1.83 | 1820 | 0.29 | 0.16 | 291.77 |

creased while in the former it has recorded a considerable decline. Although the capital intensity was higher in the chemical & chemical products compared to rubber & rubber products, value added per employee was almost comparable in both the industries. During both the phases, value added per employee was highest in the chemicals and rubber industries while it was lowest in the wood & wood products industry.

In cotton textiles, wood & wood products, basic metal & alloys, electrical machinery and paper products, the value added per unit of output has declined in the second phase while in other industries, this ratio has shown a marginal increase; highest increase was in the rubber & rubber products industry—from 5% in the first phase to 11% in the second phase.

Cotton textiles is the major employer of industrial workers. Employment per unit is maximum in the cotton textiles industry although average number of employees has declined from 168 during 1980-85 to 139 during 1985-91. In the other industries, except wood & wood products and manufacturing of non-metallic mineral products, the employment per factory has increased marginally.

### Structural Ratios in the Census Sector

Table 7 shows that average factory employment has recorded a decline in all except woollen/silk and the decline was highest in the cotton textiles industry. The capital intensity has increased in all the industries except rubber products, in which it has recorded a marginal decline. However, the investment per employee was highest in the rubber & rubber products and chemicals & chemical products industries.

Average value added per employee was highest in the chemicals & chemical products and rubber product industries. Value added per employee declined during the second phase (1981-87) in the tobacco, wood, leather, rubber, non-metallic mineral products, basic metal products and manufacture of metal products and the decline was alarming in the leather & leather products industry.

Value added per unit of output was highest in the manufacture of transport equipment followed by chemicals and repair services. This ratio has recorded a decline in all except chemicals and food products and the decline was considerable in the leather, rubber and beverage & tobacco industries.

The analysis of factory as well as census sector units shows that the textiles and chemicals industries play a major role in the generation/absorption of industrial employment. Capital intensity and labour productivity were higher in the chemicals and rubber compared to other industries.

**The textiles and chemicals industries play a major role in the generation/absorption of industrial employment.**

### Factor Productivity & Output Elasticity

Factor productivity and output elasticity are two different measures for estimation of returns to factor inputs. While indices of factor productivities show the trends in factor productivities over the period of time, the output elasticities indicate the expected increase in value added with additional use of factor inputs.

### Factor Productivity

Measurement of the productivity of factor inputs is important in view of their limited availability, this is particularly true of capital. Depending upon the nature of the product and the process of production, different industries employ different combinations of factor inputs. However, an increase in factor inputs often does not bring about proportionate increases in their productivities because an increase in one factor influences the productivity of the other factor. Since total factor productivity (TFP) takes into account the productive efficiencies of both capital as well as labour, TFP is a more comprehensive measure to understand the overall trends in productive efficiencies of the factors of production. Trends of partial factor productivities, however, provides an inference about the TFP because the TFPI is a composite index of capital productivity and labour productivity indices. The trends in total factor productivity (TFP) can be measured through different methods. In an earlier study on Trends of Factor Productivity in the Manufacturing Sector in Gujarat and All India, (Sidhu, 1995) four methods had been attempted viz., direct method, Kendrick method, Solow method and Divisia method. While the TFPIs obtained through the direct and

**Table 7:** Industry-wise important structural ratios in the ASI census sector units in Gujarat

| Industry Code | Year | Fixed Capital per | | Productive Capital per | | Value-Added per unit of | | | | Output per unit of | | | No. of Employees per Factory | Emoluments per Employee (Rs '000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Employee (Rs '000) | Factory (Rs '000) | Employee (Rs '000) | Factory (Rs '000) | Fixed Capital (Rs) | Productive Capital (Rs) | Output (Rs) | Employee (Rs) | Productive Capital (Rs) | Output (Rs) | Employee (Rs) | | |
| 20-21 | 1974–81 | 20.51 | 4049.78 | 30.70 | 6062.26 | 0.48 | 0.32 | 0.08 | 9910 | 6.21 | 4.15 | 127292 | 197 | 3607 |
| | 1981–87 | 26.46 | 4940.59 | 43.60 | 8141.24 | 0.56 | 0.34 | 0.10 | 14828 | 5.64 | 3.42 | 149232 | 187 | 5677 |
| 22 | 1974–81 | 5.86 | 468.54 | 29.00 | 2320.75 | 1.40 | 0.28 | 0.14 | 8185 | 10.00 | 2.02 | 58554 | 80 | 1958 |
| | 1981–87 | 8.50 | 631.25 | 17.60 | 1307.53 | 0.55 | 0.27 | 0.07 | 4701 | 8.20 | 3.96 | 69692 | 74 | 3685 |
| 23 | 1974–81 | 10.35 | 5057.87 | 20.88 | 10199.76 | 1.28 | 0.63 | 0.26 | 13214 | 4.87 | 2.41 | 50381 | 488 | 7212 |
| | 1981–87 | 19.45 | 7549.20 | 26.26 | 10191.43 | 0.78 | 0.57 | 0.21 | 15094 | 3.73 | 2.76 | 72487 | 388 | 10207 |
| 24 | 1974–81 | 20.67 | 3940.78 | 29.74 | 5670.54 | 0.66 | 0.46 | 0.17 | 13739 | 3.90 | 2.71 | 80642 | 191 | 7175 |
| | 1981–87 | 53.41 | 10817.66 | 72.48 | 14680.99 | 0.40 | 0.30 | 0.15 | 21448 | 2.60 | 1.91 | 138627 | 203 | 7622 |
| 26 | 1974–81 | 7.76 | 822.41 | 10.76 | 1139.53 | 0.75 | 0.54 | 0.14 | 5824 | 5.34 | 3.85 | 41454 | 106 | 2586 |
| | 1981–87 | 11.60 | 1832.86 | 19.23 | 3036.58 | 0.93 | 0.56 | 0.16 | 10738 | 5.86 | 3.54 | 68028 | 158 | 3995 |
| 27 | 1974–81 | 4.15 | 239.98 | 13.91 | 803.92 | 2.30 | 0.68 | 0.22 | 9363 | 10.80 | 3.17 | 45051 | 58 | 2588 |
| | 1981–87 | 9.24 | 316.11 | 23.34 | 798.00 | 0.88 | 0.35 | 0.21 | 8107 | 4.27 | 1.69 | 39457 | 34 | 5405 |
| 28 | 1974–81 | 34.03 | 6915.89 | 42.32 | 8598.41 | 0.45 | 0.36 | 0.24 | 15214 | 1.84 | 1.48 | 62772 | 203 | 6771 |
| | 1981–87 | 40.91 | 6043.82 | 53.45 | 7897.19 | 0.38 | 0.29 | 0.18 | 15635 | 2.18 | 1.67 | 89123 | 148 | 9918 |
| 30 | 1974–81 | 320.55 | 37484.32 | 411.63 | 48135.29 | 0.29 | 0.22 | 0.12 | 92057 | 2.39 | 1.86 | 765163 | 117 | 11429 |
| | 1981–87 | 165.01 | 13001.79 | 484.00 | 38136.41 | 0.31 | 0.11 | 0.03 | 51738 | 11.31 | 3.86 | 1866954 | 79 | 13665 |
| 31 | 1974–81 | 103.99 | 31759.21 | 146.79 | 44828.70 | 1.44 | 1.02 | 1.41 | 149574 | 1.02 | 0.72 | 105773 | 305 | 10114 |
| | 1981–87 | 189.52 | 44924.98 | 280.56 | 66507.96 | 1.49 | 1.01 | 1.48 | 283205 | 1.01 | 0.68 | 191364 | 237 | 16566 |
| 32 | 1974–81 | 15.42 | 1909.19 | 25.53 | 3160.50 | 0.87 | 0.53 | 0.23 | 13426 | 3.74 | 2.26 | 57613 | 124 | 5221 |
| | 1981–87 | 45.08 | 4890.11 | 54.82 | 5947.71 | 0.27 | 0.22 | 0.18 | 12141 | 1.52 | 1.25 | 68642 | 108 | 6896 |
| 33 | 1974–81 | 24.99 | 4093.45 | 37.79 | 6188.29 | 0.73 | 0.49 | 0.17 | 18360 | 4.37 | 2.89 | 109224 | 164 | 3785 |
| | 1981–87 | 40.22 | 5843.63 | 55.80 | 8106.72 | 0.38 | 0.28 | 0.10 | 15423 | 3.82 | 2.76 | 153784 | 145 | 8346 |
| 34 | 1974–81 | 22.76 | 2912.10 | 36.41 | 4658.1 | 0.84 | 0.52 | 0.23 | 19107 | 3.62 | 2.26 | 82457 | 128 | 7045 |
| | 1981–87 | 20.97 | 2092.25 | 35.57 | 3549.16 | 0.80 | 0.47 | 0.17 | 16701 | 4.61 | 2.72 | 96735 | 100 | 8204 |
| 35 | 1974–81 | 21.67 | 4413.31 | 41.25 | 8401.53 | 0.89 | 0.47 | 0.26 | 19265 | 3.37 | 1.77 | 73087 | 204 | 8527 |
| | 1981–87 | 28.96 | 4955.42 | 51.04 | 8734.93 | 0.86 | 0.49 | 0.25 | 24789 | 3.48 | 1.97 | 100729 | 171 | 10648 |
| 36 | 1974–81 | 13.39 | 3298.01 | 31.28 | 7702.23 | 1.45 | 0.62 | 0.21 | 19478 | 6.79 | 2.91 | 90904 | 246 | 8637 |
| | 1981–87 | 24.86 | 4393.28 | 53.00 | 9368.09 | 1.11 | 0.52 | 0.20 | 27652 | 5.51 | 2.58 | 136912 | 177 | 10482 |
| 37 | 1974–81 | 10.80 | 1757.86 | 20.85 | 3393.72 | 2.16 | 1.12 | 1.94 | 23367 | 1.12 | 0.58 | 12041 | 163 | 8577 |
| | 1981–87 | 18.31 | 3910.93 | 29.72 | 6347.34 | 1.61 | 0.99 | 1.62 | 29534 | 0.99 | 0.61 | 18176 | 214 | 10178 |
| 38 | 1974–81 | 14.95 | 1364.57 | 27.55 | 2514.07 | 1.01 | 0.55 | 0.24 | 15138 | 4.22 | 2.29 | 63084 | 91 | 5460 |
| | 1981–87 | 19.43 | 1550.25 | 36.97 | 2949.27 | 1.10 | 0.58 | 0.29 | 21315 | 3.80 | 2.00 | 73878 | 80 | 7524 |
| 97 | 1974–81 | 6.70 | 996.45 | 11.12 | 1653.66 | 1.79 | 1.08 | 0.34 | 12025 | 5.21 | 3.14 | 34895 | 149 | 8860 |
| | 1981–87 | 4.88 | 549.06 | 9.71 | 1094.08 | 2.77 | 1.39 | 0.34 | 13522 | 8.25 | 4.14 | 40224 | 113 | 11449 |
| All Mfg. | 1974–81 | 25.11 | 6688.56 | 39.85 | 10614.08 | 1.08 | 0.68 | 0.36 | 27153 | 2.97 | 1.87 | 74696 | 266 | 6990 |
| | 1981–87 | 49.28 | 9980.56 | 74.91 | 15170.81 | 1.03 | 0.67 | 0.40 | 50522 | 2.59 | 1.70 | 127690 | 203 | 9857 |

Kendrick methods provided almost same results, those obtained through Solow and Divisia methods showed trends which were almost in consonance with the direct and Kendrick indices.

In this study the TFPIs are computed through the direct method which is the geometric average of the partial factor productivity indices. Partial factor productivity has been obtained by dividing value-added by the respective factors of production. If partial factor productivity index of capital is taken as PFPI (K), labour as PFPI (L), and total factor productivity index as TFPI, then

$$PFPI(K) = \frac{V(t)}{K(t)}$$

and

$$PFPI(L) = \frac{V(t)}{L(t)}$$

where V(t) = index of value added for the year t

K(t) = index of capital employed for the year t and

L(t) = index of labour employment for the year t.

The TFPI through the Direct Method will be calculated as

$$TFPI = \frac{V(t)}{\text{Squareroot } [K(t) \times L(t)]}$$

or $\text{Squareroot } [\{PFPI\ (K)\} \times \{(PFPI\ (L)\}]$

**Factor Productivity in the ASI Factory Sector**

The index of capital productivity for all the manufacturing industries shows a decline of 1.49% per annum during the period 1980-91 (table 8). Highest growth of 8.9% per annum was recorded in the rubber & rubber products industry (table 10). Food products and chemicals & chemical products were the other two industries which registered positive growths of capital productivities i.e. 2.84% and 2.06% per annum respectively. In the remaining industries, the indices of capital productivity recorded a negative growth and the decline was highest in the wood & wood products (–9.89%). Non metallic mineral products and textiles were the other two industries which experienced considerable decline in capital productivity.

The index of labour productivity recorded a positive growth in all the industries under study. Overall labour productivity in all the manufacturing industries in Gujarat registered a growth of 7.14% per annum during 1980-91. Highest growth in the labour productivity was registered by the food products (10.49%) and chemicals & chemical products (8.86%). On the other hand, the growth in the index of labour productivity was lowest in the basic metal & alloy industry (2.54%).

During 1980-91, total factor productivity in the manufacturing sector in Gujarat had increased by 2.82% per annum. The growth in total factor productivity was highest in the food products (6.67%), followed by rubber & rubber products (6.66%), chemicals & chemical products (5.46%), electricals (2.76%) and metal products (0.98%). Lowest growth in TFP was in the wood & wood products in which the TFP declined by 2.58% per annum. Other industries which recorded negative growth in TFP were non-metallic mineral products (–1.19%), basic metal & alloy (–0.53%), paper & paper products (–0.41%) and cotton textiles (–0.33%).

**Factor Productivity in the Census Sector**

Industry-wise indices of partial and total factor productivities were computed for the years 1976-87. Table 9 shows that in the manufacturing sector in Gujarat, while labour productivity registered an appreciable growth of 11% per annum, the increase was marginal (0.23%) in capital productivity. The compound effect of variations in partial factor productivities was reflected in the total factor productivity which recorded an increase of 5.68% per annum during 1976-87.

Higher growth in capital productivity was recorded by repair services (4.5%). Other industries in which the indices of capital productivity recorded a positive growth were manufacture of machinery & machine tools and paper & paper products. On the other hand, higher decline in capital productivity was registered by rubber & rubber products (–20.83%) and non-metallic mineral products (–14.49%).

Growth in labour productivity was highest in the chemicals & chemical products (11%) followed by textile products (8.36%), other manufacturing industries (5.8%), manufacturing of electrical machinery (5.2%), wool, silk, & synthetic industries (5%), machine & machine tools (4.5%), food products (4.5%) and cotton textiles (3.1%). Decline in the index of labour productivity was experienced in the beverages & tobacco products (–6.8%), rubber & rubber products (–5.4%), and wood & wood products (–3.0%).

**Table 8:** Industry-wise indices of factor productivity in the ASI factory sector units in Gujarat

| | Food Products | Textiles | Wood & Wood Products | Paper & Paper Products | Rubber & Rubber Products | Chemicals & Chemical Products | Non-Metallic Mineral Products | Basic Metal & Alloy Products | Metal Products | Electricals & Electricls Machinery | All Mfg. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Productivity | | | | | | | | | | | |
| 1980-81 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 1981-82 | 117.93 | 86.09 | 68.06 | 70.21 | 82.16 | 131.15 | 84.13 | 95.56 | 95.80 | 100.69 | 105.37 |
| 1982-83 | 109.78 | 72.38 | 83.64 | 52.02 | 87.17 | 163.16 | 86.33 | 64.75 | 85.12 | 90.95 | 103.07 |
| 1983-84 | 142.88 | 81.01 | 47.52 | 58.64 | 71.09 | 115.19 | 32.85 | 67.36 | 66.18 | 89.40 | 108.51 |
| 1984-85 | 71.25 | 62.90 | 61.01 | 92.02 | 78.51 | 155.01 | 41.57 | 53.66 | 84.40 | 107.30 | 93.03 |
| 1985-86 | 107.50 | 62.95 | 67.21 | 48.35 | 140.32 | 130.42 | 54.39 | 55.50 | 105.18 | 108.55 | 91.78 |
| 1986-87 | 95.42 | 65.17 | 54.63 | 62.37 | 228.04 | 125.06 | 33.10 | 57.08 | 64.35 | 106.31 | 91.37 |
| 1987-88 | 118.80 | 56.77 | 36.03 | 56.47 | 125.71 | 140.82 | 39.29 | 55.95 | 108.55 | 105.47 | 90.02 |
| 1988-89 | 105.69 | 51.51 | 37.05 | 53.23 | 222.89 | 210.58 | 44.16 | 60.97 | 95.47 | 94.25 | 105.80 |
| 1989-90 | 166.44 | 63.80 | 31.12 | 51.50 | 271.45 | 148.65 | 31.01 | 59.78 | 76.76 | 96.69 | 98.26 |
| 1990-91 | 147.38 | 70.44 | 39.49 | 58.76 | 99.37 | 117.66 | 48.64 | 72.63 | 53.36 | 92.69 | 81.09 |
| Annual Growth (%) | 2.84 | –4.22 | –9.89 | –3.90 | 8.88 | 2.06 | –8.61 | –3.60 | –2.69 | –0.10 | –1.49 |
| Labour Productivity | | | | | | | | | | | |
| 1980-81 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 1981-82 | 110.61 | 99.44 | 109.41 | 99.56 | 51.72 | 122.67 | 94.64 | 97.58 | 98.73 | 108.58 | 107.46 |
| 1982-83 | 122.17 | 82.03 | 106.66 | 69.10 | 65.03 | 163.82 | 100.45 | 78.90 | 97.91 | 201.00 | 109.98 |
| 1983-84 | 186.90 | 109.25 | 125.58 | 86.43 | 64.76 | 136.79 | 67.32 | 101.91 | 99.31 | 120.93 | 141.74 |
| 1984-85 | 105.16 | 104.35 | 125.24 | 142.33 | 51.82 | 188.42 | 88.21 | 70.79 | 103.27 | 143.34 | 133.02 |
| 1985-86 | 157.45 | 125.63 | 148.86 | 82.31 | 72.26 | 198.41 | 140.85 | 90.51 | 135.00 | 154.70 | 153.90 |
| 1986-87 | 154.72 | 125.60 | 109.40 | 105.09 | 136.79 | 211.99 | 106.76 | 87.76 | 97.72 | 169.10 | 167.50 |
| 1987-88 | 209.52 | 114.81 | 107.75 | 91.82 | 50.76 | 210.91 | 118.28 | 93.90 | 156.08 | 185.28 | 167.09 |
| 1988-89 | 207.09 | 112.46 | 142.50 | 96.85 | 117.02 | 310.77 | 149.57 | 127.58 | 122.80 | 180.59 | 201.41 |
| 1989-90 | 326.16 | 118.60 | 142.91 | 104.80 | 157.19 | 212.93 | 118.32 | 91.33 | 146.37 | 179.03 | 181.01 |
| 1990-91 | 272.73 | 148.88 | 209.61 | 160.01 | 69.62 | 252.46 | 199.04 | 136.86 | 149.45 | 201.02 | 196.99 |
| Annual Growth (%) | 10.49 | 3.57 | 4.72 | 3.08 | 4.44 | 8.86 | 6.22 | 2.54 | 4.65 | 5.63 | 7.14 |
| Total Factor Productivity | | | | | | | | | | | |
| 1980-81 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 1981-82 | 114.21 | 92.52 | 86.30 | 83.61 | 65.19 | 126.84 | 89.23 | 96.56 | 97.26 | 104.56 | 106.41 |
| 1982-83 | 115.81 | 77.05 | 94.45 | 59.96 | 75.29 | 163.49 | 93.12 | 71.47 | 91.29 | 135.21 | 106.47 |
| 1983-84 | 163.29 | 94.08 | 77.25 | 71.19 | 67.85 | 125.52 | 47.03 | 82.85 | 81.07 | 103.98 | 124.01 |
| 1984-85 | 86.56 | 81.01 | 87.41 | 114.44 | 63.79 | 170.90 | 60.55 | 61.64 | 93.36 | 124.02 | 111.24 |
| 1985-86 | 130.10 | 88.93 | 100.03 | 63.08 | 100.70 | 160.86 | 87.52 | 70.88 | 119.16 | 129.59 | 118.85 |
| 1986-87 | 121.51 | 90.47 | 77.31 | 80.96 | 176.62 | 162.83 | 59.45 | 70.78 | 79.30 | 134.08 | 123.71 |
| 1987-88 | 157.77 | 80.73 | 62.31 | 72.01 | 79.88 | 172.34 | 68.17 | 72.48 | 130.16 | 139.79 | 122.65 |
| 1988-89 | 147.94 | 76.11 | 72.66 | 71.80 | 161.50 | 255.82 | 81.27 | 88.19 | 108.27 | 130.46 | 145.98 |
| 1989-90 | 232.99 | 86.99 | 66.69 | 73.47 | 206.57 | 177.91 | 60.58 | 73.89 | 106.00 | 131.57 | 133.37 |
| 1990-91 | 200.49 | 102.40 | 90.98 | 96.97 | 83.18 | 172.35 | 98.40 | 99.70 | 89.30 | 136.50 | 126.38 |
| Annual Growth (%) | 6.67 | –0.33 | –2.58 | –0.41 | 6.66 | 5.46 | –1.19 | –0.53 | 0.98 | 2.76 | 2.82 |

Total factor productivity (TFP) recorded higher growth in the chemicals & chemical products (5.4%), followed by textiles products (4.6%) repair services (3.1%), machinery & machine tools (2.7%), other manufacturing industries (2.6%), paper & paper products (1.6%), electrical machinery (1.2%) and food products (0.7%). The industries which recorded decline in the growth TFP indices were manufacture of rubber & rubber products (–13.1%), manufacture of non-metallic mineral products (–8.2%), wood & wood products (–6.2%), beverages & tobacco products (–4.1%), basic metal & alloys (–3.9%), paper & paper products (–3.6%), silk & synthetic textiles (–2.0%), manufacture of transport equipment (–0.1%) and cotton textiles (–0.03%).

**Table 9:** Industry-Wise indices of factor productivity in the ASI census sector units in Gujarat

| Year | 20-21 | 22 | 23 | 24 | 26 | 27 | 28 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 97 | All Mfg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Productivity | | | | | | | | | | | | | | | | | | |
| 1976-77 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 1977-78 | 131.71 | 104.78 | 105.32 | 90.92 | 60.02 | 90.50 | 95.39 | 553.71 | 100.35 | 141.40 | 102.19 | 94.10 | 128.60 | 119.53 | 98.99 | 111.24 | 86.56 | 123.15 |
| 1978-79 | 124.95 | 99.20 | 41.72 | 87.38 | 72.09 | 70.50 | 158.89 | 486.46 | 103.58 | 142.50 | 105.45 | 171.48 | 91.09 | 100.62 | 96.47 | 91.56 | 108.96 | 88.74 |
| 1979-80 | 125.17 | 105.73 | 113.05 | 75.23 | 58.92 | 130.36 | 178.07 | 406.33 | 106.77 | 123.32 | 105.65 | 120.85 | 110.86 | 102.67 | 90.50 | 102.07 | 92.05 | 125.83 |
| 1980-81 | 115.51 | 102.58 | 101.56 | 70.02 | 76.93 | 82.45 | 299.02 | 159.49 | 96.32 | 115.02 | 108.69 | 138.06 | 126.99 | 96.58 | 86.67 | 103.39 | 64.93 | 92.72 |
| 1981-82 | 142.68 | 107.13 | 84.91 | 66.40 | 40.18 | 33.75 | 136.76 | 107.48 | 98.04 | 118.66 | 124.68 | 137.43 | 124.63 | 93.67 | 83.95 | 85.28 | 60.89 | 107.11 |
| 1982-83 | 310.96 | 48.38 | 94.99 | 75.89 | 89.28 | 59.30 | 102.67 | 116.23 | 97.37 | 108.84 | 73.05 | 155.91 | 100.77 | 77.81 | 83.31 | 118.72 | 100.62 | 110.61 |
| 1983-84 | 138.41 | 26.75 | 81.04 | 56.84 | 111.29 | 48.78 | 116.88 | –211,78 | 97.49 | 38.89 | 44.14 | 101.29 | 105.55 | 82.93 | 84.83 | 75.46 | 145.28 | 93.89 |
| 1984-85 | 35.31 | 145.21 | 61.83 | 42.49 | 76.90 | 39.94 | 130.81 | 104.00 | 98.21 | 40.89 | 56.88 | 94.27 | 117.68 | 78.32 | 84.18 | 78.73 | 110.74 | 99.50 |
| 1986-86 | 112.00 | 96.06 | 67.40 | 42.55 | 73.64 | 45.98 | 147.81 | 324.94 | 100.61 | 40.89 | 56.61 | 112.10 | 123.97 | 85.06 | 82.86 | 109.40 | 145.71 | 113.73 |
| 1986-87 | 96.19 | 126.18 | 65.74 | 43.18 | 73.52 | 47.75 | 119.92 | 396.55 | 100.16 | 37.81 | 75.15 | 52.92 | 116.56 | 93.61 | 82.46 | 121.55 | 134.12 | 113.47 |
| Labour Productivity | | | | | | | | | | | | | | | | | | |
| 1976-77 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 1977-78 | 124.22 | 78.00 | 124.16 | 79.00 | 67.06 | 102.46 | 102.81 | 14.13 | 97.76 | 175.97 | 73.46 | 114.19 | 121.82 | 120.22 | 69.17 | 104.36 | 110.36 | 106.03 |
| 1978-79 | 118.01 | 84.72 | 116.64 | 90.59 | 67.42 | 110.57 | 184.79 | 12.17 | 110.49 | 153.36 | 165.38 | 132.04 | 117.55 | 106.33 | 73.30 | 128.82 | 120.93 | 109.04 |
| 1979-80 | 117.53 | 77.35 | 125.15 | 107.14 | 65.94 | 73.84 | 161.76 | 9.74 | 108.61 | 115.94 | 138.05 | 101.76 | 95.58 | 83.70 | 37.10 | 122.40 | 103.81 | 108.62 |
| 1980-81 | 114.62 | 108.60 | 116.68 | 113.45 | 99.30 | 71.48 | 166.72 | 150.97 | 97.80 | 119.78 | 142.30 | 90.98 | 113.30 | 114.29 | 49.15 | 141.49 | 87.65 | 114.26 |
| 1981-82 | 122.89 | 74.38 | 112.39 | 100.61 | 125.67 | 54.72 | 139.71 | 75.12 | 141.85 | 119.05 | 142.48 | 86.90 | 112.82 | 131.51 | 37.53 | 145.22 | 96.02 | 134.78 |
| 1982-83 | 280.12 | 18.45 | 133.28 | 155.05 | 151.12 | 75.45 | 109.62 | 95.33 | 151.95 | 138,58 | 113.90 | 100.95 | 118.76 | 140.71 | 53.26 | 143.45 | 111.33 | 155.67 |
| 1983-84 | 193.78 | 10.29 | 147.30 | 193.01 | 195.32 | 87.40 | 140.28 | –205.13 | 217.48 | 81.93 | 88.31 | 83.79 | 125.07 | 114.10 | 69.61 | 101.56 | 130.28 | 187.49 |
| 1984-85 | 56.57 | 51.30 | 109.47 | 128.05 | 118.88 | 49.54 | 178.03 | 69.81 | 204.60 | 88.38 | 86.31 | 107.85 | 145.21 | 127.94 | 80.91 | 122.62 | 110.97 | 203.31 |
| 1986-86 | 211.50 | 112.99 | 147.98 | 130.79 | 149.66 | 85.94 | 173.69 | 17.76 | 228.13 | 119.06 | 106.15 | 112.45 | 151.26 | 143.32 | 63.34 | 195.33 | 123.79 | 255.06 |
| 1986-87 | 185.38 | 72.33 | 161.87 | 119.66 | 140.23 | 89.67 | 150.39 | 204.95 | 274.10 | 138.27 | 119.64 | 62.62 | 176.76 | 206.00 | 116.76 | 210.47 | 122.03 | 299.11 |
| Total Factor Productivity | | | | | | | | | | | | | | | | | | |
| 1976-77 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 1977-78 | 127.91 | 90.41 | 114.35 | 84.75 | 63.54 | 96.29 | 99.03 | 88.45 | 99.05 | 157.74 | 86.64 | 103.66 | 125.17 | 119.88 | 82.75 | 107.75 | 97.74 | 114.27 |
| 1978-79 | 121.43 | 91.67 | 69.76 | 88.97 | 69.72 | 88.29 | 171.35 | 76.94 | 106.98 | 147.83 | 132.06 | 150.47 | 103.48 | 103.43 | 84.09 | 108.60 | 114.79 | 98.37 |
| 1979-80 | 121.29 | 90.43 | 118.94 | 89.78 | 62.33 | 98.11 | 169.72 | 62.92 | 107.68 | 119.57 | 120.76 | 110.90 | 102.94 | 92.70 | 57.94 | 111.77 | 97.76 | 116.91 |
| 1980-81 | 115.07 | 105.55 | 108.86 | 89.13 | 87.40 | 76.77 | 223.28 | 155.17 | 97.06 | 117.38 | 124.37 | 112.07 | 119.95 | 105.06 | 65.27 | 120.95 | 75.44 | 102.93 |
| 1981-82 | 132.42 | 89.26 | 97.69 | 81.73 | 71.06 | 42.97 | 138.23 | 89.86 | 117.93 | 118.86 | 133.28 | 109.28 | 118.58 | 110.99 | 56.13 | 111.28 | 76.46 | 120.15 |
| 1982-83 | 295.14 | 29.87 | 112.52 | 108.47 | 116.15 | 66.89 | 106.09 | 105.25 | 121.64 | 122.81 | 91.22 | 125.45 | 109.39 | 104.64 | 66.61 | 130.50 | 105.84 | 131.22 |
| 1983-84 | 163.77 | 16.59 | 109.26 | 104.74 | 147.44 | 65.29 | 128.05 | –208.43 | 145.61 | 56.44 | 62.43 | 92.13 | 114.90 | 97.28 | 76.85 | 87.54 | 137.58 | 132.68 |
| 1984-85 | 44.70 | 86.31 | 82.27 | 73.76 | 95.61 | 44.49 | 152.60 | 85.26 | 141.76 | 60.11 | 70.06 | 100.83 | 130.73 | 110.10 | 82.53 | 98.25 | 110.85 | 142.23 |
| 1986-86 | 153.91 | 104.18 | 99.87 | 74.60 | 104.98 | 42.86 | 160.23 | 75.97 | 151.50 | 69.77 | 77.52 | 112.27 | 136.94 | 110.41 | 72.45 | 146.19 | 134.30 | 170.32 |
| 1986-87 | 133.54 | 95.54 | 103.16 | 71.88 | 101.54 | 65.43 | 134.29 | 285.08 | 165.69 | 72.30 | 94.82 | 57.57 | 143.54 | 138.87 | 98.12 | 159.94 | 127.93 | 184.23 |
| Annual Growth of Productivity (%) | | | | | | | | | | | | | | | | | | |
| Capital | –3.13 | –1.40 | –3.12 | –8.98 | 0.80 | –9.46 | 0.15 | –20.83 | –0.28 | –14.49 | –7.08 | –4.10 | 0.96 | –2.81 | –2.05 | –0.01 | 4.50 | 0.23 |
| Labour | 4.46 | –6.77 | 3.07 | 4.95 | 8.36 | –2.97 | 3.02 | –5.38 | 11.01 | –1.95 | –0.63 | –2.99 | 4..48 | 5.18 | 1.87 | 5.20 | 1.72 | 11.14 |
| TFP | 0.66 | –4.09 | –0.03 | –2.02 | 4.58 | –6.21 | 1.59 | –13.10 | 5.36 | –8.22 | –3.86 | –3.55 | 2.72 | 1.19 | –0.09 | 2.60 | 3.11 | 5.68 |

A general conclusion from the analysis is that there is almost one-to-one correspondence between the capital intensity and value added in most of the industries. Therefore, we may say that modernisation of process technology is inevitable to increase the level of productivity.

**A general conclusion from the analysis is that there is almost one-to-one correspondence between the capital intensity and value added in most of the industries. Therefore, we may say that modernisation of process technology is inevitable to increase the level of productivity.**

### Output Elasticity

The analysis of output elasticity with respect to capital and labour provides information on the returns to factor inputs. This measure indicates whether there is any further scope to invest capital or employ labour for increasing the output/value added in a particular industry. Output elasticity with respect to capital and labour was estimated through the following logarithmic form of regression method:

$$\text{Ln } Y = a + bi \text{ Ln } K + b2 \text{ Ln } L + b3\ t$$

where

Y is the value added,

K is capital investment,

L is labour employed,

t is the time period

b1 is the regression coefficient of capital investment or elasticity of output with respect to capital,

b2 is the regression coefficient of labour employed or elasticity of output with respect to employment.

b3 is the regression coefficient of time or contribution of process technology to value added, and a is constant or intercept of regression line.

