Environment: Technology Holds the Key

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This paper seeks to explore the relationship between man and nature and how this relationship has resulted in technological and economic growth. The issue is not man vs. nature but how best to control and harness nature through non-polluting energy sources.

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When one talks about environment from the popular environmentalist's viewpoint one seems to view the issue as man vs. nature. As if all the steps towards progress are an evil and would threaten the very existence of the planet. With such a perspective one unfortunately appears to forget that man is also a part of Nature, and that Mother Nature unbounded or untamed is the most potent killer of both the man and the Nature. The fury of cyclones that strike the coast of Andhra Pradesh is no less deadly than the human engineered Bhopal disaster or Chernobyle accident.

Over the millenia we have seen viruses obliterate the human and livestock population indiscriminately, pests destroy foodstock grown for the survival of human beings and cattle, forest fires burning alive the entire forest population including wildlife of dwindling species, volcanic eruptions level populated cities and villages, tidal waves and floods submerge and extinguish sparks of civilization in many parts of the globe. Hurricanes and typhoons which periodically lash coastal areas bring untold misery to millions. These are just a few examples of the destructive facets of our Mother Nature; however, they are enough to make our life uncertain, short and disease-ridden.

Other things, however, are not equal: while Man is part of Nature, the human species is unique among Nature's phenomena in that we have been endowed with creative mental capacity, mind. Alone among the natural phenomena, we possess the ability to discover the laws of the universe and to deliberately alter our behaviour to transform ourselves and our environment for better or worse. Man has the capacity to maintain and improve Nature and himself in a lawful fashion, and that is the key to our species' development.

Looking back into mankind's history one cannot help but notice how few of us were around only four centuries ago. At that time the population of the earth was only 470 million—less than one-tenth the number of people alive on our planet today. Going further back to days when man was still a hunter, the world population was not more than 10 million. And that too predominantly adolescent. But as Man controlled Nature he multiplied into the present 5 billion

Nature has provided us the basic facilities for sustenance of our life, but it has been largely our own efforts to subdue and later master the forces of nature that has enabled us to sustain a larger population on this earth and lengthen our life span. Much *of our effort historically has been devoted to halting the degeneration of Nature, whether resulting from human folly or Mother Nature's own destructive forces.* Efforts to green our deserts and stop further desertification of habitable lands, or to prevent intrusion of saline water in the coastal areas dependent upon agriculture are typical examples of such human endeavor.

The issue is not of Man vs. Nature. It is apparent that we live through Nature, in a process defined by technological advance. The increase in human potential over the ages has been accomplished through our curiosity to understand the natural laws, so that instead of being trappped by circumstances we are in a position to improve the environment and potential alike. This is not merely a species-defensive effort: it is a positive developmental project corresponding to the unique mental and moral qualities of Mankind.

This quest to discover the laws of nature, far from complete at this time, and the application of that acquired knowledge in improved means of social reproduction is the core of human progress. Technological advance, and in particular an increasing command over energy, is at its heart. Each successive more advanced mode of technology has embodied a more perfect grasp of the laws of the Universe. Thus it has not only facilitated a more efficient-less wasteful and polluting-use of existing resources, but regularly defined entirely new arrays of resources inaccessible to more primitive technologies. To our ancestors, uranium was a useless piece of rock. Today, with the development of nuclear technology, it is a valuable resource. Or, take the thorium-rich sands of Kerala's beaches; they have been transformed from a nice tourist attraction to a precious energy resource by our nuclear scientists' discovery and development of the thorium fuel cycle.

Energy and Environment

One of the basic ingredients necessary for the survival of human society is energy. Every human activity and for that matter all natural activities require energy. The quantity of goods and services available for mankind is also a function of the availability and use of energy. Energy input, its concentration and quality, is the main determinant of human productivity which, in turn, determines the level of wastes, pollution and the rate of resource depletion associated with any particular industry and a given society generally.

In fact, the technological progress that has increased human productivity and potential has been accomplished by an increasing command over energy. Beginning with the agricultural revolution, and ocean fishing boats earlier, mankind has increased the amount of useful energy available to the average individual, and has increased the number of kilowatt-hours' value of the amount of usable energy obtained by society per square-kilometer.

Historically energy generation has been a major source of pollution. In the days of a hunting and gathering society the amount of energy generated was negligible. But as soon as the making of fire became known to man, burning of dry leaves, and twigs became the source of generating heat. The polluting character of such energy sources, as one knows nowadays, is high, but because of the sparse population that existed then the effect of air pollution was never felt. What was felt then, and is still felt today in many parts of the world, was the absolute lack of energy availability. Various available resources remained useless for lack of a scientific understanding of how to utilize them. Consequently the world population remained low and extremely vulnerable to the whims of Nature.

Over the following centuries an awareness of the necessity of generating more energy emerged. The concept of concentrating energy did not crystalise for practice, and the quest to expand energy supplies proceeded largely by trial and error. Burning of anything and everything to generate heat became the norm. With the advent of the industrial revolution came the burning of coal and oil. Generation of power without polluting air and water was never given a serious thought. Poor technology, more and more of it, was employed for performing work. Human beings continued to be used as beasts of burden, be it in agricultural fields, mining quarries or transportation.

The feudal-colonial social set-up over most of the developing world has reinforced this practice to date. On the one hand, the feudal landlords using bonded labour and a poor level of technology continued to get richer and, on the other, they funded sociologists and anthropologists, through new institutions, to glorify human labour in its crudest form and oppose automation. These sociologists made a decent living preaching how automation makes people "worthless" and "dehumanizes" society. They preached that to be a "beast of burden" is a right of every individual. Poor technology was the bedrock of this social system in which, quite lawfully, the disparity in economic condition between the haves and have-nots has increased rapidly.

Meantime pollution had become rampant and human misery, in large parts, increased. Those who had the misfortune of seeking some of the hell-holes in industrialized Britain in the earlier part of this century caused by indiscriminate burning of coal, would know the misery the British work force had been subjected to. Those who want to see such hell-holes today can visit many of the developing nation's so-called "industrial centers" where coal, firewood, cow-dung, briquettes, or whatever are burned in open fire and the noxious fumes are allowed to enter the lungs of every citizen.

Unless we want to go back to the days of hunting and gathering—a proposal which presupposes the elimination of more than four billion people right now—we need energy for growing food, building shelters, manufacturing the basic necessities, and so on. It is, therefore, a prime necessity that we generate energy efficiently, without polluting the environment. While "zero pollution" may never be a reality, we can certainly produce energy which is a thousand-fold less polluting than the energy generated through burning coal, oil or cow-dung. By concentrating energy we reduce our work-time; we will be able to extract more out of any resource and, in the process, generate less waste and pollution. Through concentration of energy and application of such energy to the agro-industrial field, we will actually save energy.

Deforestation

One of the major sources of environmental damage is neither large-scale mining operations nor untreated sewage, but deforestation. In the developing nations this problem is particularly acute. Because firewood and not gas or electricity is used extensively for cooking and heating purposes by a large section of the population. Take the capital city of Upper Volta, Ouagadougou, a city of some 80,000 people. Not one bush or tree remains standing for a radius of 40 kilometers around the city; all the trees and bushes have been cut down for firewood, and the government has done next to nothing in evolving an effective reforestation programme. For cooking alone, the annual firewood consumption in Ouagadougou is one tonne per person.

In the Indian sub-continent, a mass-scale deforestation has stripped the Himalayan foothills in Nepal & India. Besides a large part of northern and north-eastern India is similarly being denuded of tree cover. Most of the deforestation was caused by organized contractors, working hand-in-glove with local politicians and local toughs, who bring the firewood to the plains to sell it to a vast market. It is not an exaggeration to say that the deforestation has caused increased land erosion, aggravated flooding of rivers downstream and choked the rivers and reservoirs with silt and clay brought down from the stripped slopes of the Himalayas. The result has been disastrous, affecting the best agricultural lands of India, Pakistan and Bangladesh.

The Indian sub-continent is confronted with yet another environmental disaster. There is ample evidence to prove that such large-scale burning of cow-dung produces a great amount of air pollution, particularly during the winter months when the noxious fumes stay close to the ground level. If, on the other hand, this 10 million tons of cow-dung were utilized as fertilizer, at least one-third of India's present demand for fertilizer could be met.

Coal: Major Pollutant

Another major pollutant of air is coal. The pollution hazards associated with the coal industry are widely known, yet curiously they are overlooked. Burning coal results in the emission of particulates and oxides of sulfur and nitrogen; the disposal of fine fly ash resulting from the burning of coal also constitutes a major environmental problem. For example, in 1970 the 320 million tonnes of coal burnt by electric utilities in the United States resulted in the generation of about 35 percent ash, burning the same amount of coal would produce approximately 100 million tons of fly ash. Such an amount of coal when burnt would also produce 25 million tons of sulfur dioxide, assuming an average of 3.5 percent sulfur content in the coal burned.

From a technological standpoint, control of particulate emission from coal-burning plants is well established. Techniques include the installation of mechanical collectors and electrostatic precipitators with normal removal efficiencies in excess of 99 percent from all the flue gas streams at these plants. Technology to control sulfur emission from the coal-fired plants, however, is inadequate. Excess sulfur and nitrogenous oxides in the air can be devastating. These gases will come down mixed with rain forming weak yet potent acids such as sulfuric and nitric acids. In such a case the natural ecology as well as standing crops and aqua-life can be damaged severely. It will also change the soil characteristics and increase the acidity of flowing water. While scrubbing of stack gases containing sulfur and nitrogen oxides is technically feasible, it is expensive and controversial in many respects. Since sulfur cannot be removed efficiently, enforcement of strict environmental emission standards should severely restrict the use of coal to that containing a low percentage of sulfur.

There is yet another hazard associated with coal

burning: the release of radon gas. Radon is in the chain of decays of the uranium atom. Since all rock and soil contains naturally occurring uranium in small quantities, radon gas is emitted from every pile of rocks and stone, and more so from significant piles of coal kept as stock at the coal-fired thermal stations. Burning of coal also emits radon. One estimate reported that the extra radon emissions caused by the burning of coal in one large power plant for one year may eventually cause 30 fatal lung cancers. (Health Physics, 1982).

While large-scale burning of coal—which has come to be accepted as the energy policy in India and elsewhere—causes environmental pollution through release of noxious gases and generation of millions of tons of fly ash, extensive coal mining itself creates additional environmental problems. Besides the hazard of hundreds of people losing their lives in mining accidents, deep mines also act as conduits carrying acidic water, as a lot of acidic material soluble in water exists within a mine, into the groundwater aquifer, contaminating it in the process.

Solar Energy

The environmental problems associated with energy generation are directly related to the quality of the energy source and associated level of energy generation technology. If we try to generate commercial power of a certain concentration from a relatively diffused energy source, as we do in burning coal, oil, etc. or in utilizing sunlight on earth for the same purpose, we will not only waste a large amount of resources but also turn them into pollutants. A case in point is solar energy. Without sunlight, habitation on earth would not have been possible. Everything that grows on our earth is dependent on sunlight. However, solar energy can "contribute over a period of time significantly to the energy-mix". Let us see how viable is such a statement, and what are the environmental implications.

To many, solar energy is free, a "gift of nature." It is free for plants and trees and most of the living organisms, but it becomes extremely expensive when an attempt is made to arrest it and convert it into electricity. Construction resources are perhaps the most significant factor in evaluating capital cost. A detailed assessment of this was performed by H. Inhaber of the Canadian Atomic Energy Commission. Inhaber compared a number of alternative means of producing electricity for the power grid and concluded that 10 to 30 times more materials were required for solar energy systems than for conventional plants. It is of course the mining, processing, transportation, and construction of these much larger quantities of materials that account for the bulk of the difference between the 8 to 20 years payback period for solar generating systems and 1 to 2 years payback periods for conventional power systems (table 1). It is to be kept in mind that more mining and more processing to obtain the same amount of power than a conventional power plant necessarily implies more environmental pollution per unit of power produced.

Table 1: Payback Period of Different Sources of Energy

Energy Source	Energy Payback Time (Years)
Fission: Pressurized water reactor	1.0
Fission: Fast breeder reactor	1.0
Fusion: Tokamak (UMAK-III)	2.0
Coal	2.0
Solar: Reflectors	8.0
Solar: Silicon Cells	20.0

Energy Density

The reason why one energy source is more efficient than another has to do with its energy density. The density of an energy source can be thought of simply as the amount of energy delivered from a given volume of energy source. Often, in order to compare different energy sources, such as a solar energy collector with a fossil-fueled boiler or a nuclear reactor, the total surface area that the energy passes through is used instead of a simple volume measurement.

These densities actually indicate in power-generation terms a rough measure of the size of the power plant. Scientists tell us that the energy density of solar power collectors is between 4 and 5 orders of magnitude smaller than the energy density of a fossil-fueled boiler. Thus in order to collect enough of this very diffuse sunlight to produce the same amount of electricity that a fossil-fueled power plant produces, the solar plant would have 4 to 5 orders of magnitude larger in size than the fossil fuel plant.

At this point in time, electricity is the most efficient energy form that is available. Electricity is also least polluting and has got other advantages, such as its ability to be transported over a long distance. Moreover, the use of electricity increases productivity, thus significantly reducing energy use per unit of GNP output. One study shows that averaging the results obtained in metal, fold, chemical and miscellaneous industries, one kilowatt-hour of electrical energy rated at 10,400 Btu displaced 26,140 Btu of non-electrical energy, yielding an average productivity of 2.5. Electricity also allows for more sophisticated manufacturing processes and it thus makes it possible to

turn out lighter products that not only save material and energy, but also create more jobs.

At the same time, there is an urgent need to generate more concentrated forms of energy which can do more work in a shorter time and which do not pollute the environment. At this time, nuclear fission is the least polluting of the energy-generation processes. However, with the advent of nuclear fusion, which uses the hydrogen isotopes of ordinary seawater as fuel and would produce no radio-active wastes, energy generation will enter a qualitatively more advanced phase. It will be more efficient and concentration of energy will be significantly higher. As energy forms, both laser and plasma processes—for instance, fusion—are highly concentrated and more dense than electricity. For transportation, development of hydrogen as fuel will eliminate environmental pollution now caused by automobiles.

So far our industrial applications and power generation have been confined to a small portion of the electromagnetic spectrum. We have advanced our ability to go to the atomic range which has a higher frequency and shorter wavelength. With the development of laser devices, which are absolutely non-polluting, we hope to exploit the x-ray range commercially. Laser devices concentrate an enormous amount of energy over an extremely short period of time very precisely onto a small point. The capability of concentration of energy depends on making use of higher coherent and relatively short wavelength parts of the electromagnetic spectrum.'

There is no doubt that laser is going to be the single most important machine tool of the future. For developing nations like India which need highly productive non-polluting sources for industrial applications, the laser offers a unique opportunity to meet that demand. That would require a real big push to the R&D effort so that the expectation becomes a reality.

The case of Japan

For many reasons, Japan can be considered an ideal case for an environmental study. Japan is a densely populated nation where about 325 people on an average live in one square kilometre. Japan's population density, no doubt an asset, can be considered extremely high when compared to most other Asian nations where population is considered a "problem". India, for instance, has a population density of only 228 persons per square kilometre; Pakistan, 110, Vietnam, 175, Indonesia, 81, and Malaysia just 45.

By environmentalist logic Japan ought to be an ecological disaster area—yet the country has a lush green forest cover of over 70 percent of its land area, its water is fresh and air pollution has dropped by 60 percent over the past ten years. How has Japan managed to defy the logic, while nations like India and Pakistan with far less population pressure have apparently succumbed?

There are many ways this question could be answered. The most common and simplest way is to compare the GNP per capita of Japan with that of other nations. Japan's GNP per capita is 40 times that of India, 27 times of Pakistan, 31 times Vietnam, 17 times Indonesia and 5.4 times Malaysia. Such contrast in GNP per capita is particularly significant in light of the fact that Japan imports most of its raw materials from many of the nations named earlier. This only underscores the fact that Japan carries out a massive industrial and processing operation in an extremely densely populated land mass.

What's more, the concentration of population and economic-industrial activity in Japan is made much greater because 70 percent of Japan is covered by forest. In other words the real activity which makes Japan an industrial giant takes place within just 30 percent of its geographical landmass. Unlike other developed nations, Japan does not have the luxury of having a large population away from the manufacturing centres and the noise and hubbub of urban living.

Japan is perhaps more effectively urbanized than any other nation in the world. And this points directly to the answer to our original question; in as much as effective urbanization is a unique expression of real economic development. Building cities requires basic infrastructure—domestic and commercial water and sewage, roads and transport, power, housing, etc. In quantity, together with a certain minimum density of skilled and educated manpower, these are the fundamental building blocks for a nation. It is the basis for creating an economic surplus, raising productivity and living standards along with the level of investment in improving the environment.

Indeed, poverty and underdevelopment—not population—is the lawful corollary of pollution and environmental degradation. It is precisely Japan's economic and technological development which gives the lie to the Malthusian dogma. Moreover, this has not been a prolonged process. The Second World War pretty much destroyed Japan's physical economy—in the early fifties, Japan was producing less saleable steel than India. In fact, when India's plan to add one million tonnes of steel every year was made public, Japan wondered how they could ever be able to compete with India. Today Japan produces about 12 times more saleable steel than India! In just thirty years, Japan emerged from the ashes of a defeated and devastated

nation to be a leader in many spheres of industry, technology and science.

It is not that Japan "escaped" environmental disaster by growing rapidly, but that growth provided the resources to solve the most basic ecological problems—provision of clean drinking water, fuel and power, medicine, etc.—as well as to control the environmental effects of industrialization. Not surprisingly, by the 1950s and 1960s industry's pell-mell pursuit of greater production had brought the type of industrial pollution that has plagued other industrially developed nations. Yet, even with intense industrial growth Japan's pollution—mortality rate was far lower than that in technologically—underdeveloped nations such as India or Pakistan today, where there is little "industrial pollution" but where the most elementary water pollution—contaminated drinking water, no sewer system, lack of medical facilities—still claims thousands of lives each year in the form of cholera, typhoid, malaria and many other simple diseases.

By the late sixties Japan's industrial pollution had reached a very high level. In a little town near Yatsushiro Bay on the Western coast of Kyushu, mercury poisoning of 428 people, of whom sixty nine died, brought the problem into the spotlight. Named after the little town, Minamata disease was found by researchers at Kumamoto University to be the result of trace deposits of mercury in the brain which caused paralysis in arms and legs, developed deformities or caused undiagnosable pain ending in death. The mercury found in the victims' brains was traced to the Chisso Corporation's dumping of waste in the bay. Mercury, which the Chisso plant used in the process of manufacturing vinylchloride was contained in the waste discharged into the bay, and got into the food chain through fish.

Another case epitomized the growing environmental abuse: itai-itai disease. It was found that the Mitsui Mining and Smelting Company's Kamioka mine was discharging waste containing cadmium into the Jinzu River, and that the cadmium entered the irrigation water used on downstream rice paddies and got into the food chain. The result was poisoning of kidneys and softening/weakening of bones by dissolving calcium. It is not clear why the disease preferred women but, it turned out to be a dangerous one. Itai-Itai claimed 155 victims, including thirty-two deaths.

These incidents and the general deterioration of air and water quality in Japan's major cities pushed the environmental issue to the forefront. In 1971 the Environmental Agency was set up by the Japanese Government as the central administrative body for protecting the natural environment and eliminating pollution. New agencies were set up by local governments to deal with the same problem in their respective regions. Kogai—environment destruction—soon became a hated world. The government's anti-pollution drive was backed by a clear and massive public consensus.

Japan attacked the problem on two fronts. Stringent standards were adopted and budget allotments for national and local government activities concerned with environmental preservation rose sharply. By 1981 the Japanese Government was spending more than $ 17 billion annually on pollution control-related activities at both the national and local level. In the process private industries also joined in with an anti-pollution investment campaign. The private sector's investment level peaked out in 1975 when $ 4.7 billion—about 17 percent of the year's total equipment investment—was spent on pollution control measures. In later years, due mostly to a tentative attainment of anti-pollution standards by 1975, private sector investment has begun to decline.

Vehicle exhaust is a major target of environmental controls in Japan. The jump in the number of automobiles—from 1.4 million vehicles in 1960 to 17.6 million in 1970 and 42.9 million in 1983—was accompanied by a leap in the severity of air pollution caused by auto emissions. The countermeasures adopted by the Japanese Government were so stringent that some foreign countries have complained that the tough standards and restrictions constitute a nontariff trade barrier against foreign-made cars!

The second front of attack is the expenditure for research and development on environmental disruption. On this front too, government and private industry are jointly developing new technological processes and instruments to ensure a better environment for future. Tools for more effective monitoring and detection of environmental damage as well as sources and remedies for environmental degradation are the focus of ongoing research.

Countermeasures to prevent sulfur dioxide emission control, for example, have led to the building of desulfurization plants to reduce the sulfur content of heavy oil. By March 1983, 12 direct desulfurization units (capacity: 73 thousand kiloliters/day) and 44 indirect desulfurization units (capacity: 156 thousand kiloliters/day) were processing heavy oil. The effect of desulfurization of heavy oil can be seen in the reduction of sulfur dioxide concentration in the air.