The linear relation of value-added with the factor inputs was calculated after inclusion or exclusion of the time variable. The inclusion of time variable shows to what extent the values of input coefficients (elasticities) undergo changes.

Since the ASI census sector covers lesser number of units, the results of factory sector and census sector units may differ from each other. However, a careful observation would provide an insight into the operations of medium scale units which remain outside the scope of the ASI census sector.

### Output Elasticity in the ASI Factory Sector

The analysis of output elasticity with respect to capital and labour (table 10) states that output was more elastic to capital in food manufacturing, basic metal and electrical industries. The value of regression coefficient (b1) which is greater than unity indicates that additional investment would yield higher returns in the aforesaid industries. The other industries with relatively higher capital elasticities are paper products, non-metallic mineral products, rubber & rubber products and wood products. The wood industry has high elasticities for both capital and labour which indicates the balanced use of factor inputs.

The output elasticity with respect to capital was low in the chemicals, metal products and textiles industries which indicates excess capital investment and / or under utilisation of investments. Higher labour elasticity (greater than unity) in the chemicals industry states that additional employment in chemical industry would be more productive. The other industries in which additional employment is expected to yield higher returns are metal products and wood products.

### Output Elasticity in the ASI Census Sector

In the ASI census sector units, the returns to capital were higher in the food products, rubber & plastic, chemicals & chemical products, manufacture of machinery & machine tools and manufacture of transport equipment industries (table 11). Negative returns to capital (though not statistically significant) were recorded in the wood & wood products and other manufacturing industries. It appears from the table that there is almost balanced use of capital and labour in the cotton textiles industry (census sector) and there exists a potential for further mechanisation/ modernisation in the manufacture of transport equipment.

**There is almost balanced use of capital and labour in the cotton textiles industry and there exists a potential for further mechanisation/ modernisation in the manufacture of transport equipment.**

**Table 10:** Elasticities of capital and labour and contribution of process technology in the ASI factory sector units in Gujarat (1980-91)

| Industry | R-Equation | a | b1(K) | t-value | b2(L) | t-value | b3(T) | t-value | R-Squared |
|---|---|---|---|---|---|---|---|---|---|
| Food Products | 1 | –5.1684 | 1.2565 | 7.9116** | 0.3361 | 1.1683 | | | 0.888 |
| | 2 | –2.6297 | 0.3505 | 0.8208 | 0.9272 | 2.6143 | 0.0680 | 2.2273 | 0.935 |
| | 3 | 0.2646 | 0.1396 | 0.4115 | | | 0.0790 | 2.9172* | 0.944 |
| Textiles | 1 | 4.0806 | 0.4849 | 2.4891* | 0.1989 | 2.5103* | | | 0.595 |
| | 2 | 1.8533 | 0.2471 | 1.6752 | 0.5820 | 4.6182 | 0.0341 | 3.3444 * | 0.844 |
| | 3 | –0.1361 | 0.3552 | 3.0691 | | | 0.0375 | 3.7719** | 0.969 |
| Wood & Wood Products | 1 | –4.1919 | 0.7489 | 5.7897** | 0.8240 | 2.0362* | | | 0.808 |
| | 2 | –6.5733 | 0.3832 | 1.3691 | 1.3700 | 2.5628 | 0.0664 | 1.4498 | 0.853 |
| | 3 | –0.3046 | 0.3987 | 1.2845 | | | 0.0449 | 0.9194 | 0.811 |
| Paper & Paper Products | 1 | 9.5208 | 0.9397 | 9.4910** | –0.8625 | –2.1221* | | | 0.921 |
| | 2 | 9.2472 | 0.7468 | 3.0253 | –0.6624 | –1.3946 | 0.0160 | 0.8557 | 0.929 |
| | 3 | 0.2073 | 0.6917 | 2.2333 | | | 0.0170 | 0.7210 | 0.867 |
| Rubber & Rubber Products | 1 | 6.4557 | 0.6630 | 1.8359 | –0.1676 | –0.4770 | | | 0.296 |
| | 2 | 21.7950 | 0.6062 | 1.7876 | –1.7607 | –1.5642 | 0.1094 | 1.4794 | 0.464 |
| | 3 | 1.5572 | 0.8006 | 2.1924 | | | –0.0170 | –0.5960 | 0.552 |
| Chemicals & Chemical Products | 1 | –12.1448 | 0.3784 | 1.2813 | 1.7724 | 2.1082* | | | 0.910 |
| | 2 | 7.2854 | –0.0527 | –0.2426 | 0.4711 | 0.7482 | 0.1010 | 3.7302** | 0.970 |
| | 3 | 0.8177 | –0.0543 | –0.2501 | | | 0.0796 | 4.8080** | 0.927 |
| Non-Metallic Mineral Products | 1 | 12.3142 | 0.5158 | 5.7513** | –0.6668 | –1.0792 | | | 0.817 |
| | 2 | 5.6473 | –0.2606 | –1.3813 | 0.5999 | 1.3126 | 0.1209 | 4.2716** | 0.949 |
| | 3 | –1.7765 | –0.4029 | –2.0222 | | | 0.1387 | 4.5063** | 0.918 |
| Basic Metal & Alloy | 1 | 16.3417 | 1.0291 | 9.3344** | –1.5226 | –5.1804** | | | 0.921 |
| | 2 | 13.8309 | 0.6121 | 3.1804 | –0.8972 | –2.5908 | 0.0299 | 2.4280* | 0.957 |
| | 3 | 0.0472 | –0.1097 | –0.2811 | | | 0.0646 | 2.3489* | 0.699 |
| Metal Products | 1 | –2.9981 | 0.4415 | 5.0050** | 0.8858 | 3.4184* | | | 0.958 |
| | 2 | –0.4617 | 0.3493 | 2.4403 | 0.7020 | 2.0330 | 0.0181 | 0.8276 | 0.961 |
| | 3 | 0.0217 | 0.3404 | 2.8757 | | | 0.0206 | 1.9573 | 0.894 |
| Electricals & Electrical Machinery | 1 | –1.7212 | 1.1400 | 13.7047** | 0.0793 | 0.6894 | | | 0.971 |
| | 2 | 6.1504 | 0.3370 | 1.1038 | 0.1098 | 1.2616 | 0.0728 | 2.6866* | 0.986 |
| | 3 | 0.4814 | 0.8813 | 8.8679 | | | 0.0241 | 3.0323* | 0.970 |
| All Manufacturing | 1 | –0.0785 | 0.7490 | 8.0796** | 0.3014 | 0.7174 | | | 0.902 |
| | 2 | 4.2237 | –0.0434 | –0.2889 | 0.7279 | 3.4883 | 0.0695 | 5.5278** | 0.982 |
| | 3 | 0.0435 | 0.0485 | 0.3410 | | | 0.0643 | 5.0571** | 0.982 |
| Regression Equation | 1 $Ln\ Y = Ln\ a + b1\ LnK + b2\ LnL$ | | | | | | | | |
| | 2 $Ln\ Y = Ln\ a + b1\ LnK + b2\ LnL + b3\ T$ | | | | | | | | |
| | 3 $Ln\ (Y/L) = Ln\ a + b1\ Ln(K/L) + b3\ t$ | | | | | | | | |

** Significant at 1%, * Significant at 5%.

During 1975-87, there does not seem to be any technological breakthrough in the manufacture of transport equipment industry. This has been inferred from the negative coefficient of technological progress. The other industries in which the contribution of technological progress to total factor productivity were negative (though not statistically significant) were wood and wood products and repair services. Besides, the contribution of process technology was dismal in the textiles, chemicals & chemical products industries. The analysis shows that rubber, plastic, petroleum and coal were the only industry groups in which contribution of technological progress to the net value added was significant during 1975-87.

The analysis of elasticity in the factory as well as census sector units shows higher capital elasticity in the food products, wood & wood products and rubber & rubber product. This is an indicator of the positive contribution of improved process technology. Further the inference from lower capital elasticity in the factory sector chemical units and high capital elasticity in census sector chemical units is that the process technologies of chemicals plants are available in specific sizes (capacities) and the units in the factory sector particularly medium scale plants are unable to make optimum use of investments. Similarly the manufacturing of paper and paper products would be more productive in the larger plants. Higher

**Table 11:** Elasticities of capital and labour and contribution of process technology in the ASI census sector units in Gujarat (1975-88)

| I-Code | R-Equation | a | b1(K) | t-value | b2(L) | t-value | b3(T) | t-value | R-Squared |
|---|---|---|---|---|---|---|---|---|---|
| 20-21 | 1 | 3.7630 | 0.7033 | 3.9435** | 0.2005 | 0.7429 | | | 0.685 |
| | 2 | 14.5195 | –0.3386 | –0.7048 | 0.5009 | 1.9128 | 0.0776 | 2.2820* | 0.801 |
| | 3 | 3.1721 | 0.5258 | 1.7236 | | | 0.0169 | 0.7690 | 0.657 |
| 22 | 1 | 1.9262 | 0.1623 | 1.8208 | 1.0605 | 6.6871** | | | 0.896 |
| | 2 | 2.7608 | 0.0076 | 0.0458 | 1.1247 | 6.7234** | 0.0303 | 1.1051 | 0.909 |
| | 3 | 3.9201 | –0.0569 | –0.3922 | | | 0.0426 | 1.8538 | 0.403 |
| 23 | 1 | 0.3686 | 0.6288 | 9.9710** | 0.5414 | 10.0563** | | | 0.923 |
| | 2 | –0.3946 | 0.7169 | 4.3460** | 0.5004 | 5.5735** | –0.0072 | –0.5821 | 0.926 |
| | 3 | 2.7651 | 0.4975 | 5.1654** | | | 0.0044 | 0.4115 | 0.976 |
| 24 | 1 | –0.2140 | 0.3768 | 2.1480 | 0.9695 | 2.1592 | | | 0.948 |
| | 2 | 2.0474 | 0.2917 | 1.2250 | 0.8488 | 1.6477 | 0.0296 | 0.5565 | 0.950 |
| | 3 | 3.4559 | 0.2859 | 1.2709 | | | 0.0418 | 1.3106 | 0.818 |
| 26 | 1 | 0.0044 | 0.2794 | 2.1133 | 1.1121 | 6.6743** | | | 0.967 |
| | 2 | 1.6278 | 0.2971 | 2.1696 | 0.8738 | 2.4714* | 0.0322 | 0.7688 | 0.969 |
| | 3 | 2.8961 | 0.3129 | 2.4153 | | | 0.0551 | 4.7357** | 0.753 |
| 27 | 1 | 5.7007 | –0.0230 | –0.2872 | 0.7196 | 4.8636** | | | 0.703 |
| | 2 | 6.7089 | 0.0887 | 1.2616 | 0.4704 | 3.4042** | –0.0536 | –2.9966* | 0.851 |
| | 3 | 3.7822 | 0.1260 | 1.2700 | | | –0.0324 | –1.3519 | 0.175 |
| 28 | 1 | –1.5861 | 0.2479 | 1.1039 | 1.2937 | 3.1288* | | | 0.719 |
| | 2 | 3.2699 | 0.0680 | 0.5242 | 0.9840 | 4.1426** | 0.0486 | 4.8631** | 0.923 |
| | 3 | 3.7485 | 0.0665 | 0.5393 | | | 0.0498 | 6.0158** | 0.809 |
| 30 | 1 | 1.9453 | 0.8903 | 3.4218** | 0.1210 | 0.1884 | | | 0.817 |
| | 2 | 7.1306 | 0.9918 | 4.7629** | –0.8345 | –1.3482 | 0.2378 | 2.6736* | 0.898 |
| | 3 | 1.6323 | 0.7759 | 4.1593** | | | 0.1313 | 1.8110 | 0.747 |
| 31 | 1 | 0.0379 | 0.9772 | 41.1978** | 0.0313 | 0.9908 | | | 0.999 |
| | 2 | 0.0406 | 0.9834 | 29.6410** | 0.0225 | 0.4969 | –0.0009 | –0.2850 | 0.999 |
| | 3 | 0.0679 | 0.9917 | 41.8403** | | | –0.0015 | –0.6266 | 0.995 |
| 32 | 1 | 6.7730 | 0.2331 | 3.9064** | 0.4347 | 1.8233 | | | 0.854 |
| | 2 | 8.3854 | 0.0478 | 0.4210 | 0.4927 | 2.788* | 0.0404 | 1.8487 | 0.894 |
| | 3 | 3.8039 | 0.0676 | 0.4920 | | | 0.0217 | 0.8784 | 0.538 |
| 33 | 1 | 0.6866 | 0.3269 | 1.8019 | 0.9943 | 3.4643** | | | 0.924 |
| | 2 | 4.5043 | 0.0366 | 0.1261 | 9634 | 3.4400** | 0.0443 | 1.2583 | 0.935 |
| | 3 | 4.5050 | 0.0366 | 0.1580 | | | 0.0443 | 2.6473 * | 0.656 |
| 34 | 1 | 1.4023 | 0.2896 | 1.6749 | 0.9578 | 3.1212* | | | 0.701 |
| | 2 | 5.6457 | 0.3775 | 2.9497* | 0.3380 | 1.1457 | 0.0345 | 3.1856 * | 0.860 |
| | 3 | 3.1952 | 0.3656 | 2.8332* | | | 0.0266 | 3.2091** | 0.602 |
| 35 | 1 | –3.0365 | 0.8634 | 10.0195** | 0.5959 | 3.1461 * | | | 0.942 |
| | 2 | 6.7280 | 0.1243 | 1.0746 | 0.5770 | 7.1060** | 0.0577 | 6.7441** | 0.990 |
| | 3 | 3.1132 | 0.3294 | 4.0256** | | | 0.0419 | 7.5253** | 0.978 |
| 36 | 1 | 0.8032 | 0.6985 | 6.7766** | 0.5021 | 1.7216 | | | 0.941 |
| | 2 | 9.6211 | 0.1587 | 0.6968 | 0.2099 | 0.8042 | 0.0865 | 2.5451* | 0.966 |
| | 3 | 3.2090 | 0.4374 | 2.5526* | | | 0.0361 | 2.0238 | 0.909 |
| 37 | 1 | 1.4473 | 0.9756 | 51.4214** | –0.1250 | –3.1675** | | | 0.998 |
| | 2 | 0.4406 | 1.0397 | 65.3184** | –0.0793 | –3.5075** | –0.0203 | –5.1854** | 1.000 |
| | 3 | 0.0899 | 1.0520 | 72.0633** | | | –0.0252 | –10.3813** | 0.999 |
| 38 | 1 | –1.5964 | –0.5244 | –1.0839 | 2.4509 | 3.1020* | | | 0.678 |
| | 2 | –0.4232 | –0.5303 | –1.0457 | 2.2969 | 2.4296* | 0.0125 | 0.3371 | 0.682 |
| | 3 | 4.8124 | –0.3486 | –0.7097 | | | 0.0436 | 1.6732 | 0.219 |
| 97 | 1 | 5.7812 | 0.4034 | 0.5958 | 0.2790 | 0.2658 | | | 0.419 |
| | 2 | 8.5719 | –0.9733 | –0.6721 | 1.6602 | 1.0026 | –0.0694 | –1.0732 | 0.485 |
| | 3 | 6.2989 | –1.2993 | –0.9764 | | | –0.0698 | –1.1094 | 0.112 |
| All Mfg. | 1 | –6.4608 | 0.7532 | 9.4732** | 0.8875 | 2.5934 * | | | 0.909 |
| | 2 | 0.6815 | 0.2429 | 1.6305 | 0.9579 | 4.1790** | 0.0628 | 3.6671** | 0.963 |
| | 3 | 3.4608 | 0.1873 | 1.4676 | | | 0.0689 | 4.6247** | 0.957 |

Regression Equation

1 $Ln\ Y = Ln\ a + b1\ LnK + b2\ LnL$

2 $Ln\ Y = Ln\ a + b1\ LnK + b2\ LnL + b3\ T$

3 $Ln\ (Y/L) = Ln\ a + b1\ Ln(K/L) + b3\ t$

** Significant at 1%, * Significant at 5%.

labour elasticity in the factory as well as census sector cotton textile units states that the cotton textiles industry would continue to play a major role in the generation of employment in Gujarat.

## Conclusion

The industrial growth in Gujarat has brought about major structural changes in the industrial scenario of the state. Textiles, chemicals & chemical products, rubber & rubber products, electrical, food products are the major industries contributing significantly to output and value added. The share of industrial sector and mining activities in the net State Domestic Product (SDP) increased from 20% in 1970-71 to 29% in 1980-81 and further increased to 34% in 1988-89.

Although the textiles industry has lost its supremacy to the chemicals & chemical products, still a major chunk of the industrial employment is in the former. The analysis also suggests the potential for further employment generation in the textile industries.

The analysis, in general, indicates that the value-added and capital intensity have almost one-to-one relationship. Therefore, in the present competitive economy where the product quality is equally important, capital investment for the adoption of improved process technology is inevitable. On the other hand, capital investment is dearer and often substitutes labour which is undesirable in the labour surplus economy of Gujarat. Therefore, investment decisions for setting up of new units or the expansion of existing capacities should be strictly based on proper investment appraisals because investment beyond certain limits becomes unproductive.

**Decisions for setting up of new units or the expansion of existing capacities should be strictly based on proper investment appraisals because investment beyond certain limits becomes unproductive.**

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To return to the root is repose; it is called going back to one's destiny. Going back to one's destiny is to find the Eternal Law.

*Tao Teh Chin (The Way)*
*Laotse*

Feature

# Efficient Heuristic for Total Covering Problem

**R. Panneerselvam**

*This paper discusses an efficient heuristic for total covering problem. The aim of the total covering problem is to cover all the customers with the minimum number of facilities. First, an efficient heuristic is proposed for this problem. The results of the proposed heuristic are compared with the results of an existing heuristic and also with the optimal results of a mathematical model.*

*R. Panneerselvam is Reader, School of Management, Pondicherry University, Pondicherry - 605 014*

Consider the residential regions (customers) in a state which are to be covered by a set of dealers (facilities) of a particular company. A region is said to be covered if there is a dealer located within say, a 30 km distance. The objective is to cover all the residential regions with the minimum number of dealers. Hence, it is called as a total covering problem. In general, all the emergency-service/essential-service related situations are formulated as total covering problems. Locating fire extinguishers, emergency food grain reserve stations, railway accident relief equipment stations, health centres, branch banks, schools are some examples.

**All the emergency-service/essential-service related situations are formulated as total covering problems.**

Consider another problem presented by Toregas, et al (1971) for locating emergency facilities which is given in table 1. The table summarizes the distances between 30 major areas in New York State. It is assumed that it is desirable to locate facilities among the areas such that no area is more than, say, 69 miles from a facility. This means that if $d_{ij} \leq 69$ miles, then the area $i$ is covered by the facility located at the area $j$; otherwise the area $i$ is not covered by the facility located at the area $j$. Based on this assumption, the covering co-efficient is defined as follows:

$C_{ij} = 1$, if $d_{ij} \leq 69$.

$= \phi$, otherwise

The corresponding covering co-efficient matrix $C$ (0-1 matrix) is shown in table 2. In this table, the rows

Table 1: Distance Matrix

| Area i \ Area j | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 244 | 140 | 128 | 281 | 196 | 181 | 51 | 248 | 167 | 338 | 54 | 203 | 146 | 295 | 211 | 295 | 78 | 169 | 38 | 167 | 112 | 71 | 220 | 157 | 16 | 135 | 7 | 90 | 165 |
| 2 | 244 | 0 | 158 | 359 | 37 | 111 | 66 | 268 | 60 | 112 | 101 | 278 | 272 | 328 | 51 | 222 | 77 | 200 | 106 | 281 | 332 | 263 | 294 | 33 | 284 | 233 | 109 | 248 | 161 | 164 |
| 3 | 140 | 158 | 0 | 202 | 194 | 56 | 92 | 170 | 117 | 46 | 215 | 137 | 256 | 170 | 209 | 206 | 160 | 62 | 113 | 177 | 279 | 105 | 136 | 136 | 239 | 129 | 78 | 144 | 92 | 148 |
| 4 | 128 | 359 | 202 | 0 | 395 | 258 | 294 | 179 | 319 | 248 | 416 | 90 | 331 | 61 | 410 | 339 | 361 | 176 | 290 | 100 | 295 | 106 | 70 | 337 | 285 | 143 | 254 | 133 | 211 | 293 |
| 5 | 281 | 37 | 194 | 395 | 0 | 145 | 102 | 305 | 92 | 148 | 69 | 317 | 309 | 366 | 19 | 259 | 74 | 236 | 143 | 318 | 369 | 299 | 330 | 70 | 321 | 272 | 146 | 285 | 198 | 201 |
| 6 | 196 | 111 | 56 | 258 | 145 | 0 | 60 | 229 | 61 | 34 | 159 | 189 | 269 | 226 | 162 | 219 | 104 | 118 | 112 | 233 | 315 | 161 | 192 | 100 | 274 | 185 | 91 | 200 | 128 | 161 |
| 7 | 181 | 66 | 92 | 294 | 102 | 60 | 0 | 200 | 67 | 47 | 157 | 220 | 225 | 262 | 117 | 175 | 114 | 134 | 59 | 218 | 279 | 197 | 228 | 46 | 237 | 170 | 49 | 185 | 101 | 117 |
| 8 | 51 | 268 | 170 | 179 | 305 | 229 | 200 | 0 | 275 | 195 | 366 | 105 | 152 | 197 | 319 | 180 | 322 | 108 | 186 | 81 | 116 | 163 | 124 | 242 | 106 | 41 | 159 | 48 | 107 | 175 |
| 9 | 248 | 60 | 117 | 319 | 92 | 61 | 67 | 275 | 0 | 87 | 111 | 254 | 292 | 287 | 111 | 242 | 56 | 175 | 126 | 285 | 346 | 222 | 253 | 60 | 304 | 237 | 116 | 252 | 168 | 184 |
| 10 | 167 | 112 | 46 | 248 | 148 | 34 | 47 | 195 | 87 | 0 | 185 | 179 | 235 | 216 | 163 | 185 | 130 | 93 | 79 | 204 | 281 | 151 | 182 | 90 | 240 | 156 | 57 | 171 | 94 | 127 |
| 11 | 338 | 101 | 215 | 416 | 69 | 159 | 157 | 366 | 111 | 185 | 0 | 348 | 373 | 381 | 88 | 323 | 55 | 273 | 207 | 375 | 433 | 316 | 351 | 134 | 385 | 327 | 206 | 342 | 258 | 265 |
| 12 | 54 | 278 | 137 | 90 | 317 | 189 | 220 | 105 | 254 | 179 | 348 | 0 | 257 | 95 | 329 | 250 | 293 | 86 | 205 | 65 | 221 | 58 | 20 | 254 | 211 | 69 | 169 | 61 | 126 | 204 |
| 13 | 203 | 272 | 256 | 331 | 309 | 269 | 225 | 152 | 292 | 235 | 373 | 257 | 0 | 349 | 323 | 66 | 339 | 236 | 168 | 233 | 60 | 315 | 274 | 239 | 46 | 193 | 178 | 200 | 171 | 108 |
| 14 | 146 | 328 | 170 | 61 | 366 | 226 | 26 | 197 | 287 | 216 | 381 | 95 | 349 | 0 | 379 | 343 | 326 | 179 | 284 | 144 | 313 | 69 | 75 | 306 | 303 | 161 | 248 | 151 | 219 | 297 |
| 15 | 295 | 51 | 209 | 410 | 19 | 162 | 117 | 319 | 111 | 163 | 88 | 329 | 323 | 379 | 0 | 273 | 93 | 251 | 157 | 332 | 383 | 314 | 345 | 84 | 335 | 284 | 160 | 299 | 212 | 215 |
| 16 | 211 | 222 | 206 | 339 | 259 | 219 | 175 | 180 | 242 | 185 | 323 | 250 | 66 | 343 | 273 | 0 | 289 | 192 | 118 | 248 | 126 | 293 | 270 | 189 | 92 | 198 | 128 | 213 | 129 | 58 |
| 17 | 295 | 77 | 160 | 361 | 74 | 104 | 114 | 322 | 56 | 130 | 55 | 293 | 339 | 326 | 93 | 289 | 0 | 218 | 173 | 332 | 393 | 261 | 296 | 106 | 351 | 284 | 163 | 299 | 215 | 231 |
| 18 | 78 | 200 | 62 | 176 | 236 | 118 | 134 | 108 | 175 | 93 | 273 | 86 | 236 | 179 | 251 | 192 | 218 | 0 | 130 | 118 | 221 | 124 | 106 | 178 | 194 | 67 | 94 | 82 | 64 | 146 |
| 19 | 169 | 106 | 113 | 290 | 143 | 112 | 59 | 186 | 126 | 79 | 207 | 205 | 168 | 284 | 157 | 118 | 173 | 130 | 0 | 206 | 228 | 219 | 225 | 73 | 180 | 156 | 36 | 171 | 79 | 60 |
| 20 | 38 | 281 | 177 | 100 | 318 | 233 | 218 | 81 | 285 | 204 | 375 | 65 | 233 | 144 | 332 | 248 | 332 | 118 | 206 | 0 | 191 | 123 | 76 | 257 | 187 | 52 | 172 | 37 | 127 | 202 |
| 21 | 167 | 332 | 279 | 295 | 369 | 315 | 279 | 116 | 346 | 281 | 433 | 221 | 60 | 313 | 383 | 126 | 393 | 221 | 228 | 191 | 0 | 279 | 238 | 299 | 52 | 157 | 230 | 162 | 187 | 168 |
| 22 | 112 | 263 | 105 | 106 | 299 | 161 | 197 | 163 | 222 | 151 | 316 | 58 | 315 | 69 | 314 | 293 | 261 | 124 | 219 | 123 | 279 | 0 | 60 | 241 | 269 | 127 | 103 | 119 | 164 | 247 |
| 23 | 71 | 294 | 136 | 70 | 330 | 192 | 228 | 124 | 253 | 182 | 351 | 20 | 274 | 75 | 345 | 270 | 296 | 106 | 225 | 76 | 230 | 60 | 0 | 272 | 220 | 86 | 109 | 76 | 146 | 224 |
| 24 | 220 | 33 | 136 | 337 | 70 | 100 | 46 | 242 | 60 | 90 | 134 | 254 | 239 | 306 | 84 | 189 | 106 | 178 | 73 | 257 | 299 | 241 | 272 | 0 | 251 | 209 | 85 | 224 | 135 | 131 |
| 25 | 157 | 284 | 239 | 285 | 321 | 274 | 237 | 106 | 304 | 240 | 385 | 211 | 46 | 303 | 335 | 92 | 351 | 194 | 100 | 187 | 52 | 269 | 228 | 251 | 0 | 149 | 108 | 154 | 147 | 120 |
| 26 | 16 | 233 | 129 | 143 | 272 | 185 | 170 | 41 | 237 | 156 | 327 | 69 | 193 | 161 | 284 | 198 | 284 | 67 | 156 | 52 | 157 | 127 | 86 | 209 | 149 | 0 | 124 | 15 | 77 | 152 |
| 27 | 135 | 109 | 78 | 254 | 146 | 91 | 49 | 159 | 116 | 57 | 206 | 169 | 178 | 248 | 160 | 128 | 163 | 94 | 36 | 172 | 230 | 183 | 189 | 85 | 188 | 124 | 0 | 139 | 52 | 70 |
| 28 | 7 | 248 | 144 | 133 | 285 | 200 | 185 | 48 | 252 | 171 | 342 | 61 | 200 | 151 | 299 | 213 | 290 | 82 | 171 | 37 | 162 | 119 | 76 | 224 | 154 | 15 | 139 | 0 | 92 | 167 |
| 29 | 90 | 161 | 92 | 211 | 190 | 120 | 101 | 107 | 160 | 94 | 250 | 126 | 171 | 219 | 212 | 129 | 215 | 64 | 79 | 127 | 187 | 164 | 146 | 135 | 147 | 77 | 52 | 92 | 0 | 83 |
| 30 | 165 | 164 | 140 | 293 | 201 | 161 | 117 | 175 | 184 | 127 | 265 | 204 | 100 | 297 | 215 | 58 | 231 | 146 | 60 | 202 | 160 | 247 | 224 | 131 | 120 | 152 | 70 | 167 | 83 | 0 |

represent the customers and the columns represent the proposed potential sites for locating the facilities. The objective is to determine the minimum number of facilities required to cover all the customers and identify the corresponding sites.

## Literature Review

The total covering problem can be classified based on the type of input. The input for the total covering problem may be a distance/cost matrix or 0-1 matrix.

**Table 2:** Covering co-efficient matrix

| | | Site j | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Ø | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Ø | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Ø |
| | 1 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | 1 | Ø | 1 | Ø | Ø |
| | 2 | Ø | 1 | Ø | Ø | 1 | Ø | 1 | Ø | 1 | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø |
| | 3 | Ø | Ø | 1 | Ø | Ø | 1 | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø |
| | 4 | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø |
| | 5 | Ø | 1 | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø |
| | 6 | Ø | Ø | 1 | Ø | Ø | 1 | 1 | Ø | 1 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø |
| | 7 | Ø | 1 | Ø | Ø | Ø | 1 | 1 | Ø | 1 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | 1 | Ø | Ø | 1 | Ø | Ø | Ø |
| | 8 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | 1 | Ø | Ø |
| | 9 | Ø | 1 | Ø | Ø | Ø | 1 | 1 | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø |
| | 10 | Ø | Ø | 1 | Ø | Ø | 1 | 1 | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | |
| | 11 | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø |
| | 12 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | 1 | 1 | Ø | Ø | 1 | Ø | 1 | Ø | Ø | |
| | 13 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | 1 | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | |
| | 14 | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | |
| Customer i | 15 | Ø | 1 | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | |
| | 16 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 |
| | 17 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | |
| | 18 | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | 1 | Ø | |
| | 19 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | 1 | | |
| | 20 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | 1 | Ø | 1 | Ø | Ø | | |
| | 21 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | | |
| | 22 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | | |
| | 23 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | | |
| | 24 | Ø | 1 | Ø | Ø | Ø | Ø | 1 | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø |
| | 25 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø |
| | 26 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | 1 | Ø | 1 | Ø | Ø | Ø | Ø | Ø | 1 | Ø | 1 | Ø | Ø |
| | 27 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | 1 | Ø | |
| | 28 | 1 | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | 1 | Ø | 1 | Ø | Ø |
| | 29 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | 1 | Ø | |
| | 30 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 | Ø | Ø | 1 | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | Ø | 1 |

Toregas, et al (1971), Panneerselvam (1990), Rajkumar and Panneerselvam (1991) and Roth (1996) have contributed to the total covering problem with 0-1 matrix as the input. Panneerselvam, Balasubramanian and Thiagarajan (1990), Panneerselvam and Balasubramanian (1985), Panneerselvam, Balasubramanian and Nambirajan (1990), and Balasubramanian and Panneerselvam (1993) have concentrated on the application of the total covering problem with the distance/cost matrix as an input. As a unique attempt, Panneerselvam and Balasubramanian (1985), Panneerselvam, Balasubramanian and Nambirajan (1990), Balasubramanian and Panneerselvam (1993) have extended the applications of the total covering problem to group technology at the shop floor level. (For further details on the covering problem, see the recent review by Schilling, et al, 1993).

In this paper, the total covering problem with the 0-1 matrix as the input is considered. This problem comes under combinatorial category. Also, the various Operations Research softwares which can solve 0-1 programming models have limitations on the maximum number of 0-1 variables and the maximum number of constraints. Hence, an attempt has been made to develop an efficient heuristic for the total covering problem.

**Zero-one Programming Model for Total Covering Problem (M1)**

A well known zero-one programming model discussed by Schilling et al (1993) for the total covering problem is as follows:

$$\text{Minimize } Z = \sum_{j=1}^{N} Y_j$$

Subject to

$$\sum_{j=1}^{N} C_{ij}\ Y_j \geq 1,\ i = 1,2,3,\ldots..,\ M$$

where, $Y_j$ is equal to 1, if the site $j$ is selected for assigning a facility and it is equal to $\phi$, otherwise. $C_{ij}$ is equal to 1, if the customer $i$ is served by the facility $j$. It is equal to 0, otherwise. $M$ is the total number of customers and $N$ is the total number of proposed potential sites. In this model, the objective function minimizes the total number of sites selected to assign facilities. The constraints ensure that each customer is covered by at least one facility.

**Efficient Heuristic for Total Covering Problem**

Now, an efficient heuristic based on add and drop concept to solve the total covering problem is proposed. Let this heuristic be H1.

Step 1: Input: Number of customers (rows), $M$.
Number of proposed potential Sites (columns), $N$, Covering co-efficient matrix (C).

Step 2: Find the number of ones in each column $j$ of the matrix $C$. Let it be $CS_j$.

Step 3: Select the column (site ) with the maximum $CS_j$ for assigning facility.
Store the selected site number in an array $Q$.
Store the elements in the column corresponding to the selected site of the matrix $C$ in an array $F$.
Set the actual number of sites selected (kk) to 1.

Step 4: If Maximum $CS_j = M$ then go to step 15; otherwise go to step-5.

Step 5: For each unselected site $j$ (for $j$ not in the array $Q$), find the total number of customers covered by the set of sites in the array $Q$ after it is tentatively included in that array $Q$. Let it be $TC1_j$.

Step 6: Find the maximum of $TC1_j$ values.

Step 7: If there is no tie for the maximum $TC1_j$, then select the site with the maximum $TC1_j$ and place it in the array $Q$. Otherwise, find the number of ones in each of the columns of the matrix $C$, corresponding to the maximum $TC1_j$. Then, select the column with the maximum number of ones among such columns and places it in the array $Q$. Increment the actual number of sites selected by 1 (kk=kk+1).

Update the array $F$ as shown below.

$F_1 = \underset{j \in Q}{\text{Maximum}}\ C_{ij}$, for $i = 1,2,3,\ldots.,M$.

Step 8: If Maximum $TC1_j = M$, then go to step 15; otherwise go to step 9.

Step 9: If kk = 2 then go to step 5; otherwise go to step 10.

Step 10: For each selected site-$j$ in the array $Q$, find the total number of customers covered by the set of sites in the array $Q$, after it is tentatively removed from that array $Q$. Let it be $TC2_j$.

Step 11: Find the maximum of the $TC2_j$ values.

Step 12: If there is no tie for the maximum $TC2_j$, then identify the site with the maximum $TC2_j$.

Otherwise, find the number of zeros in each of the columns of the matrix $C$, corresponding to the maximum $TC2_j$. Then, identify the column with the maximum number of zeros among such columns.

Step 13: If the identified site number is the same as the last element in the array $Q$, then go to step 5; otherwise go to step 14.

Step 14: Remove the identified site number from the array $Q$ and decrement the actual number of sites selected by one (kk = kk – 1).

Also, update the array $F$ as follows and then go to step 5:

$F_1 = \underset{j \in Q}{\text{Maximum}}\ C_{ij}$, for $i = 1,2,3,\ldots.,M$.

Step 15: Print the array $Q$ which contains the set of selected sites for locating facilities.

**Comparison of Results**

An existing heuristic (developed by Rajkumar & Panneerselvam, 1971) is as follows:

Step 0: Input 0-1 covering co-efficient matrix *C*.

Number of customers (number of rows of the matrix *C*, *M*. Number of proposed potential sites (number of columns of the matrix *C*), *N*.

Step 1: Compute the row totals, $RT(i)$, $i = 1,2,3,....,M$ where $RT(i)$ is the number of "1" entries in the row corresponding to the customer region *i*.

Step 2: Obtain a modified matrix *C*1 by rearranging the rows of the matrix *C* as per the ascending order of row totals.

Step 3: Find the top most undeleted row (customer region) in the matrix *C*1. Let it be *p*.

Step 4: Identify the number of undeleted columns which are having "1" entries in the row corresponding to the region *p*. Let it be *q*1 and the corresponding set of undeleted column (sites) be *S*.

If *q*1 is equal to 1, let *q*2 be the corresponding undeleted column. Then go to step 7; otherwise go to step 5.

Step 5: Compute the column totals $CT(j)$, $j(-S$, where $CT(j)$ is the number of "1" entries in the column corresponding to the site *j* in *S*.

Step 6: Select the column (site) from *S* with maximum column total (On tie, break it randomly). Let this selected column (site) be *q* 2.

Step 7: Delete all customer regions covered by site (column) *q* 2 Also delete the column corresponding to the site *q* 2. Include the site *q* 2 in the set *Q*. Check, whether all the rows (customer regions) are deleted.

If not, go to step 3; if yes go to step 8.

Step 8 : List the sites from *Q* as the set of selected sites for serving all the customer regions. Then, from the above set of selected sites, identify the site from where each of the customer regions can be served.

Now, the proposed heuristic, *H*1 is compared to an existing heuristic (Rajkumar & Panneerselvam, 1991) and also with the model, *M*1 in the following ways.

*Experiment 1:* Comparison of the proposed heuristic, H1 with the mathematical model, *M*1 (Schilling, 1993) and also with the heuristic developed by Rajkumar and Panneerselvam (1991) using moderate size problems. Let the heuristic developed by Rajkumar and Panneerselvam (1991) be *H*2 . The heuristic *H*2 is given in appendix.

*Experiment 2:* Comparison of the heuristic *H*1 with *H*2 using problems varying from moderate size to large size.

First heuristic *H*1 is compared with model *M*1 and heuristic *H*2 using moderate size problems. The closeness of the results of the heuristic, *H*1 towards the optimum results of the model, *M*1 is verified by an experiment. In the same experiment, the results of the heuristics, *H*1 and *H*2 are compared. The covering co-efficient matrix which is shown in table 2 is considered for this experiment. Twenty six problems have been generated from this table, whose sizes are as shown in table 3. A problem size, 5*5 represents a problem with a covering co-efficient matrix formed by using the first 5 rows and the first 5 columns of table 2. These problems are solved using model *M*1 as well as the heuristics, *H*1 and *H*2 and the results are reported in table 3. It is clear that the heuristic *H*1 gives the optimal solution for all the 26 problems. Hence, the efficiency of the proposed heuristic, *H*1 is 100%. Heuristic, *H*2 gives the optimal solution only for 13 problems which amounts to 50% efficiency.

**Table 3**: Results of moderate size problems

| Problem Size | Minimum number of sites selected | | | Problem size | Minimum number of sites selected | | |
|---|---|---|---|---|---|---|---|
| | Model (M1) | Heuristic H1 | Heuristic H2 | | Model (M1) | Heuristic H1 | Heuristic H2 |
| 5* 5 | 4 | 4 | 4 | 18*18 | 7 | 7 | 7 |
| 6* 6 | 4 | 4 | 4 | 19*19 | 7 | 7 | 7 |
| 7* 7 | 4 | 4 | 4 | 20*20 | 7 | 7 | 7 |
| 8* 8 | 4 | 4 | 4 | 21*21 | 7 | 7 | 7 |
| 9* 9 | 4 | 4 | 4 | 22*22 | 7 | 7 | 8 |
| 10*10 | 4 | 4 | 4 | 23*23 | 8 | 8 | 8 |
| 11*11 | 4 | 4 | 5 | 24*24 | 8 | 8 | 8 |
| 12*12 | 4 | 4 | 5 | 25*25 | 8 | 8 | 8 |
| 13*13 | 5 | 5 | 6 | 26*26 | 7 | 7 | 9 |
| 14*14 | 5 | 5 | 6 | 27*27 | 7 | 7 | 9 |
| 15*15 | 5 | 5 | 6 | 28*28 | 7 | 7 | 8 |
| 16*16 | 5 | 5 | 6 | 29*29 | 8 | 8 | 10 |
| 17*17 | 6 | 6 | 7 | 30*30 | 9 | 9 | 10 |

Detailed comparison of heuristic *H*1 with heuristic *H* 2.

Next the performance of the heuristic *H*1 is compared with that of the heuristic *H*2 using problems varying

**Table 6:** F Ratios based on expected mean squares

| Source of Variation | Expected Mean Squares (MS) | F Ratio |
|---|---|---|
| A | $\sigma^2 + bcn\,\sigma_A^2 + cn\,\sigma_{AB}^2$ | $MS_A/MS_{AB}$ |
| B | $\sigma^2 + acn\,\sigma_B^2 + cn\,\sigma_{AB}^2$ | $MS_B/MS_{AB}$ |
| C | $\sigma^2 + anb \sum_{\frac{k=1}{c-1}}^{n} C^2 + bn\,\sigma_{AC}^2 + an\,\sigma_{BC}^2 + n\,\sigma_{ABC}^2$ | $MS^1/MS^{11}$ |
| AB | $\sigma^2 + cn\,\sigma_{AB}^2$ | $MS_{AB}/MS_e$ |
| AC | $\sigma^2 + bn\,\sigma_{AC}^2 + n\,\sigma_{ABC}^2$ | $MS_{AC}/MS_{ABC}$ |
| BC | $\sigma^2 + an\,\sigma_{BC}^2 + n\,\sigma_{ABC}^2$ | $MS_{BC}/MS_{ABC}$ |
| ABC | $\sigma^2 + n\,\sigma_{ABC}^2$ | $MS_{ABC}/MS_e$ |
| e | $\sigma^2$ | |

$$P = \frac{(MS_C + MS_{ABC})^2}{\frac{MS_C^2}{c-1} + \frac{MS_{ABC}^2}{(a-1)(b-1)(c-1)}}$$

$$q = \frac{(MS_{AC} + MS_{BC})^2}{\frac{MS_{AC}^2}{(a-1)(c-1)} + \frac{MS_{BC}^2}{(b-1)(c-1)}}$$

As per the proposed ANOVA model, the details of analysis for the minimum number of sites selected, which are presented in table 4 are summarized in table 7. At $\alpha = 0.05$ the effect of all the components of the model are significant except the effects of *AB* and *ABC*. From this, it is clear that the effect of the factor, heuristic on the number of sites selected is significant. This means that there is significant difference between the solutions of the heuristics, *H*1 and *H*2. From table 4, one can see that the minimum number of sites selected in the heuristic, *H*1 is lesser than or equal to the minimum number of sites selected in the heuristic *H*2 under all the experimental combinations. Thus heuristic, *H*1 is proved to be better than *H*2 to obtain the minimum number of sites to cover all the customers.

Again, based on the proposed ANOVA model, the details of analysis for the execution times which are presented in table 5, are summarised in table 8. At $\alpha = 0.05$ the effects of all the components of the model are significant. From this, it is evident that the effect of the factor, heuristic on the execution time is significant. From table 5, one can see that the execution time of the heuristic *H* 1 is greater than that of *H* 2 for all the experimental combinations. So, it is concluded that *H* 1 takes more time than *H* 2. However, though, *H* 1 takes more time, one can see the trade- off in terms of better solution when compared to *H* 2. Hence, it is concluded that the heuristic, *H* 1 performs better than *H* 2.

**Table 7**: ANOVA results for minimum number of sites selected

| Source of Varience | Degrees of freedom | Sum of squares | Mean sum of squares | F-Ratio |
|---|---|---|---|---|
| Sparsity (A) | 6 | 1080.711 | 180.119 | 162.269 |
| Problem Size (B) | 5 | 633.399 | 126.680 | 114.126 |
| Heuristic (C) | 1 | 1569.867 | 1569.867 | 41.250 |
| AB | 30 | 33.203 | 1.111 | 0.833 |
| AC | 6 | 23.602 | 3.934 | 4.281 |
| BC | 5 | 170.762 | 34.152 | 37.162 |
| ABC | 30 | 27.570 | 0.919 | 0.689 |
| Error | 336 | 380.800 | 1.333 | |
| Total | 419 | 3919.914 | | |
| Revised d.f. to test the effect of C = 1,16 | | | | |

**Table 8:** ANOVA results for execution times

| Source of Varience | Degrees of freedom | Sum of squares | Mean sum of squares | F-Ratio |
|---|---|---|---|---|
| Sparsity (A) | 6 | 2459.332 | 409.889 | 10.777 |
| Problem Size (B) | 5 | 12406.280 | 2481.256 | 65.238 |
| Heuristic (C) | 1 | 17061.440 | 17061.440 | 10.078 |
| AB | 30 | 1141.027 | 38.034 | 3.637 |
| AC | 6 | 2521.020 | 420.170 | 10.571 |
| BC | 5 | 6383.446 | 1276.689 | 32.119 |
| ABC | 30 | 1192.473 | 39.749 | 3.801 |
| Error | 336 | 3514.117 | 10.459 | |
| Total | 419 | 46679.135 | | |
| Revised d.f. of test the effect of C = 1,8 | | | | |

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We are what we repeatedly do.
Excellence, then, is not an act, but a habit.

*Aristotle*

# QPR: A Quality Efficiency Improvement Technique

**K. Shankaraiah**

*The past decade has witnessed the remergence of quality as a key factor. Quality performance measurement and evaluation play a vital role for ensuring desired quality. Quality Performance Ratios' (QPR) have been found to be useful for continuous evaluation, monitoring of quality performance, and for identifying the ways to improve the same, as well as assessing the effectiveness of the management programmes and functions. In this context, an attempt has been made in this paper to examine QPR and their application.*

*K. Shankaraiah is Reader in Commerce, Post-Graduate College, Secunderabad Osmania University. 500 003.*

Quality control is as old as industry itself. From the time man began to manufacture, there has been an interest in the quality of output. As far back as the middle ages, the medieval guilds insisted on a long period of training for apprentices and required that those seeking to become master-craftsmen offer evidence of their ability. Such rules in the past, were aimed at the maintenance of quality, (Duncan, 1970) whereas, in the present competitive environment, the priorities are different.

## Quality Performance

Today, our daily lives and schedules depend totally upon the satisfactory performance and operation of products and services. It is quality as well as price that sells and quality that brings customers back (Feigenbaum, 1986). Hence, the total-customer satisfaction oriented concept of quality, together with reasonable costs has become one of the primary business goals.

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There exists tough competition in meeting the customer's expectations for quality performance and costs. As domestic market gets saturated, recourse to overseas markets again presents a challenge as demands in quality and costs are to be effectively met (ISI Document, 1988). A variety of tools and techniques of quality management is required to survive in the competitive environment as the means to achieve quality

at economic cost is only through continuous monitoring of quality performance. Companies throughout the world recognise the need for dramatic improvements in their manufacturing operations, and focus on quality as the single most important force leading to organisational success and growth in national and international markets. Success in the global environment requires that companies commit to order-of-magnitude improvements in quality, enormous reduction in inventory and adoption of advanced manufacturing technology (Kaplan & Atkinson, 1990). Quality performance results in increased return on investment and profitability, which in turn reflects managerial effectiveness. Hence, quality performance has to be continuously evaluated and monitored to appraise the factors that improve it. Here lies the importance of the QPR (Quality Performance Ratios), which improves the efficiency of the total quality management programme.

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## Quality Performance Ratios

The quality of a product is primarily based on the manufacturing process, the effectiveness of which, is reflected by the 'Manufacturing Performance Ratios'. The manufacturing performance is dependent on the quality of various aspects such as the quality of inputs, indicated by 'the Vendor Performance Ratios'. Customers also play a vital role. Quality is customer oriented and is based upon the customer's actual experience with the product or service, measured against his or her requirements (Feigenbaum, 1980). The feed back given by the customers viz, 'the Customer Performance Ratios' may be also taken as an important measure of quality performance.

In cases where the standards are lower, the customer may not be satisfied with the finished product. On the other hand, when quality standards are too high, in order to make a fair profit, the selling price may need to be higher than what the customer is willing to pay. Economy in either case means that the desired quality level must be achieved at the lowest unit cost. Hence, quality efforts should be curtailed at a point where the marginal benefit from further defect reduction is below the marginal quality cost. This is desirable from the stand point of both the customer and the producer. This factor may be evaluated by 'Cost Performance Ratios'.

The management has to adopt a suitable method not only to maintain high quality, but also to satisfy the customers' growing and changing demands. The analysis of 'Method Efficiency' in terms of cost is an important aspect to understand quality performance. The 'Competitive Rank' of the company in the market which is again based on quality performance may be taken as the overall indicator of the reputation of the company. Some of the important ratios based on manufacturing, vendors, customers, method efficiency and competitiveness are shown in table 1. Table 2 presents the hypothetical figures, that are taken as a basis for the computation of QPR.

## Analysis

Table 1 reveals that the total production contains 20 per cent defective items; 20 per cent of the items sold are returned due to poor quality and 10 per cent items are returned due to other reasons. Per day defective production and the per day returns are also significant, for which, the main reason may be the supply of defective raw materials (20 per cent) and delayed and insufficient delivery of materials. The customer performance ratios indicate that 10 per cent of customers have complained and 70 per cent of such complaints are attended by the company. Customer service expenses are low, hence 30 per cent of the complaints are not attended.

The total quality cost of the organisation is 25 per cent of the total manufacturing costs, 16 per cent of the total sales and 50 per cent of the value added. The quality costs to sales is comparatively insignificant. The analysis of the components of quality costs reveals that internal quality costs are higher than the external failure costs. particularly, the prevention costs are less, hence the appraisal, internal and external failure costs are more.

**Table 1:** Quality performance ratios (QPR)

| Ratio | | Principle | Ratio |
|---|---|---|---|
| **MANUFACTURING PERFORMANCE** | | | |
| Mfg. Performance | : | Total defects/ Total mfg. | 20% |
| Per Day Defective | : | Total defects / No. of days | 666.7 |
| Yield | : | Units passed the inspection / Total units sent for inspection | 80% |
| Lot Acceptance % | : | Lots accepted by outgoing quality control/Total lots sent for acceptance | 80% |
| RM % Qlty. | : | RM due to poor qlty. / Total merchandise | 20% |
| RM % Total | : | RM % qlty. +% returned due to the reasons other than poor qlty. | 30% |
| Per Day Returns | : | Total returns/ No. of days | 500 |
| Rework | : | Rework / Total defects | 50% |
| Scrap | : | Scrap / Total defects | 50% |
| **VENDOR PERFORMANCE** | | | |
| Vendor Performance | : | Defects of received materials / Total materials received | 20% |
| OTD to Total Delivery | : | OTD / Total delivery | 80% |
| OTD to Total Orders | : | OTD / Total orders | 66.7% |
| **CUSTOMER PERFORMANCE** | | | |
| Customer Acceptance Level | : | Customer acceptances / Total delivery | 90% |
| Customer Performance | : | No. of complaints / Total delivery | 10% |
| Attending to Complaints | : | No. of complaints attended / Total complaints | 70% |
| Customer Service | : | Customer service expenses / TQC | 15% |
| **COST PERFORMANCE** | | | |
| TQC to Mfg. Costs | : | TQC / Mfg. costs | 25% |
| TQC to Value Added | : | TQC / Value added | 50% |
| TQC to Sales | : | TQC / Net sales | 16% |
| Prevention Costs to TQC | : | Prevention costs / TQC | 15% |
| Appraisal Costs to TQC | : | Appraisal costs / TQC | 25% |
| IFC to TQC | : | IFC / TQC | 35% |
| EFC to TQC | : | EFC / TQC | 25% |
| Total IQC to TQC | : | Total IQC / TQC | 75% |
| **METHOD EFFICIENCY** | | | |
| Method Efficiency | : | Cost of changed engineering method /Cost of existing method | 1.33 |
| Changed Method Efficiency | : | Reduction in defects costs/Difference cost of changed method & existing method | 1.6 |
| COMPETITIVE RANK | : | Ranking relatively to competitors | 11 |

EFC- External Failure Costs; IFC - Internal Failure Costs; Mfg. - Manufacturing; OTD - On Time Delivery; Qlty.- Quality; RM - Returned Merchandise; TQC - Total Quality Costs. IQC - Internal Quality Costs.

**Table 2**: Quality performance report

| Particulars | Units / Rs |
|---|---|
| No. of days | 30 |
| Manufacturing | 1,00,000 |
| Units sent for inspection | 1,00,000 |
| Units passed the inspection | 80,000 |
| Total defects | 20,000 |
| Lots sent for acceptance | 1,000 |
| Lots accepted | 800 |
| Total merchandise | 50,000 |
| Returned merchandise due to poor quality | 10,000 |
| Returned merchandise due to other reasons | 5,000 |
| Total returns | 15,000 |
| Scrap | 10,000 |
| Rework | 10,000 |
| Total materials received | 1,50,000 |
| Defects of received materials | 30,000 |
| Total orders | 60 |
| Total delivery of orders | 50 |
| On time delivery | 40 |
| Total delivery of items | 50,000 |
| Customer acceptances | 45,000 |
| No. of complaints | 5,000 |
| No. of complaints attended | 3,500 |
| Customer services expenses | 60,000 |
| Sales | 25,00,000 |
| Manufacturing costs | 16,00,000 |
| Value Added | 8,00,000 |
| Total quality costs | 4,00,000 |
| Prevention costs | 60,000 |
| Appraisal costs | 1,00,000 |
| Internal failure costs | 1,40,000 |
| Total internal quality costs | 3,00,000 |
| External failure costs | 1,00,000 |
| Cost of changed engineered method | 4,00,000 |
| Cost of existing method | 3,00,000 |
| Cost of difference due to change of methods | 1,00,000 |
| Reduction in defects costs | 1,60,000 |
| Ranking | 11 |

The reduction in defective costs being more than the increase in the costs due to the change of process, implies that process upgradation has reduced the defectives. The overall competitive position in the market is 11.

The above analysis draws the attention of the management towards the vital role of prevention; i.e. by spending more on prevention, the other costs may be reduced. The process technology, vendor relations, process control and improved customer relations help the management in reducing the defectives and costs. Thus QPR helps the management in identifying the areas where management action towards quality is necessary so as to improve the efficiency and performance.

## Conclusion

The attainment and maintenance of satisfactory levels of customer satisfaction with the quality of products and services are today fundamental determinants for business health and growth, and quality performance has become a vital guide post in the development and successful implementation of programmes for realising major business goals. QPR can help not only the management, but also the accountants to evaluate and monitor the quality performance.

To attain quality performance, tools and techniques must be fully and effectively structured to cover all the aspects that affect quality and satisfy the demands of the new market and business framework. Accountants, academicians and cost engineers have to develop and modify QPR to match the situation. Top management support and encouragement are also imperative for its success.

**To attain quality performance, tools and techniques must be fully and effectively structured to cover all the aspects that affect quality.**


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Feature

# Waste Recycling Industry — Efficient Management of Resources

**P. Thippaiah**

*In view of the depleting natural resources various steps have been undertaken in several countries in recent years with a view to conserving these resources. One such measure is the recognition of waste recycling activity on account of its multiple advantages. The article analyses recycling activities going on in India and recommends governmental support to this informal sector to control the mounting pollution besides restoring the ecological balance.*

*P. Thippaiah is Assistant Professor, ADRT Unit, Institute for Social and Economic Change, Bangalore - 560072.*

In the past, the needs of the people were limited. Therefore, they were able to use the limited resources more effectively. Over a period of time, life styles have changed enormously leading to over-use of resources. This has depleted not only the scarce natural resource level in the earth crust but also disturbed the balance in nature due to neglect of recycling process.

## Recycling : Answer to Pollution

However, in recent times it has been recognised that recycling activity is valuable as it helps in conserving the natural resources as the world is running out of many key raw materials and the available resources are dwindling; helps in preserving bio-diversity; reduces waste accumulation, checks pollution and reduces the amount of solid waste in the land fill; involves less capital and energy requirement; minimises the import of raw materials and thereby saves valuable foreign exchange and provides more employment opportunities and source of living to millions of people. In other words, recycling is the way for developing countries to produce much needed materials without adding new debts. Recycling is also the key to achieve better standard of living in the Third World, where many people still lack basic materials. Realising these advantages, several countries have initiated steps to make use of waste for producing useful goods. For instance, the British Government has appointed a "Minister of Waste" in 1985 to co-ordinate efforts on waste disposal and its recycling. (Deccan Herald, 1985). In Denmark, throwaway containers have been banned (The Economic Times, 1994).

**Recycling is the way for developing countries to produce much needed materials without adding new debts.**

In India, waste recycling has existed way back in the past. In fact, its importance has been well documented in the Indian Buddhist lore "Shyamavathi". According to this, Shyamavathi, the queen-consort of king Udayana, offered five hundred new garments to Ananda, the favorite disciple of Buddha, who received them with great satisfaction. Hearing this, the king suspected Ananda of dishonesty and asked him what he was going to do with 500 garments. Ananda replied : Oh king, many of the brothers are in rags; I am going to distribute the garments among the brothers. What will you do with the old garments? We will make bed-covers out of them. What will you do with the old bed covers? We will make pillow cases. What will you do with the old pillow cases? We will make floor covers of them. What will you do with the old floor covers? We will use them for foot towels. What will you do with the old foot towels? We will use them for floor mops. What will you do with old floor mops? Your highness, we will tear them into pieces, mix them with mud and use the mud to plaster the house walls. [1]

**Waste Recycling: Definition & Sources**

Waste recycling refers to the process by which once used goods are used again to substitute for virgin materials. In common usage, the term "recycling" has evolved into a concept encompassing any productive use of what would otherwise be a residual requiring disposal (Beukering, 1994. The British government's Management paper No. 28 defines recycling as "the collection and separation of material from waste and subsequent processing to produce marketable goods (Fairlie, 1992:276). In general terms, recycling has been defined as a method to reprocess waste in order to recover an original raw material.

**"Recycling" has evolved into a concept encompassing any productive use of what would otherwise be a residual requiring disposal.**

Items produced by small, medium and large scale industries are being used by industry, commerce, transportation and consumed by the wealthy sections of the urban population. A substantial portion of the used goods are thrown on the streets and dust bins. A large segment of the working population in the urban informal sector is engaged in collection of these materials from factories, warehouses, shops and dust bins in order to manufacture useful items by making use of waste materials that have little or no value in the environment in which they were earlier used (Mazumdar, 1980). Both formal and informal sectors are playing a useful role in collecting and processing of the waste in many of the Third World urban areas. In the informal sector, several small units are engaged in procuring the waste by their own devices. Within the sector, the garbage pickers, and mobile scrap merchants or itinerant merchants are the major category of workers who do the job of waste mobilisation and facilitate the units for manufacturing of useful goods. The studies of Sethuraman, (1977), Amin, (1987), Nihan and Jourdain, (1976), Birkbeck, (1979), Gangrade, (1983) and Aziz, (1984) have highlighted the role of these groups and units engaged in recycling. There are also some large scale industries (formal sector) which are engaged in the recycling in recent years. But they heavily depend on the informal sector units for recuperated materials and partly on the formal sector units for virgin materials for making the recycled goods more attractive.

**Estimates of Some Waste Materials**

In the World, a vast amount of waste paper, metals, plastics and glass are thrown away annually. In 1981, the aluminium thrown away in USA in the form of beverage containers was more than the metal produced in the whole of Africa. (The Economic Times, October 17, 1983). In Britain, the average British household throws away 45 kilos of plastic annually (Panascope, 1994), and in the same country "the average family of four throws away six trees worth of paper every year, whilst in the USA a City size of San-Francisco disposes of more aluminium than is produced by a small Bauxite mine" (The Economic Times, June 6, 1994: 14). This practice of throwing away of material amounts to throwing away of energy. Now several countries have realised the importance of waste in view of the dwindling resources and have undertaken effective steps to make use of the wastes.

**In 1981, the aluminium thrown away in USA in the form of beverage containers was more than the metal produced in the whole of Africa.**

[1] This story was quoted by Dr. T.N. Khoshoo in his presidential address to the 56th annual session of the Academy of Sciences at Jaipur, see "Recycling Chain", **Sunday Herald**, February 22, 1987.

## Recycling of Some Waste Materials

*Paper*:

Several developed and less developed countries in the World are consuming a significant proportion of paper and paper board which is being collected and recycled. Table 1 shows the extent of recovery and consumption of waste paper by different countries.

**Table 1:** Recovery of waste paper In different countries

| Country | Recovery of waste paper in 1989 (in million tonnes) | Recovery rates of waste paper as% of total paper and paper boards consumed | % change in quality of waste paper in 1989 recovered between 1985 and 1989 |
|---|---|---|---|
| North | 66.70 | 35.5 | 32.2 |
| South | 13.90 | 31.1 | 63.7 |
| USA | 24.95 | 32.9 | 39.7 |
| Japan | 13.09 | 47.7 | 28.9 |
| W.Germany | 5.62 | 43.0 | 28.6 |
| Former USSR | 3.00 | – | – |
| UK | 2.98 | 31.1 | 37.1 |
| France | 2.88 | 34.4 | 48.7 |
| Italy | 1.76 | 33.9 | 34.3 |
| China | 3.73 | 26.7 | 116.4 |
| South Korea | 1.90 | 49.2 | 132.9 |
| Taiwan | 1.72 | 54.3 | 91.3 |
| Brazil | 1.55 | 37.4 | – |
| India | 0.90 | 36.9 | 80.0 |
| Former East Germany | – | 47.1 | – |
| Netherlands | – | 49.4 | 29.9 |
| Switzerland | – | 46.9 | 34.0 |
| Former Czechoslovokia | – | 46.3 | – |
| Canada | – | 28.2 | 50.4 |
| Australia | – | 25.0 | 23.9 |
| Newzealand | – | 19.4 | –7.2 |
| Colombia | – | 44.1 | – |
| Argentina | – | 41.6 | – |
| Thailand | – | 34.8 | 191.7 |
| Chile | – | – | 85.8 |
| Indonesia | – | – | 68.8 |
| Malaysia | – | – | 44.4 |
| Africa | – | – | –6.9 |

Source: UNIDO, Data for India are Estimates made by Pulp and Paper International, Quoted in *Down To Earth*, March 31, 1993, p.56.

USA, Japan and West Germany alone accounted for 44 million tonnes of the 81 million tonnes of waste paper recovered across the World in 1989. Taiwan, Japan, South Korea have higher percentage of waste paper in the total consumption.

In India, about 36.90 per cent of the total production of the paper was from waste paper, which is far too low compared to Thailand (54.3 per cent). This is mainly due to non-availability of waste paper to the paper industry.

According to another estimate, India has used about 0.50 and 0.90 million tonnes of waste paper for recycling in 1988 and 1989 respectively. In spite of this, the country is experiencing shortage of paper. The study conducted by the All India Small Paper Mills Association (AISPMA) on waste paper shows that waste paper is a potential resource for paper, however due to its non availability the country will face shortage of paper in the coming years (Observer of Business and Politics, December 31, 1990). In recent years, the waste paper availability in the country is unable to meet the demand and about 30 per cent of the requirement is imported. It is expected that the waste paper use will increase up to 50 per cent by the year 2001 A.D. Presently there are about 10 lakh tonnes of raw materials for the manufacturing of paper and paper board in our country. Of this, seven lakh tonnes of waste is available indigenously. (Financial Express, December 12, 1993). In view of this, the government should give economic incentives and advances to paper technology and manufacturing from recycling and stimulate waste paper collection.

**The government should give economic incentives and advances to paper technology and manufacturing from recycling and stimulate waste paper collection.**

*Metal Scrap*:

Like paper recycling, the recycling of scraps is going on in a big way in India and elsewhere and contributing significantly to the total output. According to the available information in India, there are 175 mini-steel plants in the organised or formal sector producing approximately 2.8 million tonnes of iron and steal per annum using steel scrap as a raw material. As per the estimates of the World Bureau of Metal Statistics the recycled non-ferrous metal in India [2] accounts for 36 per cent of the copper, 45 per

[2] Non-Ferrous metals such as copper, aluminium, zinc and lead are very popular in recycling sector. Non-ferrous recycling is advantageous because it saves lot of energy. Non-Ferrous is easy to reprocess because quality will not last and thus less environmental pollution.

cent of lead and 24 per cent of aluminium. The statistics of the International Lead and Zinc Study Group indicates that out of the total consumption of all forms of zinc, about 23 per cent is derived from a wide range of secondary sources. In Britain, six per cent of total annual consumption of glass, 27 per cent of paper, 33 per cent of aluminium and 41 per cent of copper are derived from waste (Deccan Herald, April 18, 1985).

*Plastics* :

Plastic waste forms an important share in Urban Solid Waste. To quantify the extent of plastic waste, NCAER carried out a survey during 1987-88 and recorded and quantified the plastic wastes available and recycled in major metropolitan towns and cities in India. According to this Survey, the plastics reprocessing/recycling industry comprises over 2,000 units, with an output of 3,23,209 tonnes. This represents 37.2 per cent of the thermoplastics available in the country (domestic production and imports) at 3.5 lakh tonnes during 1987-88 period (Ratra, 1994). Plastic is a major contributor to the street waste with the total contribution going up to 7 per cent by weight and 18 per cent volume of Municipal waste (Economic Service, April 15, 1994).

**Uses of Waste Recycling**

Evidences in India and elsewhere have shown that recycling has the potential to create jobs and offer a source of livelihood to many. In India, the ferrous scrap [3] recycling alone employs around 4,00,000 people. Another estimate shows that about 25 million people are making their living by collecting and selling scrap, rag-picking, recycling of waste paper, glass and plastic materials. In USA every million ton of waste materials recycling creates approximately 2,000 jobs.

Waste recycling is a process through which the country could benefit in several ways. As natural resources are in short supply, products made out of waste materials particularly in informal sector have significant market in several countries. For instance, in Nouakchott, the informal sector constitutes an important market for the formal sector trade amounting to around 400 million ouguiya a year. (Nihan & Jourdain, 1978:715).

[3] Ferrous metal are mostly Iron and steel.