Research and development efforts are in progress on fuel-gas desulfurization of coal-fired power plants. Practical desulfurization plants have increased to 1366 units by January 1983. Fundamentally, the key to environment problem is technological progress and not choking the industrial growth.

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Focus

Energy Policy Perspectives in India

Stephan Paulus

From the Indian point of view, global environmental problems constitute just one single factor exerting pressure on the Indian economy and energy policy for adjustment. Problems cropping up in the short and medium terms, such as inadequate supplies, underemployment, balance of payment constraints, the energy crunch, as well as an environmental crisis aggregated to menacing proportions, await resolution. This paper attempts to seek out 'synergetic effects' which will address all these problems to the greatest possible extent.

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"The quantity of energy a nation needs is largely determined by what it is trying to do."
(Mintzer, 1988; 30)

The globalisation of environmental problems manifesting itself in a phenomena such as the "green-house effect" and the ripping up of the ozone layer will certainly have an impact on North-South relations. The industrial countries are undoubtedly responsible for the greater proportion of environmental pollution and resource consumption. Nevertheless, the developing countries also find themselves subjected to increasing pressure from the countries of the North to contribute their share towards the ecological regeneration of the "Spaceship Earth" (K.Boulding).

The combustion of fossil fuels and worldwide deforestation have been especially singled out as factors contributing to the increase in the concentration levels of greenhouse gases in the earth's atmosphere. It is only to be expected that, sooner or later, a "climate convention" will be concluded through international negotiations, with the express purpose of reducing global emissions of greenhouse gases by a certain percentage (20-25%), within a stipulated period of time (15-25 years). A question of vital importance posed in this connection relates to the distribution of burden arising from this task among the individual countries.

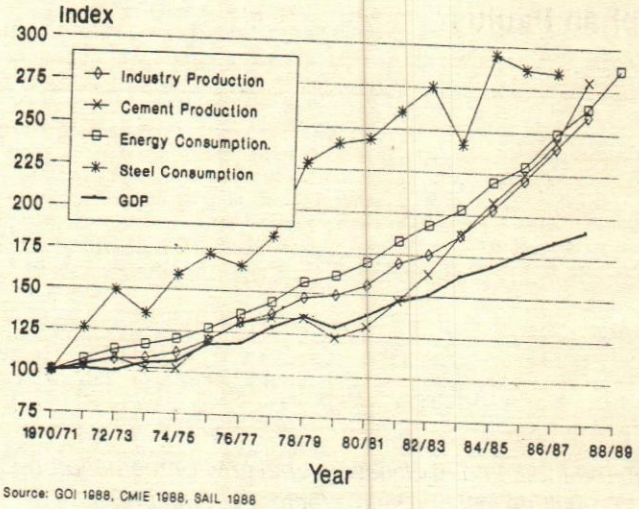
Basically, India has always displayed a certain amount of reserve *vis-a-vis* such agreements, substantiating its stand with the arguments that such demands ran counter to prevailing development schemes, that there was a lack of requisite funds for implementing such measures and that the industrial countries bore a certain technological responsibility for the emission of greenhouse gases in India and other developing countries. Nevertheless, the contention that greenhouse gas emissions constitute a problem solely to be handled by the industrial countries is only partially tenable. Table 1 clearly shows that India accounts for as much as 2.2% of CO_2 emissions, thus placing it tenth on the 1982 list of countries with the highest emission levels. It is the object of this paper to present the problems

facing energy policy-making in India and indicate the perspectives for bringing the Indian economy closer to the goal of checking greenhouse gas emissions, especially of carbon dioxide (CO_2), rather than further distancing it.

Table 1: Worldwide Co_2 Emissions 1982

Countries	Co_2 Emissions (Million t)	Share (%)
USA	4166	23.9
USSR	3306	19.0
Japan	831	4.8
FRG	666	3.8
All Industrial Countries	12637	72.4
China	1516	8.7
India	386	2.2
Mexico	270	1.6
Brazil	152	0.9
All Developing Countries	2324	13.4
Others	2456	14.1
World[1]	17417	100.0

1. including Eastern Europe
Source: Bach, 1988



Source: GOI 1988, CMIE 1988, SAIL 1988

FIG 1 RESOURCE INTENSIVE GROWTH—INDIA 1970/71-1987/88 (1970-71=100)

To begin with, it should be pointed out that, from the Indian point of view, global environmental problems constitute just one single factor—one making itself felt only in the long-term at that—exerting pressure on the Indian economy and energy policy for adjustment. Problems cropping up in the short and medium terms, such as inadequate supplies, underemployment, balance of payment constraints, the energy crunch, as well as an environmental crises aggravated to menacing proportions, await resolution. A policy which would commit the Indian government solely to a reduction of greenhouse gas emissions, without concurrently addressing the aforementioned problems, would hardly meet the realities of the situation. Thus, the need of the hour is to seek out "synergetic effects" which will address all these problems to the greatest possible extent.

Problems of Energy Supply

Resource-Intensive Economic Growth

The problematic nature of the relationship between economic growth and energy consumption, particularly in regard to environmental and climatic aspects, is clearly presented in figure 1. Here, the growth of the Indian Gross National Product for the period 1970-88 as compared to primary energy consumption and some selected energy-intensive sectors (industrial production, crude steel, cement) has been traced.

Economic structural change in India was extremely energy and resource intensive. Growth rates in the sectors concerned and in primary energy consumption exceeded the GNP rate for practically the entire period (figure 1) There was no delinking of economic growth and energy consumption in India as could be observed since the seventies in the industrial countries of the West and even in some threshold countries (Janicke et.al. 1989). For the period 1985-87, the energy elasticity of the Indian economy remained comparatively high with a value of 1.45 (GOI, 1989 : 35).

Should this trend, whose causes will be subsequently dealt with in this paper continue, then India's energy and even environmental policy would be confronted with serious problems. It would prove to be an obstacle to the reduction of greenhouse gas emissions (especially CO_2) and to the conservation of natural and, in particular, non-renewable resources. This is all the more relevant in view of the fact that the per-capita energy consumption, especially among the poorer sections of the population, will and has to necessarily rise in the future.

Commercial Energy Supply

The energy sector has always been accorded high priority in India's economic policy and planning. In the Seventh Plan, over 30% of Government investment was pumped into this sector. Table 2 provides an overview of fund allocation. Electricity generation, particularly the expansion of the generating capacities of power plants, devours the lion's share of investment. The remaining funds are invested in oil, gas and coal production. Despite the fact that the Department of Non-Conventional Energy Sources had been established some years back, funds earmarked for this are but meagre.

Table 2: Energy Sector in Seventh Plan (Rs 100 crores)

	Outlay	Share(%)
Power	342.7	64.3
Generation	213.0	(62.2)
Distribution	91.9	(26.8)
Rural Electrification	21.1	(6.2)
Modernisation	9.7	(2.8)
Others	5.9	(2.0)
Oil and Gas	125.3	23.0
Exploration/Extraction	105.5	(84.1)
Refineries/Marketing	19.7	(15.9)
Coal	74.0	13.5
Renewable Energy Sources	5.2	0.9
Biogas	1.9	(36.5)
Solar Energy	0.2	(3.8)
Fuel efficient Stoves	0.4	(7.7)
R & D/Demonstration	1.2	(23.1)
Others	1.5	(28.9)
Total Outlay	548.2	100.0
Total Plan	1800.0	—

Source: GOI, 1985

Table 3 provides a simplified energy balance for India. In terms of primary energy input, coal (hard coal and lignite accounting for 58%) constitutes the mainstay of energy supply. Since 1975, the annual output rate has risen by over 80%, whereby, assuming an increase in mining output of 4% p.a., the known available reserves in the country today will last out approximately another 130 years. The situation with regard to oil and gas is, however, much more dismal. Since 1975, consequent on tapping considerable deposits in India, the share of oil and gas in energy supply rose markedly. However, at the current level of production, known extractable reserves of oil are likely to last another 20 years, whereas this would be just under 50 years for natural gas.

Table 3: India's Energy Balance 1987/88[1] (mtoe)

	Coal	Petro-leum Pro-ducts	Power	Total %	Prim-ary Ene-rgy	%-End Energy	Increase 1980-88 (%)
Primary Energy	88.20	58.30	4.42	151.35	100.0	—	63.9
Imports	1.45	22.00	—	23.45	15.5	—	—2.9
End energy	42.27	46.94	13.32	102.53	67.8	—	51.5
Non-energetic Consumption	—	8.91	—	8.91	5.9	—	68.5
Consumption	42.27	38.03	13.32	93.62	61.9	100.0	48.7
Agriculture	—	0.45	3.17	3.62	—	3.9	125.0
Industry	39.31	7.29	6.50	53.10	—	56.7	48.3
Transport	2.96	20.44	0.33	23.73	—	25.3	39.4
Households	—	8.83	1.96	10.79	—	11.5	68.1
Others	—	1.03	1.36	2.39	—	2.6	35.3

1. Commercial energy only
Source: Based on TERI, 1989

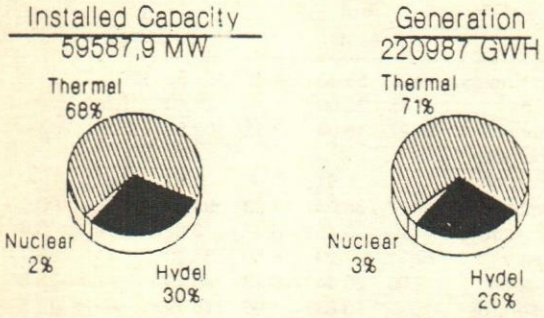
Since 1980, energy conversion losses have risen disproportionately (1980/81: 24 mtoe, 1987/88: 48 mtoe; TERI, 1990). For dearth of pipelines, for instance, over 30% of the natural gas produced is flared. In the case of electricity, transmission and distribution losses account for 21.5% of total power generation.

These heavy losses should be primarily attributed to inefficient and growing power generation, particularly in the case of fossil-fuel combustion. Barely 31% of the primary energy input in thermal power stations is available as electricity—an outcome of the continued deployment of obsolete technologies in power stations. Thermal power stations continue to be by far the most important component of power generation in India (fig.2) followed by hydro-electric power plants. At present, nuclear power plays only a subordinate role. Traditionally, the annual capacity utilisation of Indian power stations has been low.

More than half the available commercial end-use energy is consumed by the industrial sector (fig.2). Besides, the transport sector (accounting for 25.3% totally, and as much as 54% of oil/gas energy consumption) and private households (11.5%) also have large shares. By contrast, the agricultural sector, accounting for a mere 3.9%, has tilldate had but a secondary role to play.

Non-commercial Energy

As in most developing countries, non-commercial sources of energy play an important role in India, though there is no accurate and comprehensive data to corroborate this. As per estimates for the year 1982, 140 million tons of fuelwood, 77 million tons of dung cake and 43



Utilization (%)

	1988/89	Best Year
Hydel	37,48	46,48 (1981/82)
Thermal	44,19	47,86 (1987/88)
Nuclear	49,78	49,78 (1988/89)
Average	42,33	44,96 (1975/76)

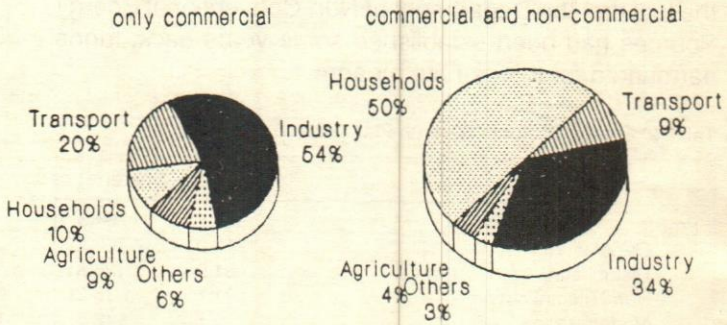
Source: TERI 1990, CEA 1989

FIG. 2 INDIA'S POWER GENERATION—1988/89

million tons of agricultural wastes were consumed in Indian households (CSE, 1982 : 148). It is however difficult to quantify the share of these sources of energy in India's total energy supply. The last few decades witnessed a decline in this share and, according to estimates, these sources of energy still account for approximately 50% of end-energy supply today (TERI, 1988 : 24; Pendse, 1989: 64; TERI, 1990:3). Non-commercial sources of energy meet three-fourths of the demand for energy in rural households and nearly half of the requirements of urban households (CSE, 1982 : 149). The continuing predominance of these sources of energy should not detract from the fact that, with an efficiency rate of 6%, these fuels are being used in a highly inefficient manner (GOI, 1985 : II, 146).

Despite state subsidies, the substitution of non-commercial sources of energy in the household sector and particularly in rural areas with kerosene and LPG, for the most part, has been proceeding at a slow pace'. Given the prevailing conditions of poverty and underemployment, the hitherto for the most part cost-free method of providing for oneself, as had been adopted in the rural areas, is naturally a more attractive economic proposition than the purchase of kerosene or gas stoves and fuel for the same. Traditional patterns of behaviour and shortage of kerosene and gas cylinders have further contributed to the slowing down of this process of substitution.

If one were to include non-commercial forms of energy in the survey of energy consumption, then one obtains a completely different picture of the sector-wise distribution of consumption (fig.3). While households account for only 10% of commercial energy consumed, their share of total energy consumption amounts to 50% , with the shares of the other sectors declining correspondingly.



Source: Goldemberg 1987

FIG. 3 TOTAL ENERGY CONSUMPTION IN INDIA—Sectoral Shares (%)

Apart from the low efficiency rate, the widespread use of non-commercial sources of energy, particularly fuelwood, is also linked with serious ecological problems. Deforestation has assumed menacing proportions in India and is one of the causes triggering off a series of grave, inter-linked environmental problems, particularly the depletion of ground water, soil erosion, growing incidence of floods, silting of dams etc. Of the 2.66 million sq.kms. of cultivable land (India having a total area of 3.24 million sq.kms), 0.9 million sq.kms. are considered degraded to such an extent that they can no longer be put to agricultural use. The productivity of another 0.85 million sq.kms. has been severely eroded owing to deforestation, soil erosion, swamping, salinity and other factors (Vohra, 1987 : 3). The objective framed in 1952, aiming at a compact forest cover comprising 30% of the total area of the country, is far from being achieved. Rather, recent satellite pictures point to the alarming likelihood of less than 10% of the country being under forest cover.

Fuelwood accounts for just under half the per capita, consumption of wood (TERI, 1990:112). However, it would be wrong to conclude from this that the non-commercial use of firewood is the main cause for large scale deforestation. For, as it stands, the rural population still confines itself,as far as possible, to dry twigs and dead trees while collecting firewood. Rather, it is the growing commercialization of fuelwood supply in urban areas together with

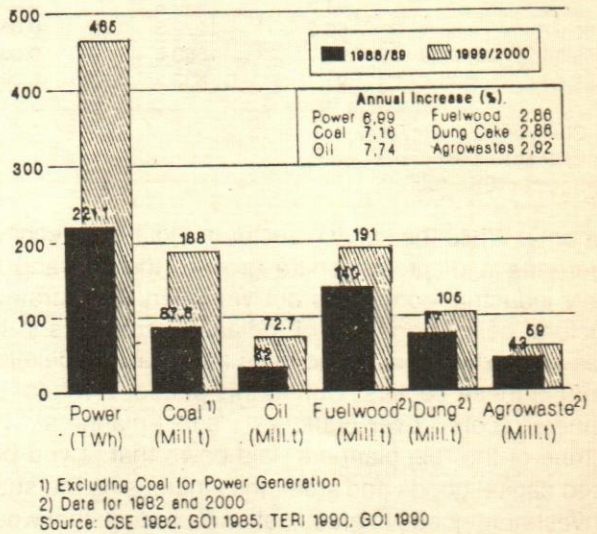
other forms of use (such as in construction, in industry and as logs) which are mainly responsible for the denudation of whole tracts of forest. The overexploitation of timber resources, which has already led to an ominous depletion of forest cover, will culminate in a vicious circle of interrelated factors, with the rural population itself driven to large-scale cutting-down of trees to compensate for the lack of sufficient quantities of dead wood.

Perspectives for India's Energy Policy

A way out of the Energy Crisis: New Priorities

The preceding exposition was aimed at presenting a picture of the energy crisis—to be more precise, the oil, power and fuel wood crisis—confronting India today. The present reserves of oil will be used up in less than 20 years. Rising oil imports will only further aggravate the balance of payments position. Power supply constraints have already perceptibly impaired industrial production. An expansion of existing capacities will call for tremendous financial input. Added pressure on the environment by way of thermal, hydroelectric and nuclear power stations cannot be permitted indiscriminately. In India, the depletion of forest cover has already reached proportions which portend grave ecological repercussions. Even though India's planners have recognised the problematic nature of the situation, the thrust of long-term energy policy continues to lie in supply-oriented strategies. Figure 4 provides government projections on energy requirements for the year A.D.2000. With regard to commercial sources of energy, the average rates of increase per annum of about 7%, clearly exceed the projected annual economic growth rate of 5-6%. In the case of non-commercial energy, somewhat lower growth rate of just under 3% has been estimated. If these projections prove accurate, India may soon be at the end of its tether—on the financial, foreign trade and ecological fronts.

An increase in oil requirements of just under 8% p.a. will give rise to additional oil imports, even if oil explorations prove fruitful. Since the past few years, the balance of payment position has been serious and could get out of control even without the added burden of increased oil imports. This is the main reason why the Indian government is giving priority to indigenous coal and to the expansion of hydro and nuclear power facilities. But even here there are limits. Controversies over the erection of large dams, as in the Narmada Project, bring home an increasingly strong case against expansion plans in the future. On this account, estimates of the country's hydroelectric potential (85,000 MW; Koshoo, 1986:155) are



1) Excluding Coal for Power Generation
2) Data for 1982 and 2000
Source: CSE 1982, GOI 1985, TERI 1990, GOI 1990

FIG. 4 INDIA'S ENERGY REQUIREMENTS IN A.D. 2000 —Government Projections-

merely of theoretical interest. The expansion of the nuclear power potential from the present 1330 MW to 10,000 MW within a period of merely 10 years seems unrealistic, given the unresolved problems of waste disposal, the capital and amount of time required and the safety factor.

Table 4 clearly shows that, as opposed to the situation in most industrial countries, the Indian economy has grown more energy-intensive since the beginning of the seventies. This is partly due to the fact that non-commercial sources of energy were substituted with commercial sources. However, this development which is difficult to quantify does not provide an adequate explanation for the level of energy-intensity being so noticeably high and getting yet higher, for the consumption of non-commercial energy is more or less confined to the household sector. However, the industrial sector, which consumes over 50% of the commercial energy produced is likewise extremely energy-intensive and has not shown any signs of getting any less so.

In several countries, delinking has been effected to satisfy the demand for energy-intensive goods (heavy industries etc.), coupled with a "tertiarisation' of the

Table 4 : Energy Intensity of the Indian Economy (1970/71—1986/87)

	Energy Cons[1] (mtoe)	GDP[2] (Rs Billions)	Intensity (Kgoe/Rs)
1970/71	39.3	824.5	0.048
1975/76	51.8	940.4	0.055
1980/81	68.2	1222.3	0.056
1985/86	92.7	1560.8	0.059
1986/87	97.4	1623.3	0.060

1. Commercial energy only
2. GDP at 1980-81 prices
Source: TERI, 1990

economy. While the service sector in India has definitely undergone a disproportionate growth, the demand for heavy industrial goods has not yet fallen. The strategic structural policy decisions of Indian governments in the fifties and sixties continue to have an impact on developments in these sectors. During this period, Nehru's "big planners" scored over Gandhi's "small planners". The doctrine of the "big planners" laid down that "if you produced capital goods and steel, thus increasing the share of investment goods in gross national product, that would automatically mean a higher savings rate since you cannot eat steel" (Bhagwati, 1970 : 118). This policy of maximising the capital stock resulted in nominally high rates of investment coupled with gross inefficiency, ultimately giving rise to substantial amounts of "dummy investment".

One cannot overlook the fact that the prevailing industrial growth strategy in India is directly linked with high resource and energy-intensive development, not to speak of ambivalent economic and social consequences. Even though the beginning of the eighties ushered in the liberalisation of the economy, aiming at greater efficiency, a gradual 'opening-up' in foreign trade and rising growth rates,the capital and energy-intensive sectors of the Indian economy (particularly steel, cement, fertilisers, chemicals and the energy sector itself) devoured as much as 70% of government investment even in the Seventh Five Year Plan (GOI, 1985).

Yet another important area of reorientation is energy policy itself. Here, high priority should be accorded to a reduction in conversion losses in the energy sector. Other factors demanding immediate attention relate to the increase in efficiency of Indian power stations, the maintenance and upgrading of transmission systems, a reduction in the volume of flared gases and the processing of extracted coal-all of which presuppose a restructuring of budgetary allocation. Even the price policy in the energy sector is inefficient from the economic point of view; administered subsidised prices for electricity in particular have hampered technical innovation, impeded energy conservation and have, in addition, deprived the state of funds urgently required for modernisation (Anandlingam, 1983; Bhattacharyya, 1984).