**Recycling has the potential to create jobs and offer a source of livelihood to many.**

In several other countries, the informal sector produces cheap mass consumption goods for the low income groups using materials which are "recuperated and recycled". A vast number of waste collectors in the urban informal or unorganised sector earn their income by recycling old shoes to shoe menders, plastic bags and wrappers to women peanut sellers, plastic mineral bottles to restaurants, tins to artisans, old tyres to cobblers who make shoes out of them. Glass bottles are supplied to distillers for re-use and broken glasses (cullects) to the glass factories to convert them into molten glass. In Denmark 99 per cent of glass products is recycled and reused 30 times (The Economic Times, June 6, 1994). Iron scraps are used to manufacture agricultural tools and implements, kitchen ware, household stoves, fixtures required by the construction industries. Old papers are used to make envelopes to sell vegetables, fruits, peanuts and other provisions in the unorganised sectors. Even textile waste is used to make useful products. In Ahmedabad city, the waste produced by textile mills in the form of small scraps of cloth called "Cindhi" is purchased by the traders who pass it on to women home workers to sew into quilt covers (Jhabvala, 1983). These goods are produced without incurring much cost or energy constituting efficient management of scarce raw materials.

The formal or organised sector also plays a role in both saving energy and producing useful goods from waste materials. For instance, with every tonne of recycled steel scrap half a tonne of iron ore, and quarter ton of coke could be saved. Also with every tonne of ferrous scrap energy consumption can be reduced by 74 per cent, air pollution by 86 per cent, water pollution by 76 per cent and water use by 40 per cent. It is also estimated that every 1,000 tonnes of steel manufactured from recycled ferrous scrap can save energy equivalent to 140 thousand gallons of petrol. Similarly, several waste materials save enormous energy as has been shown in table 2.

**With every tonne of recycled steel scrap half a tonne of iron ore, and quarter ton of coke could be saved.**

**Table 2:** Energy saving from recycling

| Types of Waste Material | Energy Saving* (in per cent) |
|---|---|
| Magnesium | 97 |
| Aluminium | 96 |
| Steel & Iron | 65 |
| Plastic (Polyethylene) | 97 |
| Plastic (Polymer) | 92 |
| Rubber | 70 |
| Glass (100 per cent Cullet) | 22 |
| Paper | 60 |

Note: * Energy savings from the use of secondary material in comparison to the use of a virgin material for the production of the same product (From Extraction to Manufacturing).

Source: Powel, "A comparison of the Energy Savings from the Use of Secondary Materials", in Conservation and Recycling, vol. 6, No. 1-2, 1983, P. 37, cited in Pieter Van Beukering in Isa Baud and Hans Schenk (eds.), *Solid Waste Management, Modes, Assessments, Appraisals and Linkages in Bangalore,* Manohar, New Delhi, 1994, p. 111.

Several organised sector units use waste materials and produce useful goods. The Paper industries procure paper board and card board and make products such as tissues, cardboard, asphalted card board roofing tiles, packing material and egg trays. In some industries rags are used to make fine paper and artificial silk (Vaidyanathan, 1990). The plastic industries engaged in manufacturing school bags, play ground equipment, pipes and plastic utensils (Chokkalingam, 1993) and cheap plastic bags for vegetables, fruits, grocery shops are depending on recycled plastics to the extent of 50 per cent. Bones are used in some units for extracting gelatin, which is used in the preparation of sweet meats (sugar), chocolates, soup, medicines and photographic films (Vaidyanathan, 1990). Bones extracted from garbage by the informal sector is also used as an important raw material by some units in the formal sector for making animal food and artificial manure. A few units are engaged in extraction of carbon from old batteries and filaments from light bulbs and are returning to the factories. Some bottle manufacturing units are using the broken glass pieces for re-blowing into bowls, jugs and glasses.

## Concluding Remarks

There has been enormous growth of solid waste in several cities in the world due to rapid urbanisation. Until now, many countries have not understood the economic value of the waste. As a result of this, natural resources have been over exploited leading to imbalances and disastrous consequences. However, in recent years, waste recycling has been recognised as an important sector, in view of depleting resources and mounting pollution as non-bio substances such as metal, plastic and paper do not easily decompose. In spite of the positive roles played by the waste collectors and waste recycling units, adequate attention has not been given by the state in extending benefits to this sector. Consequent upon this, the participants in the waste recycling industry are facing problems. Therefore, it is desirable to consider the following suggestions to tackle the problems of ragpickers, waste collectors and producers to make them more productive. Firstly, many of the waste pickers are tied up with retailers and wholesalers because of borrowings, the latter group exploiting the former by way of purchasing their output at lower than the market price. To overcome this problem credit institutions should provide financial assistance to these groups in case of need at low rate of interest. Secondly, co-operatives may be started to regulate the sector. Thirdly, Technical Training may be imparted to waste recycling industrial entrepreneurs to make their products safe, attractive and marketable. Several big companies in India are importing waste metals rendering scrap collectors unemployed. Such measures should be stopped. [4]

**Technical Training may be imparted to waste recycling industrial entrepreneurs to make their products safe, attractive and marketable.**

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[4] Maharashtra state has taken up budgets against the Steel Ministry for permitting import of ferrous scrap on large scale for supplying to the electrical arches and induction furnaces squandering foreign resources (See The Economic Times, January 3, 1991:3).

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I love Bridgestone. I love my job. I love the people I work with. I love bragging about it.

*Louis Amirault*
*Section Manager*

Feature

# Constraints in Tree Growing in Tamil Nadu

**D. Suresh Kumar & C. Ramasamy**

*A study was conducted to examine the major factors influencing adoption of agroforestry (tree growing) in Western zone of Tamil Nadu based on the One-limit Tobit model. Farm size, higher non-farm and off-farm income, frequent contact with extension personnel and adequate possession of livestock are found to be the significant factors influencing tree growing. The authors conclude that creating avenues for different sources of income to the farmers such as animal husbandry, sericulture, apiculture and non-farm activities promote tree growing in rural areas. Planned tie-up arrangements between tree growers and industries consuming forest products is suggested so as to provide assured prices and market for the products on a continuous scale.*

*D. Suresh Kumar is Assistant Professor (Agrl. Economics), Agricultural Research Station, Tamil Nadu Agrl. University, Bhavanisagar and C. Ramasamy is the Professor and Head, Department of Agricultural Economics, Agrl. College and Research Institute, Madurai - 625 104.*

In the past four decades of planned development, continuous efforts have been made by the Central and State governments, international agencies and non-governmental organisations (NGOs) in the arena of forestry development. Forestry research and extension activities were geared up to promote tree growing in rural areas to meet the local needs for fuel, fodder, timber and food. Despite these efforts, by the large, desired results to the extent planned, have not been achieved. Paradoxically, degradation of forests is on the increase. FAO estimates indicate that the total forest cover is being exploited at an appalling rate of 1,47,000 hectares every year. Pressure due to rising population, faulty and indiscriminate use of forest lands, overgrazing, shifting cultivation and illicit felling of trees are the primary causes for degradation and disappearance of forests.

## Issues

There are several factors which have led to poor and slow adoption of agroforestry in India. Lack of positive mind set, low awareness in recent technological know-how, paucity of effective organisational efforts in generation of forest production technologies and inadequate activities of transfer of technologies are found to be the major constraints (Malik, 1983 and Brahmbhatt, 1984).

Inadequate market information, poor marketing facilities, unservplers middlemen, insecurity of tree tenure and forced sales are the constraints in marketing timber and wood (Saxena, 1990). Market failure is crucial, because, the prices of timber are mainly dictated by the buyers as oligopoly market structure prevails. A study conducted in Dharmapuri of Tamil Nadu, revealed that this is mainly due to lack of information and the number of intermediaries in timber marketing (Indian Market Research Bureau, 1989).

**Inadequate market information, poor marketing facilities, unservplers middlemen, insecurity of tree tenure and forced sales are the constraints in marketing timber and wood.**

Insecurity of land tenure and subdivision and fragmentation of holding are also reported to be responsible for poor adoption of agroforestry. High initial investment and inadequate capital funds combined with longer gestation period and increased uncertainty in realising the investment among resource poor farmers were also reported as constraints (Tewari et al, 1990).

The land use pattern in Tamil Nadu, is changing. Mostly the farmers who are switching over to tree growing practices belong to the category of large land holdings (Ramasamy et al, 1993). And the reasons attributed are: agricultural labour scarcity during peak seasons of agricultural production, high agricultural wage rate, consistent depletion of ground water potential, fluctuations in prices of agricultural commodities and absentee landlordism. Besides, the benefits derived from tree growing push the farmers to adopt agroforestry, as: it yields extended range of products viz., food, fodder, fuel, fibre etc., helps in providing employment for family labour during off-seasons, helps in soil and water conservation in dry lands and imparts stability and results in risk reduction in agriculture.

## Study Area

A study was conducted in the Western zone of Tamil Nadu which is one among the seven agro-climatic zones classified by the National Agricultural Research Project (NARP). The zone is situated between 9.30° and 12° North latitude and 70-30° to 78° east longitude. The altitude of the zone ranges from 160 to 2700 M above sea level. In this zone red non-calcareous, red calcareous, black calcareous, alluvial, colluvial, mixed soils and association, forest soils and saline alkali soils are of the predominant type. The climate in the zone ranges from semi arid to sub humid with frequent occurrence of drought. Four distinct seasons occur viz., south-west monsoon (June-September), north-east monsoon (October-December), winter (January-February) and summer (March-May). The annual rainfall of the zone varies from 524 to 1428 mm with an average of 786 mm. Of the total rainfall, 48.4 per cent is received during north-east monsoon and 32.8%, 18.6% and 2.8% received during south-west monsoon, summer and winter seasons respectively. The maximum temperature of the zone ranges from 26.9°C to 42.1°C and the minimum from 16.2°C to 24.5°C.

The total geographical area of the zone is 2.5 million hectares. Of the total area, net sown area accounts for 42.4 per cent, forest 22.7 per cent and current fallows 16.0 per cent. Of the total area irrigated, well irrigation accounts for 66.5 per cent, canals 26.2 per cent and tanks 7.3 per cent. The total cropped area amounts to 12.48 lakh hectares; of which, cholam (jowar) forms a major part 24.3 per cent, rice 11.7 per cent, other millets 16.9 per cent, pulses 10.1 per cent and oil seeds 23.3 per cent.

The agroforestry systems commonly practised in the study area are agrisilviculture and silvipasture. In agrisilviculture, agricultural crops are raised in the inter row spaces of trees to reap more profit from the limited land resources. In silvipasture system, trees are allowed to grow inside farm lands with grasses. In mixed farming tracts, *Acacia leucophloea* is allowed to grow inside farm lands with *Cenchrus ciliaris*. Cattle graze on the grasses and eat pods of Acacia trees. Another feature of agroforestry is that trees are grown in farm bunds, boundaries, surrounding farm buildings and wastelands.

**In agrisilviculture, agricultural crops are raised in the inter row spaces of trees to reap more profit from the limited land resources. In silvipasture system, trees are allowed to grow inside farm lands with grasses.**

## Theoretical Framework

A decision maker adopts a technology with the view to maximising utility (Rahm & Huffman, 1984). But the success of adoption is determined by a set of factors. Unless these factors are identified and manipulated, adoption rate of a technology may not take off. Let us denote a technology index by I, where I is equal to 0 for the old technology and 1 for a new technology and a utility function that ranks $i^{th}$ farm's performance for these technologies as U ($F_{Ii}$, $T_{Ii}$). Utility depends on a vector $F_I$ of moments that describe the distribution of net returns for technology I, including adoption cost, and a vector $T_I$

of other attributes associated with the technology. The variables $F_{Ii}$ and $T_{Ii}$ are unobserved and unavailable. But a linear relationship is postulated for $i^{th}$ farm between the utility derived from the $j^{th}$ technology postulated to be a function of the vectors of observed farm specific characteristics $X_i$ (e.g. farm size, experience, education) and the technology specific characteristics and a disturbance term (ei) having a zero mean.

$$U_{Ii} = X_i \alpha_j + e_{Ii} \qquad I = 0,1 \quad i = 1,2..n \qquad (1)$$

Farm operators are assumed to choose the technology that gives them the largest utility. The $j^{th}$ farmer adopts the new technology if $U_{1i} > U_{Oi}$ and the qualitative variable $D_i$ indexes the adoption decisions.

$$D_i = i \quad \text{if } U_{Oi} < U_{1i}; \quad \text{new technology is adopted and the old one is replaced} \qquad (2)$$

$$= 0 \quad \text{if } U_{Oi} > U_{1i}; \quad \text{old technology is continued}$$

The probability that $D_i$ is equal to one can be expressed as a function of farm-specific characteristics.

$$\begin{aligned} P_i &= P_r (D_i = 1) \\ &= P_r (U_{Oi} < U_{O1i}) \\ &= P_r (X_i \alpha_0 + e0i < X_i \alpha_1 + e1i) \qquad (3) \\ &= P_r [e0i - e1i < Xi (\alpha_1 - \alpha_0)] \\ &= P_r (\mu_i < X_i) \\ &= P_r (X_i \beta) \end{aligned}$$

Where $P_r(\cdot)$ is a probability function, $\mu_i$ i.e. e0i–e1i is a random disturbance term, $\beta$ i.e. $\alpha_1 - \alpha_0$ is a coefficient vector, and $F(X_i \beta)$ is the cumulative distribution function for $\mu_i$ evaluated at $(X_i \beta)$. Thus, the probability of the $i^{th}$ farm adopting new technology is the probability that the utility of the old technology is less than the utility of the new technology. The exact distribution for *F* depends on the distribution of the random term $\mu_i = e0i - e1i$. If $\mu_i$ is normal, then *F* is a cumulative normal; and if $\mu_i$ is uniform, then *F* is triangular. This type of functional analysis can be best estimated by employing qualitative choice models.

The most widely used qualitative choice models are Linear Probability Models (LPM), Logit and Probit. Among these, Linear Probability Model is the simplest as it can be estimated within the Ordinary Least Squares. In the LPM, the conditional mean value of the dependant variable is simply the conditional probability that the event occurs, given the values of the explanatory variables. This model is beset by several problems: non-normality of the error term, heteroscedasticity, possibility of the estimated probabilities lying outside the 0-1 bounds. Besides, LPM is logically not a very attractive model in that one does not expect the conditional probabilities to increase linearly with the explanatory variables. More likely, the probabilities will tend to taper off as the values of the explanatory variables increase or decrease indefinitely. Therefore, what we need is a probability model that has 'S' shaped feature of the cumulative distribution function (CDF) (Gujarati, 1988).

Although, the choice of CDF is wide, in practice the logistic and normal CDFs are chosen, the former giving rise to the Logit and the latter to the Probit model. Both the Logit and Probit models guarantee that the estimated probabilities lie in the 0-1 range and they are non-linearly related to the explanatory variables. But the models, wherein emphasis is on the potential adopter's decision about whether or not to adopt an innovation and where the adoption variable is specified in binary form, are also defective. This is because the chosen methodology provides no information on the intensity of use (Akinola & Young, 1985).

The Tobit model, which permits a discrete and continuous dependant variable which will capture the simultaneous nature of decision about whether or not to adopt an innovation and intensity of use after adoption. Thus, Tobit model is considered appropriate for the present context.

**Empirical Framework**

The data on which the empirical model is based were collected during 1993 by an intensive village survey from 60 farm households. During the survey it was found that most of the farmers have not planted the trees,however, they maintain 10-15 trees which have come up in the natural course. Thus, the dependent variable (number of trees planted) would take some values. Maddala (1987) points out that if the dependant variable is censored, values in a certain range may all be recorded as single value. In such a case, Tobit estimators (Tobin, 1958) may be used. Following equation (3), the functional form of the model specified in the present study with a Tobit

model, with an error term which is independently, normally distributed with zero mean and constant variance, is

$$T_i = X_i \beta + e_i \quad \text{if } T_i^* > c \qquad (4)$$

$$= c \quad \text{if } T_i^* \, c$$

where,

$T_i$ = Probability of planting trees and the intensity of plantations

$T_i^*$ = Non-observable latent variable

c = Threshold level (which is assumed in the present study 15 trees)

i = 1, 2 .... 60.

Thus, the Tobit model measures not only the probability that a farmer will plant trees but also the intensity of plantations. The specified model in eqn. (4) explains the dependant variable, number of trees planted (T), is a function of experience of farmers (EXP), Farm size (FSIZE), contact with extension personnel (EXTN), educational level of the decision maker (EDN), non-farm income earned (NINCOME), off-farm income earned (OFFINCOME), irrigated area (IRRIGATION), and possession of livestock (LIVE STOCK). The definition of the variables studied is presented in table. 1

**Table 1:** Definition of the variables studied

| Variables | | Definition |
|---|---|---|
| Dependent variable | : | Number of trees planted (threshold level fixed at 15). Thus dependent variable is 15 if the farmer planted and maintains 15 and continuous if he planted and maintains >15. |
| EXP | : | Experience of the farmer in years (accounted only after the farmer has come to decision making) |
| FSIZE | : | Farm size in acres. |
| EXTN | : | Contact with extension personnel (minimum of twice per month). Measured as a binary variable 1 if the farmer has been in contact with any extension personnel, 0 otherwise. |
| EDN | : | Educational level of the decision maker / head of the household. Measured as a binary variable 1 if the farmer has completed schooling upto 8th, 0 otherwise. |
| NINCOME | : | Non-farm income earned in rupees per year. |
| OFFINCOME | : | Off-farm income earned in rupees per year. |
| IRRIGATION | : | Net area irrigated in acres |
| LIVESTOCK | : | Number of livestock possessed. |

*A priori* relationships between dependent and selected explanatory variables are visualised as follows. Experience of the farmers in farming will have influence on tree growing as their experience in rational use of land and other limiting resources may be a favourable factor for inclusion of 'tree husbandry' in farm portfolio. It is reasonable to expect that large farm size may provide more area for tree planting. Earlier studies confirm this kind of relationship [Polson & Spencer, 1991]. Contact with extension agents is expected to have a positive effect on adoption according to the innovation diffusion theory. Such contacts exposing farmers to availability of information, can be expected to stimulate adoption [Polson & Spencer, 1991]. Education makes the farmers to have access to new innovations. *A priori*, it can thus be assumed that EDN will have a positive influence on adoption of tree growing.

Income from off-farm activities such as hiring out bullocks, machinery and labour etc., and non-farm income will reduce the dependency of farm households on crop production. Tree growing involves longer gestation period combined with cash flow problems, and as such, the income from non-farm and off-farm sources will enable tree growing. Thus, the variables NINCOME and OFFINCOME will logically have a positive effect on tree growing.

Allied farm activities may increase the income of the households. Adequate livestock population would mean lesser dependence on crop production for subsistence needs and greater ability to deal with cash flow problems associated with the longer gestation periods of tree growing. Thus, presence of LIVESTOCK enterprise may have positive influence on tree growing. As indicated earlier, Tobit model was estimated to study the adoption behaviour. An iterative maximum likelihood algorithm procedure using LIMDEP 6.0 computer package was employed to empirically estimate the model.

## Results and Discussion

The summary statistics of variables used in the model are presented in table 2 and estimated coefficients of Tobit model are displayed in table 3. FSIZE is found to be a significant determinant of adoption of agroforestry in Western zone of Tamil Nadu. The explanatory variables, NINCOME and OFFINCOME show significant and positive influence on tree growing decisions of farmers. Contact with extension personnel (EXTN) and possession of livestock (LIVESTOCK) also show positive influence but the coefficients are significant only at

10 per cent level of probability. The explanatory variables in the model such as EXP and EDN show negative but insignificant influence on the dependent variable.

**Table 2:** Descriptive statistics of the variables used in adoption model

| Variables | Unit | Mean | Std. Dev. |
|---|---|---|---|
| *Dep. variable* | | | |
| Number of trees planted | Numbers | 41.767 | 117.16 |
| *Explanatory variables* | | | |
| EXP | Years | 25.367 | 11.903 |
| FSIZE | Acres | 6.7750 | 5.1463 |
| EXTN | Binary | 0.5000 | 0.5086 |
| EDN | Binary | 0.4667 | 0.5074 |
| NINCOME | Rs/year | 2486.70 | 4153.90 |
| OFFINCOME | Rs/year | 723.33 | 1071.20 |
| LIVESTOCK | Numbers | 5.6337 | 4.7813 |

**Table 3:** Estimates of Tobit adoption model, eestern zone of Tamil Nadu

| Variables | Coefficients | Std Errors | 't' ratio |
|---|---|---|---|
| Constant | –63.4803 | 54.94 | –1.155 |
| EXP | –1.6020 | 1.625 | –0.986 |
| FSIZE | 6.2098 | 1.829 | 3.394* |
| EXTN | 2.3997 | 1.366 | 1.756*** |
| EDN | –5.9604 | 60.20 | –0.099 |
| NINCOME | 0.0176 | 0.0083 | 2.107** |
| OFFINCOME | 0.0637 | 0.0279 | 2.279** |
| IRRIGATION | 8.7642 | 6.540 | 1.340 |
| LIVESTOCK | 0.6566 | 0.349 | 1.881*** |
| Pseudo R2 | | : 0.9336 | |
| Log-likelihood | | : – 86.668 | |
| Sigma ( $\sigma$ ) | | : 37.2070 | |

* : P < 0.01; ** = P < 0.05 and *** = P < 0.10 significant level.

As Tobin (1958) shows, the expected value of the dependent variable (T) i.e. number of trees planted in the model is

$$E(T) = I\,F(z) + \sigma\, f(z) \qquad (I = X\beta) \qquad (5)$$

Where, $z = 1/\sigma$, f(z) is the unit normal density function and F(z) is the cumulative normal distribution function. Thus, the expected number of trees planted by an average farmer in the study area worked out to 64.39.[1] The expected value of the dependent variable T for observation above the limit, called T*, is simply $X\beta$ plus the expected value of the truncated normal error term [Amemiya, 1973].

$$E(T^*) = E(T/T > c)$$

$$= E(T/e > -X\beta)$$

$$= X\beta + \sigma\, f(z)/F(z)$$

Economic implications can be drawn by using the results of the empirical model. Following a Tobit decomposition framework suggested by Mc Donald and Muffitt (1980), the effects of the changes of the explanatory variables (variables which significantly influence tree growing) on the probability of planting trees and intensity of plantations are obtained and presented in table 4.

**Table 4:** Tobit total elasticity decomposition for changes in the explanatory variable

| Variables | Elasticity of | | |
|---|---|---|---|
| | Expected intensity of plantations | Probability of adoption | Total elasticity |
| FSIZE | 4.9116 | 1.0532 | 5.9648 |
| EXTN | 1.8980 | 0.4065 | 2.3045 |
| NINCOME | 0.0139 | 0.0029 | 0.0168 |
| OFFINCOME | 0.0504 | 0.0108 | 0.0612 |
| LIVESTOCK | 0.5193 | 0.114 | 0.6307 |

1a. I = –63.4803 – 1.6020 (25.367) + 6.2098 (6.7750) + 2.3007 (0.5000) – 5.9604 (0.4667) + 0.0176 (2486.70) + 0.0637 (723.33) + 8.7642 (3.8250) + 0.6566 (5.6337)

= 63.44

b. (I/e) = 63.44 / 37.21 = 1.70

c. The area under the normal probability curve for (I/e) = 1.70 is 0.96. Therefore, there is a 96 percent chance that an average farmer, as defined, would plant trees and so F(I/e) = 0.96.

d. The expected amount of trees planted by an adopter is
E (P/I) = I. F(z) + *e* f(z)
(63.44) (0.96) + (37.21) (0.094) = 63.44.

e. f(z) is the value of the ordinate of the normal density function at 1.70.

The basic relationship between the expected values of all observations, E (T), the expected value of trees planted conditional on the farmer being above the threshold, E (T*), and the probability of the farmer being above the threshold (i.e. probability of adoption) can be represented as F(z),

$$E(T) = E(T^*) F(z)$$

The effect of a given change in the level of the explanatory variables on the dependent variables can be obtained by decomposing the above equation.

$$d E(T)/c Xi = F(z) (d ET^*/dXi) + E(T^*) (d F(z)/d Xi)$$

Thus, the total elasticity of a change in the level of any of the explanatory variables consists of two effects: (a) change in the elasticity of the intensity of plantations, for those farmers who are already above the threshold level and (b) change in the elasticity of probability of being above threshold (i.e. adoption probability).

The estimates of elasticity (table 4) show that any change in explanatory variables will increase the probability of planting trees and the intensity of plantations. Thus the variable FSIZE has the highest impact on both probability and intensity of plantations. The total elasticity worked out to 5.96 which is divided into 4.9116 for elasticity of intensity of plantation and 1.0532 for elasticity of probability of planting trees. This suggests that a 10 per cent increase in the size of holding is expected to result in about 59 per cent increase in adoption (planting trees) and intensity of plantation. The probability of planting trees will increase by 10 per cent. Improved extension is estimated to increase the total elasticity of 2.30, which is decomposed into 1.8980 for elasticity of intensity of plantation and 0.4065 for elasticity of probability of plantation. Similarly, increased livestock improves the total elasticity by 0.6307, decomposed into 0.5193 for intensity of plantation and 0.1114 for probability of planting trees, i.e. a 10 per cent increase in the number of livestock in the farms increases 6.3 per cent in probability of plantation and intensity of plantation. Though the explanatory variables NINCOME and OFFINCOME show inelastic response, they have some influence on the probability of plantation and plantation intensity.

## Conclusion

The study lucidly shows that increase in size of holding, promotion and strengthening of extension and livestock activities alongwith agricultural crop production accelerate the adoption of tree planting and intensity of plantations. It is mainly because large size of holding and having more access to other income sources reduce dependence on agricultural crop production, which involves more risk and uncertainty. Moreover, the longer gestation period combined with cashflow problems could be managed. Appropriate training on non-farm and allied activities may be given to farmers of small and marginal groups so as to profitably engage them during off-seasons also. Thus, creating avenues for different income sources (such as allied activities, off-farm and non-farm income) would enhance tree plantations by farmers of different size groups. Tie-up arrangements between tree growers and industries consuming forest products may be encouraged to provide assured prices and market. This will enable tree growing at a fast pace at the farm level.

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I know of no more encouraging fact than the unquestionable ability of man to elevate his life by conscious endeavor.

*Henry David Thoreau*

# Relationship Between Land & Labour Force of the Household

R. Nagarajan

*This article examines the effect of household labour force on adjustment of land by purchase and lease - in with the help of household level data collected from an agrarian community in rural Tamil Nadu. The findings reveal the significant positive influence of household labour force, particularly adult male labour force on acquiring land by purchase and lease-in. Child labour power of the household is not found to influence land acquisition suggesting that children contribute to the household only after they attained their adulthood. It is concluded that for the farm households one of the important mechanisms for upward mobility with regard to the landholding is the size of the adult male labour force in the household.*

*R. Nagarajan is Lecturer, Gokhale Institute of Politics and Economics, Pune 411 004.*

The recent empirical evidence gathered from a number of population surveys in agrarian societies led to a debate on the nature and extent of the relationship between landholding and fertility behaviour (Stokes & Schutjer, 1984; Cain, 1985, 1986; Stokes et al., 1986; Thomas, 1991; Clay & Johnson, 1992). The main disagreement is about the causal direction of the relationship. The debate has yielded the following plausible ways in which land operates on fertility: large landholdings may raise the household's need for labour and consequently fertility, i.e., there is a positive relationship between landholding and fertility (land-labour demand hypothesis); land is adjusted to accommodate changes in the labour force of the household (reverse causation hypothesis) i.e., landholding being influenced by fertility/family size; landholding increases fertility not by increasing the demand for children but by increasing the supply of children/natural fertility; ownership of land reduces the importance of children as a source of old age security and thus fertility (land-security hypothesis); and the extent of land fertility/family size relationship depends on institutions like the market for land, labour and produce. The relationship is certainly quite complex and these theoretical issues on the cause-effect mechanism of the relationship need further investigation separately on each of these dimensions. While a large number of studies have investigated the land labour-demand hypothesis in the rural areas of less developed countries (LDCs), very few studies are available on the reverse causation hypothesis. Hence, this study focuses on the reverse causation hypothesis with the help of household level data collected from an agrarian community in rural Tamil Nadu.

## Literature Review

The relationship between landholding and fertility of peasant households received the attention of demographers very recently. Stokes and Schutjer (1984) gave special attention to the land-fertility relationship for the

formulation of agricultural and rural development policy. They argue that the farm family with access to large expanses of arable land can raise its income by profitably employing more of its family members in the family farm. This income in turn should increase the demand for children by making children more profitable as a source of family labour. Support for this argument is available from a large number of macro and micro level studies conducted in many parts of LDCs. But these studies failed to show which variable has initiated a change in the other variable. This land-labour demand explanation has been questioned by Cain (1985). In refuting the land-labour demand hypothesis, he provides an alternative explanation by suggesting that family size is relatively fixed, while the size of operational holdings is determined by leasing-out to accommodate the changes in the labour force of the households. In support of his argument Cain provides an evidence from Bangladesh. Cain's cross-sectional data from a rural village in Bangladesh shows that the presence of each additional adult male worker aged 12-65 years in a household is associated with an additional increment of 0.6 acres of land rented by the household (Cain, 1981).

**The farm family with access to large expanses of arable land can raise its income by profitably employing more of its family members. This income in turn should increase the demand for children.**

This reverse causation hypothesis may be identified by going back to the Chayanov theory of peasant economy (a translated version of Chayanov's papers is available in Thorner et al., 1987). The assumption is that demographic process of growth and distribution of family size determine to a considerable extent the distribution of farms by sown area and number of livestock. Chayanov's theory was supported by his Russian peasant farm household data. He found that usable land area was positively correlated with the number of family members or that the area of land use is directly proportional to the development of the family. He further observed that older families have sown more land area than younger ones. The reverse causation hypothesis is also supported by studies in Bangladesh (Chaudhury, 1989; Mahmud & McIntosh, 1980), Pakistan (Irfan, 1989), China (Chang, 1991), Zaire (Shapiro, 1990), Rwanda (Clay & McAlister, 1991) and India (Jodha, 1980).

**Demographic process of growth and distribution of family size determines to a considerable extent the distribution of farms by sown area and number of livestock.**

In an earlier work, Mamdani (1972) had strongly argued that children represent a means of acquiring land. He noted that farmers in Punjab villages want a larger number of sons to enhance their economic condition by way of adding land. Many others have also suggested this possibility (Mazur, 1975; Chernichovsky, 1976; McInnis, 1977; Stokes & Schutjer, 1984; Cain, 1985; Binswanger & Rosenzweig, 1986; Binswanger & McIntire, 1987; Shapiro, 1990; and Sharif & Saha, 1993). However the available empirical evidence does not necessarily establish the reverse causation. To see whether an increase in family size has led to acquitition of land, a longitudinal approach, in which the sequence of events could be observed, is required.

The magnitude of the strength of the relationship may depend on the availability of land and market for rental land (Rosenzweig et al., 1988). For example, in Rwanda where arable lands are scarce, household size does not appear to have an effect on farm size (Clay & Johnson, 1992). But in Zaire, where abundant land is available and land can be cleared without involving cost, household size is positively related with landholding (Shapiro, 1990). Market for labour and produce also determines the strength of the relationship. For example, where farming is labour-intensive and where farm surplus is made profitable by easy access to markets, the farm household with more arable land should be able to earn extra agricultural income by using their family labour (Clay & Johnson, 1992). Under these conditions more family labour means more profit to the household or as a source of acquiring additional land. Further a large family size is economically advantageous to the landholder only in the absence of cheap and dependable labour market (Cain, 1985; Thomas, 1991). If a cheap labour market is available, there is no need for the farmer to have more family members to work on the farm. He would be able to employ labourers at lower wage rate and send the other members of the household to off-farm activities. Hence the complementarity between labour and land depends on the labour market in the area.

**The complementarity between labour and land depends on the labour market in the area.**

## Sample Design

Data analysed in this study pertain to the farm households selected for the landholding-fertility survey in Periyar district of Tamil Nadu. Since land-labour relationship is relevant for a population which is purely dependent on agriculture, this study was specifically restricted to the Kongu Vellala community, which is the predominantly agrarian community in the northwestern region of Tamil Nadu.

The nature of land-labour relationship could vary, among various other factors, by the source of irrigation. In particular, this relationship in assured irrigated areas (with more cropping intensity) could be different from that in non-assured irrigated areas (with less cropping intensity). But the scope of this study is restricted to non-assured irrigated areas only. Open wells are the main source of irrigation besides rain-fed cultivation in the study area. At least two crops can be cultivated per year by using well irrigation and one crop by rain-fed cultivation. Major crops cultivated are groundnut, vegetables, millets, pulses, mulberry, cotton and to a limited extent paddy. Kongu Vellala agricultural households, in the primarily well irrigated and rain-fed parts of Dharapuram taluk of Periyar district, were the universe of the study.