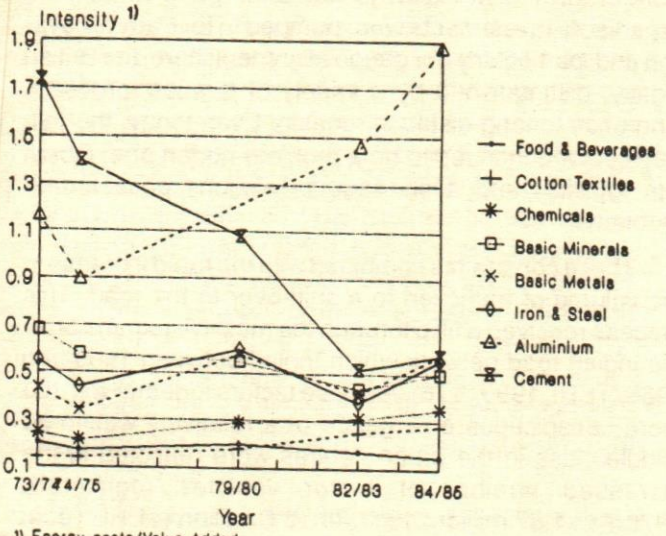
Of prime importance are measures directed at increasing the efficiency of fuel utilization whose potential is significant and hitherto left largely untapped. In the medium term, priority should be accorded to the industrial transport and household sectors which together account for 84% of commercial energy and 93% of total energy consumed.

The Industrial Sector: Structural Change, Modernisation and the Lowering of Energy Intensity

The Industrial sector in India consumes (table 3) more than half of the total amount of end-use energy available, 41% of electricity (43% incl. captive power generation), 90% of coal (excl. coal converted into electricity) and 19% of petroleum products. This figure is as much as 42%, if one takes into account the fact that practically the entire non-energetic consumption of oil is accounted for by industry. These figures go to prove that the industrial sector is of the highest significance for energy policy making.

On the whole, the energy intensity of Indian industry dropped by just 5.9% between 1972-73 and 1982-83 (Department of Power, 1989 : 9). This implies that, contrary to the impact in many other countries, the first oil crisis at least had hardly any impact on the efficiency of energy use in India. The specific energy consumption of Indian steel plants (total capacity : 21.2 million tonnes) exceeds that of German and US-American steel plants by 83% and 57% respectively (TERI, 1989 : 29). In this respect, the cement industry, which despite high growth rates has traditionally been a 'bottleneck sector' exceeds German cement plants by as much as 140%, American by 110% and even the world average by 30%. However, the situation has somewhat improved over the last few years with the creation of new, modern capacities (Department of Power, 1989 : 9; TERI, 1989 : 32). The aluminium industry, which with a total capacity of 362,000 tons is nowhere close to meeting Indian requirements, consumes 13% more power per ton than the average rate in the industrial countries (TERI, 1989 : 35).

In the case of other branches of industry, efficiencies can be rated only on the basis of less indicative monetary parameters, particularly on the share of energy costs in the value added. Figure 5 shows the trend for the period between 1972-73 and 1984-85. 75% of the energy consumed by industry is accounted for by the sectors of



1) Energy costs/Value Added
Source: TERI 1989

FIG. 5 ENERGY INTENSITY IN INDIAN INDUSTRIES—Selected Subsectors 1973/74-1984/85

food(20/21), textiles (23), chemicals (31) and basic minerals(33), as shown in figure 5. It can be observed that energy intensity temporarily dropped in the wake of the two oil crises, only to regain its original level after a few years. The trend in the iron and steel sector (330) and the aluminium industry (335) is shown separately : while the trend in the steel industry mirrored that of all the branches, though at a higher level, energy intensity in the aluminium industry rose dramatically, whereby it must be said that this dramatic rise was partly the outcome of a disproportionate increase in power rates. In the cement industry (324), the share of energy costs was reduced through capacity expansion and related modernisation. Given the fragmentary data at hand, one cannot discern an uninterrupted trend towards energy saving in Indian industry, as had been the case in many other countries since the beginning of the seventies.

The level of energy consumption continues to be extremely high. In the first extensive study of its kind undertaken by the National Productivity Council in 1983, it was found that on the whole about 25% of the energy consumed by the industrial sector could be saved. The measures proposed to achieve this end do not by any means involve full-scale modernisation to the level of state-of-the-art technology. Essentially, they are directed at better housekeeping, fuel processing, optimisation of combustion processes, small changes in the production run and the replacement of obsolete equipment, especially furnaces. In order to implement this package of measures, it was estimated that an investment of Rs. 3600 crores would be required. As against this, the decrease in energy costs would amount to over Rs. 1900 crores annually and—by way of a computational counter-weight —the saving in investment, which would have been necessary to supply the conserved energy additionally, is estimated to be to the tune of almost Rs. 5800 crores (NPC, 1983 I : 3). Thus, even in India, it is cheaper to save energy rather than to provide new infrastructure for energy supply time and again, even without taking into consideration the external costs involved.

A more recent study on some branches of industry, which have special relevance for the country's energy policy, confirms that the saving potential remains considerable even at the end of the eighties. Here again, the level of technology is not taken as a basic parameter. Table 5 shows that, under these circumstances, it is the "traditional" industries which indulge in some of the most indiscriminate "energy squandering ". The Indian government should keep this overall potential in mind.

Table 5 : Energy Conservation Potential In Indian Industries —Selected Subsectors

	% Share of Energy Cost[1]	Conservation Potential (%)
Iron & Steel	15.8	8-10
Fertilizers	18.3	10-15
Textiles	10.9	20-25
Cement	34.4	10-15
Chlor-Alkali	15.0	10-15
Pulp & Paper	22.8	20-25
Aluminium	34.2	8-10
Ferrous Foundry	10.5	15-20
Petrochemical	12.7	10-15
Ceramics	33.7	15-20
Glass	32.7	15-20
Refineries	1.0	8-10
Sugar	3.4	70-80
Ferro-Alloys	36.5	8-10

1. Energy Cost/Value of Output
Source: Raghuraman, 1989

The Transport Sector: Modernisation and Restructuring

In the last few years, the Indian transport sector recorded rapid growth and contributed 5.4% to the GNP in

at the disposal of this department are much too modest, and therefore, not commensurate with the importance of this sector (table 2). In most areas, efforts in this direction have not extended beyond pilot projects and development programmes.

The largest measure of success has been achieved in the utilisation of bio-gas which has been receiving state support since 1981 through the "National Project on Biogas Development". By 1988, approximately 1.05 million biogas units had been installed; however it is a known fact that a considerable proportion of these—officially 15%—are non-functional. It is estimated that the biogas units in operation today generate 1020 million. c.u.m of biogas and 17 million tons of organic fertiliser which is equivalent to a saving of 3.7 million tons of firewood (Dayal, 1989 : 48). It is reckoned that the energy requirements of 16-22 million households with 4 or more heads of livestock can be met by biogas (Dayal, 1989 : 40). Various standard models are available today which can be deployed according to the site of use. The investment of about Rs. 6000 per plant (of which approximately 30% is offered as state subsidy) gets amortised within 2 years (Dayal, 1989 : 54), if the market prices of firewood are put down as opportunity costs.

Fuel-efficient woodstoves (*chulhas*) constitute yet another possibility of saving firewood in substantial quantities, while at the same time preventing environmental and health damages. As compared to an average thermal efficiency of merely 6% for traditional stoves of which around 112 million have been installed in rural households, these improved fuel-efficient stoves have an efficiency rate of 14-25%. Since 1980, the dissemination of this improved technology has been promoted by subsidies ranging from 50-80% of the cost of the stove. By 1988,4.5 million such chulhas are reported to have been installed (Dayal, 1989 : 63). Upto 110 million tons of fuelwood could be saved through biogas and improved 'chulha' programmes alone (Goldenberg, et al 1987 : 256).

Particularly in mountainous regions, additional electricity to the tune of 5000 MW could be generated by small hydro-energy systems attached to irrigation systems and small river courses. To date, there are only 89 such "mini power plants" with a total capacity of 171 MW. 87 more are under construction (capacity : 198 MW) and another 255 in the pipeline (Dayal, 1989 : 155).

Even solar energy has been rated as having tremendous potential in India. However, practically speaking, it has had hardly any role to play so far. Pilot projects involving photovoltaic street lighting systems have been undertaken in a number of villages. Solar power systems are being installed within the framework of a few pilot projects underway. So far, the high investment costs for solar cells have proved to be a drawback for commercial use and it is only in extremely remote villages that these systems have proved economically viable. The thrust of research efforts has therefore been cost reduction.

Other alternative forms of energy are still in the experimental stage. Despite the technical and economical problems still linked with the utilisation of alternative sources of energy, their potential in India is extremely high —an aspect not accorded due weightage in the energy policy. Even if external environmental costs and the long erection time required for conventional energy projects are not taken into account, biogas, wind energy and small hydro-energy systems are economical even today, in terms of total expenditure/kwh (Dayal, 1989 : 225; Reddy, 1990 ; 1213). Thus, in the medium term, a palpable increase in fund allocations for the dissemination and further development of alternative energy technologies would not only yield ecological but also economic returns.

Conclusion: India's Contribution to the Reduction of Greenhouse Gas Emissions

Obviously, an energy policy directed at solving India's energy problems does not hold much promise for success if it is purely supply-oriented and otherwise isolated from other policy areas. In order to frame a "sustainable growth policy", it is of great expediency that policy measures in the various fields of activity be harmonised on the basis of the inter-relationships outlined above. Such a policy should seek to bring the above-mentioned goals in line with an appropriate measure of economic development, using the following priorities as guidelines:

Firstly, the pace of structural change should be forced in a direction which favours the delinking of economic growth and energy consumption. The intersectoral dimensions of this structural change could be encapsuled in the formula "High-ICOR-Moratorium" and would require a clear departure from the policy of capital stock maximisation. This intersectoral dimension would signify that—especially in the industrial sector—such branches are specifically promoted which have relatively low energy and environment intensities. The case of the Indian software industry is illustrative of the fact that India has considerable potential even in the area of know-how-intensive branches.

Secondly, there is a tremendous need for modernisation, a factor which is closely linked with the point outlined above. Even in India it has been established that conserved energy is far cheaper than additionally generated energy. Increases in energy production and utilisation

efficiencies could indeed be effected on a large scale, although this has not received any priority so far.

Thirdly, the utilisation of renewable sources of energy can be considerably expanded by promoting the development and dissemination of alternative forms of energy, or ecologically stabilised through afforestation. This would not only check deforestation, but also curtail the additional demand for non-renewable sources of energy which would arise from the substitution of non-commercial with commercial forms of energy.

Fourthly, there are a number of institutional reforms which could contribute toward solving India's energy problems. Among these is the reform of *usufructuary* and ownership rights for forest and fallow land where state administration has proved ineffective. Even the small measure of autonomy invested in state-owned enterprises, which are particularly active in the energy, basic and heavy industry sectors promotes the already widespread inefficiency.

The emission of greenhouse gases is only one criterion among many. Yet, even here it is clear that in the face of the on-going international debate on this issue, India cannot arbitrarily increase its share of the global emission of greenhouse gases in the next fifteen years and totally insulate itself from the pressure bearing down on every country to save energy. Table 7 gives the structure of the emissions of the most important greenhouse gases for the year 1988, whereby it should be pointed out that this data is more of the nature of estimates. A reliable quantification is not possible at present. Nevertheless, these figures will be used in the following as a basis for projecting certain scenarios—by way of illustration—which will at least give a rough impression of the scope available for containing emissions, particularly of Co_2, by the year A.D.2005.

Table 7: Emissions of Greenhouse Gases in India—1988 (Million t p.a.)-

Source	CO_2	CO	CH_4	No_2
Coal	294	26	16	1.8
Petroleum	107	11	3	1.0
Natural Gas	30	4	2	0.7
Fuelwood	54	12	2	0.2
Biomass	31	3	1	—
Total	516	56	24	3.7

Source: Dave, 1988

Scenario 1

Assuming an economic growth rate of 5% p.a. until A.D. 2005 and a constant energy elasticity of 1.45, the consumption of commercial energy in India would undergo an overall increase of about 180% as compared to the 1988 level. With structures of energy generation and utilisation remaining constant, CO_2 emissions would rise at more or less the same rate and amount to approximately 1.4 - 1.5 million tons by A.D.2005.

Scenario 2

This scenario is based on the following assumptions discussed above:

(a) An industrial growth of 7.8% p.a and the phased realisation of the energy conservation potential of 25% by 1995.

(b) An agricultural growth of 2.4% p.a. and the phased realisation of the conservation potential of 30% by 1995.

(c) A growth of 7% p.a. in the transport sector and the phased realisation of an energy conservation potential of 30% by 1995.

(d) An increase of 5% p.a. in the consumption of commercial energy in the household sector and a 50% reduction in the utilisation of non-commercial energy through substitution and higher efficiency (improved, fuel-efficient stoves etc.).

(e) An increase of 5% p.a. in energy consumption in the other sectors.

(f) A 30% reduction in conversion losses during energy generation by increasing the rate of efficiency of power stations, effecting a clear-cut reduction in transmission losses and in the volume of flared gas.

Under these assumptions and on the basis of 1988-figures, one obtains an energy demand of approximately 230 million tons of oil, equivalent for the year A.D. 2005. In the same period, primary energy requirements would shoot up by 120-130%, amounting to 330-350 million tons of oil equivalent. The elasticity of energy would drop from the present level of 1.45 to a long-term average of 1.16. Assuming that the structure of commercial energy generation remains constant, CO_2 emissions would increase by 90-100% to 990-1050 million tons p.a.

Scenario 3

The assumptions underlying this scenario are more far-reaching than those of Scenario 2:

(a) An industrial growth of 6.5% p.a. Further, the realisation of an energy conservation potential of 40%

upto A.D. 2000. This would necessitate more extensive modernisation as well as the accelerated restructuring of the industrial sector. As a result, there would be a decline in the share of energy-intensive industries in favour of new branches.

(b) An agricultural growth of 3.5% p.a. and the gradual realisation of the energy conservation potential of 30% upto the year 1995.

(c) Growth in the transport sector of 7% p.a. and the gradual realisation of the energy conservation potential of 35% until the year 1995.

(d) Increase of 3% p.a in the commercial energy consumption of the household sector and a 75% reduction in the utilisation of non-commercial sources of energy. Due to the growth in population, this would only allow for marginal substitution effects and would assume total exploitation of alternative sources of energy and a substantially higher rate of efficiency with regard to the residual use of firewood and other sources of energy.

(e) A 5% p.a. rise in energy consumption in the other sectors.

(f) A 40% reduction in conversion losses during the generation of commercial energy until A.D. 2005 through basic modernisation schemes, utilisation of possibilities for cogeneration etc.

On the basis of these assumptions, end-energy consumption in India would rise to around 175 million tons of oil equivalent by the year A.D. 2005. Primary energy requirements would grow by 60-70% to 240-255 million tons of oil equivalent. Energy elasticity would decline to a long-term average of 0.57. Assuming that the structure of commercial energy produced remains constant, Co_2 emissions will increase by 35-45% to 690-740 million tons p.a..

Figure 7 shows how the Gross National Product would develop upto the year A.D.2005 in relation to primary energy consumption, assuming a growth rate of 5% p.a. and given the various scenarios presented above. It is only in combination with far-reaching modernisation measures and, above all, through the enforcement of both intersectoral and intrasectoral structure change that conditions leading to a gradual delinking of economic growth and energy consumption can be created. The scenarios outlined here however also show that more far-reaching measures would have to be adopted as a necessary prerequisite for an absolute reduction of greenhouse gas emissions, which will form the goal of an international convention in global the climate.

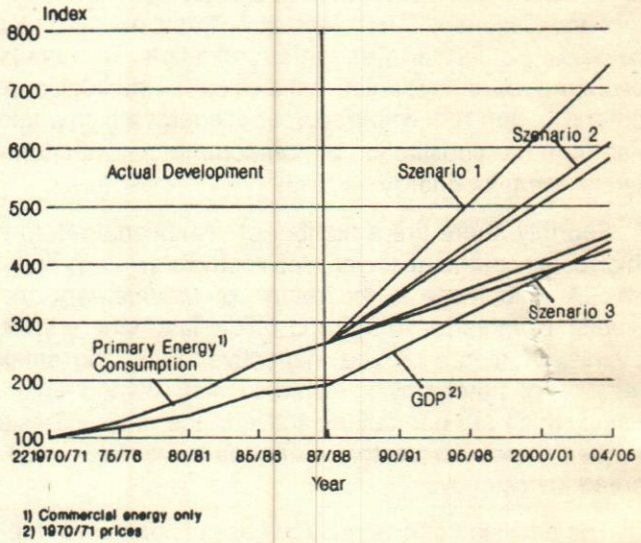


FIG. 7 ECONOMIC GROWTH AND ENERGY CONSUMPTION— 1970/71-2004/05 (1970/71=100)

These scenarios do not include the entire range of measures which would help check greenhouse gas emissions. For instance, they proceed on the assumption that the structure of commercial energy generation will remain unchanged. It is a known fact that emissions vary according to the source of energy. Restructuring will be possible to some extent. In particular, the foreign trade implications of a switch-over to petroleum and the ecological problems arising from an expansion of hydel and nuclear power projects serve as limiting factors here, by proving a hindrance to a perceivable measure of restructuring. It must be borne in mind that in the long term the potential for renewable sources should be further explored and utilised.

The stepping up of afforestation efforts combined with the abovementioned measures for curtailing the consumption of firewood along with institutional reforms pertaining to forest *usufructuary* rights could prevent further deforestation and, alongside other socio-ecological benefits, also make a positive contribution towards containing the Co_2 load on the environment through a higher absorption capacity.

It is to be expected that the Indian government will stick to its reserved stand *vis-a-vis* an absolute reduction of emissions and, with the growing insistence of calls for

delinkage, demand increasingly higher financial compensations. On the other hand, it is also clear that the Indian economic policy has considerable leeway to induce a change in the trend through a shift to priorities. The sooner such a development sets in, the more clear-cut will be the results.

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Responsibility of Industry Towards the Environment

Michael G. Royston

In this paper the author attempts to look at the environment and Industry as a single system to show some of the actions which have been taken by people who have had a positive, imaginative and holisticapproach to the environmental crisis. The author believes that the true value of environment is to be found not in its exploitation but in its preservation as a natural wealth. He puts forth the view that responsibility of the industry towards environment is indistinguishable from the responsibility of industry towards itself and towards its own shareholders and stakeholders.

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The true value of environment is to be found not in its exploitation but in its preservation as a natural wealth. Already in the 17th century Thomas Traherne could say, "Is it not easy to conceive the world in your mind? To think the heavens fair? The sun glorious? The earth fruitful? The air pleasant? The sea profitable? The giver bountiful? Yet these are things which it is difficult to retain. For could we always be sensible of their use and value, we should always be delighted in their wealth and glory".

This paper would specifically look at environment and industry as a single system and show some of the actions which have been taken by people who have had a positive, imaginative and holistic approach to the so-called environmental crisis.It is this unified view which will enable industry to transcend the dualism implied by the phrase "responsibility of industry towards the environment" and achieve a viewpoint where such responsibility is indistinguishable from the responsibility of industry towards itself and towards its own share-holders and stakeholders.

The enterprise has a basic set of objectives. Survival is perhaps the most fundamental, but in a changing world this is contingent on growth which is certainly qualitative and may also be quantitative. Such growth depends on making a profit or surplus. These corporate objectives are realised by the products and services which are marketed, by the production operations which produce them and by projects for new production operations and new products.

The environment in which these activities take place is initially the technological environment (fig. 1). But the new technological activity soon has a qualitative and quantitative impact on the economic environment. Resource demands and pollution have an impact on the physical environment, which in turn, through the curtailing of certain activities and conflict with cultural values, has an impact on the cultural environment. This in turn, acting through various social institutions, has an impact on the societal environment which in its turn, through concerned individuals and groups, affects the political environment

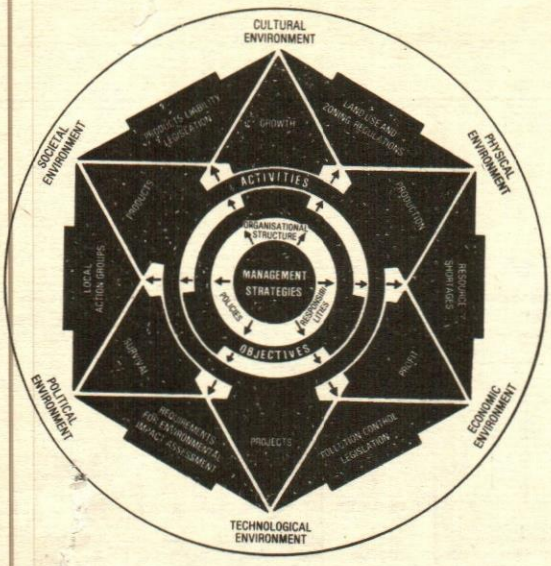


FIG. 1. THE INTERLOCKING OF THE 'ENVIRONMENT—MANAGEMENT' SYSTEM

which then brings pressure to bear on the technological choices which started the chain reaction. In response to these impacts projects are increasingly having to submit to the prior assessment of their impact on environment and are being forced to conform to pollution control legislation. Production operations are constrained by resource shortages and by land use and zoning regulations. Products are threatened by new legislation on product liability and by direct action by citizen groups. Thus the main activities of the enterprise are imperilled and its chances of attaining its objectives of profit,growth and survival are threatened. The response is a set of management strategies which address themselves to a corporate environmental policy, a corporate environmental organisational structure and a corporate wide set of environmental responsibilities for every function and every level; from the chairman to the gatekeeper.

Corporate Objectives

Profits

Increasingly, firms see that pollution of air, water and land is an indication of waste—wasted water, wasted raw materials, wasted product and wasted energy. Many of our processes were designed when the cost of water, energy and raw materials were low—much lower than they are now—and the cost of effluent treatment could be ignored. More important, most designs were based on discounted cash flow calculations when long-term high running costs, with excessive water, energy and raw materials usage seemed an acceptable price to pay for short term savings in capital cost. If this approach is replaced by a unified view of the complete system of raw materials, services, products, by-products, pollution, capital costs and running cost, and if the aim is to re-optimise this whole, it becomes possible to reduce the use of energy, raw materials and water, and to cut costs and pollution at the same time.

The 3M Company has pioneered this approach. Under the title of "Pollution Prevention Pays" (PPP), proposals for special cost effective pollution abatement programmes have been encouraged. In the nine months after the programme was introduced into 15 countries, it resulted in the elimination of 70,000 tons of air pollutants and of more than 500 million gallons of waste waters. Instead of costing money, the clean-up saved the company 11 million dollars a year in operating costs. In the United Kingdom in 1976, the PPP programme saved £739,000 per year by reducing solid waste, £15,000 by reducing water pollution and £311,000 by reducing gaseous emissions. Each year since its inception similar savings have been made by further reductions of waste. The only difference is that now it is becoming necessary to spend money in order to save money, whereas in the early days little or no investment was necessary. Other companies have been equally successful. In their complex in Midland, Michigan, over a period of three years, Dow Chemicals saved 6 million dollars in materials that were previously going to the sewer. Dow Corning invested $2.7 million to reduce chlorine and hydrogen escape and cut operating costs by $900,000 per year.Hercules invested $750,000 to cut water pollution and saved $250,000 per year as a result. In Dow's 14 latex plants an investment of $2 million in pollution control cut operating costs also by $2,000 per day simply by tightening some flanges and reducing gas escape. In the United Kingdom, ICI amongst otners, has many similar experiences. In Scotland, North British Distilleries were threatened with closure because their still bottoms were polluting the local salmon river. The cost of installing effluent treatment equipment to deal with this heavily polluting material would have been prohibitive. Instead, with the aid of APV, they installed evaporators and driers, at a cost of some £600,000. In the first year of operation, the dried 'pollution' which proved to be a very good animal feed, rich in protein, starch, vitamins and minerals, was sold for over £1 million. The 'pollution control' plant paid for itself in less than a year making everyone wonder why, if it was so profitable, it hadn't been done long before. The answer is, of course, the 'tunnel vision' which afflicts us all. We see only our traditional area of activities and are locked into considering solutions in that narrow area. By broadening the vision, by taking a systems view, North British Distilleries found a new busi-

ness in high protein animal feed; English Clays found a new business in prefabricated houses which use up their china clay wastes in Cornwall, and the Ready mixed Concrete Company found a new business in running a large profitable aquatic sports centre at Thorpe, just outside London, in what would have otherwise been yet another rather nasty water-logged hole left after the extraction of gravel. In France we see similar opportunities have been realised. Some of these are listed in table 1.

Table1: Examples of Pollution Prevention and Resources Recovery measures in France.

Process	Company	Annual Cost Saving in French Francs
Recovery of hydrocarbon in an oil refinery	Raffinerie Elf Feyzin (Rhone)	5,356.000
Recovery of methionine mother liquor by evaporation	Soc. Alimentaire Equilibree de Commentry (Allier)	2,500,000
Recovery of plum juice	Etablissements Laparre Castelnaud de Gratecombe (Lot-et-Garonne)	107,500
Recovery of Glycerine in a soap factory	Savonnerie de Lutterbach (Haut-Rhin)	173,300
Water recycle in fibreboard plant	Isorel, Casteljaloux (Tarn-et-Garonne)	250,000
Recycle of effluents in glue and gelatine manufacture	Soc.des Ets. Georges Alquier Bout-du-Pont-de-l'Ain, Mazamet(Tarn)	18,000
Recovery of iron dust in steel works	Sacilor, Gandrange, (Moselle)	800,000
Recovery of Whey	Soc.Lacto-Centre Bas-en-Basset (Haut Loire)	726,000
Recovery of quarry washings	Soc. d'Exploitation de l'Entreprise Mir-Saint-Lary (Hautes-Pyranees)	7,800
Recovery of protein and potassium from a yeast factory	Soc. Industrielle de la Levure Fala (SILF), Usine de Strasbourg (Bas-Rhin)	155,500
Recovery of lead and tin from furnace fumes	Soc.des Alliages d'Etain et Derives, Montreuli (Seine-Saint Denis)	8,730
Conversion of phosphoric acid waste into plasterboard	Rhone Progil, Les Roches de Condrieu (Isere)Rouen (Seine-Maritime)	500,000
Conversion of semi-chemical by thermo-mechanical pulp mill	La Raochette-Cenpa, Usine de la Rochette (Savoie)	137 per tonne

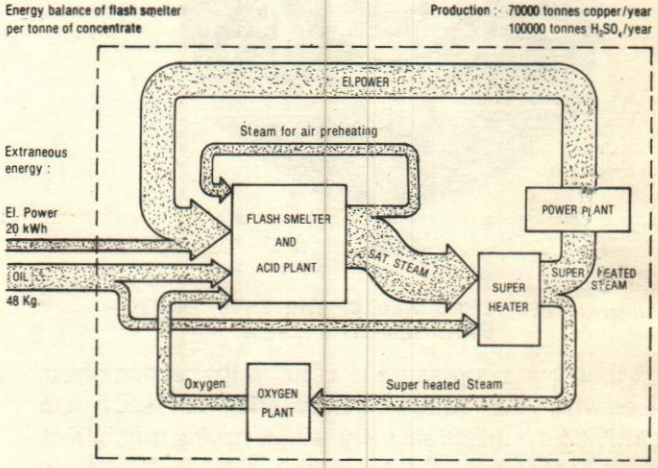


FIG. 2 SCHEMATIC ENERGY BALANCE FOR A COPPER SMELTER USING OXYGEN-ENRICHED PROCESS AIR, WITH A SMELTING CAPACITY OF 1000 TONS OF CONCENTRATE A DAY AND A PRODUCTION RATE OF 70,000 TONS OF COPPER AND 100,000 TONS OF SULPHURIC ACID.

Table 2 shows similar examples from the Federal Republic of Germany. These examples are only a small part of the many thousands of cases where a more positive and imaginative approach has enabled a potential pollutant to be turned into a profitable product, which were mentioned at the International Conference on "Non-Waste Production and Technology", held recently by the Economic Commission for Europe in Paris.

However the extraordinary thing is not so much that so many examples exist, but that in almost all cases they exist despite the complete absence of a management policy aimed at mobilising the efforts and imagination of everyone in the organisation to re-examine existing practices and come up with more efficient solutions which are both cheaper and cleaner.

Table 2: Examples of Pollution Prevention and Resource Recovery Measures in Germany.

Name of Company	Problem	Solution	Benefit
Gesamtverband der Deutschen Steinkohlenbergbaus	Air and Water pollution from loading of dusty coal and wet quenching of hot coke from coke ovens	Enclose discharge area and quenching zone AND Continuous coking process gas	Less pollution and recovery of water gas and steam which provides 30-40% of energy of plant or production of synthesis gas
Forschungsinstitut der Zementindustrie	Dust emissions from cement works	Dust collection from mills and kilns and klins and recycle of material	Less pollution and greater efficiency
Verein deutscher Eisenhuttenleute	Water pollution from steelworks 29 million tons of solid from reused steel works producing 50 million tons of steel	99% recycle of water. Recycle and re-use all but 2 1/2 million tons as road material, cement, fertilizer, recycle of iron dusts, etc.	Less water costs, less pollution Increased efficiency and sales from reused products
Vereinigte Aluminium Werke	Fluoride rich waste gases	Absorption of fluorides on aluminium oxide and return to the smelters	Reduced air pollution and saving in purchase of cryolite flux
Fa. W. Reffelmann, Metall-verarbeitung KG	Water pollution from electroplating solutions, especially the rinse waters.	Counter-current washing rent washing of workpieces, followed by ion exchange of concentrated solution	No pollution. Recovery of nickel and chromium salts improved water quality. Reduced use of chemicals
Rohm GmbH	Waste acid from acrylic resins	Pass waste salts through cracker and regenerate 500 ton/ day of sulphuric acid.	No polluttion, no purchase of acid.
Verband Kunststofferzeugende Industrie	Disposal of waste plastics	Retorting or pyrolysis of wastes to produce original monomers for re-synthesis or fuels AND Melting down and production of foams AND Re-melting and moulding new products AND Burning fuel	No pollution New product Energy saving
ENKA-Glanzstoff AG	Pollution of rivers by zinc from rayon spinning bath	Precipitate zinc with lime water and recycle to process	Reduced pollution Reduced process costs.
Wirtschaftsverband der deutschen Kautschukindustrie	Waste tyres	—Retread —Rubber recovery —Blacktop for surfacing —Pyrolysis for recovering raw materials —Backing of rails —Coastal protection	Eliminates intractable waste problem and creates new materials and energy.

Alternatively, it is possible to look at these opportunities sectorally.

At an even higher level, and given the right policy guidelines, clean operation becomes as much as indication of good management as does profitability. Thus a study of 17 companies running 120 pulp and paper mills in the USA showed a strong correlation between a good record of pollution control and a good profit record. (table 3)

While the association measured here does not necessarily imply causality, the investigators of this particular study did conclude that the good profit record reflected the lower costs associated with better pollution control and better management.

Growth

A Wall Street analyst recently posed a rhetorical question "What business sector has grown fastest over the last 7 years is already close to a $ 50 billion business, and will certainly continue to grow in the future?" The answer was "the environmental business",

Table 3: Relationship between Pollution Control and Profit

	Rank Correlation Coefficient		
Between and	Earnings per share	Return on equity	Return on capital
% of plants with pollution control equip.	Significant*	Significant*	Not Significant
% of plants with advanced waste water treatment	Significant*	Significant*	Not Significant
Subjective evaluation by Council of Economic Planning of pollution control effort	Significant*	Significant*	Significant*

* *significant at the 95% confidence level)*

which in the USA, as in most countries, has been expanding at 20% per year and is likely to continue growing in the future. The environmental 'business' is now perceived as a legitimate business sector. Most societies are calling for safer and cleaner products produced by safer and cleaner

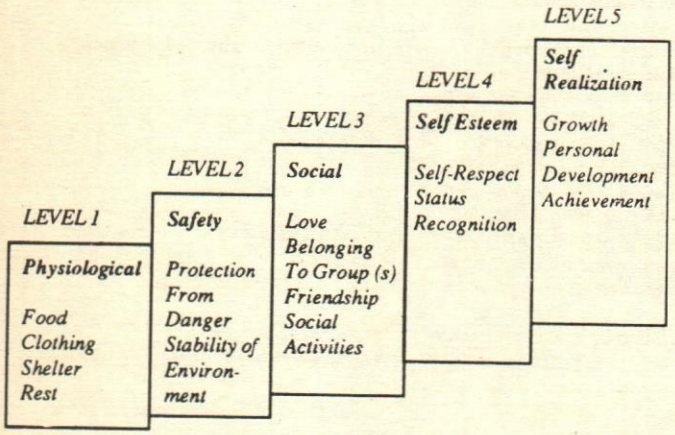


FIG. 3. HIERARCHY OF HUMAN NEEDS

production facilities. This new activity is as legitimate an area of business as the old one of more and bigger products from more and bigger production facilities. It is simply an example of moving one step higher in the hierarchy of needs. (fig.3.). Both types of activity contribute to economic growth but they are different in nature. We are moving from an economic age dominated by quantity to one concerned increasingly with quality.

In this new climate a company that has a negative attitude to environment, that thinks that the drive against pollution is an anti-industry conspiracy and that believes that we can go back to growth based on quantity rather than quality, will not recognise the opportunities for new products and services, let alone be able to exploit them. However, the same positive, pro-active, imaginative approach which contributed to attaining the corporate profit goal has led many companies to grow into the area of environmental protection and the associated areas of products and services which contribute to human health, safety and well-being.

There are many specialist companies growing up in the environmental area and many large companies are setting up specialised divisions:

* In the USA, Apollo Chemical Co.started in the air pollution business 15 years ago employing 10 people and now employs over 400 and has subsidiaries all round the world.
* Boeing has systems for recycling industrial wastes and for drying sewage sludge.
* FMC Corporation markets equipment to treat waste from steel plants.
* Oil companies such as Exxon, Shell and BP provide chemicals and equipment to combat oil spills.
* Ciba-Geigy, Krupp, Dow, Philips and 3M all have specialised divisions to market environmental services.
* ICI has three environmental service divisions—general technical and instrument, deepshaft treatment systems and biological services plus plastic filter medium.
* PLM in Sweden doubled its turnover to 2 billion Swedish Crowns by adding reclamation systems to its existing packaging business.
* A "Mega-buck Revolution" is claimed by companies in the garbage handling business. One US company in this area has a turnover of $350 million.
* Caterpillar Company markets an integrated and self supporting power system for sewage works.
* In Germany 200 new firms have been set up to provide environmental products and services.
* To turn garbage into useful products:

  —a Union Carbide process converts it to ammonia,

  —an Occidental Petroleum process to fuel oil,

  —the Destrugas process to fuel gas.

A study carried out by MIT looked at the impact of environmental legislation on innovation in France, Germany, the Netherlands, the United Kingdom and Japan. It identified 164 'environmentally' induced innovations and concluded that environmental legislation produced major technological and economic benefit to the companies and the countries concerned. Table 4 shows their distribution by country and sector.

In 1970 Sweden was faced with an economic recession. Amongst other measures it introduced strict pollution

Table 4: Sectoral Opportunities for Resource Recovery and Waste Minimisation.

Food Industry	—	Estimated potential for saving 5,000 million francs a year in France by converting food industry wastes to animal feed.
	—	Goldkist poultry plant cut wastes by 66% and reduced costs $ 2.33 per annum for each $1 invested.
	—	Tomatim Distillery plan to raise £3-4 million of eels in hot water effluent.
	—	Recovery of protein from slaughterhouse waste yields return of 30% on investment.
	—	Union Camp Converts wastes into flavours and fragrances and sells them at $1 per pound. This has boosted sales over $ 100 million.
Pulp and paper Industry	—	Displacement bleaching produces one tenth waste and uses half the energy of conventional process.
	—	Closed water cycle in chipboard plant eliminates waste water and increases yield by 30%.
	—	Precipitators costing $4.5 million recovering $3.5 million worth of salt cake each year.
	—	The Great Lakes Paper Co. has a closed cycle pulp mill which is only 5% more expensive to build than a dirty mill but is 5% cheaper to operate.
Textile Industry	—	Solvent dyeing eliminates 99.9% of water pollution and cuts energy consumption by one third.
Chemical Industry	—	Westvaco converts chemical wastes to fine chemicals and has thus doubled its turnover to $45 million.
	—	In the Soviet Union energy convertion and water recycle cut costs in ammonia plant to 40-45 roubles/ton.
	—	An ICI petrochemical complex separates oil, wastes and burns them to raise steam and save £300,000 per year.
	—	A small UK company grew to a £ 100,000 per year profit operation by recovery and re-selling waste low boiling point solvents.
	—	FMC rayon plant recovers 7.5 million pounds of zinc with a pay back time of 2 1/2 years.
	—	Finnish chemical plant uses activated carbon to recover 95% of solvent vapours. Return on investment 51%
	—	Ciba Geigy took advantage of the recession to re-examine all its chemical plants in Basel and with minor modifications eliminate half the pollution and improve production costs.
Oil Refineries	—	Shell Canada ploughs refinery sludge into the prairie and increases barley crops 18-31%.
	—	Mobil plans to use its waste heat to run a £20,000 tomato growing operation in the Thames estuary.
Metallurgical Industries	—	Steel industry recovery 98% water recycle, 99% dust recovery and 90% solid waste recovery increases yields and reduces costs.
	—	Pickle liquors yield iron dust and pigments.
	—	Electrolytic recovery of copper from waste waters yields 23% return on investment.
	—	Combining flash smelting of copper with sulphuric acid production eliminates 98% of air pollution, saves 50% energy and makes a useful product. (fig. 2).
Extraction and Building Industries	—	English Clays use china clay wastes for prefabricated houses.
	—	Ready Mixed Concrete Co. Ltd converted old gravel pits into Thorpe international aquatic sports centre.
	—	In Switzerland, cement dust abatement equipment paid for itself in three years and allowed for productivity to increase 60%.
	—	British powerstations produce over 5 million tons of fly ash each year for insulating bricks.
	—	In Poland 90 million tons of mineral wastes are re-used each year for building materials, etc.
Agricultural Industries	—	Frigoscandia in Sweden markets equipment to dry chicken droppings as cattle feed.
	—	Battelle North West process cattle manure to raise its nutritive value for recycle as cattle feed again.
	—	In France agricultural wastes represent an energy potential equivalent to 20 million tons of oil.
	—	In India 40,000 Biogas units are built each year to convert manure into methane plus compost.

Table 5 : Innovations in which environmental concerns were considered

Sector	France	Fed.Rep. Germany	Japan	Nether-lands	United Kingdom	Total
Automobiles	4	12	2	0	10	28
Chemicals	9	12	6	5	12	44
Computers	5	9	7	0	10	31
Consumer electronics	7	8	6	3	8	32
Textiles	10	6	0	7	6	29
TOTAL	35	47	21	15	46	164

control measures, but gave up to 75% cash grants towards the purchase of pollution control equipment. The result was a massive stimulation to the construction, equipment and chemical industries which helped pull the country out of the recession. A similar policy in Japan in the post oil-crisis recession in 1974 produced similar results; 20% of the economic growth was attributed exclusively to the new strict environmental legislation. It has also, incidentally, helped put Japan among the world's leading suppliers of advanced pollution control equipment (e.g., pyrolysis plants and fuel gas de-sulphurizers). The environmental industry has generated considerable employment in the USA where some 2 million people are employed in the construction, operation, design, development, marketing and administration of products and services to protect the environment.

The inescapable conclusion is that pollution control contributes to economic growth by stimulating innovation, economic activity and employment. This is particularly significant since pollution itself is a drain on the economy. Damage to health, agriculture, amenities and materials in the United Kingdom amounts to some 3% of GNP each year.

If embarking on a vigorous programme of clean up is good for the economy as a whole—particularly if backed with subsidies for cleaning up old plants—it is even better for the firms who supply all the new equipment, chemicals, services, etc. In many instances it is just a question of grasping opportunities. One of the largest companies in the USA making air conditioning equipment was hit by the energy crisis, and is now aiming to double its business by moving into heat pumps. As its vice-president said, "If you have been dealt a lemon, you'd better start thinking about making lemonade".

A positive commitment to environmental protection and a sensitive appreciation of the changes in social values which are behind the environmental movement stimulates the enterprise and enables it to grow with new social directions. New pollution control products and services is only the tip of the iceberg.

Survival

The survival of the enterprise is obviously its fundamental objective; survival is linked to growth and adaptation in the changing world— particularly growth in and adaptation to a world which is increasingly well-educated, increasingly concerned with non-material needs such as health, safety, well-being, self-realization; and is clearly moving into a post industrial phase. What is the role of industry in such a post-industrial society? Clearly the answer lies in adaptation, in evolving with the times, in becoming in fact a 'post-industrial' manner. In practice this might, for example, mean facing the challenge of the micro processor and its myriad of applications and being prepared to abandon outdated and inappropriate industries such as shipbuilding.

The implications of such an adaptation could be very fundamental. Take the case of United Kingdom. In a small over-crowded island, desperately short of raw materials, energy and space but rather well endowed with highly educated and remarkably creative people, is there a future for raw material, energy and pollution intensive, unpleasant and dangerous industries such as basic steel making? Should we not rather import the steel and export fine engineered products?

In many industrialised countries this type of accommodation is already well under way, and has usually led to considerable re-structuring. Japan, for example, is consciously and officially heading for an all-electronic future—shipyards and steel mills and heavy chemical plants are closing. In some quarters it is even being questioned whether the Japanese automobile industry has any future. And Japan is one of the countries which is most advanced in the use of industrial robotics!

On a shorter and more immediate time scale and very much nearer home, the survival of companies is being threatened by conflict; conflict which can only be avoided by a positive, pro-active and imaginative approach to environment and pollution. The social scene of all western industrialised countries has been marked by conflict between central governments and industry on the one hand and ordinary citizens, action groups and local governments on the other. (This is hardly surprising since according to the EEC in Brussels in the most economically developed parts of Europe over 30% of the population have a 'post-materialist' or 'post-industrialist' attitude or value system.)