A two-stage self-weighting sampling scheme was adopted to select the sample households. In the first stage, five villages were selected with probability proportional to size. In the second stage, all the agricultural households in the selected villages were listed and from each village, a sample was selected systematically. Information from 360 married respondents aged between 20 and 55 was obtained through personal interviews by the author. Data for the study were collected during the months of July 1991-February 1992. In the sample households only five landless Vellala households were encountered. Hence, the landless households were dropped as they were very small in number for a meaningful analysis. The information of the remaining 360 cultivator households was retained for the analysis.

## Analysis

As discussed earlier, if a reverse effect exists, we would expect that if the size of family increases more land is acquired by purchase or lease and vice versa. To examine this, the information on the timings of the changes in the family size and land purchase is required. Such longitudinal data are difficult to obtain in a one time study. However, we do have information on recent land transfers, i.e., since the inheritance of the land by the respondent. These are transfers during the adult life of the respondent and thus are broadly over the child bearing period. Three variables are considered: whether there has been any addition of land (LADD: dichotomous); whether there has been any purchase of land (LPUR: dichotomous); and the size of land leased-in (LLIN). These are regressed on household labour force variables. To represent the household labour force, three variables are used: household adult members aged 15+; household adult male members aged 15+; and children aged <15. The first variable represents the household's adult labour force (ADLT). Since major agricultural operations in this region are performed by adult males, for example ploughing, irrigating, land preparation are tasks rarely performed by women, the availability of male workers may be perceived to be crucial. Hence the variable household adult male members aged 15+ (ADLM) is used. The third variable, children aged <15 (NOC) represents the availability of child labour. Since ADLT and ADLM are highly correlated (artifactually), only one of these is used in any single regression as an explanatory variable.

Among the household composition variables (independent variables), age of respondent (AGER) is used in the regression because older respondents have more time to acquire additional land through lease or purchase. Also they might be well endowed with other forms of production like livestock, machineries, and other farm implements than young farmers to increase their output and income. Land transfers would also depend on other factors — size of land inherited, alternate avenues of investment etc. The education level of the household head in the Indian rural setup may also influence the relative importance given to land and alternate investment. Therefore, in addition to the household composition variables, land inherited (LINH) and education of the respondent (EDN) are also used. A list of variables included in the regression analysis, their definitions, means and standard deviations are given in table 1.

Regression coefficients are estimated from the following logistic regression equations since LADD and LPUR are dichotomous variables. The results are given in table 2.

**Table 1:** Definitions, means and standard deviations of variables used in analyses, (n = 360)

| Variable | | Description | Mean | SD |
|---|---|---|---|---|
| LADD: | Land added | = 1 if landholding of the household increased by means of purchase or leasing-in, 0 otherwise | 0.48 | 0.50 |
| LPUR: | Purchase of land | = 1 if household purchased any land | 0.37 | 0.48 |
| LLIN: | Leased-in land (in acres) | Size of land leased-in by the household | 0.80 | 2.70 |
| ADLT: | Household members aged 15+ | Number of adult household members aged 15 and above* | 3.40 | 1.05 |
| ADLM: | Household male members aged 15+ | Number of adult household male members aged 15 and above* | 1.74 | 0.72 |
| NOC: | Children aged <15 | Number of children aged below 15 years in the household* | 0.98 | 0.88 |
| LINH: | Inherited land (in acres) | Size of land inherited from parents | 9.05 | 10.69 |
| LOWN: | Land owned (in acres) | Size of land owned and cultivated+ owned land leased-out | 10.52 | 9.99 |
| AGER: | Age of respondent | Age of respondent in completed years | 42.06 | 7.24 |
| EDN: | Education of respondent | Completed years of education | 5.06 | 3.25 |

* The attached labourers, if any, are not treated as usual residents of the households of the landholders. Hence, they are not counted as members of household.

Logit LADD = f (ADLT, NOC, LINH, AGER, EDN) (1)

Logit LADD = f (ADLM, NOC, LINH, AGER, EDN) (2)

Logit LPUR = (ADLT, NOC, LINH, INC, AGER, EDN) (3)

Logit LPUR = f (ADLM, NOC, LINH, INC, AGER, EDN) (4)

The results show that the household labour force aged 15+ (ADLT) does have a role in acquiring additional land in both modes of acquisition (LADD and LPUR). Households with more adult workers have a greater tendency to acquire land. Further, the size of male adult workers (ADLM) has even a stronger influence on the propensity to acquire land, as the effect of this variable is highly significant. On the other hand, availability of children does not have any effect. Size of land inherited (LINH) has a negative and significant effect on both addition and purchase of land, i.e., those who have already inherited more land from their parents are less inclined to add further land. The life cycle variable, age of respondent (AGER), increases the acquisition of land; in particular, it has highly significant positive effect on the purchase of land. Education also has a positive effect, on the purchase of land.

**The life cycle variable, age of respondent (AGER), increases the acquisition of land; Education also has a positive effect, on the purchase of land.**

**Table 2:** Logistic regression results for land added and purchase of land on age and sex composition of household (n = 360)

| | Dependent Variable | | | | | |
|---|---|---|---|---|---|---|
| | Land added (LADD) | | | Purchase of land (LPUR) | | |
| | Zero order correlation "r" | Regression coeffi. equation (1) | Regression coeffi. equation (2) | Zero order Correlation "r" | Regression coeffi. equation (3) | Regression coeffi. equation (4) |
| Independent variable | | | | | | |
| ADLT | 0.1030 | 0.2630* (2.210) | – | 0.1388 | 0.2610** (2.164) | – |
| ADLM | 0.1582 | – | 0.5379*** (2.893) | 0.1885 | – | 0.5505*** (2.969) |
| NOC | –0.1269 | –0.0684 (–0.429) | 0.0230 (0.138) | –0.1639 | –0.0827 (–0.502) | 0.0211 (0.123) |
| LINH | –0.2740 | –0.0819*** (–4.889) | –0.0824*** (–4.904) | –0.1764 | –0.0623*** (–3.837) | –0.0634*** (–3.873) |
| AGER | 0.1207 | 0.0278 (1.404) | 0.0323* (1.617) | 0.1893 | 0.0615*** (2.955) | 0.0669*** (3.171) |
| EDN | –0.1337 | 0.0028 (0.069) | 0.0110 (0.270) | –0.0723 | 0.0740* (1.773) | 0.0840** (1.992) |
| Constant | – | –1.3955 | –1.7508 | – | –3.8360 | –4.2797 |
| Log likelihood | – | –226.3023 | –224.4008 | – | –217.7215 | –215.4929 |

– Variable not included in the regression model
*** Significant at the 01 percent level
** Significant at the 05 percent level
* Significant at the 10 percent level
t values are given in parentheses

The two dependent variables LADD and LPUR used in the above regression analysis represent the changes in landholding that have taken place over the past several years or since the inheritance. Hence information of household labour force at the time of such transfers rather than at the time of survey would be more relevant. But transfers have taken place at different time points in such households and we could not collect information on the exact labour availability at the time of transfers since such longitudinal data are difficult to obtain.

To overcome this problem, the size of land leased-in (LLIN) is regressed on household age-sex composition variables to investigate the reverse causation. Land owned (LOWN), AGER and EDN are the other variables in the regression. LLIN shows the very recent adjustment of land by the households and could be influenced by the availability of household labour. We noted in the study area that land leasing-in arrangements are taking place only on a short term basis. Hence this measure may help to test whether the availability of labour in the household is associated with the additional area of land leased-in. If there is any reverse causation, the current size of land leased-in must be related with the current labour force of the household. The regression equations for LLIN were:

$$LLIN = f(ADLT, NOC, LOWN, AGER, EDN) \quad (5)$$

$$LLIN = f(ADLM, NOC, LOWN, AGER, EDN) \quad (6)$$

The results are presented in table 3. The number of household adult members aged 15+ (ADLT) does not have a significant effect on the size of land leased-in. But the number of household male members aged 15+ (ADLM) has a significant positive effect on the size of land leased-in. Children below age 15 (NOC) do not have a significant effect on land leased-in. Higher educational attainment of the respondent significantly reduces the amount of land leased-in. The more educated may be interested in investing in non-agricultural avenues rather than agriculture to earn additional income. In does appear from the results, as suggested by Cain (1985), that land transfers (LADD, LPUR, LLIN) are influenced by the size of adult workers, particularly adult male workers, of the household. Hence the data strongly support the reverse causation hypothesis.

**Land transfers are influenced by the size of adult workers, particularly adult male workers, of the household.**

**Table 3:** Regression result for size of land leased-in on age and sex composition of household (n = 360)

| | Dependent variable: Size of land leased-in | | |
|---|---|---|---|
| | Zero order correlation "r" | Regression coeffi. | |
| | | equation (4) | equation (5) |
| Independent variable | | | |
| ADLT | 0.1019 | 0.2362 (1.597) | – |
| ADLM | 0.1701 | – | 0.5804*** (2.638) |
| NOC | –0.1219 | –0.2321 (–1.163) | –0.1112 (–0.541) |
| LOWN | –0.0761 | –0.0132 (–0.873) | –0.0138 (–0.930) |
| AGER | 0.0737 | –0.0160 (–0.655) | –0.0123 (–0.503) |
| EDN | –0.1753 | –0.1352*** (–2.758) | –0.1285*** (–2.637) |
| Constant | – | 1.7254 | 1.2154 |
| R2 | | .05 | .06 |

– Variable not included in the regression model

*** Significant at the 01 percent level

t - values are given in parentheses

## Discussion

The land labour demand hypothesis is one of the most prominently and frequently mentioned in literature, because the demand for child labour in landholding households was presumed to create a demand for higher family size. In the present study, we find that the link between land acquisition and household child labour is very weak. In this situation, land obviously cannot have any notable impact on demand for higher family size because of the child labour factor. Our findings also confirm that the size of landholding significantly reduces the labour contribution of children aged 6-17 to household productive activities and increases the schooling level of the children (Nagarajan, 1993). This is probably one of the reasons why the relationship between land transfer and child labour force of the household does not appear to exist in the sample households. Further, now that schooling has become nearly universal at least during the early childhood, the contribution of children is no longer perceived to be important. The possibility of a strong land-child labour link in other agrarian settings within India and other LDCs cannot, of course, be ruled out.

As discussed earlier the strength of the land-labour relationship depends on the market for land, labour and

produce. In this sample, it is found that about half of the households have increased (LADD mean = .48) their landholdings either by means of purchase or leasing-in. Land acquisitions in the way of purchase and leasing-in reveal that there is an active market for land in the area and suggest that ownership or cultivation of additional land is considered remunerative. Analysis of the labour market also shows that, most of the farmers are cultivating with the help of hired labourers and some even employ attached labourers (20 per cent of the households) suggesting that they are able to employ permanent labourers at affordable wage rates. The availability of hired labourers and ability of farmers to pay for them together may have an influence on the labour contribution of children to the household.

**The strength of the land-labour relationship depends on the market for land, labour and produce.**

The findings suggest that for the farm households one of the important mechanisms for upward mobility with regard to the landholding is the size of the family. The availability of greater number of adult household workers helps a farm household to achieve organizational efficiency through the division of labour, particularly during the peak agricultural seasons when there is not only a shortage of wage labourers but the wage of agricultural labour also goes up. As a strategy to exploit multiple sources of income, the household with more number of adult labour force will be in a better position to send one or more members of the family to work in off-farm activities, leaving behind others to work on the farm. Moreover, such income from off-farm activities may permit the household to add more land or to invest more in agriculture. Further, modernisation of agriculture needs substantial cash expenditure for inputs like seeds, fertiliser, pesticides, electricity etc. With limited cash resources, such expenses may compete with the need for payment of wages to hired labour. The availability of adult labour in the farm household may, then facilitate modernisation by releiving cash constraints.

## Conclusion

The study has examined the relationship between land transfers and the labour force of the household. The data support the reverse causation hypothesis. Our findings reveal the significant positive relationship of land acquisition (addition, purchasing and leasing-in) with adult members and particularly with adult male members. Number of children below 15 years is not related with land transfers. This implies that children contribute to the household only much later i.e., after attaining adulthood. Hence having more children to cultivate the available land is not an attractive proposition.

**Number of children below 15 years is not related with land transfers. Having more children to cultivate the available land is not an attractive proposition.**


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The real heroes in making Total Quality Management work were the depot commanders who took it up and believed in it and practiced it at substantial risk.

*Former Admiral John Kirkpatrick*
*March 1990 interview*

Feature

# Yield Sustainability & Strategies in North Eastern States

**U.C. Sharma**

*Inspite of its rich natural resources of land, water and vegetation, the North Eastern Region of India, comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura is deficient in foodgrains production. The paper presents the current foodgrains production scenario and the sustainability yield index of various food crops in different states of the region. Yield sustainability and its relevance in North Eastern Region states have been highlighted and suggestions are offered on the methodology for fertilizer use in order to increase productivity of food crops in the region.*

*U.C. Sharma is Joint Director, ICAR Research Complex for North Eastern Hills Region, Barapani-793 103, Meghalaya.*

The North Eastern Region, comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, is endowed with rich natural resources of land, water and vegetation and as such, has tremendous potential for growing varied crops. However, inspite of its rich resource base, the region has not progressed to the expected level. The major constraints are the prevalence of shifting cultivation, land tenurial system, small size of holding, lack of finance for inputs, lack of proper communication system, free grazing, infestation of crops with pests and diseases due to favourable climatic conditions etc. Shifting cultivation has been the major hitch in higher productivity of crops. Annual area under this practice in the region is around 386.5 thousand hectares. Crops are sown in intimate mixture and the yields are poor. Hence the states of the region are still deficit in foodgrain production. There is an urgent need to recast the present approach and work out a long term strategy, making use of locally available resources, for increasing as well as sustaining the productivity for ensuring enduring food security in the region. A detailed analysis of the existing productivity levels of various crops is necessary to suggest some viable, measures for enhancing the current yields.

## Methodology

The Sustainable Yield Index (SYI) was calculated as per the method suggested by Singh et al. (1990) i.e. $SYI = (\bar{Y} - \sigma)/Y$ max., where $\bar{Y}$ is the average yield over the years, $\sigma$ is the standard deviation and $Y$ max is the minimum yield observed during a particular year. In the present case, the SYI was calculated from the average yields of various crops in different states of the region obtained during different years. Whereas the SYI gives the sustainability index of the yield, it does not, however, indicate the increase or decrease in the yield over the years. Hence a new term (Productivity Potential Index or

'PPI') has been devised and a new formula suggested for calculating the same (Sharma, 1992). PPI not only gives the extent of increase or decrease of productivity of a particular crop in an area/state/country, but also shows the capacity or the present potential of state for enhancing its productivity. The formula can also be used for calculating 'Foodgrains Production Potential Index' (FPPI), where instead of productivity per hectare, production during particular years of a crop or total foodgrains is considered. A sustainable production system for a state will be the one in which the production potential index of foodgrains is higher than that of its population. The 'PPI' was calculated as:

$$PPI = (10^b - 1) \times 100 \; [\; (p \text{ max.}) / (\bar{p} - \sigma) \;]$$

where $b = \dfrac{\sum [\log p\,(x - \bar{x})}{\sum (x - \bar{x})^2}$, is the year as 0,1,2, ...n

(0, is the base year), $P$ is the productivity, $P$ max. is the highest productivity during a particular year; $\bar{p}$ is the average productivity over the years and $\sigma$ is the standard deviation. $10^b$ means antilog of 'b'. The population index can also be calculated by the above formula. Instead of productivity, population of a state/area is substituted in the formula.

Minimum guaranteed yield was determined as the SYI multiplied by the highest yield obtained during a particular year. The productivity, production data of various crops for different states was taken from the Basic Statistics of North Eastern Region (Anonymous; 1982, 1992).

### Foodgrains Production Scenario

Productivity trends of various food crops in North Eastern Region are presented in table 1 and fig. 1. About

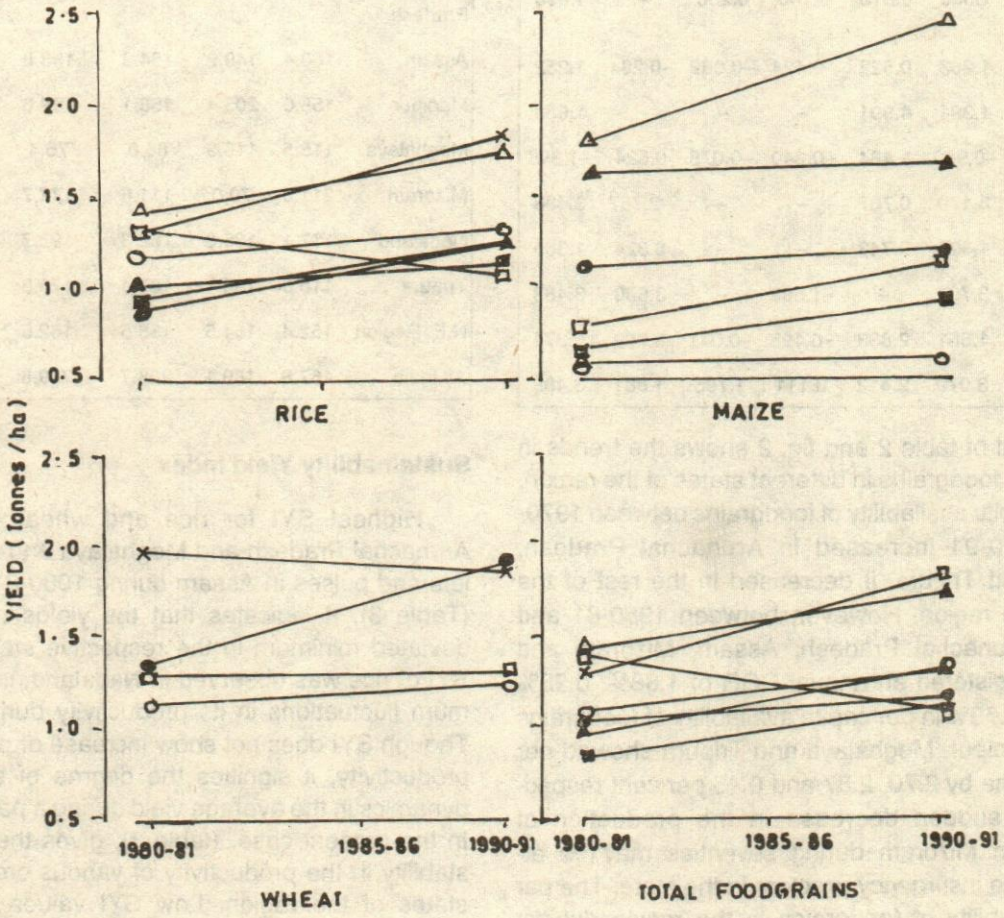



**Fig. 1 :** Productivity trends of various food crops in North-eastern states.
Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura

4.88 million tonnes of foodgrain production was recorded in North Eastern Region during 1990-91, which was 27.6 per cent higher over 1980-81 production. The annual compound growth rate (CGR) of foodgrain production during the period was 1.37%. Highest annual CGR of rice during this period was observed in Tripura (3.70%) followed by Mizoram (3.17%); of maize in Manipur (4.99%); of wheat in Arunachal Pradesh (6.14%); and pulses in Nagaland (8.32%). Meghalaya showed a decline in the productivity of rice, wheat, millets and pulses during the period. Wheat and millets showed an overall decline in productivity in the region between 1980-81 and 1990-91.

**Table 1:** Annual compound growth rate (%) of productivity of various crops (1980-81 to 1990-91)

| State | Rice | Maize | Wheat | Millets | Pulses | All food crops |
|---|---|---|---|---|---|---|
| Arunachal Pradesh | 1.030 | 0.815 | 6.140 | 0.230 | – | 1.908 |
| Assam | 1.263 | 0.522 | –0.424 | –0.062 | –0.284 | 1.232 |
| Manipur | 1.391 | 4.991 | – | – | – | 1.688 |
| Meghalaya | –0.980 | 1.484 | –0.340 | –0.079 | 0.524 | –1.398 |
| Mizoram | 3.170 | 0.767 | – | – | –2.767 | 3.488 |
| Nagaland | 1.425 | 0.743 | – | – | 8.324 | 1.365 |
| Tripura | 3.707 | – | –1.508 | – | 3.839 | 3.468 |
| N.E. States | 1.561 | 2.838 | –0.198 | –0.041 | 3.709 | 1.374 |
| All India | 3.079 | 2.412 | 3.111 | 1.795 | 1.881 | 3.488 |

A perusal of table 2 and fig. 2 shows the trends in availability of foodgrains in different states of the region. While per capita availability of foodgrains between 1970-71 and 1990-91 increased in Arunachal Pradesh, Nagaland and Tripura, it decreased in the rest of the states of the region. However, between 1980-81 and 1990-91, Arunachal Pradesh, Assam, Mizoram and Nagaland registered an annual CGR of 1.88%, 0.28% 4.77% and 1.79% in per capita availability of foodgrains whereas Manipur, Meghalaya and Tripura showed per annum decline by 2.70, 2.87 and 0.45 per cent respectively. The sudden decrease in the production of foodgrains in Mizoram during seventies may be attributed to the insurgency problem in the state. The per capita availability of foodgrains in the region did not change significantly and was only 155.5 gms per capita/day during 1990-91 as against 208.7g in the country. At the present rate of growth in foodgrains and population, the North Eastern Region is expected to have 162.5 gms of foodgrains daily for each individual by 2000-01 compared to that of 229.6 gms in the country. Unless concerted efforts are made for increasing the productivity in the region, no significant change can be expected in the per capita availability of foodgrains even by the turn of the century and the region will continue to remain a food deficit area.

**Table 2**: Per capita availability of foodgrains (kg/annum)

| State | 1970-71 | 1980-81 | 1990-91 | Compound annual increase between 2000-01 (Expected) | 1970-71 and 1990-91 | 1980-81 and 1990-91 |
|---|---|---|---|---|---|---|
| Arunachal Pradesh | 107.8 | 207.2 | 249.7 | 300.0 | 4.29 | 1.88 |
| Assam | 160.4 | 149.9 | 154.3 | 158.8 | –0.19 | 0.28 |
| Manipur | 158.0 | 205.4 | 156.1 | 159.6 | –0.06 | –2.70 |
| Meghalaya | 115.5 | 115.9 | 86.6 | 75.4 | –1.43 | –2.87 |
| Mizoram | 211.8 | 70.0 | 111.6 | 177.7 | –3.15 | 4.77 |
| Nagaland | 137.1 | 135.8 | 162.3 | 193.7 | 0.84 | 1.79 |
| Tripura | 116.0 | 196.1 | 187.4 | 178.5 | 2.42 | –0.45 |
| N.E. Region | 152.4 | 154.5 | 155.5 | 162.5 | 0.10 | 0.06 |
| All India | 167.8 | 189.1 | 208.7 | 229.6 | 1.09 | 0.99 |

## Sustainability Yield Index

Highest SYI for rice and wheat was found in Arunachal Pradesh and Meghalaya and for maize, millets and pulses in Assam during 1980-81 and 1990-91 (Table 3). It indicates that the yields of these crops deviated minimum in the respective states. Maximum SYI of rice was observed in Nagaland, indicating maximum fluctuations in its productivity during the period. Though SYI does not show increase or decrease in the productivity, it signifies the degree of stability or the dynamics in the average yield during a particular period. In the present case, (table 3), gives the variation and stability in the productivity of various crops in different states of the region. Low SYI values indicate more dynamism in productivity, thus suggesting less dependability for making future estimates.

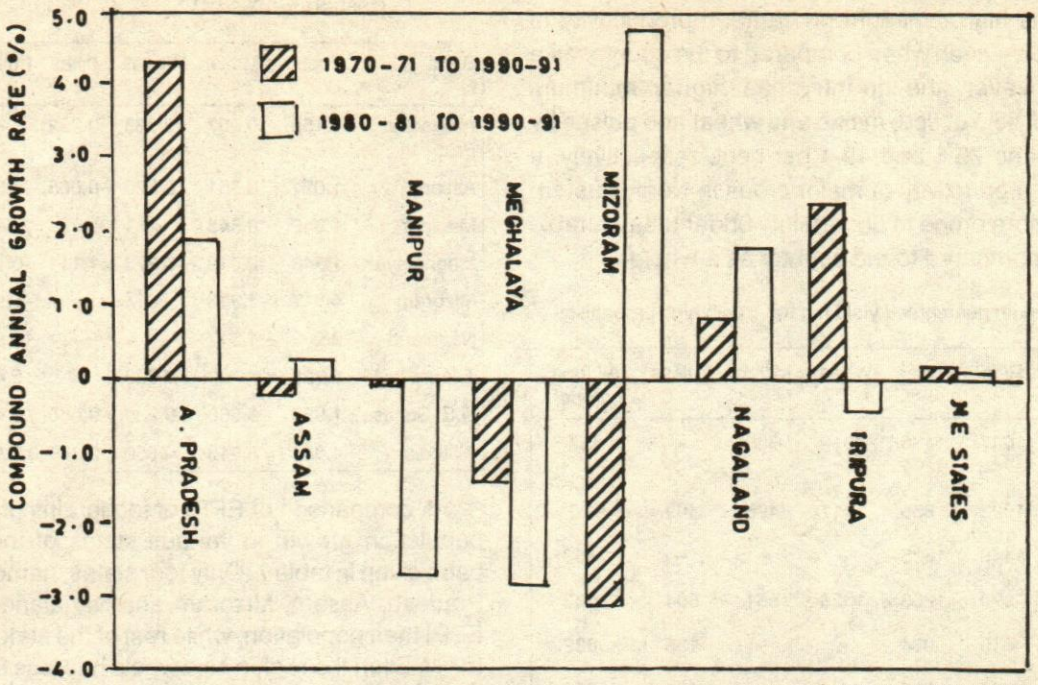



**Fig. 2 :** Growth in per capita foodgrains availability in N.E. States

**Table 3:** Sustainable yield index of various food crops (1980-81 to 1990-91)

| State | Rice | Maize | Wheat | Millets | Pulses | Total foodgrains |
|---|---|---|---|---|---|---|
| Arunachal Pradesh | 0.895 | 0.898 | 0.308 | 0.785 | – | 0.573 |
| Assam | 0.779 | 0.947 | 0.814 | 0.943 | 0.887 | 0.782 |
| Manipur | 0.717 | 0.584 | – | – | – | 0.713 |
| Meghalaya | 0.727 | 0.735 | 0.910 | 0.881 | 0.716 | 0.850 |
| Mizoram | 0.658 | 0.584 | – | – | 0.408 | 0.648 |
| Nagaland | 0.647 | 0.564 | – | – | 0.426 | 0.647 |
| Tripura | 0.709 | – | 0.745 | – | 0.709 | 0.731 |
| N.E. States | 0.793 | 0.774 | 0.827 | 0.679 | 0.439 | 0.797 |
| All India | 0.761 | 0.686 | 0.768 | 0.764 | 0.868 | 0.787 |

A comparison between SYI during the period 1971-72 and 1980-81 (table 4) with that during 1980-81 and 1990-91 (table 3) shows that SYI decreased in the second phase indicating more fluctuation in the productivity of foodgrain crops during the period and hence low sustainability of yields. However, SYI does not show increase or decrease in productivity but only the extent of deviation. A lower value indicates instability in productivity, a value nearer to one indicating stability.

**Table 4:** Sustainable yield index of food crops

| State | 1970-71 to 1980-81 | 1980-81 to 1990-91 |
|---|---|---|
| Arunachal Pradesh | 0.670 | 0.573 |
| Assam | 0.844 | 0.782 |
| Manipur | 0.804 | 0.713 |
| Meghalaya | 0.706 | 0.850 |
| Mizoram | 0.457 | 0.648 |
| Nagaland | 0.648 | 0.647 |
| Tripura | 0.695 | 0.731 |
| N.E. States | 0.855 | 0.797 |
| All India | 0.809 | 0.787 |

## Minimum Guaranteed Yield

Minimum guaranteed yield is an index of the probability with which an area/state/country has the capacity to produce the expected yield even under odd circumstances. At the present rates of productivity of different crops in various states of the region, highest minimum guaranteed yield with high probability was observed in Manipur for rice and maize, in Tripura for

wheat and in Meghalaya for millets and pulses (table 5). Manipur has high minimum guaranteed productivity of rice and maize even when compared to the country as a whole. However, the country has higher minimum guaranteed yield of rice, maize and wheat and pulses by 23.3, 27.4 and 75.6 and 49.4 per cent, respectively. It shows that productivity of major crops in North Eastern Region is more prone to uncertainty under unfavourable conditions compared to the country as a whole.

**Table 5:** Minimum guaranteed yield (kg $ha^{-1}$) with high probability

| State | Rice | Maize | Wheat | Millets | Pulses | All food crops |
|---|---|---|---|---|---|---|
| Arunachal Pradesh | 1047 | 1136 | 1012 | 769 | – | 857 |
| Assam | 1023 | 605 | 1017 | 495 | 409 | 990 |
| Manipur | 1448 | 1825 | – | – | – | 1453 |
| Meghalaya | 970 | 1203 | 1326 | 881 | 604 | 1002 |
| Mizoram | 819 | 984 | – | – | 136 | 839 |
| Nagaland | 794 | 527 | – | – | 494 | 751 |
| Tripura | 1312 | – | 1588 | – | 410 | 1304 |
| N.E. States | 1080 | 879 | 1020 | 596 | 342 | 1049 |
| All India | 1332 | 1120 | 1792 | 375 | 511 | 1095 |

## Existing Productivity Potential Index

Existing Productivity Potential Index (EPPI) gives an idea of the present potential or capacity of a particular region/country for enhancing productivity over the years. EPPI in this case was calculated from the productivity data available for various foodgrain crops (Anonymous, 1992) (table 6). A negative EPPI value indicates decline in productivity. Highest EPPI in foodgrains productivity was shown by Mizoram, followed by Tripura, Arunachal Pradesh, Manipur, Nagaland and Assam in that order. Meghalaya had a negative EPPI between 1980-81 and 1990-91, which is not a good sign. Maximum EPPI was shown by Tripura for rice, Manipur for maize, Arunachal Pradesh for wheat and millets and Nagaland for pulses. A perusal of EPPI shows that wheat and millets are not suited to the region. In case of wheat, heavy showers at the maturity stage spoil the crop and hence the productivity is on the decline except in Arunachal Pradesh. The EPPI of north eastern region is still poor when compared to the country as a whole.

**Table 6:** Productivity potential index of various crops in N.E. States (1980-81 to 1990-91)

| State | Rice | Maize | Wheat | Millets | Pulses | Food crops |
|---|---|---|---|---|---|---|
| Arunachal Pradesh | 1.150 | 0.907 | 19.935 | 0.292 | – | 3.329 |
| Assam | 1.621 | 0.551 | –0.520 | –0.065 | –0.320 | 1.575 |
| Manipur | 1.940 | 8.546 | – | – | – | 2.367 |
| Meghalaya | –1.348 | 2.019 | –0.373 | –1.111 | –0.726 | –1.644 |
| Mizoram | 4.817 | 1.313 | – | – | –5.912 | 5.382 |
| Nagaland | 2.202 | 1.317 | – | – | 19.539 | 2.109 |
| Tripura | 5.228 | – | –2.029 | – | 5.414 | 4.744 |
| N.E. States | 1.968 | 3.666 | –0.239 | –0.060 | 8.448 | 1.724 |
| All India | 4.046 | 3.516 | 4.050 | 2.349 | 2.167 | 4.432 |

A comparison of EPPI of foodgrains production and population growth in various states of the region has been given in table 7. Only four states, namely Arunachal Pradesh, Assam, Mizoram and Nagaland have higher EPPI than population, while rest of the states have lower EPPI. Even the region as a whole has less EPPI than the population which indicates that foodgrains production is not increasing commensurate with the growth of population and hence, food deficit is likely to persist.

**Table 7:** Productivity potential index of foodgrains production and population

| State | Foodgrains | Population |
|---|---|---|
| Arunachal Pradesh | 7.39 | 4.00 |
| Assam | 2.98 | 2.55 |
| Manipur | 0.76 | 3.12 |
| Meghalaya | –1.16 | 3.53 |
| Mizoram | 14.68 | 4.39 |
| Nagaland | 8.37 | 6.71 |
| Tripura | 3.57 | 3.79 |
| N.E. States | 2.89 | 2.93 |
| All India | 3.53 | 2.56 |

## Area Under Food Crops

The data given in table 8 shows that per capita net sown area in North-eastern states has declined in all the states of the region. From net per capita availability of 0.184 hectare in 1970-71 in the region, the net sown area reduced to 0.119 hectare in 1990-91. This is very low when compared to the country as a whole (0.150 ha). The increase in the total cultivated area in the region has not been at the expected pace. Net sown area is likely to increase by about 2.38 per cent annually. However,

based on last ten years figures, it has been seen that annual CGR in the area has actually been only 0.77 per cent (Sharma, 1992). At the present rate of increase, the net sown area in the region is expected to be around 4.0 million hectare by the turn of the century. So, the possibility of enhancing production of foodgrains through increase in area is limited. Between 1972-73 and 1990-91, the contribution of increase in area under foodgrains production in the region has been only 33.8 per cent against 66.2 per cent through increase in productivity (table 9). Manipur, Mizoram and Tripura are the states where more than 98 per cent increase in foodgrain production has been through increase in productivity over the years. As the chances of enhancing area under food crops in the region will go on declining in future, increase in productivity is essential to increase production to fill the deficit. Data given in table 8 and 9 signals that only increase in productivity can ensure enduring food security in the region. On a global basis, increase in foodgrains production has generally exceeded the growth of population resulting in overall increase in per capita availability of foodgrains by 0.60 per cent annually between 1950 and 1988 (York Jr., 1991) But in North Eastern Region, the increase in per capita availability of foodgrains has been only 0.10 per cent between 1970-71 and 1990-91 and only 0.06 per cent between 1980-81 and 1990-91.