Over the last ten years, in the United Kingdom there have been hundreds of conflicts blocking, delaying or

closing down industrial activities. Opposition groups include such disparate bodies as local branches of the National Farmers Union, Housewives Action Groups, Local Residents Associations, Conservation Societies, groups such as Friends of the Earth, Members of Parliament, Country Councils, District Councils, and Parish Councils. Groups such as these have been locked in conflict with almost every major company and public enterprise. The list of proponents looks like the Who's Who of British Industry. The issues involved have covered water pollution, air pollution, noise, safety and hazard. Such conflict usually results in economic loss for industry and an undermining of the company's chances of survival.

One typical case illustrates the problem involved and also points to one possible form of solution. British Acheson Electrodes Ltd. operates a graphite electrode plant on a pleasant green site just outside Sheffield. Over the years it became engulfed in housing developments, and in due course the local residents began to complain about dust, smell and noise. The dissatisfaction grew to such an extent that the continued existence of the factory was threatened. The company decided that rather than fight it, it would try to reach an accord with the local community. A joint advisory council was set up, chaired by the local vicar, in which representatives of local interest groups and company people met together to share information and problems and to work together towards solutions. This procedure proved to be very effective in minimising conflict and maintaining constructive dialogue between industry and community.

There are many other similar cases where joint planning and dialogue have led to peaceful coexistence: the Molybdenum mine in Colorado, USA which was planned with the Sierra Club; in the Federal Republic of Germany, Mobil's Wilhelmshaven oil refinery; in Belgium, Esso Chemicals polyethylene plant; to name but a few. One of the most notable examples is that of the Sullum Voe oil terminal in Shetland. The terminal was designed to handle the oil from two North Sea oilfields, but met with considerable opposition from the islanders who were determined to protect their environment and their way of life. The solution found was a partnership between the communities and the companies in the form of a joint body, the Sullum Voe Advisory Group, whose task it was to plan in detail where and how development should take place. Despite the inevitable problems this experiment in ecology was successful and since last December, the Sullum Voe terminal has been feeding north Sea oil to the British markets.

Such examples illustrate that, in order to ensure its own survival and that of its projects and activities, industry needs a pro-active and imaginative approach to the environment. In this area of possible environmental conflict it implies, above all, adopting environmental values as part of the company culture and accepting environmental claims by those outside the company as being perfectly legitimate. Only then can there be communication, participation and negotiation based on a commonly agreed language, a mutual respect for the other's concerns and interests and a common goal. Thus by taking the initiative in environmental affairs the company can ensure that it will meet the three primary corporate objectives of profit, growth and survival. This type of policy will naturally be reflected in the activities of the company.

Activities

Projects

In project planning, taking the initiative means involvement early in the planning process of all those who appreciate the impacts which the project might have on the total human environment. The objective is to avoid conflict and excessive control by the regulating authorities by meeting their requirements ahead of time. This requires thorough knowledge of the institutional as well as the physical, cultural and social environment in which the project is to be realised. Such an approach means spending time on the site, studying the ecology and getting to know the people. It means: identifying clearly the project activities and the environmental components with which they will interact, predicting the impacts, identifying the persons most concerned about the impacts, and, above all, discovering what can be done to mitigate or offset these impacts.

This environmental impact assessment should be part of the early design process and should aim at producing projects that are better, both ecologically and economically. The questioning of the classical project team of engineers and economists by 'outsiders' such as ecologists, health experts, sociologists and the local people themselves raises questions about 'traditional' design wisdom, forces a justification of traditional thinking, generating creative ideas and often gives birth to cheaper and better solutions.

The increasing demand to prove the 'need' for a project has weeded out a number of proposals that were basically unsound. There were many companies that were very happy in 1974 that their projects for oil refineries or petrochemical plants had been blocked by environmental-

ists in the early 1970s! Prior impact assessment may save a company the embarrassment in a public hearing of having the 'ignorant' public undermining the economic viability of a project and proposing cheaper alternatives, as happened recently in Northern Canada over a hydro-electric project and as happens frequently at public hearings of road building projects in this country. Thus the early introduction of different views can be very beneficial for projects. In fact, one could say that good project management, which is defined as delivering a project on time, on budget and on specification, can only be achieved if the environmental factors are taken into account. Failure to appreciate the inevitable interaction between a project and the physical and social environment in which it will be realised may lead to unexpected snags which cause delays and hence cost over-runs, and may well mean that the full range of projected benefits will not materialise. So good project management includes environmental management.

Processes

Paradoxically enough, in production operations when faced with a pollution problem, the last thing that one should do is to call in a salesman of pollution control equipment. In most instances the least favourable solution to a pollution problem is to add on, often at considerable expense, a piece of equipment that does nothing to reduce the cause of that pollution.

Bearing in mind that pollution is merely waste material being discharged into water or the atmosphere, it is better by far to tackle the problem at its roots by a non-waste approach. Such an approach might include some or all or the following actions:-

1. Cut down waste by improving efficiency.
2. Sell wastes to someone else.
3. Build-on extra plant to convert wastes into raw materials or products which are valuable to the enterprise or to someone else.
4. Work with the self-cleansing and dispersing power of the environment so as to permit maximum discharge of effluent.
5. Negotiate emission standards and subsidies with the authorities and the community.
6. Build the treatment facility needed for residual wastes jointly with another enterprise or with the local authority.
7. Build the plant with company manpower and know-how and sell the acquired know-how to others with the same problem.

The 3M Company has formalised its approach to solving the problem of pollution under its 'Pollution Prevention Pays' programme. The four basic aims are; reduction of pollution through product reformulating: reduction of pollution through process modification; reduction of pollution through equipment redesign and reduction of pollution through recovery of waste material for re-use. The concept is promoted actively throughout the company, particularly at shop floor level, and rewards are offered for successful programmes. To qualify the programmes must: firstly eliminate or reduce a pollutant; secondly, bring about reduced energy consumption and more efficient use of raw materials, water, etc.; thirdly, it should include some innovative features and fourthly, it should bring monetary benefit through reduced or deferred pollution control or manufacturing costs, increased sales of existing or new products, or by reduced capital or running costs.

Union Carbide has a two-pronged approach. The first stage consists of an internal Environmental Impact Analysis which gives numerical ratings for the impact of each of their operations on each of the major environmental areas: air, water, land, noise, plant life and animal life. Such an analysis highlights the priority areas where something should be done, whether there is external pressure to do it or not. The second stage is a detailed materials balance to determine exactly what goes in, in the form of raw materials, energy, water, etc. and what comes out, in the form of products, by-products, solid wastes, liquid effluent, gaseous effluents, etc.

The non-waste technology approach means looking critically at alternative processing conditions and selecting the most cost effective in terms of cost savings per unit of pollutant removed. A check list of procedures might look like this:-

Stages of Introducing Non Waste Technology

Step 1. ANALYSIS OF CURRENT SITUATION

- Site analysis
- Flow sheets, operating conditions and flexibility
- Pipe runs and drains
- Materials balance
- Energy balance
- Water balance
- Legislative trends
- Waste treatment costs (actual and potential)

Step 2. POSSIBLE ALTERNATIVES

a) For reduced water consumption, including measures to:
   - Reduce wastage
   - Reduce waste waters
   - Treat and recycle water in the plant
   - Use separate drains
   - Substitute other solvents

b) For reduced materials use, including measures to:
   - Increase conversion
   - Increase yields
   - Recycle materials
   - Avoid spillage
   - Re-use wastes from other processes
   - Reduce wastes

c) For reduced energy use, including measures to:
   - Re-use waste heat
   - Couple endo-and exothermic processes
   - Integrate heat and power production
   - Reduce temperatures
   - Reduce boil-up rates
   - Reduce pump and compressor loads
   - Reduce heat losses, insulate

Step 3. SELECTION OF OPTIMUM MEASURES

   - Examine the impact of the proposed alternatives on the capital and operating costs of the site (Process plants and waste treatment plants) taking into account practicability of the suggestions and their interactions with each other.

The other steps that might be considered include making use of computerised Waste Exchanges to find a buyer for wastes, linking in with other process to find uses for waste energy, materials or water, careful siting of discharges, working with local communities both administratively and operationally, e.g., taking advantage of combined treatment of industrial and municipal wastes which is cheaper and more effective than treating wastes separately, or mixing alkaline wastes with someone else's acidic wastes. Table 6 shows such examples. Basically the non-waste approach means taking a systems view of an environmental problem and optimising the system both economically and ecologically.

Table 6: Summary of Examples of Non-Waste Technologies

Integrated Systems	Wastes Avoided
Copper smelting—Sulphuric Acid—Fertilizer	SO2 Heat, Resources
Garbage Disposal—Power Generation—Drinking Water Production	Land, Heat, Resources
Garbage Disposal—Fuel production—Metal Recovery	Land, Resources
Chemicals-Fine Chemicals	Water Pollution
Harbours—Oil	Water Pollution
Paper—Alcohol—Protein	Water Pollution
Foods—Protein	Water Pollution
Steel—Municipal Waste Water	Water Pollution
Cheese—Pigs	Water Pollution
Chickens—Pigs	Water Pollution
Electric Power—Sulphuric Acid	Air Pollution
Domestic Water—Industrial Water—Pollutant recovery	Water Pollutants, Resources
Whisky Production—Animal Feed	Water Pollutants, Resources
Timber—Plywood—Pulp	Water Pollutants, Resources
Heat—Power	Air Pollution, Heat Resources
Metallurgy—Paper	Air Pollution, Heat Resources
Aluminium—Cryolite	Air Pollution, Energy Resources
Alloy Steel Tubes—Pigments	Water Pollution
Titaninum Dioxide—Pigments-	Water Pollution
Magnetic Tape Steel—Ceramic	Solid Wastes
Phosphates—Plaster Board	Water Pollution
Mining—Building Material (Bricks, Cement, Agregate)	Solid Wastes
Electricity—Insulating Bricks	Solid Wastes
China Clay—Prefabricated Houses	Solid Wastes
Mining—Recreation (Fishing, Boating, Walking, etc.)	Land
Electricity—Heating (Homes, Fish Ponds, Glass Houses, Fields)	Heat
Animal Waste—Gas	Water Pollution
Food—Fine Chemicals Products	Air Pollution, Resources

Products

The same changes in social values which are producing a threat to industry also present an opportunity. All studies which have been conducted into success and failure, in industrial innovation for example, have shown that one of the prime mechanisms for success is a deliberate response to an identified societal need. This was certainly the main conclusion of the University of Sussex SAPPHO study. In other words by responding to the environment in a positive, pro-active and imaginative way, industry is better able to discern these needs which are at the root of successful innovation.

Looking again at the environmental model (fig.4), one can see how industry might respond to problems of pollution with non-waste and integrated technology, with emphasis on biochemical technology, development of pollution control and low impact products; to problems of

resource depletion with alternative fuels and materials, increased food production, increased forestation and conservation; to problems of physical and mental disease, with new products which enhance well-being, health products and services, with a return to traditional and 'natural' products, educational systems, recreational systems, safety products; to problems of alienation with decentralisation, smaller scale autonomous and highly integrated self optimising systems based on microprocessors, hybrid transportation and communication systems, small-scale housing, improved communications and individualised information systems; to problems of conflict by greater involvement and participation, job enrichment, enhancement of opportunities for full and meaningful employment and the use of an appropriate technology which makes maximum use of all available resources while meeting corporate and human needs at minimum social and economic cost.

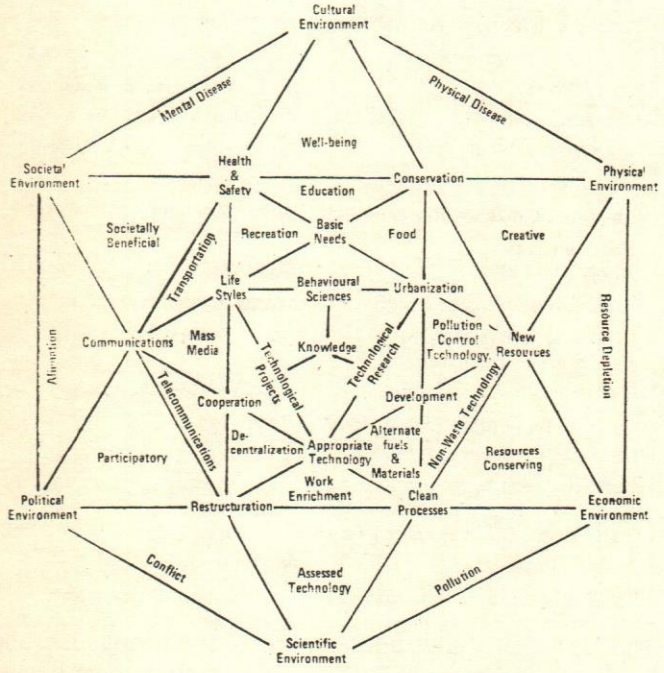


FIG. 4 THE .ENVIRONMENTAL MODEL

Increasingly corporations such as for example, AKZO in the Netherlands are using just this sort of a model to predict future demands for new products.

Strategy

Turning to the more immediate problem of response to the environmental strategy programmes rest essentially on three elements: environmental policy, environmental organization and the explicit environmental responsibilities of each industrial manager.

Policy

As regards environmental policy, what is basically required is for each enterprise to establish quite clearly an open declaration of its position in relation to pollution and the environment in general. Specific areas of responsibility usually have to be spelled out, so that all employees have a clear guideline for their future behavior. Most of the major companies have such policy statements. One of the most specific and the most imaginative is that of the Dow Chemical Company, which under its so-called Product Stewardship policy has set out the company's expectations as follows:

"We are committed to exercising responsible care for our products both during our manufacture and later in their use by our customers. This means assessing the environmental impact of the products and then taking appropriate steps to protect employees and public health and the environment as a whole. In addition to safe production and judicious customer use it means we have a continuous concern for the ultimate disposal of our products in the environment."

The Policy statement then goes on to elaborate the specific responsibilities of research and development personnel, of manufacturing personnel, and of marketing personnel. Armed with such a specific policy statement, all those in the company can determine their areas of responsibility and those outside the company have a firm basis for assessing whether the company and its managers are living up to their responsibilities or not. With the establishment of such guidelines or policies it becomes possible to determine the organisational structure of environmental management within the enterprise.

Environmental Organization

Fig. 5. shows diagrammatically how the organization for environment is evolving in most firms. This organization and the associated coordinator provide a key link, catalyst and a communication channel between the various government and private groups outside the corporation and the various operations and functions within the corporation.

In most corporations it consists of a small team responsible primarily for supplying technical information at the centre of a web of formal and informal contacts both outside and inside the corporation, and having a direct reporting relationship to the top decision-making and

policy-making body in the company. The job of the environmental coordinator is to explain company action and plans to outside bodies as well as to elucidate external trends for the benefit of his various colleagues inside the corporation to help them in the decisions they have to make. He will also provide expert assistance in interpreting environmental legislation, providing environmental technology and developing environmental impact assessment and environmental planning techniques.

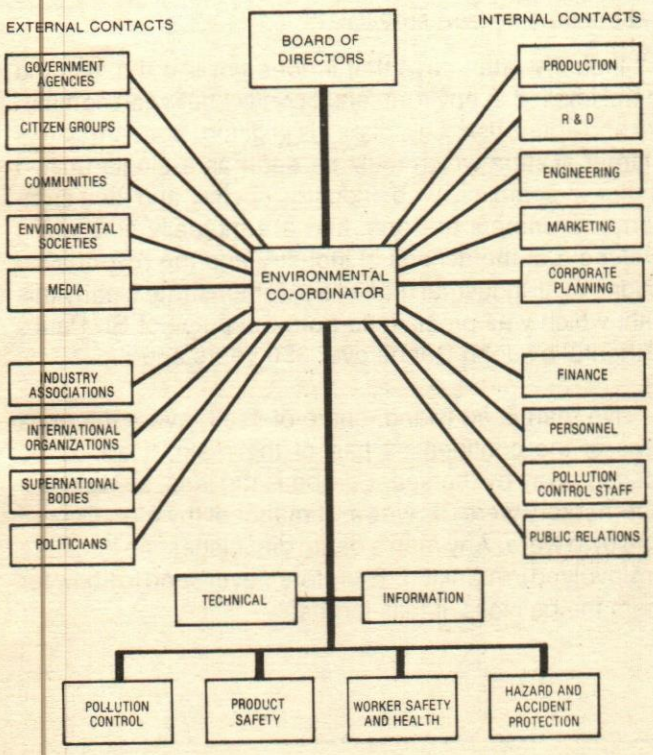


FIG. 5. ENVIRONMENTAL ORGANISATION IN AN INDUSTRIAL FIRM.

Environmental Responsibilities

The 'environmental responsibilities of management' has a definite meaning for each of the other managers and adds a new dimension to their every day jobs.

The production manager or plant manager is in the 'front-line' of the environmental battle. His job includes control of operations—to tighten up on waste, spillage and accidents; it includes innovation—to modify processes to reduce resource consumption and increase useful products and by-products; it also requires community involvement. The company has to become more involved in community concerns and the community has to be involved more closely in the life of the plant.

The research manager needs to ensure that among the criteria for the selection of research projects, environmental compatibility of the final product or process is explicitly included. He should also be active in developing non-waste technologies, low-impact products, renewable resources and advanced environmental protection devices.

The manager responsible for engineering services and new construction projects need to develop a variety of techniques to forestall negative interaction between his projects and the environment in which they will be realized. He needs to be acquainted with techniques of non-waste processes, opportunities for integrating with other processes to reduce waste, pollution control, environmental impact assessment, risk and hazard analysis and net energy accounting as well as with methods for surveying the attitudes and responding to the needs of the communities which will be affected by the projects.

The marketing function also has a major role to play in helping sell the environmental technology which the company has developed for its own needs and which can be marketed to others.

The corporate economist or planner needs above all to work closely with government in order to harmonize future corporate objectives with government policy, with evolving social development needs, with regional plans, etc. Failure to do this can be very costly for the enterprise concerned. The planner needs to carry out some form of environmental sensitivity mapping to see where and over what time frame, what sort of activities will be needed and which activities will be restricted.

Two particular environmental functions which ***the personnel manager*** should perform are, firstly, the continuous education of the worker to ensure that he contributes to making the work place, the plant and the environment as clean, as safe and as healthy as possible, and, secondly, the close involvement of the worker's family with the enterprise. This he can achieve by such activities as opening up company facilities and arranging visits. The workers and their families are best ambassadors a company has in the local community and the best source of early warning of 'environmental' trouble.

·Clearly if ***top management*** does not believe in environmental sensitivity, no-one else in the company will be able to develop it. Top management must explicitly support all the other staff in their environmental endeavors, particularly in the event of emergencies, such as explosion, gas release, major spillage or product recall. The criteria it sets for staff performance must include environmental sensitivity and contributions to long term goals as well as the contribution to this year's profit. Top management must also play a major role in interacting with top level governmental officials to harmonies investment policy and environmental protection policy and to negotiate subsidies for environmental protection based on an argued cost/benefit analysis where the benefits the whole community receives from environmental protection measures are compared with the cost of such measures which are borne by the enterprise.

Environmental Management/Systems Management

If he is to meet the environmental challenge and within this challenge recognize the responsibility that his company has to the environment, the modern manager has to learn how to manage not only his own company but the wider system which includes the physical environment and the community groups and government bodies with whom the enterprise interacts through its daily operations.

By increasingly taking such a systems approach to his job, the modern manager will learn to exercise greater corporate/social responsibility with the resultant build up of trust in the community and in government; he will begin to take an 'outside-in' view of the corporation, thus seeing more clearly its weaknesses and its strengths; he will begin to be more 'participatory' in his planning and decision-making, thus opening up that process for the introduction of new ideas; he will find new markets in meeting new social needs; and finally he will stand a better chance of avoiding trouble with community and government and so will increase his chances of survival and achievement of the corporate objectives of profit and growth.

Industry and the Environment

Viewed in such a context it becomes obvious that the responsibility of industry to the environment is total and indistinguishable from its responsibility to itself and to its shareholders and stakeholders. By discharging its responsibility to the environment in a positive, pro-active and imaginative way in its daily activities, the corporation automatically furthers its own objectives of profit, growth and ensures its own survival.

Industry often says that it does not like the 'us' and 'them' implied in environmental conflict between community and enterprise. This dislike is justified. Both are part of a larger system which must be seen as a single unified whole—a seamless web. Industry, society and their common environment are one, and are mutually and totally involved. Let the actions of industry and the responsible actions of all industrial managers demonstrate clearly this truth, which was proclaimed from the pulpit of St. Paul's Cathedral by John Donne over 350 years ago:

"No man is an island, entire of itself, every man is a piece of the continent, a part of the main; If a clod be washed away by the sea, Europe is the less, as well as if a promentory were, as well as if manor of thy friend's or of thine own were; Any man's death diminishes me because I am involved in mankind; Therefore never send to know for whom the bell tolls, it tolls for thee".