**As the chances of enhancing area under food crops in the region will go on declining in future, increase in productivity is essential to increase production to fill the deficit.**

**Table 8:** Per capita net sown area.

| State/Country | 1970-71 | 1990-91 | Annual CGR in area (%) | |
|---|---|---|---|---|
| | | | 1970-71 to 1980-81 | 1980-81 to 1990-91 |
| Arunachal Pradesh | 0.245 | 0.200 | 9.73 | 3.89 |
| Assam | 0.183 | 0.121 | 1.16 | 0.75 |
| Manipur | 0.130 | 0.076 | 2.84 | –2.15 |
| Meghalaya | 0.176 | 0.111 | 0.94 | 0.67 |
| Mizoram | 0.232 | 0.098 | –9.86 | 5.96 |
| Nagaland | 0.352 | 0.147 | 3.70 | 3.23 |
| Tripura | 0.158 | 0.098 | 0.56 | –0.33 |
| N.E. States | 0.184 | 0.119 | 1.30 | 0.80 |
| India | 0.212 | 0.150 | 0.75 | 0.067 |

**Table 9 :** Relative contribution (%) of area and productivity towards foodgrains production between 1972-73 and 1990-91.

| State | Area | Productivity |
|---|---|---|
| Arunachal Pradesh | 66.7 | 33.3 |
| Assam | 41.8 | 58.2 |
| Manipur | 1.1 | 98.9 |
| Meghalaya | 52.3 | 47.7 |
| Mizoram | – | 100.0 |
| Nagaland | 31.4 | 68.6 |
| Tripura | 0.7 | 99.3 |
| N.E. States | 33.8 | 66.2 |
| All India | 8.5 | 91.5 |

## Strategies : Yield Sustainability

'Sustainable agriculture' could be defined as economically viable land use systems which ensure enduring security of food, fibre and quality of life for the society, at the same time improving the environment of the area. The land use systems in vogue at present in the region, do not conform to the above norms by any standard. In addition, they have spoiled the quality of environment in North-eastern States due to indiscriminate cutting of forests and misuse of non-renewable resources.

**'Sustainable agriculture' could be defined as economically viable land use systems which ensure enduring security of food, fibre and quality of life for the society at the same time improving the environment of the area.**

In heavily populated but land-hungry countries like India, China and Bangladesh, enduring food security will depend on strategies to enhance crop yields (Swaminathan, 1991). In the case of North-eastern states inspite of low density of population (125 persons per sq km) almost all the states are deficient in foodgrains. The region is very rich in resource base like land, water and vegetation. Then what could be the probable reason for low production and stagnant yields? When the yields of foodgrain crops have plateaued in the country, the North Eastern Region, as one of the non-traditional areas of production, should be the hope for future to provide food, not only for its own people but to the rest of the country. Paradoxically, large quantities of foodgrains are required to be brought in from elsewhere

to feed its sparse population. It has also been not possible to prevent the expansion of cultivated area at the expense of forests and soils prone to erosion, thus adding to the environmental degradation.

In North-eastern states the challenge is, first, to increase productivity and then sustain it for food security in the region over the years. The region had enormous resource base but its indiscriminate use through faulty systems such as shifting cultivation has almost exhausted this. At present, the annual area under shifting cultivation in North-eastern states is around 386.5 thousand hectares which has resulted in large scale land and environmental degradation. This practice may have been alright when the shifting cycle used to vary between 25-30 years as the land could get enough time for rejuvenation. But now, this cycle has come down to 3 - 7 years and the practice has become unprofitable, undesirable and unsustainable and needs to be abandoned forthwith.

Rice is the staple food of the people of the region and has about 3325.6 thousand hectares area under its cultivation which forms 86.6 per cent of the total area under foodgrains. The average yield of rice in the region is 1361 kg $ha^{-1}$ against an all India average of 1751 kg $ha^{-1}$ (Anonymous, 1992). These yields are very poor when compared to world average yield of paddy of 3457 kg $ha^{-1}$ and that of Australia, 7749 kg and Egypt, 7529 kg $ha^{-1}$. Even Punjab and Tamil Nadu have average yields of 5365 and 4638 kg $ha^{-1}$ of paddy, respectively. The average yield in the North-eastern region has not reached a respectable level where they could be sustained. The main task is to find ways and means to increase the productivity at greater pace without exhausting the resource base. If we consider the bare minimum requirement of 6.15 million tonnes of foodgrains for 33.7 million population of the region, from a gross area of 3800 ha, the average productivity in the region should be about 1618 kg $ha^{-1}$ against 1315 kg $ha^{-1}$ at present. This productivity should further increase at an annual CGR of 1.60 per cent to keep pace with the increase in population at an annual CGR of 2.40 per cent in the region, considering that 0.806 per cent annual increase in foodgrain production would be met through increase in gross area under these crops.

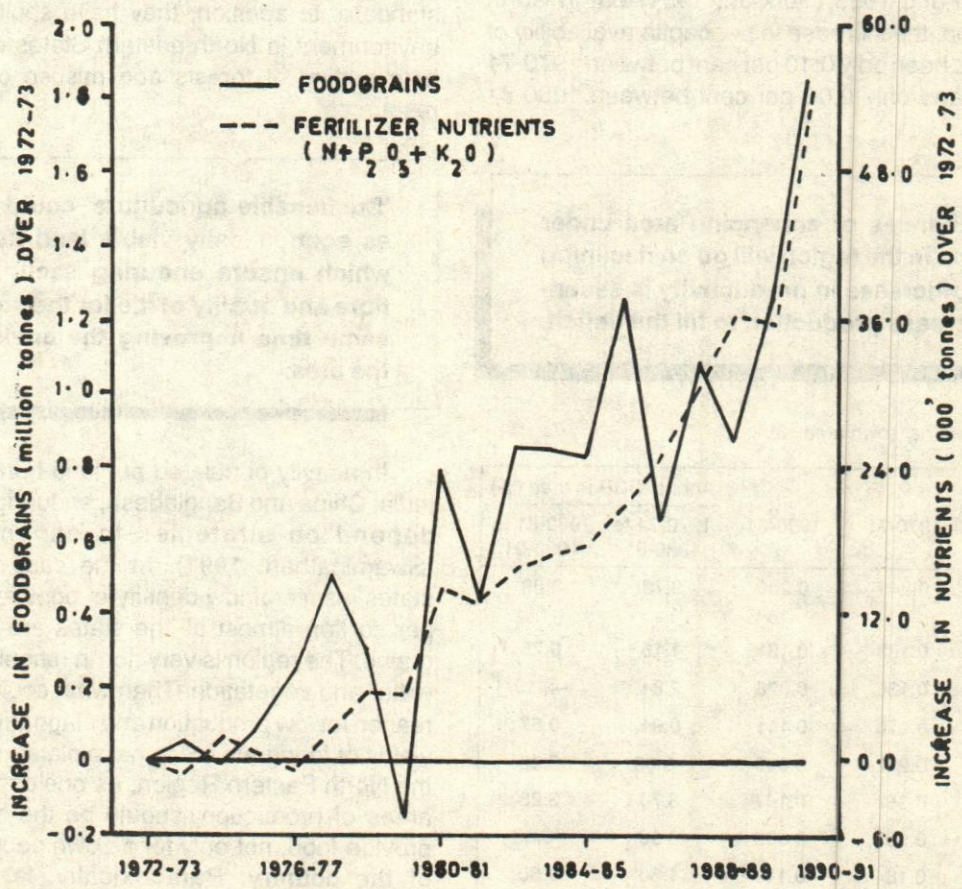



Fig. 3 : Fertilizer consumption and foodgrains production since 1972-73.

### Increase in Irrigation Facilities

Agriculture in North-eastern states is mostly rainfed. Crops are grown generally during the rainy season (February to October) and during winter, there is practically no crop. The scope for increasing irrigation in additional area in the region is limited as the rugged and undulating topography of the region makes it expensive and difficult to bring further area under irrigation. Secondly, because cultivated area is sparsely distributed in the region, only marginal area can be brought under irrigation even after heavy expenditure on an irrigation project. The cost of irrigation per unit of land would be quite high. So the possibility of increasing productivity of crop by bringing more area under irrigation is low. Between 1977-78 and 1988-89, the increase in area under irrigation in the region has been only 5.26 per cent. Productivity of food crops in the region can be raised only by the judicious use of nutrients, high yielding varieties and proper management practices.

### Use of Nutrients

Table 10 shows that, except for Manipur state, the use of fertilizer has been very limited. On an average, around 250 kg $ha^{-1}$ (120, 80, 50 kg $ha^{-1}$ of N, $P_2O_5$), of the three major nutrients are recommended for foodgrain crops. Against this the use of fertilizer nutrients varied between 1.2 kg $ha^{-1}$ in Arunachal Pradesh and 71.9 kg $ha^{-1}$ in Manipur during 1990-91. The average use of N, $P_2O_5$ and $K_2O$ in the region has risen from 2.97 kg $ha^{-1}$ in 1977-78 to 13.61 kg $ha^{-1}$ in 1990-91. Concerted effort needs to be made to raise the use of nutrients by providing financial help and subsidies to the farmers for a limited period in order to raise productivity in the region.

**Table 10:** Consumption of plant nutrients (N ++$P_2O_5$ + $K_2O$) per unit of grossed cropped area (kg $ha^{-1}$)

| State | 1979-80 | 1985-86 | 1990-91 |
|---|---|---|---|
| Arunachal Pradesh | 0.70 | – | 1.20 |
| Assam | 2.06 | 4.70 | 10.50 |
| Manipur | 14.60 | 26.30 | 71.90 |
| Meghalaya | 8.30 | 14.40 | 12.50 |
| Mizoram | 0.70 | – | 13.50 |
| Nagaland | 0.50 | 1.25 | 4.60 |
| Tripura | 5.50 | 13.90 | 19.80 |
| All India | 30.50 | 48.40 | 72.40 |

Source : Basic Statistics of North Eastern Region, North Eastern Council, Shillong (1982, 1992)

Fig. 3 shows that the production of foodgrins in the region has increased with increase in the applied nutrients. Thus the use of adequate nutrients holds the key in enhancing foodgrians production in the region.

### Maximum Return Per Unit Area

In this case the fertilizer nutrients need to be applied at a rate where the value of last increment in yield just exceeds the value of the last increment in the fertilizers. This approach should be followed in an area where the land is not a constraint (Fig. 4). Here, we can apply fertilizers up to the level where it becomes unprofitable to add additional dose. Some difficulties, however, can arise when it is difficult to obtain precision to predict this point crop response to fertilizers is variable when moisture and other environmental factors are variable, and capital is a limitation.

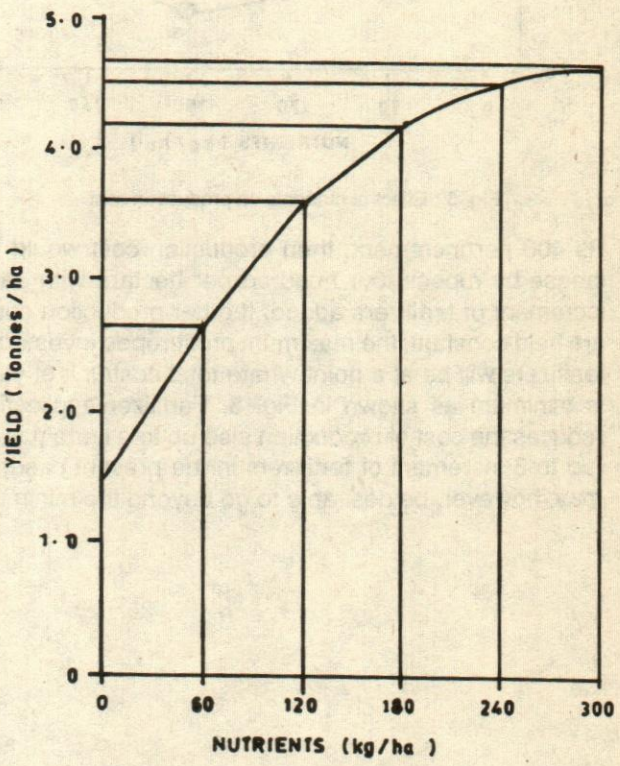



**Fig. 4 :** Increase in yield with nutrients application.

### Maximum Return Per Unit of Investment:

This approach has been illustrated through Fig. 5. Let us assume that the production cost other than fertilizers is Rs 2000. If the cost of fertilizers to be used is

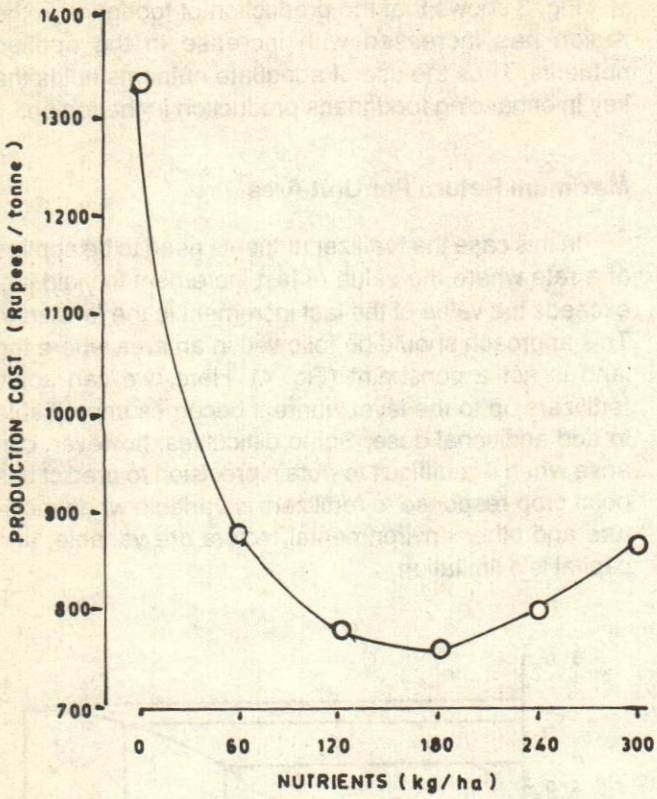



**Fig. 5 :** Effect of nutrients on production cost.

Rs 400 per increment, then production cost would increase by rupees four hundred per hectare with each increment of fertilizers added. If other production costs are held constant, the maximum profit/rupee invested in fertilizers will be at a point where total cost/unit of yield is minimum as shown in Fig. 5. Fertilizer application reduces the cost of production also up to a certain level (up to 3 increment of fertilizers in the present case). It may, however, be desirable to go beyond the minimum unit cost if the land is limited and operating cost is not a constraint. If the operating capital is a constraint, alternate uses of the capital can be considered when the point of minimum per unit cost is reached.

This approach is preferable under the conditions prevalent in North-eastern states as capital is a constraint in the region as also the availability of land. In North Eastern states, more than 55 per cent of the holdings are below 1.0 ha, 23.6 per cent between 1.0 and 2.0 ha, 10.3 per cent between 2.0 and 3.0 ha, 4.5 per cent between 3.0 and 4.0 ha and 6.6 per cent above 4.0 ha. We should try to get the maximum return per unit of investment by achieving synergy among critical crop management practices.

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Feature

# Output Change Under New Technology: A Decomposition Analysis

**G.N. Nagaraja & S.R. Subramanian**

*The change in per hectare Brinjal output with new production technology has been decomposed into that due to technical change and due to change in the input level. The contribution of technical change to total change in output was 49.69 per cent. Increased use of fertilizer, plant protection and human labour per hectare under new production technology contributed about 4.39 per cent of the change (fertilizer 1.18 per cent, plant protection 2.13 per cent and human labour 1.08 per cent) in the increased output. The scale of input saving resulted from an upward shift in the production function with the introduction of new technology.*

*G.N. Nagaraja is Asst. Farm Management Specialist, Extension Education Unit, University of Agricultural Sciences, Hebbal, Bangalore - 560 024. S.R. Subramanian is Director, Centre for Agriculture and Rural Development Studies, Tamil Nadu Agricultural University, Coimbatore - 641 003.*

Decomposition analysis involves breaking up of the causes of total output change into its basic components. It can be carried out in the context of time series analysis, forecasting or cross section analysis. The time series analysis involves the decomposition of total output growth of, say, the aggregate production or productivity into yield effect, area effect and interaction effect (Mitra & Jena, 1991). In forecasting analysis, decomposition method is employed to decompose the underlying pattern of a time series into cyclical, seasonal, trend and random sub patterns. These sub patterns are then analysed individually, extrapolated into the future and recombined to obtain forecasts of the original series (Makridakis & Wright, 1978). In cross section studies, decomposition analysis is used to breakup the total changes in output attributable to different causes. In general, changes in the output of a single crop may occur due to, at least, two different situations. Level of technology adopted, level of input use, seasonal effect, regional influence and cultivation practices adopted could be the causes.

**Changes in the output of a single crop occur due to, different level of technology adopted, level of input use, seasonal effect, regional influence and cultivation practices adopted.**

How much of the growth in output is due to technical change i.e., due to shift in the parameters of production function and how much is due to increased quantities of inputs, are the issues to be addressed. An attempt was made to decompose the total change in per hectare crop output with respect to new production technology into the proportion due to technical change and that due to the change in the input level.

Adults require 284 gms of vegetables as daily intake. But an average Indian consumes only 92 gms mainly due to scarcity and high costs. Brinjal, which is a popular vegetable available throughout the year and a good source of vitamins A and B being grown in large areas in Bangalore rural district of Karnataka, was chosen for the study.

**Methodology**

Data was collected from randomly selected farms in Bangalore rural district, pertaining to Kharif 1992. The sample size comprised 40 farms for Arka Kusumakar and Arka Navneet varieties in brinjal.

A convenient mode for decomposition of total output change is the production function. Among the production functions, Cobb - Douglas framework had been found to be more suitable (Kmenta, 1967; Sidhu, 1972; Bisalaiah, 1977). Total change in output is brought about by shifts in the parameters that define the function itself and by changes in the volume of inputs. This shift can be brought out well by the Cobb - Douglas functions.

First, the C-D function for Arka Kusumakar variety of brinjal is defined as follows:

$$\log Y_1 = \log A_1 + a_1 \log F_1 + b_1 \log P_1 + C_1 \log L_1 + U_1 \quad (1)$$

Where

$Y_1$ = Yield of Arka Kusumakar Variety of Brinjal (kgs/ha)

$F_1$ = Expenses on fertilizers (Rs / ha)

$P_1$ = Expenses on plant protection (Rs / ha)

$L_1$ = Human Labour (Man days / ha)

$A_1$ is the scale parameter and $a_1$, $b_1$ and $c_1$ denote output elasticities of respective inputs; $u_1$ is a random disturbance term independently distributed with zero mean and finite variance.

Similarly, per ha production function for Arka Navneet hybrid of Brinjal is:

$$\log Y_2 = \log A_2 + a_2 \log F_2 + b_2 \log P_2 + C_2 \log L_2 + U_2 \quad (2)$$

Definitions of variables in Eq. (2) are the same as in Eq. (1).

Now taking the differences between Eqs. (2) and (1) and adding some terms and subtracting the same terms :

$$\log Y_2 - \log Y_1 - (\log A_2 - \log A_1) + (a_2 \log F_2 - a_1 \log F_1 + a_2 \log F_1 - a_2 \log F_1) + (b_2 \log P_2 - b_1 \log P_1 + b_2 \log P_1 - b_2 \log P_1) + (c_2 \log L_2 - c_1 \log L_1 + c_2 \log L_1 - c_2 \log L_1) + (u_2 - u_1) \quad (3)$$

Rearranging terms in Eq. (3)

$$\log Y_2 - \log Y_1 = [\log A_2 - \log A_1] + [(a_2 - a_1) \log F_1 + (b_2 - b_1) \log P_1 + (c_2 - c_1) \log L_1] + [a_2 (\log F_2 - \log F_1) + b_2 (\log P_2 - \log P_1) + c_2 (\log L_2 - \log L_1)] + [u_2 - u_1] \quad (4)$$

Equation (4) can also be rewritten as:

$$\log \left[\frac{y_2}{y_1}\right] = \log \left[\frac{A_2}{A_1}\right] + [(a_2 - a_1) \log F_1 + (b_2 - b_1) \log P_1 + (c_2 - c_1) \log L_1] + \left[a_2 \log \left(\frac{F_2}{F_1}\right) + b_2 \log \left(\frac{P_2}{P_1}\right) + c_2 \log \left(\frac{L_2}{L_1}\right)\right] + [u_2 - u_1] \quad (5)$$

Equation (5) involves decomposing the natural logarithm of the ratio of 'new' or 'improved' output to 'old'. It is approximately a measure of the percentage change in output with the introduction of new technology.

Equation (5) on its RHS has four bracketed expressions. The first bracketed expression gives the measure of percentage change in output due to shift in scale parameter A. The second is the sum of arithmetic changes in output elasticities, each weighted by the log of the volume of that input used. In other words, it gives the measure of change in output due to shifts in slope parameter. The third expression is the sum of logarithms of the ratio for each input, of 'new' to 'old' input, each weighted by output elasticities of that input. It is a measure of change in output due to changes in per hectare quantities of fertilizer, plant protection and labour used, given the output elasticities of these inputs, under the new production technology. The first and second

expressions together represent the technical change and the third expression constitutes the input change.

## Results & Discussion

The estimated output elasticities of inputs for Arka Kusumakar and Arka Navneet are presented in table 1. Among the two production functions, Arka Navneet brinjal has given a better fit than the Arka Kusumakar brinjal, as revealed by the $R^2$ (co-efficient of determination) values of 0.6999 and 0.6038, respectively.

**Table 1:** Estimates of production functions for Arka Kusumakar and Arka Navneet Brinjal

| | Variables | Elasticity of output | |
|---|---|---|---|
| Arka Kusumakar (variety) | Constant ($A_1$) | 3.093 | |
| | Fertilizer ($F_1$) | 0.239* | $R^2 = 0.6038$ |
| | Plant protection ($P_1$) | 0.118 | |
| | Labour ($L_1$) | 0.236* | |
| Arka Navneet (Hybrid) | Constant ($A_2$) | 3.274 | |
| | Fertilizer ($F_2$) | 0.367* | $R^2 = 0.6999$ |
| | Plant protection ($P_2$) | 0.2111* | |
| | Labour ($L_2$) | 0.261 | |

* Significant at 5 per cent level

Equation (5) was evaluated by taking into account the mean values of inputs and outputs of the Arka Kusumakar and Arka Navneet brinjal. It could be seen from table 2 that per ha production of Arka Navneet is 54% higher than that of Arka Kusumakar. The contribution of technical change to total change in output amounted to 50% i.e, changes due to scale and slope parameters. This technical change has affected the sources of output growth by shifting the value of slope and scale parameters of production function. In other words, with the same level of per ha inputs of fertilizer ($F_1$), plant protection ($P_1$) and human labour ($L_1$) 50 per cent more output could be obtained from Arka Navneet (Hybrid) Brinjal.

**With the same level of inputs more output could be obtained from (Hybrid) Brinjal.**

**Table 2:** Decomposition analysis of total change in per ha Brinjal output between Arka Kusumakar (Variety) and Arka Navneet (Hybrid)

| Item | Percentage contributed |
|---|---|
| Total change measured in output Source of change | 0.5408 |
| 1. Technical change | 0.4969 |
| 2. Change in inputs | |
| Fertilizer | 0.0118 |
| Plant protection | 0.0213 |
| Human Labour | 0.0108 |
| Total due to input change | 0.0439 |

Similarly increased use of inputs (F, P and L) under Arka Navneet Brinjal has contributed about 4.4 per cent of the increased output. Again a breakup of the input component shows that, fertilizer, plant protection and human labour had contributed to the tune of 1.2, 2.1 and 1.1 percent, respectively.

## Conclusion

The decomposition analysis in Brinjal has explicitly broughtout the contribution of new technology to output growth. Studies of this kind, covering many agro climatic conditions will help policy makers to identify and pin-point the sources of changes in output.

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Feature

# Bullock Drawn Equipment for Agroforestry

**A.C. Varshney & Suresh Narang**

*This paper presents the yield of food crops and biomass available from subabul and economic analysis of raising agroforestry for four years. The income from agroforestry using bullock drawn equipment has been compared with the income available from most common crop rotation grown in vertisols of Bhopal region. The economic analysis showed a profit under subabul plus groundnut-wheat combination compared to a loss under subabul plus soybean-wheat and subabul plus pigeonpea crop combinations during the first year. During the second year all three crop rotations showed profit. The profit under subabul plus groundnut-wheat combination was more compared to the other combinations. During the third year all three crop rotations showed a loss due to low yield of food crops because of shading effect of forest plants and heavy weed growth.*

*A.C. Varshney & Suresh Narang are Project Coordinator and Senior Scientist respectively in the Power Tiller Scheme, Central Institute of Agricultural Engineering, Bhopal - 462038, India.*

An area of 56.2 million hectares has been assessed as cultivable waste land area in India. Sizeable area from this category of land can be conveniently put under agroforestry. The main aim of agroforestry is to grow a combination of woody perennial and annually cultivated food, forage and other crops for long term fertility restoration for the lands which are not suitable for growing crops. The advantages of forestry for maintaining clean environment are well established. Therefore, the programmes of social forestry are one of priority for both the Central and State governments in the country.

However, it is imperative to know the problems, productivity and economics of developing agroforestry before a massive programme is undertaken. The problem of shade due to the different canopy structures of trees may affect the yield of food crops. The weeds, if not controlled, may also affect the yields. Keeping these considerations in view, a study was undertaken at the Central Institute of Agricultural Engineering, Bhopal, to evaluate the performance of animal drawn equipment in growing subabul as forest tree and soybean, groundnut, pigeonpea and wheat as intercrops under rainfed conditions.

## Methodology

The study was conducted in an area of 0.3 ha with slightly undulating topography under rainfed conditions at the Central Institute of Agricultural Engineering, Bhopal, during the years 1986-87, 1987-88, 1988-89 and 1989-90. The region has black cotton soil with texture of 12.6 per cent sand, 32.7 per cent silt and 54.7 per cent clay. Planting density of 3.75m x 3.75m was selected on the basis of ease of operation for animal drawn equipment and growth of subabul plants. The treatments were combinations of subabul plus groundnut-wheat, subabul plus soybean-wheat and subabul plus pigeonpea. The pits were dug manually using pickaxe and spade. Bullock

cart was used to transport the seedlings of subabul from a nursery located at a distance of about 17 km from the Institute. Blade harrow was used for land preparation during rainy season for sowing Kharif crops and mould board plough, blade harrow and patela harrow were used during winter during different years of the study. Sowing of soybean, pigeonpea and wheat crops was carried out using CIAE 3-row bullock drawn seed-cum-fertilizer drill and groundnut crop was sown by two row bullock drawn local seed-cum-fertilizer drill. Interculture in soybean, groundnut and pigeonpea crops was done by bullock drawn blade locally known as Kulpha. Harvesting of soybean, pigeonpea and wheat crops was done by sickle and power thresher was used to thresh these crops. Groundnut crop was harvested manually by Khurpi and threshing was performed by picking the pods manually.

The seedlings of subabul were planted during the year 1986. The data on the survival of subabul were recorded after two months of plantation. Gap filling of subabul seedlings was done after the sowing of Kharif crops. Data on the yield of soybean, groundnut, pigeonpea and wheat crops were recorded. The yield of biomass was recorded by felling ten trees of subabul in the last week of November during the years 1987, 1988 and 1989. The yield of forest plants was worked out by adding the biomass available by pruning and felling the trees during the particular year. The cost of cultivation of soybean, groundnut, wheat and pigeonpea crops was worked out on the basis of expenditure on various farm operations and actual inputs like seed, fertilizer, chemicals etc. Cost of tree plantation, cost of cultivation of food crops and income were calculated for various combinations for comparison. The cost of wood was worked out at a rate of Rs 80 per quintal for subabul (sun dried) during 1987-88, Rs 85 per quintal during 1988-89 and Rs 90 per quintal during 1989-90. The cost of pods and leaves was worked out considering their fodder value at a rate of Rs 15 per quintal of green matter.

For calculating the income, the sale price of soybean was taken as Rs 450, Rs 500 and Rs 575 per quintal during the years 1986, 1987 and 1988, respectively which was close to the average market value in the respective years. The sale prices of wheat grains and straw were taken as Rs 240 per quintal and Rs 25 per quintal respectively during 1987-88. The sale prices of groundnut pods were taken as Rs 700, Rs 860 and Rs 1050 per quintal during the years 1986, 1987 and 1988, respectively. The sale price of pigeonpea grains was considered as Rs 660 per quintal during 1987-88. Sale price for pigeonpea stalks was taken as Rs 40 per quintal.

The cost of operation of various bullock operated equipment was worked out as prescribed in BIS standard (Indian Standards Institution, 1979). The cost of using a pair of bullocks was calculated on the basis of the procedure recommended by AICRP on Power Tillers. (Annual Report, 1988).

## Results

The data on the cost of transplantation of seedlings have been presented in table 1. The total cost incurred for the transplantation of seedlings was Rs 1702 in one hectare area.

**Table 1**: Cost of seedling transplantation in agroforestry

(Year 1986)

| Item | Value in Rs |
|---|---|
| Cost of seedlings, (1000 Nos) | 100 |
| Transportation charges (3 trips) | 489 |
| Pit digging | 541 |
| Transplanting | 217 |
| Basin preparation | 290 |
| Replacement of seedlings | 65 |
| Total | 1702 |

Soybean, groundnut, pigeonpea and wheat crops were raised during Kharif and rabi seasons of 1986-97, 1987-88 and 1988-89. During 1989-90, food crops were not taken due to heavy shades of forest plants. The yields of various crops have been presented in table 2.

**Table 2:** Yield of various food crops grown in agroforestry

| Crop | Yield (q/ha) | | |
|---|---|---|---|
| | I Year | II Year | III Year |
| Soybean | 6.91 | 8.62 | 4.54 |
| Groundnut | 9.80 | 7.65 | 1.29 |
| Pigeonpea | — | 3.60 (G)* | — |
| | | 10.75 (S)** | |
| Wheat | — | 16.10 (G)* | — |
| | | 31.05 (S)* | |

* G- Grain

** S- Straw/Stalks

The yield of soybean crop was 6.91, 8.62 and 4.54 q/ha and groundnut crop yielded 9.80, 7.65 and 1.29 q/ha

during 1986, 1987 and 1988 respectively. The yield of soybean and groundnut crops during the third year were low due to very heavy weed infestation and shades on the crop due to the growth of subabul plants. Wheat and pigeonpea crops could not be grown due to unfavourable conditions for crop raising during 1986 and 1988. The yields of wheat and pigeonpea crops during 1987 were 16.10 q/ha and 3.60 q/ha, respectively.

The data on the biomass available at the end of four years of study has been presented in table 3.

**Table 3:** Yield of biomass of subabul (q/ha) during different years

| Name of plant component | After I year | After 2 years | After 3 years |
|---|---|---|---|
| Wood | 36.03 | 109.68 | 172.96 |
| Leaf | — | 39.53* | 75.39* |
| Pod | — | 52.69 | 32.66* |

* Weight on wet basis

The total weight of sundried wood from subabul plantation was 17.269 tonnes per hectare. The weight of wood is the sum of weight of stems and branches of plants. The cost of growing of soybean, groundnut, pigeonpea and wheat crops during different years have been presented in table 4. The prices of various inputs were taken as per prevalent market prices in Bhopal region.

Since soybean-wheat is the most common crop rotation of Bhopal region, the cost economics of growing different combinations of subabul and food crops has been compared with this crop rotation.

The economics of agroforestry with different crop combinations has been presented in table 5. The data indicates that there is a loss of Rs 872 and Rs 2841 per hectare during the first year from subabul plus soybean-wheat and subabul plus pigeonpea compared to the profit of Rs 1882 per hectare for subabul plus groundnut-wheat during the same period mainly due to the high

**Table 4:** Cost of cultivation (Rs/ha) of growing various crops during different years

| Operation/input | Soybean | | | Groundnut | | | Pigeonpea | | | Wheat | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I year | II year | III year | I year | II year | III year | I year | II year | II year | I year | II year | III year |
| Land preparation | | | | | | | | | | | | |
| MB Ploughing | – | – | 253 | – | – | 253 | – | – | 253 | – | – | 265 |
| Blade horrowing I | 167 | 124 | 134 | 167 | 124 | 134 | 167 | 124 | 134 | – | 137 | 146 |
| Blade horrowing II | 200 | 151 | 153 | 200 | 151 | 153 | 200 | 151 | 153 | – | 163 | 169 |
| Blade horrowing III | 143 | 113 | – | 143 | 113 | – | 143 | 113 | – | – | 128 | – |
| Patela harrowing | – | – | 81 | – | – | 81 | – | – | 81 | – | – | – |
| Sowing and fertilizer application | 62 | 74 | 85 | 108 | 113 | 141 | 54 | 61 | 72 | – | 141 | 156 |
| Weeding | 69 | 79 | 119 | 69 | 79 | 119 | – | 119 | – | – | – | – |
| Harvesting | 210 | 242 | 122 | 315 | 320 | 221 | – | 282 | – | – | 176 | – |
| Handling | 134 | 143 | 100 | 116 | 125 | 100 | – | 110 | – | – | 130 | – |
| Threshing | 132 | 140 | 100 | 550 | 560 | 159 | – | 399 | – | – | 267 | – |
| Seed | 510 | 578 | 626 | 1008 | 1080 | 1220 | 60 | 68 | 73 | – | 364 | 393 |
| Fertilizer | 177 | 258 | 265 | 100 | 110 | 245 | 239 | 265 | 295 | – | 405 | 462 |
| Chemical + Plant protection | 476 | 528 | 565 | 500 | 525 | 236 | 276 | 328 | 365 | – | – | – |
| Total cost of cultivation | 2280 | 2430 | 2603 | 3276 | 3300 | 3062 | 1139 | 2020 | 1426 | – | 1911 | 1591 |
| Income from crops | 3110 | 4310 | 2611 | 6860 | 6579 | 1290 | – | 2806 | – | – | 4640 | – |
| Net Profit | 830 | 1880 | 08 | 3584 | 3279 | (–)1772 | (–)1139 | 786 | (–)1426 | – | 2729 | (–)1591 |

(–) Sign indicates loss

**Table 5:** Cost of economics of agroforestry (Rs/ha)

| Cost/Income | Subabul+Soybean | | | | Subabul+Groundnut | | | | Subabul+Pigeonpea | | | | +Wheat | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I Year | II Year | III Year | IV Year | I Year | II Year | III Year | IV Year | I Year | II Year | III Year | IV Year | I Year | II Year | III Year | IV Year |
| **Cost component** | | | | | | | | | | | | | | | | |
| Cost of cultivation of crops | 2280 | 2430 | 2603 | – | 3276 | 3300 | 3062 | – | 1139 | 2020 | 1426 | – | – | 1911 | 1591 | – |
| Cost of growing agroforestry | 1702 | – | – | – | 1702 | – | – | – | 1702 | – | – | – | – | – | – | – |
| Cost of prunning and tree felling | – | – | 106 | 701 | – | – | 106 | 701 | – | – | 106 | 701 | – | – | – | – |
| Total Rs/ha | 3982 | 2430 | 2709 | 701 | 4978 | 3300 | 3168 | 701 | 2841 | 2020 | 1532 | 701 | – | 1911 | 1591 | – |
| **Income component** | | | | | | | | | | | | | | | | |
| Income from crop | 3110 | 4310 | 2611 | – | 6860 | 6579 | 1290 | – | – | 2806 | – | – | – | 4640 | – | – |
| Income form biomass | – | – | 50 | 15339 | – | – | 50 | 15339 | – | – | 50 | 15339 | – | – | – | – |
| Total | 3110 | 4310 | 2661 | 15339 | 6860 | 6579 | 1340 | 15339 | – | 2806 | 50 | 15339 | – | 4640 | – | – |
| Net Profit | (–)872 | 1880 | (–)48 | 14638 | 1882 | 3279 | (–)1828 | 14638 | (–)2841 | 786 | (–)1482 | 14638 | – | 2729 | (–)1591 | – |

(–) Sign indicates loss.

returns from groundnut crop. High returns were obtained both from crops and forest biomass in the Kharif and rabi seasons during the second year of study. Maximum profit of Rs 6008 per hectare was obtained from subabul plus groundnut-wheat combination as compared to Rs 4609 per hectare from subabul plus soybean-wheat combination. The combination of subabul plus pigeonpea gave minimum profit of Rs 786 per hectare due to low yield of pigeonpea crop. The low yield of pigeonpea was attributed mainly due to ponding of water in the undulated field during rainy season.

**High returns were obtained both from crops and forest biomass in the Kharif and rabi seasons during the second year of study.**

During the third year of study, wheat and pigeonpea could not be taken due to unfavourable weather conditions. The combinations of subabul plus soybean-wheat, subabul plus groundnut-wheat and subabul plus pigeonpea gave losses to the tune of Rs 1639 Rs 3419 and Rs 1482 per hectare mainly because of poor yield of crops and cost involved in pruning of trees.

During the fourth year of study, very high returns were obtained from the biomass. Crops were not taken considering the intensity of shades of forest plants. The net profit from the biomass during the fourth year was Rs 14638 per hectare. Overall economics of agroforestry showed maximum profit of Rs 19109 per hectare from subabul plus groundnut-wheat combination followed by Rs 16736 per hectare and Rs 11101 per hectare from subabul plus soybean-wheat and subabul plus pigeonpea combinations.

Since soybean-wheat is the most common crop rotation of Bhopal region under the conventional system, the overall cost economics of growing soybean and wheat crops was worked out to compare with subabul plus groundnut-wheat. It was found that the total net profit of Rs 19109 per hectare was obtained under subabul plus groundnut-wheat compared to Rs 18345 per hectare under the conventional system. All other systems of agroforestry gave less profit than the conventional system. The study recommends that growing food crops is not economical during the third year of plantation. If the loss during the third year is not considered, farmers can earn about Rs 4127 more per hectare after four years by growing subabul and groundnut and wheat crops during the first two years as compared to conventional system of farming. The risk factor is also reduced

**Table 6**: Net profit (Rs/ha) of growing agroforestry under different combinations

| Consitutions | First Year | | | Second Year | | | Third Year | | | Fourth Year | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Crop | Bio-mass | Total | Crop | Bio-mass | Total | Crop | Bio-mass | Total | Crop | Bio-mass | Total | |
| Subabul+ Soyabean wheat | 830 | (–)1702 | (–)872 | 4609 | – | 4609 | (–)1583 | (–)56 | (–)1639 | – | 14638 | 14638 | 16736 |
| Subabul+ groundnut wheat | 3584 | (–)1702 | 1882 | 6008 | – | 6008 | (–)3363 | (–)56 | (–)3419 | – | 14638 | 14638 | 19109 |
| Subabul+ pigeonpea | (–)1139 | (–)1702 | (–)2841 | 786 | – | 786 | (–)1426 | (–)56 | (–)1482 | – | 14638 | 14638 | 11101 |
| Conventional system (soybean wheat crop) | 1328 | – | 1328 | 7322 | – | 7322 | 3380 | – | 3380 | 6315 | – | 6315 | 18345 |

(–) SIgn indicates loss

since the farmer has to grow food crops during the first two years only.

**Farmers can earn more by growing subabul and groundnut and wheat crops during the first two years compared to conventional system of farming.**

## Conclusion

The following conclusion can be drawn from the study:

Food crops may be grown economically as intercrop during the first two years of agroforestry. Subabul plus groundnut-wheat was found to be most economical and profitable agroforestry combination followed by subabul plus soybean-wheat and subabul plus pigeonpea combination during the four years of study. Subabul plus groundnut-wheat combination gave 4.12 per cent more profit as compared traditional method of cultivation of soybean-wheat. The study suggests that subabul plus groundnut-wheat combination can give 22.50 per cent more profit over the traditional crop rotation of soybean-wheat if intercrops are grown only during the first two years of agroforestry.


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# Energy Productivity in Indian Manufacturing Industries (1973-92)

**NPC Research Division**

In our earlier studies (Productivity 32,1 & 34,3) we arrived at energy productivity ratios for Indian manufacturing industries during the period 1973-88. In the present study the information has been updated upto 1992-93. As in the case of the previous study, energy productivity here is defined as output per unit of energy consumed, both the output and energy input being measured at constant (1981-82) prices. While in the previous study (Productivity 32,1) the variables were measured at 1970-71 constant base year prices, in the present study these are expressed at 1981-82 constant base year prices. The output is measured in terms of products as given in the Annual Survey of Industries (ASI). Energy input has been measured in terms of cost of power and fuel deflated to 1981-82 base prices. For deflation purposes, the energy price index for each industrial category has been computed by a weighted combination of the index numbers of wholesale prices of electricity, motorspirit, diesel oil, furnace oil and others; the weights being their shares in total cost of fuel at current prices in the case of various industry groups. These shares are arrived at based on the energy composition of each industry group during the year 1978-79, the latest year for which the detailed information is available from the ASI (Table 1). Table 2 provides seperately for each industry group:

(i) Share of energy inputs at current prices in the total value of inputs at current prices(%).

(ii) Output at 1981-82 prices per unit of energy input at 1981-82 prices.

(iii) Number of factories covered.

V. Anil Kumar &
K. Suryanarayanan

**Table 1:** Fuel cost weightages (%) (1978-79)

| Industry code no. | Coal | Motor Spirit | Diesel Oil | Furnace Oil | Electri-city | Others |
|---|---|---|---|---|---|---|
| 20-21 | 13.42 | 3.53 | 8.06 | 13.29 | 36.98 | 24.72 |
| 206 | 9.05 | 3.97 | 4.23 | 11.93 | 22.35 | 48.47 |
| 210 | 29.13 | 1.55 | 1.25 | 10.88 | 48.05 | 9.14 |
| 22 | 27.16 | 9.07 | 7.81 | 16.96 | 23.09 | 15.91 |
| 23 | 17.07 | 1.22 | 1.54 | 10.01 | 56.63 | 13.53 |
| 24 | 14.79 | 2.79 | 3.65 | 14.23 | 42.32 | 22.22 |
| 25 | 14.80 | 2.42 | 4.77 | 0.80 | 66.07 | 11.13 |
| 26 | 6.13 | 16.20 | 4.97 | 14.08 | 43.66 | 14.96 |
| 27 | 6.80 | 11.11 | 18.47 | 4.62 | 40.85 | 18.15 |
| 28 | 27.85 | 2.72 | 1.66 | 15.83 | 42.55 | 9.39 |
| 280 | 31.08 | 1.18 | 1.42 | 17.79 | 40.34 | 8.19 |
| 29 | 5.53 | 11.21 | 8.36 | 9.77 | 52.95 | 12.18 |
| 30 | 5.45 | 2.89 | 2.66 | 13.65 | 44.52 | 30.83 |
| 31 | 9.32 | 1.56 | 2.47 | 23.12 | 45.88 | 17.65 |
| 310 | 12.97 | 1.11 | 4.05 | 19.14 | 49.57 | 13.16 |
| 311 | 1.86 | 1.44 | 1.10 | 12.21 | 58.74 | 24.65 |
| 312 | 9.37 | 0.29 | 0.19 | 28.67 | 41.41 | 20.07 |
| 313 | 0.00 | 4.62 | 2.54 | 41.98 | 43.65 | 7.20 |
| 32 | 8.53 | 2.00 | 2.97 | 20.15 | 47.66 | 18.69 |
| 320 | 7.62 | 1.89 | 2.02 | 19.18 | 44.89 | 24.40 |
| 321 | 5.00 | 1.01 | 1.97 | 18.10 | 45.00 | 28.92 |
| 324 | 1.96 | 1.22 | 1.40 | 10.20 | 55.56 | 29.66 |
| 33 | 23.26 | 0.72 | 2.07 | 11.37 | 33.08 | 29.51 |
| 330 | 1.97 | 9.41 | 3.90 | 10.07 | 64.29 | 10.36 |
| 331 | 12.88 | 2.06 | 5.89 | 16.23 | 33.25 | 29.69 |
| 332 | 0.69 | 0.32 | 0.56 | 3.04 | 83.33 | 12.06 |
| 333 | 5.43 | 1.21 | 11.54 | 33.97 | 45.35 | 2.50 |
| 335 | 3.94 | 0.46 | 0.78 | 16.38 | 67.78 | 10.66 |
| 336 | 0.10 | 0.56 | 1.73 | 3.54 | 87.42 | 6.65 |
| 34 | 4.41 | 7.51 | 6.01 | 14.37 | 44.52 | 23.18 |
| 35 | 9.27 | 6.75 | 8.71 | 5.80 | 42.52 | 26.95 |
| 350 | 3.25 | 4.96 | 6.91 | 4.01 | 38.10 | 42.77 |
| 352 | 0.00 | 23.00 | 7.78 | 0.00 | 59.45 | 9.77 |
| 353 | 7.43 | 11.52 | 3.94 | 15.35 | 57.66 | 4.10 |
| 354 | 9.77 | 42.74 | 0.49 | 2.32 | 30.89 | 13.80 |
| 355 | 0.16 | 7.81 | 7.24 | 1.36 | 43.99 | 39.44 |
| 357 | 0.48 | 5.53 | 4.22 | 12.40 | 48.17 | 29.20 |
| 36 | 6.24 | 9.56 | 7.30 | 19.00 | 50.05 | 7.84 |
| 360 | 4.95 | 5.58 | 7.79 | 4.92 | 56.72 | 20.24 |
| 37 | 14.50 | 3.62 | 4.98 | 14.25 | 42.35 | 20.30 |
| 374 | 1.26 | 4.50 | 9.58 | 11.80 | 44.66 | 28.19 |
| 375 | 0.31 | 5.95 | 7.28 | 10.79 | 44.85 | 30.81 |
| 376 | 2.28 | 4.97 | 8.82 | 22.53 | 39.24 | 22.16 |
| 38 | 2.22 | 13.63 | 4.78 | 8.95 | 58.88 | 11.54 |

**Table 2:** Energy productivity in Indian manufacturing industries (1973-92)

| Year | Food Product (20-21) | | | Refining of Sugar (206) | | | Hydrogenated Oils, Vanaspati (210) | | | Beverages, Tobacco & Tobacco Products (22) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) |
| 1973 | 1.96 | 33.2 | 13509 | 2.03 | 44.6 | 261 | 1.72 | 35.7 | 65 | 1.52 | 43.1 | 2357 |
| 1974 | 2.23 | 33.7 | 13454 | 2.39 | 45.2 | 251 | 1.88 | 35.1 | 71 | 2.12 | 37.3 | 2080 |
| 1975 | 2.52 | 34.3 | 14126 | 2.45 | 47.5 | 243 | 2.27 | 43.3 | 75 | 2.22 | 32.3 | 2880 |
| 1976 | 2.76 | 32.5 | 15306 | 3.01 | 41.6 | 261 | 2.58 | 39.1 | 79 | 2.16 | 36.3 | 6398 |
| 1977 | 2.60 | 36.2 | 15783 | 2.90 | 46.7 | 288 | 2.01 | 39.9 | 69 | 2.04 | 34.3 | 7307 |
| 1978 | 2.66 | 43.6 | 16310 | 2.86 | 53.1 | 286 | 2.60 | 37.7 | 69 | 2.35 | 33.2 | 8240 |
| 1979 | 2.90 | 34.5 | 16840 | 3.24 | 47.0 | 293 | 3.02 | 33.0 | 83 | 2.86 | 30.5 | 9629 |
| 1980 | 3.25 | 25.3 | 17067 | 3.88 | 33.4 | 304 | 3.31 | 29.8 | 82 | 3.23 | 29.3 | 8901 |
| 1981 | 3.24 | 38.9 | 18351 | 2.77 | 52.3 | 296 | 3.44 | 30.0 | 76 | 3.43 | 31.3 | 9568 |
| 1982 | 3.17 | 36.7 | 17111 | 2.44 | 66.5 | 308 | 3.32 | 32.9 | 90 | 3.33 | 34.4 | 8486 |
| 1983 | 3.42 | 36.1 | 17523 | 2.73 | 69.8 | 318 | 3.82 | 29.0 | 109 | 3.79 | 37.0 | 8188 |
| 1984 | 3.54 | 35.3 | 17459 | 3.56 | 56.6 | 318 | 4.27 | 26.8 | 102 | 3.84 | 36.2 | 7093 |
| 1985 | 3.68 | 37.7 | 17725 | 3.07 | 63.4 | 323 | 4.26 | 34.3 | 88 | 3.99 | 35.1 | 8457 |
| 1986 | 3.60 | 39.0 | 17299 | 2.92 | 54.3 | 328 | 4.38 | 29.9 | 97 | 4.37 | 33.8 | 7163 |
| 1987 | 3.40 | 39.6 | 18333 | 2.20 | 57.4 | 349 | 3.60 | 31.3 | 99 | 2.80 | 32.7 | 7951 |
| 1988 | 3.30 | 43.4 | 18581 | 2.40 | 69.8 | 336 | 3.90 | 31.2 | 104 | 4.30 | 29.8 | 7723 |
| 1989 | 3.38 | 42.0 | 19342 | 2.38 | 65.2 | 361 | 3.86 | 36.6 | 123 | 3.55 | 36.6 | 9088 |
| 1990 | 3.25 | 42.5 | 19760 | 2.38 | 65.9 | 356 | 3.58 | 33.6 | 103 | 3.75 | 31.8 | 8448 |
| 1991 | 3.29 | 41.6 | 19721 | 2.40 | 70.1 | 352 | 3.51 | 31.8 | 119 | 4.03 | 31.4 | 8831 |
| 1992 | 3.52 | 40.8 | 21397 | 2.69 | 64.9 | 395 | 4.54 | 28.3 | 203 | 3.99 | 32.8 | 9350 |

*Table 2 Contd..*

| Year | Cotton Textiles(23) | | | Wool, Silk, Synthetic Fiber Textiles (24) | | | Jute, Hemp & Mesta Textiles (25) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) |
| 1973 | 5.96 | 14.2 | 5719 | 4.58 | 12.3 | 2413 | 4.56 | 17.2 | 429 |
| 1974 | 6.32 | 12.8 | 5560 | 5.54 | 11.4 | 2368 | 5.82 | 14.2 | 322 |
| 1975 | 7.74 | 12.5 | 5968 | 5.43 | 12.1 | 2743 | 6.57 | 16.0 | 184 |
| 1976 | 7.78 | 12.3 | 6213 | 6.14 | 10.4 | 3090 | 6.59 | 16.5 | 201 |
| 1977 | 6.99 | 12.7 | 6508 | 5.80 | 11.1 | 3112 | 6.39 | 15.3 | 223 |
| 1978 | 7.59 | 13.3 | 6701 | 5.56 | 12.0 | 3216 | 6.16 | 14.9 | 247 |
| 1979 | 8.88 | 12.4 | 7207 | 5.72 | 13.2 | 3455 | 7.06 | 12.1 | 257 |
| 1980 | 9.79 | 11.6 | 7189 | 6.71 | 12.7 | 3743 | 7.89 | 13.8 | 265 |
| 1981 | 9.59 | 12.4 | 7141 | 6.95 | 13.9 | 4100 | 9.33 | 14.4 | 297 |
| 1982 | 10.33 | 12.3 | 6569 | 7.83 | 12.9 | 3267 | 10.55 | 15.0 | 219 |
| 1983 | 12.34 | 11.7 | 6731 | 9.27 | 13.6 | 3532 | 9.66 | 12.7 | 236 |
| 1984 | 11.34 | 12.3 | 6760 | 9.31 | 14.9 | 2955 | 7.31 | 10.9 | 215 |
| 1985 | 13.39 | 11.9 | 7073 | 7.97 | 19.1 | 3236 | 6.98 | 15.7 | 204 |
| 1986 | 14.20 | 13.4 | 6981 | 8.84 | 19.9 | 2986 | 12.23 | 15.7 | 184 |
| 1987 | 12.90 | 14.1 | 6844 | 9.00 | 19.4 | 3142 | 11.20 | 15.5 | 236 |
| 1988 | 11.10 | 16.7 | 6801 | 9.30 | 19.6 | 3250 | 11.60 | 14.3 | 187 |
| 1989 | 10.90 | 17.6 | 7021 | 8.42 | 21.8 | 3325 | 10.02 | 14.1 | 327 |
| 1990 | 11.33 | 17.1 | 7218 | 8.62 | 22.0 | 3368 | 9.50 | 13.9 | 326 |
| 1991 | 10.25 | 17.6 | 7252 | 8.54 | 22.6 | 3236 | 11.02 | 14.2 | 352 |
| 1992 | 11.02 | 16.9 | 8896 | 9.19 | 21.7 | 3400 | 12.04 | 15.1 | 420 |

*Table 2 Contd..*

| Year | Textiles Products (26) | | | Wood & Wood Products Furniture & Fixture (27) | | | Paper, Paper Product, Printing (28) | | | Pulp, Paper & Bord (280) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) |
| 1973 | 1.19 | 82.9 | 1642 | 3.07 | 36.8 | 2932 | 9.10 | 10.7 | 3779 | 15.75 | 7.7 | 560 |
| 1974 | 1.53 | 59.3 | 1652 | 3.52 | 29.7 | 3158 | 9.56 | 9.6 | 3820 | 15.96 | 7.5 | 490 |
| 1975 | 1.52 | 57.3 | 1979 | 3.85 | 28.6 | 3431 | 11.63 | 8.9 | 3936 | 20.06 | 6.8 | 424 |
| 1976 | 1.49 | 58.1 | 2192 | 4.21 | 28.1 | 3573 | 11.40 | 9.1 | 4506 | 21.55 | 6.3 | 449 |
| 1977 | 1.45 | 58.4 | 2347 | 4.01 | 28.0 | 3676 | 12.55 | 8.3 | 4439 | 23.58 | 5.8 | 538 |
| 1978 | 1.49 | 53.9 | 2577 | 3.73 | 28.6 | 3788 | 11.76 | 9.1 | 4901 | 21.31 | 6.4 | 500 |
| 1979 | 1.44 | 51.5 | 2907 | 3.96 | 28.0 | 3978 | 12.15 | 8.9 | 4743 | 21.42 | 6.3 | 587 |
| 1980 | 1.52 | 54.7 | 2889 | 3.62 | 25.7 | 4033 | 12.89 | 8.7 | 4798 | 22.91 | 6.1 | 585 |
| 1981 | 1.58 | 60.2 | 2943 | 4.34 | 25.9 | 4094 | 13.75 | 9.0 | 4890 | 24.13 | 6.1 | 672 |
| 1982 | 1.69 | 63.6 | 2491 | 4.95 | 22.0 | 3618 | 14.20 | 8.8 | 4571 | 25.13 | 5.6 | 637 |
| 1983 | 2.14 | 59.9 | 2621 | 4.99 | 25.3 | 3591 | 15.05 | 8.7 | 4710 | 25.75 | 5.4 | 734 |
| 1984 | 2.00 | 62.5 | 3063 | 4.68 | 27.2 | 3847 | 15.25 | 8.7 | 4808 | 25.06 | 5.8 | 696 |
| 1985 | 1.99 | 63.5 | 2835 | 5.20 | 23.3 | 3580 | 14.89 | 8.8 | 4870 | 24.68 | 5.6 | 802 |
| 1986 | 1.93 | 74.0 | 2821 | 4.57 | 28.5 | 3873 | 15.46 | 8.7 | 4921 | 26.15 | 6.0 | 779 |
| 1987 | 2.40 | 58.3 | 3141 | 4.30 | 31.1 | 3407 | 15.20 | 8.6 | 5096 | 26.10 | 5.8 | 899 |
| 1988 | 1.90 | 70.1 | 3159 | 3.80 | 36.1 | 3355 | 15.10 | 8.6 | 4960 | 25.30 | 6.4 | 808 |
| 1989 | 1.79 | 84.5 | 3186 | 4.39 | 35.8 | 3521 | 14.50 | 10.2 | 5098 | 24.19 | 8.3 | 842 |
| 1990 | 2.04 | 75.0 | 3537 | 4.49 | 41.0 | 3419 | 14.06 | 10.7 | 5299 | 22.62 | 8.9 | 895 |
| 1991 | 2.03 | 83.7 | 3772 | 4.54 | 45.8 | 3421 | 14.89 | 9.5 | 5222 | 24.27 | 8.5 | 839 |
| 1992 | 2.15 | 86.7 | 4104 | 4.82 | 24.4 | 3608 | 15.01 | 9.1 | 5565 | 25.41 | 9.1 | 927 |

*Table 2 Contd..*

| Year | Leather and Fur Products (29) | | | Chemicals & Products (30) | | | Rubber & Plastics (31) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) |
| 1973 | 0.92 | 91.5 | 594 | 7.70 | 13.1 | 3043 | 3.67 | 31.1 | 1794 |
| 1974 | 1.26 | 78.2 | 667 | 8.07 | 10.8 | 3221 | 2.47 | 42.8 | 1952 |
| 1975 | 1.23 | 71.0 | 670 | 9.12 | 10.1 | 3732 | 2.05 | 50.0 | 2496 |
| 1976 | 1.21 | 75.3 | 727 | 10.17 | 10.0 | 4152 | 2.24 | 51.0 | 2831 |
| 1977 | 1.35 | 68.7 | 762 | 9.70 | 10.6 | 4674 | 2.25 | 52.5 | 2881 |
| 1978 | 1.13 | 76.7 | 797 | 10.26 | 10.9 | 4881 | 2.67 | 40.0 | 2350 |
| 1979 | 1.17 | 65.1 | 862 | 10.03 | 11.0 | 5328 | 2.68 | 38.4 | 3302 |
| 1980 | 1.58 | 52.6 | 886 | 10.66 | 10.0 | 5479 | 1.61 | 62.4 | 3498 |
| 1981 | 1.69 | 58.0 | 899 | 11.99 | 9.7 | 6834 | 1.75 | 57.3 | 3864 |
| 1982 | 2.08 | 54.2 | 880 | 12.08 | 10.3 | 5350 | 2.05 | 51.6 | 3514 |
| 1983 | 2.46 | 49.8 | 942 | 13.84 | 10.4 | 5824 | 3.07 | 36.8 | 3778 |
| 1984 | 2.26 | 55.0 | 929 | 13.59 | 10.5 | 6032 | 2.24 | 52.8 | 3900 |
| 1985 | 2.42 | 53.1 | 999 | 12.81 | 12.1 | 6402 | 2.22 | 59.3 | 3958 |
| 1986 | 2.19 | 61.7 | 976 | 14.38 | 11.2 | 6335 | 2.68 | 52.3 | 4097 |
| 1987 | 1.90 | 71.9 | 1074 | 14.50 | 11.4 | 6518 | 3.90 | 35.9 | 4412 |
| 1988 | 1.90 | 65.9 | 1195 | 12.50 | 13.9 | 6946 | 3.30 | 42.2 | 4660 |
| 1989 | 1.71 | 79.7 | 1238 | 12.83 | 13.0 | 6631 | 3.12 | 56.1 | 5047 |
| 1990 | 1.84 | 69.6 | 1398 | 12.80 | 13.9 | 6914 | 3.35 | 53.6 | 5289 |
| 1991 | 1.87 | 76.3 | 1545 | 12.44 | 15.6 | 7251 | 3.51 | 51.9 | 5627 |
| 1992 | 2.02 | 83.2 | 1581 | 13.40 | 15.8 | 7886 | 3.76 | 50.0 | 5971 |

*Table 2 Contd..*

| Year | Basic & Industrial Gases (309) | | | Fertilizer & Pesticides (301) | | | Paints & Varnish (303) | | | Drug & Medicines (304) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) |
| 1973 | 18.18 | 8.2 | 389 | 13.75 | 9.2 | 335 | 3.89 | 24.6 | 338 | 4.01 | 16.0 | 674 |
| 1974 | 16.89 | 6.8 | 543 | 11.65 | 7.3 | 344 | 4.84 | 17.2 | 372 | 4.49 | 17.0 | 682 |
| 1975 | 19.70 | 6.1 | 639 | 13.43 | 6.4 | 378 | 4.18 | 21.3 | 368 | 4.30 | 19.1 | 800 |
| 1976 | 21.39 | 6.2 | 701 | 16.02 | 6.6 | 440 | 4.87 | 19.2 | 403 | 5.33 | 15.3 | 865 |
| 1977 | 20.63 | 6.9 | 764 | 17.05 | 6.6 | 469 | 4.83 | 19.6 | 496 | 4.96 | 16.1 | 918 |
| 1978 | 20.58 | 6.8 | 874 | 17.54 | 7.5 | 493 | 5.18 | 19.5 | 498 | 5.11 | 16.7 | 958 |
| 1979 | 19.95 | 6.1 | 883 | 16.09 | 8.9 | 503 | 5.16 | 18.8 | 551 | 5.04 | 19.1 | 1070 |
| 1980 | 22.53 | 5.1 | 917 | 14.69 | 7.5 | 447 | 6.11 | 17.1 | 568 | 5.39 | 21.8 | 1121 |
| 1981 | 20.94 | 5.7 | 1223 | 16.95 | 6.6 | 618 | 6.51 | 17.0 | 773 | 6.10 | 20.6 | 1434 |
| 1982 | 24.61 | 5.7 | 934 | 16.88 | 7.3 | 442 | 7.44 | 15.0 | 476 | 5.96 | 22.3 | 1131 |
| 1983 | 27.98 | 5.3 | 978 | 20.83 | 7.4 | 495 | 7.79 | 17.2 | 547 | 5.85 | 26.4 | 1187 |
| 1984 | 26.29 | 5.8 | 1320 | 20.05 | 8.4 | 469 | 8.61 | 15.9 | 515 | 5.86 | 24.8 | 1265 |
| 1985 | 26.88 | 6.1 | 1040 | 18.93 | 10.0 | 546 | 7.16 | 18.4 | 555 | 5.00 | 32.5 | 1358 |
| 1986 | 27.84 | 6.4 | 1017 | 21.59 | 8.5 | 474 | 7.47 | 19.0 | 592 | 5.75 | 33.9 | 1374 |
| 1987 | 28.60 | 6.6 | 1049 | 24.40 | 8.2 | 515 | 6.70 | 20.1 | 739 | 6.10 | 28.2 | 1497 |
| 1988 | 26.50 | 7.8 | 1119 | 19.80 | 11.9 | 594 | 7.40 | 17.0 | 722 | 5.20 | 32.7 | 1554 |
| 1989 | @ | @ | @ | 20.28 | 12.7 | 556 | 5.02 | 26.6 | 853 | 4.91 | 36.7 | 1794 |
| 1990 | @ | @ | @ | 18.18 | 12.8 | 569 | 6.38 | 21.9 | 820 | 4.72 | 39.5 | 1699 |
| 1991 | @ | @ | @ | 16.55 | 15.4 | 509 | 6.02 | 25.1 | 939 | 4.47 | 46.0 | 1886 |
| 1992 | @ | @ | @ | 17.92 | 13.8 | 633 | 6.56 | 20.5 | 1021 | 5.19 | 41.9 | 2112 |

*Table 2 Contd..*

| Year | Non-Metallic Mineral Products (32) | | | Structural Clay Products (320) | | | Glass & Glass Products (321) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) |
| 1973 | 22.83 | 5.2 | 3757 | 27.69 | 5.8 | 1182 | 24.98 | 5.4 | 391 |
| 1974 | 24.44 | 4.7 | 3890 | 29.81 | 5.1 | 1223 | 29.13 | 3.7 | 932 |
| 1975 | 26.53 | 4.2 | 4820 | 31.45 | 4.8 | 1533 | 31.44 | 3.3 | 414 |
| 1976 | 26.69 | 4.4 | 5309 | 30.74 | 4.9 | 1641 | 31.89 | 3.8 | 448 |
| 1977 | 25.18 | 4.9 | 5558 | 30.35 | 5.2 | 1666 | 30.33 | 4.1 | 483 |
| 1978 | 26.03 | 4.6 | 5639 | 31.49 | 5.3 | 1727 | 29.90 | 3.7 | 560 |
| 1979 | 25.82 | 4.5 | 6083 | 28.59 | 5.3 | 1899 | 31.05 | 3.6 | 573 |
| 1980 | 25.99 | 4.7 | 6440 | 31.91 | 4.3 | 2159 | 30.02 | 3.8 | 590 |
| 1981 | 27.88 | 4.6 | 7694 | 33.41 | 4.4 | 3048 | 33.50 | 3.7 | 674 |
| 1982 | 28.54 | 4.6 | 6667 | 34.83 | 4.1 | 2495 | 34.27 | 3.9 | 607 |
| 1983 | 30.39 | 4.4 | 7618 | 34.87 | 3.8 | 3117 | 35.62 | 4.1 | 601 |
| 1984 | 30.78 | 4.3 | 7841 | 37.43 | 3.7 | 3146 | 34.67 | 4.3 | 567 |
| 1985 | 31.54 | 4.7 | 8515 | 35.88 | 4.2 | 3421 | 34.26 | 5.0 | 571 |
| 1986 | 33.94 | 4.6 | 8267 | 35.23 | 4.2 | 3247 | 33.50 | 4.6 | 556 |
| 1987 | 34.50 | 4.7 | 8706 | 32.60 | 4.9 | 3445 | 33.10 | 4.8 | 570 |
| 1988 | 34.60 | 4.9 | 9025 | 29.20 | 5.1 | 3486 | 33.60 | 5.0 | 596 |
| 1989 | 33.78 | 5.2 | 9038 | 30.39 | 4.9 | 3515 | 30.89 | 6.1 | 626 |
| 1990 | 34.46 | 5.2 | 9441 | 27.96 | 5.5 | 3674 | 29.79 | 6.6 | 598 |
| 1991 | 34.15 | 5.3 | 9919 | 27.14 | 5.1 | 3976 | 30.63 | 6.9 | 628 |
| 1992 | 34.49 | 5.1 | 10365 | 24.32 | 5.5 | 4072 | 30.35 | 7.3 | 590 |