□

From the hayloft, a horse looks like a violin.
—Lord Chesterfield

A hen is only an egg's way of making another egg.
—Samuel Butler

Man-a creature made at the end of the week's work when God was tired.
—Mark Twain

Xerox : A trademark for a photocopying device that can make rapid reproductions of human error, perfectly.
—Merle L. Meacham

Zoo : An excellent place to study the habits of human beings.
—Evan Esar

Ideas : There are well dressed foolish ideas just as there are well-dressed fools.
—Nicholas Chemfort

Industrial Restructuring or Designing Sustainability of Modern Society

Udo E. Simonis

The author focuses on three elements for tackling the problems of pollution; firstly ,the potentials of a structural change of the economy, secondly ,the shortcomings of the environmental policy and the need for a shift towards waste reduction and pollution prevention and lastly ideas on where first and how best to integrate ecological dimensions into practical economic policy.

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"Pollution is a matter of life and death, and not a minor nuisance of a faddish frivolity of the rich".

Margaret A. Mackean

"There is something fundamentally wrong in treating the Earth as if it were a business in liquidation".

Herman E. Daly

Garret Hardin, in his well received essay on *The Tragedy of the Commons* remarks: "In a reverse way, the tragedy of the commons reappears in problems of pollution. Here it is not a question of taking something out of the commons, but of putting something in—sewage, or chemical, radioactive, and heat wastes into water; noxious and dangerous fumes into the air; and distracting and unpleasant advertising signs into the line of sight" (Hardin, 1968 : 1245). Hardin states that the calculations of utility are much the same as before: "The rational man finds that his share of the total costs of wastes he discharges into the commons is less than the cost of purifying his wastes before releasing them. Since this is true for everyone, we are locked into a system of 'fouling our own nest', so long as we behave only as independent, rational, free-enterprisers." And he concludes: "The air and waters surrounding us cannot readily be fenced, and so the tragedy of the commons as a cesspool must be prevented by different means, by coercive laws or taxing devices... We have not progressed... far with the solution of this problem..." (p. 1245)

In this paper, focus is on three elements of such a solution. First, the potential of ecological structural change of the economy is presented with the help of some empirical evidence on the relationship between structure and scale of the economy and their environmental impacts. Secondly, are the shortcomings of environmental policy and the need for a shift towards waste reduction or pollution prevention. Thirdly, some ideas are given on

where first and how best to integrate ecological dimensions into practical economic policy.

'Ecological structural change of the economy', 'preventive environmental policy' and 'ecological orientation of economic policy' thus seem to be major strategic elements for decreasing the pollution load on the commons, or the points of departure for escaping from the (reverse side of the) tragedy of the commons.

Ecological Structural Change of the Economy

In both the East and the West, economists, planners and engineers are seeking to change the traditional patterns of resource use. "*Perestroika* and "*modernisation*" are two actual catchwords in this process, and new environmental priorities play a part in the envisaged conversion of the economy (Enyedi et. al, 1987). Reconciling ecology and economy in a specific sense relies on the premise that a reduction in the input of material resources (structural change) will also lead to an *ex ante* reduction of emissions and wastes that have a negative impact on the natural environment (*ecological structural change*).

In order to clarify the relationship between economic structural change and environmental impacts, one needs suitable information concerning the material side of production, for long - term sustainability cannot appropriately be described in such terms as income, investments and consumption. One possibility is to select and compare some relevant indicators describing the environmentally significant features of the production process.

The availability of environmental indicators such as emission data relating to "representative" pollutants - like sulphur dioxide (SO_2), carbon dioxide (CO_2) and nitrogen oxide (NOx)—has grown recently (e.g., the annual Reports on the Environment by several industrial nations, by UNEP and the OECD). These indicators concern certain negative environmental effects of production. Less is known on the question of which indicators provide environmentally significant information about the structure of the economy. Given the present state of statistics, only a few such indicators can be tested in a cross-national comparison of Eastern and Western countries.

De-linking Economic Growth from Environmentally Significant Inputs

Using a set of four indicators (input factors), Janicke et al. have studied 31 countries of both COMECON and OECD with regard to the relationship between structure and scale of the economy and environmental impacts.[1] The four factors whose direct and indirect environmental significance is thought to be self-evident are: *energy, steel, cement*, and *freight transport*. Regarding their patterns of production and consumption these are environmentally "hard" factors; characteristic of a certain structure and/or scale of the economy.

The main hypothesis of the research, therefore was a rather simple one and reads like this: Positive environmental effects of structural change of the economy are to be expected by actively de-linking economic growth from the use of environmentally significant inputs (resources). Such active *de-linking* (or *ecological structural policy*) would:

- result in a decrease of *resource depletion* and/or *environmental pollution;*
- mean *ex ante* instead of *ex post* environmental protection;
- promote integrated technologies which touch upon several environmental effects (pollutants) at one and the same time.

Ecological structural change as a shift of input factors can thus be conceived as a process of successive de-linking. The contribution of traditional (hard) input factors to the national production decreases, *i.e.*, they change or lose their function in the development process.

Examples of Successful and Unsuccessful De-linking

Taking the Federal Republic of Germany as an example, figure 1 illustrates a five fold de-linking from the growth of the Gross Domestic Product (GDP): The de-linking of energy and cement consumption and weight of freight transport from GDP became apparent during the 1970s; regarding steel, the de-linking process began already in the 1960s. In this way, the structural change of the economy generated *environmental gratis effect* of various kinds:

- The stagnating *consumption of primary energy* led to a reduction of harmful emissions (pollutants).
- The relative decline in the *weight of freight transport* indicates that the volume of materials employed was reduced rather than increased.
- The fall in the use of *cement* represents a direct *gratis* effect as far as the emissions from cement

1. The data and arguments used here rely on Janicke, et. al, (1989).

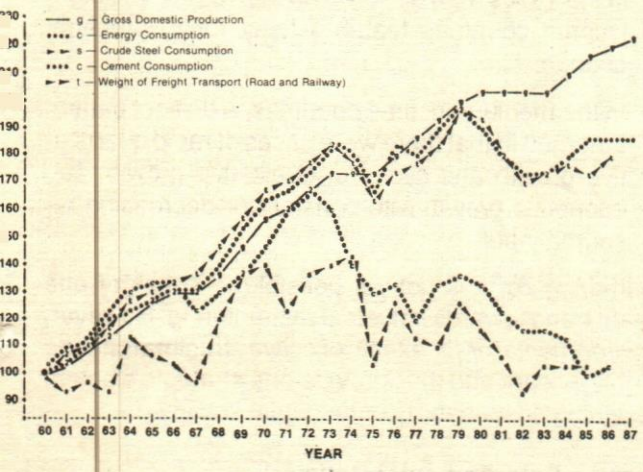


FIG. 1 : STRUCTURAL ECONOMIC CHANGE IN THE FEDERAL REPUBLIC OF GERMANY, 1960- 1987 (1960=100)

Source : Janicke et al., (1989)

factories are concerned; this decrease coincided with the trend towards labor-intensive renovation of the housing stock, as compared to new construction.

— The decrease in *steel consumption* accounts for a considerable reduction in harmful emissions as far as processing is concerned; this drop was strongly marked and partly due to increased recycling activities.

Environmental gratis effects occur when the rate of usage of the input factors (resources) having a (strong) negative impact on the environment remains below the growth rate of the GDP. Comparing the rates of usage of the four selected input factors with the GDP growth rate, three distinct development patterns emerge (Janicke, et. al, 1989):

— The factors having impacts on the environment decline absolutely; i.e., *absolute structural improvements* are induced, corresponding to absolute *environmental gratis* effects.

— The factors having impacts on the environment remain constant, or increase, but with a lower growth rate than the GDP; i.e., *relative structural improvements*, corresponding to relative *environmental gratis* effects.

— The factors having impacts on the environment increase at a higher growth rate than the GDP; *i.e.*, structural *deterioration*, corresponding to absolute negative environmental effects of economic growth.

In table 1, 16 out of the 31 countries studied are grouped according to these three development patterns. Of all the industrial countries investigated, Sweden went through the most rapid structural change. The drastic reduction in cement production (—41%), the decreasing use of crude steel (—38%), and the decrease in the weight of freight transport (—21%) add up to notable *environmental gratis* effects ("absolute structural improvements"). In Japan, the de-linking process was partly neutralised by the rapid growth in industrial production and thus only resulted in "relative structural improvement".

Table 1 : Environmental Impacts Derived from Structural Change. (Percentage Changes 1970/1985)

Country	Consumption of Primary Energy	Consumption of Crude Steel	Cement Production	Weight of Freight Transport	GDP*
Group 1: Absolute Structural Improvement					
Belgium	7.1	—24.5	—17.6	—2.2	42.7
Denmark	—2.7	—15.6	—33.2	20.1	40.8
France	30.3	—34.8	—23.4	—14.5	51.6
FRG	13.4	—26.3	—32.8	4.4	38.4
Sweden	26.4	—37.9	—41.2	—21.4	32.7
United Kingdom	—2.3	—43.5	—28.7	—18.2	32.4
Group 2: Relative Structural Improvement					
Austria	32.1	—33.9	—6.0	21.3	54.3
Finland	39.6	14.8	—11.2	12.2	65.7
Japan	37.3	—2.3	27.4	7.5	90.2
Norway	51.1	—21.6	—40.3	34.7	87.5
Group 3: Structural Deterioration					
Bulgaria	74.9	24.9	42.3	77.5	37.3
Czechoslovakia	31.5	22.5	37.3	62.9	33.9
Greece**	119.3	67.3	162.9	43.1	69.1
Portugal**	89.0	34.2	133.1	27.4	69.0
Soviet Union	76.3	33.4	35.9	70.2	47.7
Turkey	218.8	184.4	173.2	118.6	118.2

* Calculation of the Gross Domestic Product percentage changes on the basis of constant (1980) US-dollars. Bulgaria, Czechoslovakia and Soviet Union data refer to percentage change 1970/83 of the Gross National Product.

** Transport data only take railways into account.

Source : Janicke et al. (1989)

In Czechoslovakia, by contrast, no de-linking of economic growth from the four input factors took place (figure 2). The development profile of this country, with sluggish structural change, is also representative of the other economies of Eastern Europe.

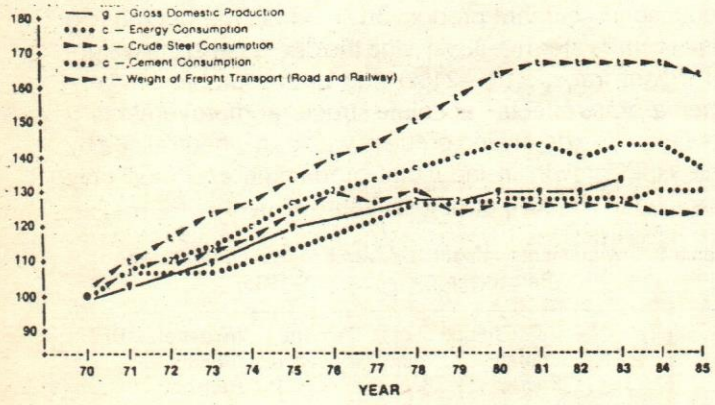


FIGURE 2 : STRUCTURAL ECONOMIC CHANGE IN THE CSSR, 1970-1985 (1970-100)

Source : Janicke et al. (1989)

Trends Towards Industrial Restructuring

Despite certain analytical limitations of such empirical research (as e.g. the selection of only four input factors), several conclusions can be drawn from this international comparison as regards past trends of industrial restructuring :

- Structural change in the form of de-linking economic growth from environmentally significant inputs was evident in most but not all of the countries studied.
- Several countries enjoyed *environmental gratis* effects as a result of active structural change. In some cases, especially for Sweden, these effects were quite considerable.
- In other countries, the possibly beneficial environmental effects of structural change were levelled off by the rapid industrial growth pursued. This was especially true for Japan.
- The strong correlation between the level of production (GDP) and environmental impacts, still evident in the 1970s, had dissolved in the 1980s. The high-income countries featured fairly rapid structural change.
- In the medium-income countries, a distinct pattern emerged in that there were cases of rapid quantitative growth and cases of qualitative growth, *i.e.*, economic growth with constant or decreasing resource input.

Summing up, it is not yet possible to speak of one dominant trend towards industrial restructuring. However, the *environmental gratis* effects of active structural change are highly evident and thus provide one strategic element for designing sustainability of industrial society.

Preventive Environmental Policy

Theoretically speaking, environmental policy can be defined as ".. the sum of objectives and measures designed to regulate society's interaction with the environment as a natural system; it comprises aspects of rehabilitation, conservation, and structural adjustment". (International Institute for Environment and Society, 1982). Practice, however, does not conform to such a comprehensive definition. Only parts of the inter-action between society and environment have become the subject of policy. So far, environmental policy has mostly been designed as react-and cure strategies concerning air and water pollution, noise and waste, with emphasis on the rehabilitation aspect.

For a variety of reasons, this conventional environmental policy was, and is still, meaningful and very much necessary. It has, however, a number of shortcomings, some of which are addressed in the following, along with some suggestions for overcoming them through preventive environmental policy, *i.e.* anticipate and prevent strategies.

Environmental Expenditures — Environmental Damages.

Since the beginning of the 1970s, when systematic records first began to keep track of the funds allocated for environmental protection, in the industrialized countries the sum of the respective public and private investments has reached large proportions. The industrial society thus

Table 2: Environmental Protection Investments, (Manufacturing Sector, Federal Republic of Germany, 1975-1987) in Millions of DM

Year	Total Investments		Waste Disposal		Water Pollution Control		Noise Abatement		Air Pollution Control	
	Current Prices	1980 Prices	Current Prices	1980 Prices	Current Prices	1980 Prices	Current Prices	1980 Prices	Current Prices	1980 Prices
1975	2,480	3.090	170	210	900	1,110	200	240	1,210	1,530
1976	2,390	2,830	200	230	820	960	220	260	1,150	1,380
1977	2,250	2,560	200	230	740	850	210	230	1,100	1,250
1978	2,150	2,370	170	180	680	750	200	220	1,100	1,220
1979	2,080	2,190	260	160	760	800	200	210	960	1,020
1980	2,650	2,650	210	210	910	910	240	240	1,290	1,290
1981	2,940	2,810	250	240	950	910	210	200	1,530	1,460
1982	3,560	3,250	390	360	1,130	1,030	230	210	1,810	1,650
1983	3,690	3,270	290	260	1,100	990	230	200	2,070	1,820
1984	3,500	3,100	270	240	1,040	920	230	190	1,960	1,750
1985	5,620	4,940	330	280	1,060	910	260	220	3,970	3,530
1986	7,300	6,400	420	350	1,150	950	250	200	5,480	4,900
1987	7,890	6,900	...	...	...	...	...	...	...	...
					Average Annual Change in %					
1975/84	3.9	0.0	5.3	1.5	1.6	–2.1	1.6	–2.6	5.5	1.5
1975/79	–4.3	–8.2	–1.5	–6.6	–4.1	–7.9	0.0	–3.3	–5.6	–9.6
1979/84	11.0	7.2	11.0	8.4	6.5	2.8	–2.8	–2.0	15.3	11.4

Source : IIES research project. Data for 1986 and 1987 from Statistical yearbook 1989.

appears to be "paying through the nose" back payments for the negative environmental impacts of production accumulated in the past.

In the Federal Republic of Germany, for instance, the sum of expenditures aimed at rehabilitating and conserving the natural environment has come to the handsome total of over 275 billion Deutschmarks (or about 175 billion US dollars). In a detailed study, Leipert et. al. from the International Institute for Environment and Society (IIES) have first established the respective data which in the Statistical Yearbook of 1989 were published as official data by the Federal Statistical Bureau.[2] Table 2 shows the total and *sectoral environmental protection investments* for the manufacturing sector of the German economy for the years 1975 to 1987. Table 3 shows the *total expenditures for environmental protection* for both industry and government for the years 1975 to 1987.

2. The data used here are from Leipert and Simonis (1989).

Table 3: Total Costs of Environmental Protection Investment's (Federal Republic of Germany), in Millions of DM, 1975-1987.

Year	Industry			Government			Industry and Government		
	Current Expenditures	Depreciations	Total Costs	Current Expenditures	Depreciations	Total Costs	Current Expenditures	Depreciations	Total Costs
					At Current Prices				
1975	3,200	1,520	4,720	3,000	1,920	4,920	6,200	3,440	9,640
1980	5,160	2,250	7,410	4,690	3,390	8,080	9,850	5,640	15,490
1985	7,930	3,160	11,090	6,430	4,340	10,770	14,360	7,500	21,860
1987	9,050	3,780	12,830	7,580	4,790	12,370	16,630	8,570	25,200
					At 1980 Prices				
1975	4,050	1,870	5,920	3,790	2,570	6,360	7,480	4,440	12,280
1980	5,160	2,250	7,410	4,690	3,390	8,080	9,850	5,640	15,490
1985	6,230	2,640	8,870	5,340	4,030	9,370	11,570	6,670	18,240
1987	7,260	3,080	10,340	6,330	4,270	10,600	13,590	7,350	20,940

Source : IIES Research Project. Data for 1987 from Statistical Yearbook 1989.

Figures like these, however, are ambivalent. On the one hand, they give cause for proud political statements about the successes of environmental protection, according to the motto "the more, the better". On the other hand, they are—presumably—the absolute minimum of what is necessary to secure industrial society's sustainability. At the same time, they may symbolise a serious structural deficiency of industrial society: Environmental protection expenditures are spent when damage to the natural environment has occurred and can no longer be denied. They are, in fact, repairs to the process of economic growth, signs of a "post-fact" policy that reacts at a rather late stage to damages (and must react to them) but does not, or cannot, prevent them. Therefore, it is necessary to always confront the "success stories" of environmental protection expenditures with figures on the environmental *damages* themselves.

Again taking the Federal Republic of Germany as an example, an estimation by Lutz Wicke from the Federal Environmental Protection Agency says that the *annual damage* of the natural environment in monetary terms may be over 103 billion DM, or in the order of 6% of GNP, and not 3%, as the OECD had estimated for the industrial countries some years ago. (Wicke, 1986)

Table 4 is based on differing estimation methods, combining data on actual damage costs and findings from willingness to pay studies. Though the results therefore must be taken with some care, the table leads to the conclusion that despite high annual environmental protection expenditures still enormously high environmental damages occur annually. Of course, this conclusion may not only be true for Germany but for all other industrial countries as well.

There are more shortcomings of the conventional environmental policy (Simonis, 1985). To name the more obvious ones: Environmental policy often identifies the given problem too late, so that the ecosystems affected cannot survive. As it is pursued as a *media-specific* policy, *i.e.* separately regulating air or water quality, noise or waste, it also lacks coordination between its specific goals, measures and institutions. And this then may result in shifting a problem from one environmental medium to another, e.g., from air to water or soil, or from one place to another, as is the case with long-range trans-boundary pollution. In addition, environmental policy often becomes entangled in a debate on principles. If measures must quickly be taken, the argument gets twisted from the "polluter-pays-principle" which is advocated in general—to the "taxpayer-pays-principle, thus shifting the burden of environmental protection costs from the individual polluter to the community, the government or society at large.

Table 4 : Environmental Damage in the Federal Republic of Germany (Measurable Damage in billions of DM per year)

Environmental Sectors	Environmental Damage
Air Pollution	ca. 48.0
Health hazards	between 2.3 - 5.8
Material damage	more than 2.3
Degradation of vegetation	more than 1.0
Forest blight, etc.	between 5.5 and 8.8
Water Pollution	far more than 17.6
Damage to rivers and lakes	more than 14.3
Damage to the North Sea and Baltic Sea	far more than 0.3
Contamination of ground water, etc.	more than 3.0
Soil Contamination	far more than 5.2
Cost of Chernoby accident	far more than 2.4
Rehabilitation of yesterday's waste'	more than 1.7
Costs of preserving biotopes and species	more than 1.0
Other soil contamination, etc.	far more than 0.1
Noise	more than 32.7
Degradation of residential amenities	more than 29.3
Productivity losses	more than 3.0
Noise rents, etc.	more than 0.4
Grand total of damage	more than 103.5

Source : Wicke. (1986)

Thus, innovations in policy planning and implementation are needed. *Preventive environmental policy*, it seems, can counter the shortcomings of conventional environmental policy. But in order to switch towards preventive policy, several conceptual as well as practical constraints have to be overcome.[3]

One constraint has to do with the particular history of an environmental impact. In case of yesterday's wastes, when damage has already occurred (*Altlasten*), a curative strategy is the only conceivable option. However, in all cases where damage must be expected for the future, the choice between a preventive and a curative strategy is basically open. The anticipatory principle strongly leads to encourage the first option. As practice often is a mixture between the existing and the new, most policies actually will also include a mixture of prevention and cure. Demanding preventive environmental policy will then mean seeking and at last finding a better balance between the anticipatory and the reactive component within policy action.

Basic Conditions for Preventive Environmental Policy

According to Scimemi and Winsemius one can conceive three factors as concomitant policy relevant processes in time: the accumulation of environmental damage;

3. Here, the arguments put forward by Scimemi (1988), are believed up on.

the acquisition of technical knowledge and the rise of public awareness. The time sequence of these processes, especially the relative timing of their *critical levels*, may be decisive for the whole issue of preventive environmental policy.

To illustrate the relationship between these factors, Scimemi has redrawn a diagram suggested by Winsemius, using three separate functions : *Level of Environmental Damage, Level of Technical Knowledge, and Level of Public Awareness* (Scimemi, 1988). The relative position and the shape of these functions depend, of course, on the specific circumstances (country, environmental sector, historical phase) under consideration; the common case may be the one illustrated in figure 3.

Line D_1-D_2 indicates the accumulation of environmental damage over time. The accumulation of damage starts at a given point in history (in the diagram somewhere between time 0 and time 10). At that point, neither the scientific community nor the general public is yet aware that anything of importance is happening. Line T_1-T_2 indicates the process of acquisition of technical knowledge. This process may not start until some time after damage has begun to accumulate (in the diagram somewhere between time 10 and 20), and proceeds gradually. During that phase the public may still be unaware of the hazard. Somewhere between time 20 and 30, public awareness starts to rise as indicated by the line P_1-P_2.

Within these concomitant processes, a certain stage becomes important (*critical level*). As illustrated, the technical understanding of the issue reaches a critical level, *t*., thus ensuring the first of two conditions required for effective policy action, *i.e.*, technical rationality. Public awareness also reaches a critical level, *p*; at that time the second condition for effective decision-making e.g., *political viability*, is fulfilled. It is at this stage that action will be undertaken to avoid the occurrence of further damage.

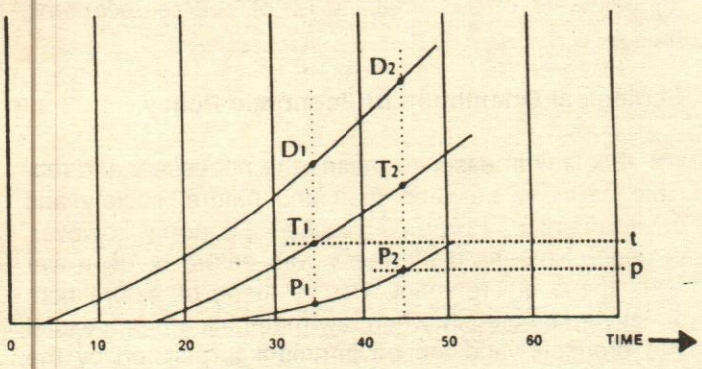


FIG 3 : FACTORS OF THE ENVIRONMENTAL POLICY CYCLE: DAMAGE, TECHNICAL KNOWLEDGE, PUBLIC AWARENESS

Source : Scimemi. (1988)

Recalling past developments in environmental policy at the national or the international level, one may easily discern that these developments evolved very much in conformity with Scimemi's theoretical interpretation. Thus, the diagram may be considered to be a true representation of real events. (There may be cases, however, where public awareness line P_1-P_2 started earlier than technical knowledge line T_1-T_2)

What then are the opportunities to influence these basic conditions of policy action in favor of preventive environmental policy? Figure 3 helps to formulate three general and two more specific options.

General options:

- *Retarding damage accumulation* (i.e., sliding the D_1-D_2 curve towards the right)
- *Accelerating technical knowledge* (i.e., sliding the T_1-T_2 curve towards the left and/or raising its slope)
- *Increasing public awareness* (i.e., sliding the P_1-P_2 curve towards the left and/or raising its slope.)

Specific options :

- Dynamic environmental standard setting (i.e., lowering threshold *t*)
- Active public participation (i.e., lowering threshold *p*)

All these options make policy decisions possible at a stage when the level of environmental damage is still relatively low, or even non-existent. (Scimemi, 1988) Two of these options are illustrated in figure 4.

Impact Assessment as Part of Preventive Environmental Policy

Acceleration of technical knowledge and public awareness can, of course, be promoted through a variety of approaches and methods, but depends a great deal on the specific environmental issue at hand. *Environmental Impact Assessments* (EIA) are increasingly being applied, not

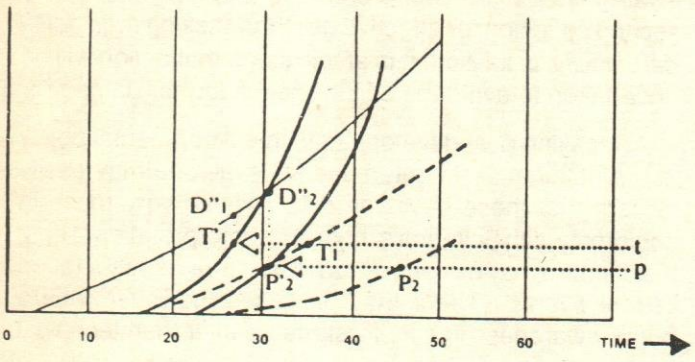


FIGURE 4 : ACCELERATING THE GENERATION OF TECHNICAL KNOWLEDGE AND/OR THE DEVELOPMENT OF PUBLIC AWARENESS

Source : Scimemi, (1988)

only for public but also for private investment projects. They entail efforts to learn more about possible environmental impacts, and are intended to allow appropriate action to be taken before damage has occurred. In that sense, environmental impact assessments can be classified as part and parcel of preventive environmental policy. (Wathern, 1988)

During the last few years, some headway has been made to institutionalise and standardise EIA procedures, nationally and to a minor extent also internationally. As the EIA procedure is particularly used for specific investment projects, it allows for the "accelerating effort" to be targeted, and generally also permit the burden of such efforts to be imposed upon the project initiator himself, thus conforming to a precondition of preventive environmental policy, *i.e.*, the polluter-pays-principle. Difficult questions, however, remain in implementing EIA as a preventive procedure in cases of global change, like climate warming or ocean pollution.

The required levels (thresholds) regarding technical knowledge and/or public participation in environmental decision-making differ widely from one environmental medium and country to the other (Scimemi 1988). The question of how much knowledge/awareness is enough normally falls upon the political decision-maker (the governmental protection agency, the institution in charge of the problem), even if the scientific community (or parts of it) is ready to say "we know enough" and the public (or parts of it) is demanding "something must be done". Therefore, stalemates in decision-making on environmental issues are quite frequent.

What is "enough knowledge/awareness" for one country (government, institution) may not be enough for the other. The normal outcome of such a situation is a compromise over the emission standards to be implemented. They will be weaker than technically/potentially feasible because knowledge/awareness on cause-effect-relationships or social priorities is said to be insufficient. Eminent cases in point are the emission standards for SO_2, CO_2 and NO_x in the air pollution field, and the nitrate standard in the water pollution field., thus, the dilemma of setting strict emission standards is a serious one. Meanwhile the forests may continue to die back, the ozone layer may continue to be affected, the water may continue to get contaminated or, as Prince Charles said at the second International North-Sea Conference, 1988: "while we are still waiting for the doctor's diagnosis, the patient may die".

The conclusion therefore is that for designing sustainability of industrial society, environmental standard setting must be conceived as a continuous process. With growing knowledge/awareness on actual and probable environmental damages the thresholds for action must be consecutively lowered, i.e., standard setting must be dynamized to make industrial restructuring possible on time.

This need to come to terms with the future is not unique to environmental policy, as Scimemi rightly observed. Implementing the prevention principle is especially requested in all other domains of policy where collective interests are at stake and/or by which the commons are threatened. One such major domain we have to address when discussing the possibilities and impediments of sustainability is, of course, economic policy.

Ecological Orientation of Economic Policy

"Ecology in essence means the necessary and feasible harmony between man and nature, society and environment" (C.F. von Weizsacker). Economy, however, in general means disharmony with nature or even war against the environment. Use is made of nature both directly and indirectly when raw materials are processed into products, and the environment is polluted by the emissions and wastes generated by industrial production. These are, then, the two processes in which nature remains the loser. She exchanges natural raw materials for produced waste materials. Besides labor and capital,

nature is the truly quiescent and exploited third production factor. How can nature's position in the "economy game" be strengthened? (Simonis, 1988)

Conflicts between Economy and Ecology

The use of raw materials and the generation of emissions and wastes are of course old, not new issues. Scientific and technological developments, however, have made it possible to increasingly exploit the depletable resouces, and have lead to an ever increasing accumulation of harmful emissions and non-decomposable wastes. Nature is no longer able to absorb all these substances, many of which are not only toxic for flora and fauna but for human beings as well.

Efforts to hide harmful emissions and toxic wastes-in land-fill sites, in transfer stations or permanent depositions, to spread them—through high smokestacks and incinerators, or to dump them—into the water bodies and abroad, have at best been temporarily successful because many emissions and wastes are "mobile poisons" or reappear in different form. These activities lead to a "*linearisation of ecological cycles*" (Johan Galtung), *i.e.*, the natural diversity is reduced, the robustness of ecosystems declines, ecological symbioses and equilibria break down. As a consequence, environmental degradation increases and the absorption capacity of the natural environment decreases.

Accordingly, the conflict between ecology and economy can be attributed to two actually or possibly (?) incompatible basic principles: The ecological principle of "stability", as a precondition for the sustainability of ecological systems, and the economic principle of "growth", as the inherent logic of economic systems-more precisely: the principles of business profitability, national economic growth, and world market expansion.

Given the actual and the pending ecological crisis, the question on whether these economic principles can be changed, reshaped and finally brought into harmony with ecological principles, on which level, in what way, and at what time, is, of course, a controversial question in both theory and practice, and represents a specific challenge to the social sciences. The answer to that question not only depends upon the respective individual and the social constellation of interests. The answer particularly depends upon the ability of and the willingness to plead for social innovations, *i.e.*, on (a) whether and how the potential of an ecological self regulation of the economy is used, and (b) whether and how the option of an ecological economic policy is implemented.

Ecological Self-regulation of the Economy

Generally speaking, only a small fraction of the present environmental problems would exist if the economic context would have remained so comprehensible that producers and consumers would personally be able and liable to recognise and perceive the consequences of their own decisions towards depleting resources and polluting the environment. Or, if business profitability, national economic growth, and the expansion in world markets could not be increased by externalising parts of the ensuing costs. This is the old but still relevant—because unresolved—problem of the external effects of production. Scientific and technological developments have been, and still are, coupled with negative external effects, i.e., the shifting of costs to society, future generations, and nature. With respect to the environmental problem, all these cost components are relevant. Take, as an example, acid rain and the ensuing damage to our forests:

- First, this example shows the shifting of a part of the costs of industrial production, i.e., no sufficiently reduced air pollutants, onto nature, which is resistant only up to certain levels: the forests are dying.
- Second, this example shows the shifting of costs onto the succeeding generations, i.e., a future with less and/or regionally even no forests.
- Third, this example shows the shifting of costs onto third parties (i.e., partial expropriation of the forest owners) and onto society, in the sense that economic and technical decisions of individual polluters (especially emissions from power plants, cars, transboundary pollution) impair the well-being and the physical health of the population.

The economic system thus evidently makes incorrect calculations with respect to the "ecosystem forest". Both business accounting and national accounting do not provide adequate signals which may prevent pollution levels that are not tolerable for the ecological systems. Conventional accounting shows favorable balances for the production of energy, for the automobile producers, and for the exporters of pollutants (just to stay with the three sources of pollution mentioned above), although the "ecosystem forest" is definitely being damaged by the emissions from these economic factors. Losses here-profit there, compensation does not take place nor is liability provided for.

One of the pending tasks both for theory and practice thus can easily be prescribed: "Internalise the external effects of production;shift the costs back to the economic

units that cause the environmental problem; include the ecological perspective into all investment decision-making"!

To re-organise the economy towards a materially integrated cycle would, first of all, mean to reduce systematically the use of depletable resources and the generation of polluting emissions and wastes; but this is in contradiction to the prevailing " throughput economy". In practice, recycling and clean technology are still at an incipient stage and the step from simply disposing or treating wastes towards systematically avoiding wastes ("low waste economy") has not been made.

Certainly, this is in part because many waste products cannot be recycled or only at high cost. But it is also true because the right price signals have not been set. No adequate incentives exist for preventing waste generation and conserving depletable resources. This state of affairs has also to do with the above mentioned shortcomings of the economic accounting procedures which do not adeqately measure the diminishing stocks. Therefore, two contradictory trends prevail :*increasing monetary income-decreasing natural stock.*

Promising proposals for *ecological accounting* at the factory level and at the national level have been made. With ecological accounting the volume of energy, materials, wastes, land use, etc. are being computed and, by simulating the given shortage, accounting units are determined which then enter the accounts. Thus a measure is developed which may guide private investment decision-making and at the same time provides a public information instrument for promoting qualitative economic processes. At the national level, *satellite systems* are being developed which complement the traditional national accounts.

In industrial society another ecological principle is no longer adhered to, that of the sustainability of resource use. Traditionally, forest owners for instance have followed the rule " Do not cut down more wood than you regrow ". This rule is substantially undermined; externally produced acid rain collides with internal resource conservation; and accumulated external debt lead to an over exploitation of the given national resources. Sustaining the yield of the forest capital stock is being replaced by indirect expropriation and by resource depletion.

Another basic principle to be re-established in industrial economy is that of liability. With respect to environmental problems, the legal system, and also economic behavior, in most countries is marked by the strict proof of causality. Only when the injured (damaged party) can prove who caused the damage (polluting party), the polluter is held liable for compensation. Instead, in some countries (for some cases) statistical probability is sufficient for obligating industry to compensate for damages (collective liability). In Japan, once this principle was established by the courts and through legislation, it quickly helped to improve air quality through ecological self-regulation of business activities.

In general, the liability principle would strengthen the anticipate and prevent strategy in environmental policy, and shift the technical solutions for environmental problems from ex-post to ex-ante approaches, i.e., from controlling or end-of-pipe technology towards low emission or integrated technology. To implement the principle in practice, small steps or big leaps could be taken: from continuous reporting on wastes or automatic monitoring of emission to collective funds or strict individual environmental liability.

Ecological Economic Policy

Confronted with serious environmental damage, conventional economic policy has increasingly been challenged. Its guiding principles, goals, instruments, and institutions are being questioned, and a new concept is emerging: ecological *economic policy.*

Conventional economic policy is based on the guiding principle of maximising flows: volume of production, income, profits, turnover. (Kenneth Boulding nearly twenty years ago called this the "throughput economy"). Instead, the "ecological economy" would be based on a different guiding principle, i.e., "increasing efficiency and maintaining sub-stencil!" Aspects such as environmental compatibility and resource conservation would become important, and structural adjustment of products and technologies according to ecological considerations would become the task.

Regarding *goals*, it seems necessary to re-assess and redefine the growth targets and to include "environmental stability" into the catalogue of economic policy goals. The conventional policy goal indicators were developed at a time when environmental pollution was already a problem but not yet a public issue, and since then they have not really been readjusted. Economic growth is still being measured in terms of goods and income categories only (GNP—Gross National Product), while their effects on the stock and the quality of the resources(natural capital) are not adequately being considered. In the conventional concept of economic growth, all monetary transactions are summed up independent of their specific function; also, increasingly more expenditures are

included which are solely being spent for the (necessary) compensation for damage originally caused by the production process ("*compensatory* or *defensive expenditures*").

Qualified goal indicators for economic policy can be defined in various ways: computations of compensatory expenditures, i.e. assessment of an environmentally adjusted net product (ENP—Eco National Product); combined growth and distribution indices (RWG-Redistribution With Growth); an integrated system of economic and environmental indicators, or attached "Satelite Systems", etc.

Conventional economic policy relies mainly on two instruments, i.e., variations of interest rates and of tax rates. From an ecological point of view, new taxes and charges are required which, to some extent, should replace traditional taxes. In a situation of structural unemployment and environmental pollution the introduction of *resource taxes* (e.g., an energy tax) and emission charges (e.g., charges on SO_2, NO_x, and CO_2 emissions), and a definite decrease of wage taxes is called for. Such a structural tax reform would change the existing incentives in the economy towards accelerating resource efficiency and increasing employment opportunities.

Economic policy manifests itself in and works through particular institutions. An ecological orientation of economic policy therefore, requries creating new economic institutions and abolishing or redefining old ones. (The current debate on the negative environmental effects of decision by the World Bank and the IMF is just a case in point). The actual and the pending environmental crisis requires structural institutional reforms by which economic institutions would have to incorporate the ecological perspective and environmental institutions to improve their conceptual and practical competence, and by which environmental impact assessments (EIA) would be integrated into all major economic decision-making.

Conclusions

According to the above deliberations, industrial restructuring or designing sustainability of modern society obviously is a demanding concept, both methodologically and practically. It requires a far-reaching conversion of the economy, a re-orientation of environmental policy, and a re-plenishment of economic policy. The social sciences—economics, sociology, political science, etc.—have to improve the methodological foundations and the institutional arrangements for a successful practical implementation of such a concept.

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In any assembly the simplest way to stop the transacting of business and split the ranks is to appeal to a principle.

—Jacques Barjun

Cleaner Production : A New Challenge for Industry

Jacqueline Aloisi de Larderel

Producing more with less resources; producing more, polluting less. These are the basic challenges of environmentally sound development; sustainable development. Cleaner production is certainly one of the keys to these challenges. This paper highlights the sources of pollution and the ways for a cleaner production.

Jacqueline Aloisi de Larderel is the Director, Industry and Environment Office, United Nations Environment Programme, Paris, France.

"We have no choice but to quicken the pace of pollution control. Low-and non-waste technologies are our single most important hope to conserve the environment and our ailing earth. We need the commitment of industry and government to end production and trade in poison. We need their commitment to ensure waste minimization."

Dr. M.K. Tolba Executive Director, UNEP, Vancouver 1990

The Need for New Development Patterns

The following figures are known. They should however be recalled: in 1960, global population totalled 3 billion. It passed the 5 billion mark in 1987 and will probably reach 8 billion by the year 2025.

As recently as 1950, the world manufactured only one-seventh of the goods it does today. About 80000 chemicals are on the market and it is estimated that 2000 new ones are entering it each year.

These figures are speaking for themselves. The growth of the world population and related human activities are clearly leaving major impacts on land use and on the environment in general, as well as on the demands for energy, fresh water, food and housing. Certainly these impacts will vary from region to region according to national incomes, rates of development, and patterns of industrialisation. In addition, pollutants know no boundary and the problems have now taken a worldwide dimension.

The Changing Atmosphere

Pollution generated by human activities (table 1) is changing the composition of the earth's atmosphere. According to recent statistics (WRI, 1990) anthropogenic emissions of sulphur-dioxides (SO_2), a precursor of sulphuric acid are estimated to range from 160-180 million metric tons per year worldwide and increasing at a rate of 4 per cent annually. Oxides of nitrogen (NO_x), precursor of nitric acid and tropospheric ozone, are estimated at about 75 million tons. 300 to 1600 million metric tons of carbon monoxide (CO) are released in the atmosphere, coming in

Table 1. Emissions of Air Pollutants in Selected Countries (000 tonnes)

	Sulphur Dioxide			Suspended Particulate Matter			Oxides of nitrogen			Carbon Monoxide			Lead			
	1973-75	1979-81	1982-84	1973-75	1979-81	1982-84	1973-75	1979-81	1982-84	1973-75	1979-81	1982-84	1973-75	1979-81	1982-84	1985
North America																
Canada	5,880a	4,610a	3,760a	2,080a	1,870a	x	1,750a	1,910a	1,870a	10,800a	9,930a	x	14.5	x	11.5	0.5
United States	25,600	23,330	21,100	10,400	8,470	6,900	19,200	20,670	19,500	81,200	76,030	69,230	147.0	78.4	46.9	21.1
Central America																
Mexico	x	x	x	x	x	x	x	x	x	x	x	x	x	19.6	8.4	x
Asia																
China	x	14,210	12.920	x	16,200b	13,740b	x	4,400	4,130	x	x	x	x	x	x	x
India	1,610	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Japan	2,620	1,640	1,610	x	x	x	1,800	1,340	1,420	x	x	x	x	x	x	x
Thailand	x	120c	310	x	40c	230	x	30x	130	x	120c	x	x	x	3.0	x
Europe																
France	3,760	3,410	2,305	295	265	210	1,675	1,855	1,730	x	6,550d	6,330d	x	x	x	x
Germany, F.R.	3,600	3,300	2,750	950	750	650	2,600	3,100	3,000	11,700	9,000	7,400	x	x	x	x
United Kingdom	5,430	4,740	3,750	450	300	230	1,870	1,900	1,770	4,820	5,090	5,180	7.9f	7.2f	7.0f	6.5f

Source : Global Environment Monitoring System (GEMS)
Notes : a. Excludes forest fires. b. Fossil fuel combusion only. c. Bangkok only. d. Excludes industrial processes. f. Gasoline (petrol) engined road vehicles only.
x: not available.

major parts from transportation. Lead emissions could total up to 450 000 tons. Other air pollutants, seldom monitored, such as hydrocarbons, fibres and organic compounds are also released.

These emissions are changing our planet climate, destroying the protective stratospheric ozone layer, acidifying rainfall, and directly affecting the health of people, plants and animals.