*Table 2 Contd..*

| Year | Cement, Lime & Plaster Industry (324) | | | Basic Metal & Alloy Industry (33) | | | Iron & Steel Industry (330) | | | Foundry for Casting & Forging (331) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) |
| 1973 | 32.14 | 3.1 | 126 | 12.04 | 8.7 | 4132 | 15.14 | 8.5 | 942 | 6.81 | 14.5 | 2440 |
| 1974 | 33.72 | 2.4 | 126 | 13.74 | 8.1 | 4215 | 17.41 | 8.0 | 1114 | 8.16 | 13.1 | 2519 |
| 1975 | 35.87 | 2.6 | 205 | 15.85 | 6.9 | 4562 | 18.69 | 7.3 | 1150 | 9.47 | 11.7 | 2737 |
| 1976 | 36.60 | 2.7 | 226 | 16.19 | 7.0 | 4988 | 18.96 | 7.5 | 1143 | 9.45 | 11.7 | 3094 |
| 1977 | 35.47 | 2.7 | 247 | 13.57 | 8.2 | 5054 | 14.11 | 10.1 | 1299 | 9.12 | 12.2 | 2973 |
| 1978 | 37.04 | 2.4 | 232 | 17.06 | 6.4 | 5259 | 19.94 | 7.0 | 1332 | 8.68 | 12.3 | 3121 |
| 1979 | 37.67 | 2.2 | 271 | 16.03 | 6.5 | 5538 | 17.67 | 7.0 | 1471 | 8.83 | 11.7 | 3173 |
| 1980 | 37.25 | 2.4 | 261 | 15.91 | 7.1 | 5779 | 17.10 | 7.8 | 1546 | 9.18 | 12.6 | 3293 |
| 1981 | 40.31 | 2.8 | 276 | 14.66 | 8.8 | 1714 | 14.66 | 8.8 | 1714 | 9.63 | 11.5 | 3307 |
| 1982 | 37.61 | 3.1 | 276 | 14.41 | 7.9 | 5509 | 13.96 | 9.8 | 1474 | 9.66 | 11.3 | 3126 |
| 1983 | 39.18 | 3.2 | 328 | 18.19 | 7.1 | 5888 | 18.90 | 8.7 | 1686 | 40.99 | 10.5 | 3208 |
| 1984 | 38.16 | 3.7 | 366 | 17.16 | 7.3 | 5901 | 16.85 | 9.4 | 1657 | 10.96 | 9.9 | 3313 |
| 1985 | 38.89 | 4.8 | 468 | 17.00 | 7.1 | 6077 | 16.87 | 9.0 | 1764 | 10.46 | 10.7 | 3337 |
| 1986 | 43.37 | 3.8 | 448 | 16.03 | 8.1 | 6191 | 15.82 | 9.5 | 1822 | 9.84 | 12.0 | 3365 |
| 1987 | 46.00 | 3.9 | 517 | 16.30 | 8.3 | 6184 | 16.00 | 9.9 | 1754 | 9.90 | 12.2 | 3313 |
| 1988 | 45.50 | 4.2 | 558 | 14.90 | 9.0 | 6203 | 14.70 | 10.9 | 1829 | 8.50 | 13.2 | 3236 |
| 1989 | 46.54 | 4.2 | 551 | 14.27 | 9.2 | 5853 | 13.94 | 10.6 | 1597 | 5.76 | 18.6 | 1442 |
| 1990 | 46.69 | 4.2 | 612 | 14.15 | 9.7 | 6014 | 13.25 | 12.2 | 1674 | 6.19 | 18.4 | 1543 |
| 1991 | 47.50 | 4.4 | 616 | 14.60 | 9.4 | 6097 | 14.05 | 11.6 | 1682 | 5.24 | 20.6 | 1326 |
| 1992 | 47.45 | 5.0 | 687 | 14.68 | 10.1 | 6247 | 14.07 | 12.4 | 1910 | 5.75 | 20.7 | 1382 |

*Table 2 Contd..*

| Year | Ferro Alloys (332) | | | Copper Manufacturing (333) | | | Aluminum Manufacturing (335) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) | Share of Energy in Total Input % | Energy Productivity Ratio | Factories (Nos.) |
| 1973 | 31.63 | 4.3 | 49 | 4.55 | 14.0 | 92 | 18.23 | 8.1 | 161 |
| 1974 | 28.86 | 4.7 | 21 | 7.18 | 8.6 | 74 | 19.29 | 8.2 | 141 |
| 1975 | 38.40 | 3.6 | 42 | 9.91 | 6.0 | 111 | 24.66 | 4.5 | 200 |
| 1976 | 31.72 | 4.5 | 70 | 13.05 | 8.1 | 116 | 26.80 | 4.5 | 183 |
| 1977 | 32.16 | 4.1 | 43 | 10.89 | 7.3 | 117 | 27.72 | 4.2 | 232 |
| 1978 | 34.44 | 4.2 | 49 | 11.26 | 7.6 | 96 | 29.22 | 4.2 | 253 |
| 1979 | 37.05 | 3.3 | 49 | 10.45 | 8.3 | 119 | 31.05 | 3.8 | 280 |
| 1980 | 40.37 | 3.5 | 53 | 12.65 | 6.9 | 141 | 30.03 | 3.4 | 308 |
| 1981 | 36.49 | 3.6 | 60 | 12.30 | 8.9 | 164 | 33.14 | 3.2 | 317 |
| 1982 | 40.59 | 3.1 | 35 | 17.24 | 6.9 | 149 | 33.78 | 3.7 | 318 |
| 1983 | 42.78 | 3.3 | 65 | 14.65 | 8.2 | 143 | 35.66 | 3.8 | 364 |
| 1984 | 39.13 | 3.3 | 53 | 16.44 | 6.9 | 129 | 35.85 | 3.7 | 335 |
| 1985 | 42.06 | 3.7 | 54 | 11.85 | 10.1 | 144 | 38.42 | 3.5 | 331 |
| 1986 | 41.45 | 4.3 | 64 | 15.99 | 6.8 | 167 | 36.59 | 4.2 | 328 |
| 1987 | 41.80 | 4.4 | 80 | 10.10 | 10.2 | 175 | 34.40 | 4.6 | 335 |
| 1988 | 42.90 | 3.9 | 76 | 8.30 | 10.0 | 193 | 31.00 | 5.4 | 395 |
| 1989 | 46.86 | 3.3 | 77 | 9.04 | 10.2 | 187 | 32.58 | 4.9 | 342 |
| 1990 | 49.03 | 3.1 | 87 | 8.93 | 11.4 | 163 | 31.18 | 4.8 | 288 |
| 1991 | 42.27 | 3.8 | 100 | 9.30 | 10.5 | 166 | 35.30 | 4.8 | 319 |
| 1992 | 43.23 | 4.1 | 96 | 9.27 | 9.3 | 144 | 31.41 | 5.7 | 368 |

The author asserts that the programmes for change in India's reforms are essentially conservative in the sense that these followed a path of least change from the course charted out before the eighties. The author considers this 'conservatism' inevitable for the reforms to be acceptable to the dominant economic and social groups. The reforms were essentially crisis driven, devoid of any debate on the need and the content, merely problem-solving in nature, not bound in any comprehensive package of actions, evolved mainly in the Finance Ministry and, introduced with heightened pace. The author argues that the reforms have hardly attempted to creating a smaller role for the state, but in reality have concentrated on redefining the role of the state and its institutions in a manner that would suit a rapidly changing world. The process of debureaucratisation which was intended to be the centrepiece of the reform, has in effect reduced the limits placed on the bureaucracy, thereby increasing the scope for bureaucratic intervention. Conservative preoccupation is evident in all spheres of reforms and, clearly enough, the consensus on change has been interpreted in its most conservative form.

The author then examines 'The Political Context of Conservatism'. Through a review of the political system that evolved in the post-Independence India, he argues that the conservative approach to reforms reflected the stability of the centrist political groups in power. Inspite of four Prime Ministers belonging to three different political parties governing during the mid-eighties till 1992, the approach to governance did not fundamentally change but remained, more or less, stable. This stability at the centre has been due to their ability to absorb new political groups that are thrown up by social change. A compulsion to maintain this stability, in turn, made it difficult for the centrist political mainstream to go for a fundamental break from the past and to pursue any radical approach to reforms.

The author ascribes the reason for conservative bias in the reforms also to the barriers of static ideas. The traditional approach to see policy packages as based on a central theme continued in the case of the latest reforms. This was a result of the limitations in the choice of knowledge about the trends in the economy, continued faith in the use of Western models for controlling the economy, an unwillingness to break away sufficiently from the past, the misplaced emphasis in the critiques of the reforms, etc. The author also analyses the mismatch between political extremism and the extremism in economic ideas to suggest that, perhaps, this played a major role in keeping any immediate resistance to the economic reforms in check.

In the concluding piece of the essay, the author argues that the economic reforms in India are merely a process of adapting the ongoing economic strategies to a changing world and that, the recognised pragmatism in the reforms is not very different from adopting a middle path. However, this middle path is not free from flaws as evidenced by the scam in the banking sector and the stock market, the trade and industrial policy given precedence over tackling the quiet crisis in the agriculture sector and the rural economy, the potential widening of regional disparities arising out of the industrial delicensing and related locational policy, etc. The author notes that there were alternatives to this flawed middle path that could have been adopted and cites as an example the merits of the Gandhian alternative of decentralisation instead of a state-dominated system, emphasis on living within one's means instead of unsustainable practices that were followed, and importance of understanding the situational aspects instead of mechanical implementation of bureaucratic rules. An emphasis on developing a more productive agriculture that makes efficient use of all resources without increasing inequity could have been the first initiative for the reforms. The author concludes by stating that economic reform must be seen as a continuous process of interaction between policy and the economy which can hardly afford to ignore the situational dimensions as well as the need to be more sensitive to local conditions.

The merit of Pani's work lies in its ability to present a comprehensive discourse on the several critical factors and forces influencing and conditioning the genesis and the character of India's economic reforms, maintaing a high level of logical consistency in the treatment of the theme. The holistic framework within which the reforms have been alaysed is indeed welcome. On the subject, perhaps this is the first effort to break away from the trend of writings on the factors and forces in isolation. However, since the work follows the style of an essay, reading long sections often becomes a little tiring. But then, given the journalistic-academic style used in the work perhaps long sections were unavoidable. It is hoped that the serious reader will not be daunted by this style-speciality of this otherwise very valuable work.

*Dr. Rabin Ganguly*
*Professor*
*Indian Institute of Management*
*Joka, Diamond Harbour Road,*
*Calcutta - 700 027*

**Limits to Kerala Model of Development:** *by K.K. George.* Centre for Development Studies, Ulloor, Prasanth Nagar, Thiruvananthapuram 1993, 197p Rs. 60.

The book under review is one among the monograph series of Centre for Development Studies prepared by K.K. George, Currently Professor at School of Management Studies, Cochin University of Science and Technology. The study is an attempt to examine the structural relationship between the Kerala Model of development and the state's fiscal crisis. The book also discusses the implication of the fiscal crisis on the state's development process.

The study covers the Fifth, Sixth and the Seventh Five Year Plan periods. In the introductory chapter, the author describes the special features of the Kerala model such as the high literacy rate, high life expectancy, low infant mortality, high unemployment, etc. It is pointed out that, in Kerala the budgetary deficit has its genesis largely in the revenue account and the recurrent revenue deficits have become increasingly a charge on the state's capital receipts, this kind of diversion reducing the ability of the state to incur capital expenditure.

The author, quoting examples, proves that the state's tax efforts till now have been much higher than that of most other states. This is evident from the high rates of sales tax existing in Kerala compared to the neighbouring states and Union Territories. It is also argued that, Kerala's non-tax revenue collection were lower than that of All States from the Sixth Plan onwards, though there is scope for raising more non-tax revenue from its public sector.

The tables provided along with Chapter IV show that the central transfer played a relatively smaller role in meeting the state's expenditure. Regarding the ratio of government expenditure to State Domestic Product (SDP), it is higher for Kerala than other states during the eleven year period under the study. The author sees a number of reasons for this phenomenon one of them being the higher share of revenue expenditure. At the end of the sixth chapter, the author reminds us that the state is caught in a vicious circle. Because of the small size of SDP despite large resource efforts, the state has not been able to generate adequate funds to finance higher levels of plan as well as non-plan expenditure.

The author discusses the developmental options available to the state in view of its inability to spend adequately on economic, social and community services. It is suggested that, the state may transform its expenditure on education and health from a mere social welfare expenditure to an investment in human capital. But the author has not put up any constructive proposal for such transformation.

In the concluding chapter, the author criticises the central funding agencies for their failure to appreciate the fiscal implications of the Kerala Model. He recommends a new strategy based on the development of the state's human resources which will be the logical extension of the Kerala Model of Development. But it is still doubtful whether this alone is a panacea for the states chronic unemployment problem existing among the young educated class.

The analysis provided by the author especially in the area of Centre-State Financial flows merits appreciation. The book is useful for planning authorities and researchers in the area.

*Sabu Thomas*
*Research Scholar in Economics*
*University of Kerala*
*Thiruvananthapuram 695 034.*

**Towards Industrial Dynamism and Harmony :** *by Sunil Guha* Oxford & IBH New Delhi, 1994, p165, Rs 250.

Industrial dynamism and harmony are the need of Indian enterprises, both in the public and the private sectors, for a total turnaround from the present situation. The crisis in the economy, and the inevitable liberalization, globalization and competitiveness forced upon, have put tremendous demands on the industrial sectors. Sunil Guha's book provides valuable insights to enable enterprises take appropriate solutions for strengthening their industrial relations systems and practices.

The first chapter brings out the salient aspects of labour policy, tripartism and the industrial relations. Guha is concerned about the non-unison shift in the working of the political business and trade union leadership and accords that to the losing representative character of the major actors. He also discusses the industrial relations scenario and the effects of the structural adjustment processes on employment and working conditions.

Next he deals with recent trends in the collective bargaining and feels that in future, trade unions and management may have to be guided more by pragmatism than ideological fixations; he states that the focus of collective bargaining will extend beyond the traditional employment relations aspects including quality of working life, quality and productivity improvement, and build

strong bridges of understanding, paving the way for lasting peace and prosperity.

Sunil Guha calls Participation Management a system based on the belief in the potential of the people and states that appropriate training and orientation of both workers and management representatives can alone ensure the success of participative management.

He emphasises the strong need for HRD for India's tripartite social partners, i.e., the Government, the Employees or Management and the Trade Union Organizations, and briefly deals with important aspects such as the restructuring in Indian Industry, employment effects, impact on labour market structure, skills composition of labour force, initiatives for training and redeployment etc. ILO's role and activities in India and the role of the tripartite partners are also discussed. According to Guha, the success of the structural adjustment reforms can herald a real industrial revolution in India.

To meet the productivity challenge, Guha has most concisely dealt with important productivity related aspects, such as the productivity lag, myths, some disquieting trends, the need for a new work and management culture, the role of tripartite partners, including ILO's crucial role.

Next he considers the recent trends in trade unionism in India.

Chapter 7 on worker's education, can be useful in developing a planned programme of worker's education.

ILO's contribution in refining the concept, the strengths and weakness of the Informal Sector is discussed along with the tripartite challenge, social protection, and ILO initiatives in India.

The author deals with the subject of environment pollution, stressing on the need for a preventive approach ("anticipate - and - present") rather than a curative approach ("Pollute - and - Cure"); New ILO initiatives and also the role of management and trade unions are presented.

The appendices contained in the book on code of Discipline in Industry, Indian and International Labour Standards, a chronological summary of liberalization under India's new Economic Policy and select indicators in respect of India, and a comparison between India and some other selected countries are informative.

Guha's book thus provides a comprehensive treatment of both the issues and the institutions concerned with structural adjustment. It will definitely contribute to a better understanding of what is at stake and how short and longer term solutions could be evolved with the active participation of the principal actors — the employees, workers and the Government. The book is not only timely, but highly informative and revealing, and provides directions for a better and improved industrial relations situation in organizations in India in an integrated way. The book is well structured and the holistic view for the entire concept of harmony in industrial sectors will provide a true direction for an improved organizational climate, work and management culture.

*V.N. Srivastava*
*Ex. Sr. Dy. Director (HRD)*
*National Productivity Council*
*New Delhi 110 019*

**Modern Economic Theory, Second Edition :** *by Sampat Mukherjee,* Wishwa Prakashan, New Delhi, 1994, 983p, Rs 175.

The book under review is the revised and second edition of the text-book of economic theory written for the students of undergraduate programmes in Indian universities, and for those appearing for the intermediate examinations conducted by various professional bodies and institutions. The objectives of the author in writing this book have been, " .... to teach enough theory to enable students to understand policy, and to present enough policy situations to give them an understanding of how to apply the theory ... To provide the analytical tools that economic theory offers the policy analyst or adviser to governments or business firms.... To present a clear, accurate, and interesting introduction to the principles of modern economics and to the institutions of India and World economy..... To make basic propositions of economics as easy as possible to grasp."

The book is divided in to five Parts: an overview, macroeconomics, microeconomics, international economics, and macrodynamics. There are 47 chapters and a number of appendices in it. The topics and issues in microeconomics and macroeconomics have been discussed well, at length, and in a balanced manner. The inclusion of both micro and macro economics in one volume, instead of presenting them in two separate volumes, is advantageous to students and teachers. The book in its present edition has included a number of new topics such as the control of prices, ad valorem taxes, international monetary system, economic growth and

development, exchange rates, fiscal policy, tariffs, quotas, etc., which were absent in its first edition. The discussion of the uses and abuses of graphs, the explanation of the fundamental terms and concepts, and the presentation of the economic formulae, and the glossary have enhanced the utility of the book. Although written primarily for the undergraduate students, the discussions in appendices, and the treatment of certain topics at advanced level would, to an extent, make it useful to the post-graduate students also.

The book, however, is weak at places in thematic organization. The author has followed Samuelson by presenting the bare elements of supply and demand in Chapter 8, and then discussing macroeconomics before returning to supply and demand and microeconomics again. The teachers and students of economics would find this arrangement or sequencing not only unnecessary but also confusing. A continuous discussion of topics in microeconomics/macroeconomics without interruption would certainly be better. Similarly, sub-sections on pages 29 to 34 appear to be a mere assemblage of the assorted topics. The Appendix on business or managerial economics between Chapter 2 and 3 is unnecessary, and it does not fit in there. Similarly, the discussion of both unemployment and business cycles is unnecessarily split. The treatment of economic growth and development, and of trade cycle theory has remained sketchy.

The book also has some major printing errors. For example, the word, "depression" under the Figure on page 866 is wrong. Certain titles, viz., "Advanced Treatout .... of model" (p.188), and "Future Analysis of Taxes" (p.668) do not make any sense. A selected reading list should have been provided to help students to go to the originals.

The author would hopefully be able to remove at least some of these lacunae in the next edition of the book. On the whole, it is a good text book and the students of B.A., B.Com., C.A., etc. would find it useful for enhancing their understanding and for doing well in their examinations. The author has largely succeeded in achieving the objectives he had set for himself.

*Prof. L.M. Bhole*
*Department of Humanities and Social Sciences*
*Indian Institute of Technology*
Powai, Bombay - 400 076

**Employment, Earnings and Poverty: A Study of Rural India and Indonesia** : *by G.K. Chadha*, Sage Publications, New Delhi, 1994, 294p, Rs 295.

The book is based on a study initiated under the auspices of the Indo-Dutch Research Programme. The study is aimed at analysing the impact of the development process on the structure of employment and earnings among the weaker sections in developing Asian countries. India and Indonesia have been selected to represent developing rural Asia. The weaker section includes landless labour, marginal and small farming households. The development process is considered under three alternative scenarios:

An extremely backward agricultural situation,

A situation where agriculture is fairly highly developed but non-agricultural activities are of low order,

A combination of highly developed agriculture and non- agricultural activities.

Indian situation is studied through a primary field survey. Three states in India viz, Bihar, Andhra Pradesh and Uttar Pradesh have been selected to represent the three development scenarios.

Discussion on employment and earnings in Indonesia is based on the published data.

The author first explains the nature of on-farm and off-farm employment activities of rural households. On-farm activities comprise work on one's own farm as cultivator including related activities like dairying, fishing, forestry, hunting and quarrying. Non-farm activities include those employed in industry, trade and other traditional services as well as those employed by others in similar occupations. Seasonal and contractual jobs not related to farming as such, available locally in the village or in the nearby urban industrial town are also a part of non-farm employment.

The book provides a detailed analysis of employment, earnings and poverty situation of rural India. Primary data is analysed to examine the changing employment structure in rural India. The data reveal that India is still predominantly rural (In 1991, 74.3 percent of the population lived in villages).

The data reveal noticeable changes in employment as well. In the rural areas, the incidence of self employment is found to have declined both for male and female workers, although in urban areas it has increased mar-

ginally for male workers. The incidence of casual employment has increased sharply in the case of rural male workers, somewhat less in the case of rural female workers and moderately in the case of urban male and female workers.

There is evidence of a gradual shift of rural workers from farm to non-farm employment during 1970s and 1980s. Employment data also demonstrate a qualitative improvement in the employment prospects for the rural work force during 1980s compared to 1970s. In comparative terms, rural areas seem to have fared better in recent years. In addition to reducing their excessive dependence on agricultural employment, they have steadily improved the absorptive capacity of non-agricultural sectors which have shown high expansion since the mid 1980s.

The employment pattern for various strata of rural households for 1987-88 show an inverse relationship between the size of the farm and non-farm employment.

An economic overview of rural Indonesia is next presented in great detail along with employment/earnings behaviour. The study shows that with the exception of rainfed areas, there has been an inverse relationship between the farm size and per hectare use of urea and TSP fertilizers. Further, labour use was found maximum in the high productivity areas and minimum in the low productivity areas. The author shows that agricultural self-employment increased for all the three strata of rural workers in Indonesia during the period of study which is contrary to the results from India. Regarding earnings, the data revealed that income from agriculture increased between 1976 and 1983 at different rates for the different strata of workers while income from non-farm employment increased considerably for all the three strata. The Indonesian experience suggests that from the point of view of the lower strata of rural household, development strategies must vary from region to region.

The summary of results and suggestions are given in the concluding chapter. The study shows intra-country variations in terms of uneven regional development, especially in the case of agriculture. This is attributed to certain constraints like the lack of irrigation facilities and low level of public investment in infrastructural development etc. Rural institutions are generally found weak in economically backward areas mainly due to poor production technologies. The study thus supports a mutually supporting relationship between technology and rural institutions.

Regarding employment and earning relationship, it is found that there is no one-to-one correspondence between the number of days worked and net earning as one moves on the development scale. The share of non-farm earnings among the weaker sections in rural Asia is found to have increased with the availability of non-farm sources of employment. It is thus the nature and level of development that determine the degree of trickle down effect.

The relationship between employment, earnings and poverty is well known. The high incidence of poverty in most parts of Asia has been attributed to low levels of employment and extremely low daily earning of the backward people in the underdeveloped regions. The study has suggested a number of policy packages for alleviation of poverty.

In most areas of developing Asian countries there is good scope for employment expansion, both within the outside agriculture. The study emphasises that for creating more employment, agriculture itself has to develop rapidly under specified technological and agronomic management conditions. This requires huge public investments in agricultural infrastructure and removal of constraints in the way of technology inspired agricultural development. However, exclusive reliance on agricultural employment cannot be the ultimate solution to poverty. As a part of medium and long-term strategies, development of non-farm activities must be carefully planned for.

Locational considerations, product line demarcations, ancillarisation and vertical integration, employment patterns and production technologies are some of the important policy issues to be addressed. Some other policy issues are related to infrastructural requirements and skill development etc.

This volume is a comprehensive and useful study on employment, earrnings and poverty in rural India and Indonesia. Policy issues are very timely and require the immediate attention of policy makers. However, the two case studies need to be focussed neatly in terms of points of similarity and differences. The book could have been condensed significantly. For instance, chapters four to six could be reduced in size and converted into appendices to make the reading compact and more effective. Similarly, chapters seven to nine should be combined and most of the tables be presented towards the end.

*R.N. Agarwal*
*Institute of Economic Growth,*
*University of Delhi*
*Delhi 110 007*

**Wonderland of KAIZEN: A Total Quality Culture for Survival :** *by Shyam Talawadekar*, Bombay : Quality Management Systems, 1994, 184p Rs 150.

The economic miracle that Japan has been able to achieve despite the devastations of the Second World War and other impediments has always created a lot of interest and euphoria about the Japanese style of management. Quality Circle (QC), Just-in-Time (JIT), *Kaisha Ninen* (Company Man), and Total Quality Management (TQM) are some of the Japanese practices and concepts which have become the buzz words all over the world. *Kaizen* is another such addition to the management vocabulary and is closely linked with TQM.

The present work by Shyam Talwadekar addresses itself to this quality *mantra*. *Kaizen* in Japanese language literally means 'change for the better', or, more appropriately, continuous improvement. The *Kaizen* philosophy, as the author rightly maintains, is based on the premise that our life, be it working life, social life, or home life, needs to be constantly improved. To begin with, it focusses on small, improvements and ultimately, encompasses all aspects of life. However, the basic thrust of this volume is in the context of an organizational setting.

As a matter of fact, *Kaizen* is a formalized system of continuous improvement in every sphere of organizational life. It starts with faith, conviction and commitment of top-management of the company, which must then perculate through to the middle management and lower down the hierarchy. The system, according to the author, is based on trust that would result in empowerment to all employees, listening to them, promoting zero-investment improvements, and focussing on efforts on *Kaizen* evaluation and performance appraisal. A formal organization structure that is advocated by the author to continuously monitor the *Kaizen* activities, somewhat resembles that of Quality Circle. There is, however, a basic difference between the two. The focus of *Kaizen* is on the quality of mind, while Quality Circles focus on the quality of work or product. As Talawadekar succinctly puts it, the objective of *Kaizen* is to create a positive attitude for excellence in everything in life; quality is one of them. Moreover, there are many Non-value-Adding (NVA) activities which we habitually go on doing in an organization at any given point of time. *Kaizen* helps to eliminate such NVAs and ensures better value to customers.

This volume is specifically addressed to practicing managers and trainers. It should not be read as a text book on *Kaizen* meant for the management academics and students in the traditional sense of the term, though it can be profitably used by them for understanding the practical aspects of *Kaizen* as well as for self- development. The book is divided into fourteen small chapters, supported by twenty-two appendices. Each of these chapters briefly, but pointedly, deal with only one aspect of *Kaizen*, such as Managing Self, Waste Elimination, Performance Appraisal, Total Quality Culture, Promotional Activities, Quality Circles and ISO 9000, etc. The entire text is dotted with practical examples, tips, illustrations and diagrams. The appendices will come handy for step-by-step implementation and monitoring of different aspects of *Kaizen* in an organization. In fact, this is a Do-How book, as the author draws from his real life implementation experiences and seeks to equip readers with the knowledge based analytical skills and management orientation required for practising *Kaizen*.

Since the basic emphasis in *Kaizen* is on changing the attitude and the mind-set, the author is not able to avoid philosophical overtones at many places. It was perhaps needed to emphasize the relevance of *Kaizen*, as also to make it acceptable by the Indian mind-set. The way we are brought up, Talwadekar rightly states, we not only hesitate to embark on creative experimentation (*sic*) but also ridicule creative questioning and thinking — what he aptly christens as "Dinosaur Programming" in our minds. It is in this context that his brief indulgence with *Kaizen* and the Indian *Mantras* (Ch. 13) assumes significance. This chapter provides an interesting reading where some of the basic elements of the Indian philosophy of *Yoga* and *Bhagwat Gita* have been shown to mesh well with that of *Kaizen* so much so that he concludes that "*Kaizen* is Indian *Mantras* in Action"!

The last chapter uses the question-answer format to provide answers to the most frequently asked questions about *Kaizen*. In a way, this chapter summarises almost the entire text in a manner that makes it understandable to even a layman.

Admittedly, the present volume cannot be described as a great piece of literature on the subject. The presentation seems to have followed more or less the same sequence and language in which the author has been conducting his training programmes on *Kaizen*. Despite the fact that the text is full of practical wisdom and operational insight that the author has gathered as consultant and trainer over a period of time, the approach inevitably remains prescriptive rather than analytical.

However, the author cannot be faulted on this, because his basic purpose was to bring out 'a Do-How book'. As such, he has made a useful contribution at a time in Indian economic and corporate history when, for the first time in India, the quality *mantra* has become the most important buzz word. As a handbook on *Kaizen* — concept, significance, process, implementation and monitoring — its usefulness for corporate management and their HRD personnel need not be over-emphasised.

*M.A. Zahir*
*Professor cum Head,*
*Deptt. of Business Management*
*PAU, Ludhiana.*

**Work Manual for Administrative and Personnel Managers** : *by R. Raghunathan.* Wiley Eastern Ltd., 4835/24 Ansari Road, Darya Ganj, New Delhi - 110 002, 1995, 244p, Rs. 295

The work book-cum-desk manual gives the readers all the information about the nuts and bolts of Personnel and Services Management in a lucid manner, especially the aspects of the latter which generally are never taught in the management institutions of the country. The book thus fulfils the long felt need of the practising manager.

The book is presented in 12 chapters covering a wide spectrum viz.: Real Life Functions of Personnel Managers, Office Administration, Systems Development & Innovation, Human Resources Development, Human Resource Maintenance, Industrial Relations, Performance Monitoring & Rewards, Self Management and Understanding the ultimate.

The author has attempted to pour his life-time experience into this volume and offers helpful systems and action tools through 48 detailed formats given as annexures.

Frontline managers, fresh management graduates and especially those promoted from ranks would find the chapters on Systems Development, Office Administration, Welfare Management, Security Management and External Relations very useful. The book throws spotlight on the thorny problems of management of services and answers their many questions. The author has given useful guidelines on the problem of rehabilitation of oustees in the chapter on Office Administration. Whenever land acquisition is made, there are demands for employment for sons of soil. At times these demands could take menacing proportions. The book provides useful tips on meeting the obligations, helping Sons of Soil with rehabilitation, educational training and infrastructural assistance.

In the chapter on System Development and Innovation, the readers would find useful tips on records management, development and maintenance of systems and procedures, setting job standards, work simplification and job enrichment.

The unique feature of the book is the author's use of micro-cases and examples given with prescriptions which could be adopted to fit most problems that might arise. The forms given by way of annexures contain useful compitation and the readers would find it handy to adopt and modify to their situational needs.

The chapters on Human Resource Development and Industrial Relations are rather sketchy especially the coverage in section 4.5 on organisational climate and section 4.6 on Motivation and Development of teams and team spirit.

Chapter 6 on Industrial Relations gives "The Rivery Theory" "8 approaches for harmonious IR" and "Employee Behavioural Theory". The author's exposition gives too simplistic a prospective of the very complex and intricate human dynamics. Management of deviant employee behaviour, for example is not as simple as it is made out by the author when he states "There are lot many things common between our family life and organisation life. Unions turn militant as our own children. We can bring up the children the right way only by a proper mix of affection, freedom, control and education. The same is the prescription for employees and for their ideal behaviour. If organisations can achieve this proper mix, then there would no more need for IR Manager, for there would be no industrial problem".

The author should have focussed on Services Administration and made a neat finely tuned manual rather than giving "quickfix" prescriptions to the complex problems in the area of Human Resource Management.

However, part of the book serves the need of the professionals in the area of service administration. The Administrators of both private and public sector organisations would find this volume handy for reference.

*A.S. Ahluwalia*
*Ex. SR. Deputy Director (HRD)*
*National Productivity Council*
*New Delhi - 110 019.*
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