Climate change is one of the most important issues the world is now facing: the scientists are now agreeing (Intergovernmental Panel on Climate Charge, 1990) emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases, carbon dioxide, methane, chlorofluorocarbons (CFCs) and nitrous oxides (tables 2, 3 and 4). These increases will enhance the greenhouse effect, resulting, on average, in an additional warming of the earth's sur-

TABLE 3. PERCENTAGE ANNUAL CONTRIBUTION TO METHANE EMISSIONS FROM DIFFERENT SOURCES

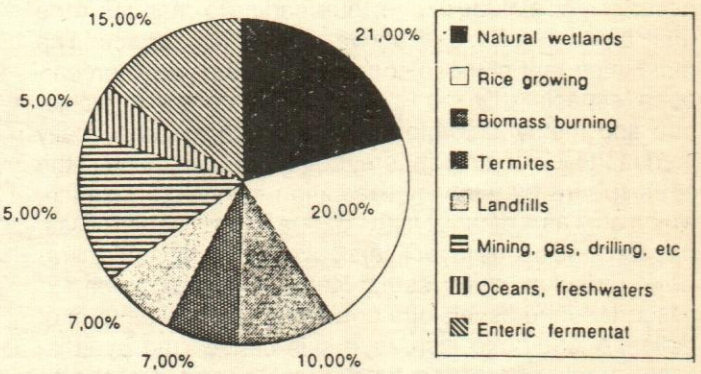


TABLE 2. GREEHOUSE GAS CONTRIBUTION TO GLOBAL WARMING

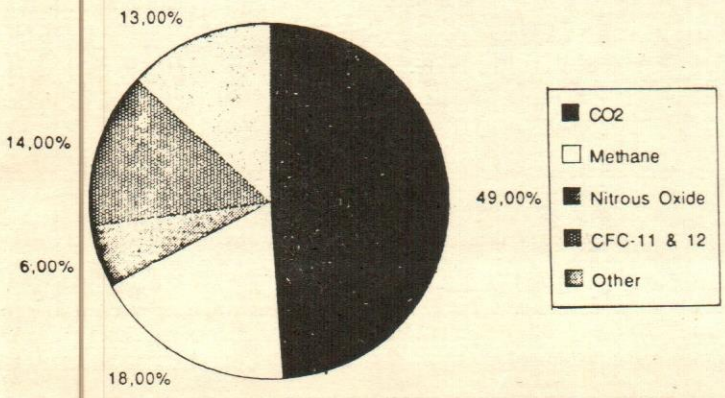
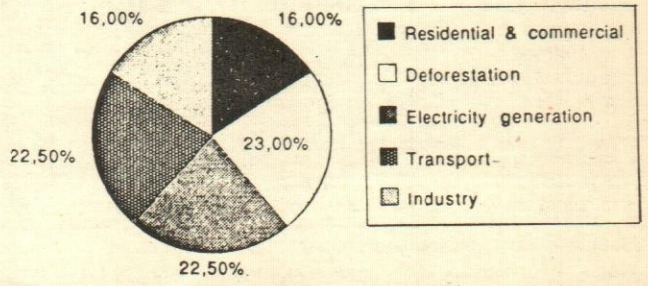


TABLE 4. PERCENTAGE CONTRIBUTION TO CO_2 EMISSIONS FROM HUMAN ACTIVITIES (1980-85)



face. The main greenhouse gas, water vapour, will increase in response to global warming and further enhance it. Scientists (Intergovernmental Panel on Climate Change, 1990) predict an average rate of increase of global mean temperature during the next century of about 0.3°C per decade with an uncertainty range of 0.2-0.5°C per decade, assuming the current trends of emissions are followed. This is a more rapid increase than seen over the past 10000 years. Sufficient evidence is now available from a variety of studies to indicate that changes in climate would have an important effect on agriculture and livestock and natural terrestrial ecosystems could face significant consequences (in particular, climatic zones could shift several hundred kilometers towards the poles). Global warming will accelerate sea level rise, modify ocean circulation, change marine eco-systems, and will certainly create large water resource problems in many areas.

The changes in atmospheric ozone (Environment Library N°2, 1987) is another critical problem we have to solve. It has been realised that human activities result in the addition of certain gases to the atmosphere that upset the balance between the production and destruction processes of high altitude ozone, thus leading to changes in the total amounts of ozone above the earth's surface. The most important of these compounds are chlorofluorocarbons (especially CFC-11 and CFC-12), carbon tetrachloride and methyl chloroform, all of which are chemically inert in the lower atmosphere, but are decomposed in the stratosphere by ultraviolet radiation to release chlorine, which acts as a catalyst in the ozone destruction process. Because the ozone layer filters out much of the sun's ultraviolet radiation, all terrestrial lifeforms may soon be exposed to higher levels of a potentially dangerous form of radiation leading to increased skin cancer and eye disease, smaller crop and timber yields, and damage to ocean ecology. Even if production of such chemicals ceased immediately, the effects would still take many years to abate.

Acidic precipitation and deposition, due to simultaneous action of sulphuric and nitric acid resulting from the transformation of SO_2 and NO_x, has effects far distant from its sources and is responsible for declines in forests in North America and Europe. Recently, concern has also been expressed over the impact of acidic deposition on drinking water quality.

Polluted Waters

The total volume of water on earth is about 1400 million cubic kilometers-some 10^{18} tonnes. But more than 97 per cent is ice, locked in the glaciers and the polar ice caps. On a global scale, there is more than enough fresh water to meet demand, both now and in the foreseeable future. But it tends to be available in the wrong place, at the wrong time or be of the wrong quality. Scarcity of supply, and heavy pollution have led to a situation in which atleast one-fifth of the Third World's city dwellers and three-quarters of its rural people lack access to reasonable safe supplies of water. Agriculture is by far the greatest user of fresh water, mostly in the form of irrigation, but is also an important source of pollution (table 5). Intensive agriculture based on chemical agents for fertilisers and crop protection is a major cause of groundwater contamination by nitrates and pesticides. Salt and sediment are two further serious water quality problems arising from intensive agriculture.

Industry uses much less water than agriculture, but is still a heavy source of pollution. Apart from the more obvious river pollution, organic and inorganic pollutants contained in industrial wastewaters can also seriously

Table 6. Freshwater Resources and Withdrawal

	Annual Internal renewable water (a)		Annual withdrawal (b) 1987		Sectoral withdrawal (%)		
	Total (cubic km)	1990 per capita cubic	% of water resources	per capita (cubic meter)	domestic	industry	agriculture
World	40673.00	7,690	9	660	8	23	69
Africa	4,184.00	6,460	3	244	7	5	88
North and Central America	6,945.00	16,260	10	1,692	9	42	49
Sourth America	10,377.00	34,960	1	476	18	23	59
Asia	10,485.00	3,370	15	526	6	8	86
India	1,880.00	2,170	18	612	3	4	93
Europe	2,321.00	4,660	15	726	13	54	33
U.S.S.R.	4,384.00	15,220	8	1,330	6	29	65
Oceania	2,011.00	75,960	1	907	18	16	76

Source : World Resources 1990/91
Notes : (a) precipitation minus evapotranspiration (b) taken for use for surface and subsurface

contaminate ground-waters which are not self-cleansing. Water is still considered in too many countries as an endless resource. The situation is changing, and the economic consequences are important.

Most of the world's wastes end up in the sea, without any preliminary processing, and about 90 per cent of these wastes stay in coastal waters where, particularly in semi-enclosed or land-locked seas, they interfere with fisheries, development, and recreation.

Contaminated Soils

The productivity of farmland overwhelmingly depends on the capacity of the soil to respond to management. The soil is not an inert mass, but a very delicately balanced assemblage of mineral particles, organic water, and living organisms in dynamic equilibrium. Soils are formed over very long periods of time, but if their environment is changed (for example, by the removal of vegetation cover), the delicate balance is upset. This can be offset by careful use an management (for example, by the addition of organic matter), but all too often this is not carried out, and a process of deterioration or degradation begins. The degradation of soil, under excessive human pressure or misguided human activity, can occur over a few decades or even years, and is often irreversible.

It has been estimated that, against the 1500 million hectares of land currently used for crop production, nearly 2000 million hectares of cultivated land (0.2-0.5 per cent) are being lost every year through soil degradation. If present trends continue, it seems that all the programmes for adding more land to the food-producing system may not compensate for the areas lost as a result of soil degradation and competing land uses. In other words, cultivated land is being lost at nearly the same rate as new land is brought under cultivation.

Concern about soil pollution is also increasing with the growing use of pesticides of which the behaviour in the soil is not yet well known. Heavy metal contamination from atmospheric fall-out and from the use of sewage sludge and synthetic fertilisers is a well-documented problem in many parts of the world. Another soil problem is the thousands of hazardous waste dumps, legacy of decades of uncontrolled disposal of toxic byproducts.

A New Approach : Cleaner Production

Certainly development is necessary to meet the basic needs of humanity for food, clothing, shelter and jobs—but, at the same time, it should not erode the natural resources based on which it depends. As Dr. Tolba, the Executive Director of UNEP states "Development and environmental preservation are compatible and essential ... but development will fail unless it is built on firm ecological foundations."

A drastic change in the overall production patterns is thus indispensable to face this environmental challenge.

The Cleaner Production Concept

For the past twenty years, "end-of-pipe" pollution control devices have been developed. Although those processes are useful and indispensable in the short term, their investment and running costs are high. It has now been realised that it is generally less costly to prevent than to cure. This is why UNEP has been promoting the "cleaner production concept" (Industry and Environment Review, Vol. 11, 12 & 13). This concept involves a new global approach to production: all phases of the life cycle of a product or of a process should be addressed with the objective of prevention or minimisation of short-and long-term risks to humans and the environment. This includes a "cradle-to-grave" approach minimizing wastes and emission into air, water and soil, pollution prevention as well as minimizing energy consumption and the use of all raw materials. It means not only developing new technologies but also good operating practices.

Introducing Cleaner Production

The development of "cleaner production" patterns means a commitment of all parts of society, and, in particular, a close co-operation between government and industry. It means also an involvement of all, at all levels.

It is government's task to set the comprehensive multimedia regulatory framework which will lead to the use of cleaner technologies. Sound environmental regulations on emissions and disposal and tight enforcement procedures are necessary. But this must be combined with incentive schemes such as research, development and demonstration grants, training activities and education programmes, collection and transfer of information.

It is industry's task to define cleaner production policies and programmes, with clear timetables and goals. Such programmes should include two complementary approaches : (1) implementation of cleaner technologies, (2) good management practices, involving all personnel.

Technology Development

Indeed there is a need to use pollution abatement equipment and to improve its performance. However, above all, there is a need to develop and deploy cleaner

technologies (UNEP/IEO, Technical Report Services No. 1,2,3 & 4) that have an inherently low environmental impact, including a low-waste production rate. Cleaner technologies also often have lower energy intensities. They mean lower costs of collection, transport, and disposal of wastes. They contribute to a reduction in technological accidents, and have a minimum disturbance on nearby ecosystems.

Five main kinds of changes can be considered in a cleaner production approach:

- redesign and/or reformulation of products (i.e. decrease in brightness of paper in order to diminish the use of bleaching agents, replacement of CFCs by substitutes in aerosols, replacement of mercury, cadmium and lead with other less toxic substances as components, energy efficient light bulbs);
- process modification i.e. replacement of single rinse processes with counter current processes, replacement of single path processes with close loop processes, recovery and recycling of caustic soda in mercerizing);
- changes in plant equipment (i.e. installation within the manufacturing process of new technologies such as ion exchange, ultrafiltration; reverse osmosis or other processes to separate components in the waste stream and allow their recovery, installation of monitoring system leading to greater efficiency in use of raw materials);
- raw or toxic material substitution (i.e. use of oxygen instead of chlorine for bleaching in pulp and paper industry, replacement of halogenated solvents by non-halogenated compounds in the electronics industry);
- simple operating and housekeeping processes (i.e. fixing leaks, separating waste streams to allow recovery).

In a study involving ten Dutch firms (Industry and Environment Review Vol. 11, 12 & 13), preliminary results of research pointed to 200 cleaner production options. 30 per cent of these fell into the category of good housekeeping; another 30 per cent were changes in plant equipment and the remaining 30 per cent were process modifications.

Cleaner production technologies often require a higher initial investment than traditional technology. However, the pay back is often surprisingly short (two to three years). Thanks to savings of raw materials and energy and lower treatment costs, numerous secondary benefits such as improved quality control of product, lower accident rates etc. are also obtained.

Management Practices

Good management is the "glue" that holds the technical measures together. Good management is impossible without high-level support in the company, and without a clearly articulated environment policy. Only then will all personnel know what is expected of them, and will be fully committed to achieve "cleaner production". Lack of maintenance of equipments is one major source of potential pollution and accidents. A leaking valve for example can lead to a major explosion as was the case in Flixborough.

Among the management tools, monitoring and auditing stand out. Overall environment auditing provides the company with a greater awareness of the environmental impacts of its products and processes, identifying compliance problems and areas of risk, pinpointing both strengths and weaknesses, and encouraging continual improvement. Recent UNEP publications provide examples of environmental practices in a few companies. (Industry and Environment Review; UNEP/IEO, Technical Report Series).

In addition, audits in specific fields, such as waste, energy or safety, can lead to the identification problems and improvements, leading to, among others: waste minimization and greater energy efficiency (APELL, 1989). The US Environmental Protection Agency, for example, has recently published a "Waste Minimization Opportunity Assessment Manual" systematically describing the possibilities for applying clean or low and non-waste technologies. (Industry and Environment Review, Vol. 12)

Training programmes for workers on the production line and other staff to increase awareness and action is an important element of good management practice for environmentally sound operations.

The Transfer of Cleaner Production Technology

Certainly, even if cleaner technologies are becoming used, there is still a very long way to go and there are many obstacles to cleaner production to overcome.

Access to adequate information is one of the first conditions to ensure transfer of technologies, and there is certainly a need for more co-operation and experience throughout the world.

This is why the Industry and Environment Office (IEO) of the United Nations Environment Programme (UNEP) can help. Many publications are already available describing technologies in use in various industrial sectors, their environmental impact, the available technologies for prevention and treatment of pollution. The documents are addressed to government officials, industry managers and

members of environmental protection associations. (UNEP/IEO, Technical Report Service; List of Publication; APELL, 1989). However, recognizing that there are already many sources of information available in many countries UNEP/IEO has started to create a "cleaner production network", linking government officials, industry decision makers, scientists and others who share an interest in cleaner production.

The UNEP/IEO programme involves four activities :

* industry sector working groups-specialists in the tanning, textiles, halogenated solvents and metal finishing industries meet regularly to share and gather information on low and non-waste technologies in their sector;
* the International Cleaner Production Clearinghouse (ICPIC), based on the US Pollution Prevention Information Clearinghouse, is a computer-based information exchange system which now has over 400 technology and programme case studies, a calendar of training events and seminars, a directory of experts, a bibliography of over 400 reference publications, and descriptions of international programmes on low and non-waste technologies. A printed directory is planned to complement ICPIC;
* the "Cleaner Production Newsletter" (Cleaner Production, April & Sept. 1990) explores the use, success or failure of clean technologies, the development of regional, national and global information resources, and provides a forum for discussion of cleaner production. The newsletter is a supplement to the "Industry and Environment" review, and is distributed by other UN organisations, by industry associations and by national environmental protection agencies;
* training activities—a seminar on the promotion of cleaner production was held on 17-20 September 1990. Over 150 senior level officials from government, industry, research institutions and international organisations participated. This seminar recommended that training activities and pilot projects be developed to assist national and local institutions;

Financial Resources

Although a great improvement can certainly be reached at a minimal cost through improved management and maintenance practices, the existence of financial resources is also crucial to ensure the necessary investments leading to cleaner production. The international community has recognised the need to help industrialising countries to acquire the necessary technologies and management tools. An amendment to the Montreal Protocol institutes a funding mechanism to help industrialising countries in phasing out the CFCs as agreed in the protocol. More generally, a "global environment facility", aimed at helping developing countries to implement programmes that protect the global environment is under discussion by the World Bank, the United Nations Development Programme (UNDP) and the United Nations Environment Programme.

Conclusion

Producing more with less resources; producing more polluting less. These are basic challenges of environmentally-sound development, of sustainable development. Cleaner production is certainly one of the keys to those challenges. Low-and non-waste technologies, safer technologies are the only way to preserve our environment. Industry and government must indeed commit themselves to take that way.

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Towards A Waste Utilization Policy in India

Purushottam Khanna, Vijay Kulkarni and Nirmala Saraswat

Certain wastes are recycled as a matter of routine in India. However, available information indicates that the total potential remains largely unutilized. The paper analyses the informational, economical, technological, managerial and socio-political constraints to waste utilization and delineates appropriate strategies for minimization and reclamation of wastes so as to achieve the twin benefits of conserving material & energy resources and circumventing environmental pollution.

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The economists' definition of waste relates to a substance which is cheaper to throw away than to make further use of. However, from the ecological point of view, waste is a misplaced resource which could be recycled and reused given the right economic framework as depicted in fig. 1.

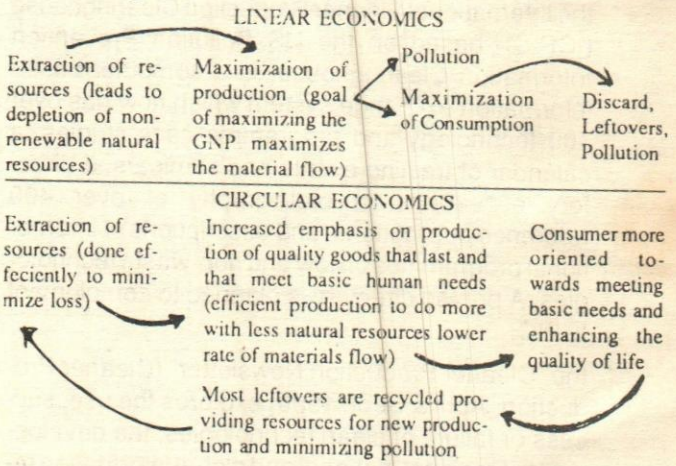


FIG. 1: RESOURCE USE FEATURES OF LINEAR AND CIRCULAR ECONOMICS

Source: Odum 1983.

Waste utilization essentially comprises waste minimization and waste reclamation. The former involves consideration of the total cycle of production in an integrated and systematic manner to allow formulation of strategies for minimizing the generation of wastes. These may relate to raw material substitution, product reformulation, equipment redesign, and other low-and non-waste technologies of production. Waste reclamation involves storage, collection, transportation and processing of wastes for recovery of reusable materials. Both strategies for waste utilization achieve the twin benefits of conserving natural material and energy resources and circumventing environmental pollution. In addition, there are the advantages of employment generation, augmentation of basic necessities of life like food, shelter, clothing and fuel; increased profitability to industry; foreign exchange savings; and added foreign exchange earnings through higher and additional value added benefits. Waste utilization could thus contribute

significantly towards sustainable development in a resource constrained economy such as ours. Certain wastes are recycled as a matter of routine in India. However, the waste utilization potential has not been exploited fully. The major reason behind this is that resource management has remained outside the realm of environmental management in India. Environmental policy and its legal instruments have focussed mainly on environmental pollution and the approach to environmental management is that of react and cure relying largely on mandatory controls, standards and legal enforcement. In fact this approach has induced the development of a pollution control industry with emphasis on treatment *per se* rather than waste prevention, recycle and reuse and utilization.

Waste Utilization—international Scenario

Anticipating the impact of rising population and increasing standards of living on material and energy resources, many developed countries have adopted policies and programmes for waste utilization as a means of resource conservation and pollution control. Developed countries including USA, Denmark, France, Germany, Netherlands, UK, Sweden, Norway and Japan have enacted legislations for recycling of solid wastes. Also, regulations for households and industries regarding source separation and use of recycled paper in public organization have been framed. Incentives for use of products manufactured using recycled materials are also offered.

Waste utilization policies and programmes have resulted in recovery rates of the order of 40 to 53 percent in Japan and Netherlands for paper, aluminium, wood, glass and steel. The high rate of success in these countries is attributed to non-availability of land for waste dumping together with economic and political costs of importing primary raw materials. Netherlands has also established the world's first waste exchange, a free brokerage service, to match buyers and sellers of waste. In addition, it has attempted to stabilize the typical boom-and-boost cycles in recyclables by establishing buffer stocks. Recovery and recycle of wastes all over the world has registered upward trends in past three decades with 5 to 10 percent increase over 1960 recovery rates for paper, aluminum and steel.

Potential for Waste Utilization in India

Certain wastes get recycled as matter of routine in India. However, available information indicates that the total potential for utilization remains untapped. The available wastes could be categorized broadly as community wastes, wastes from agriculture and agro-based industries, animal wastes, oil bearing seeds, industrial wastes and mineral wastes. The annual production of community wastes is estimated at 292 billion tonnes of sewage sludge, 7 million tonnes of night soil and 15 million tonnes of urban refuse. The night soil contains 2 million tones of nitrogen and 0.5 million tonnes of phosphate and potash each and could serve as a bio-fertilizer after composting (Sunavala, 1987). Technology is now available in India for biogas recovery from sanitary land fills.

Indian urban refuse contains about 46.5% organic matter, 6% paper, 0.7% glass, 3.2% rags, 1% plastics and about 43% moisture. While the inorganic components of refuse could be recovered and reused, the organic fraction warrants utilization through composting, incineration, pyrolysis and landfills with biogas recovery.

The availability of agricultural wastes in India is estimated at 600 million tonnes per year. These wastes include crop residues as well as wastes from agro-industrial operations such as rice milling, cane sugar manufacture, and production of tea, tobacco, groundnut and coconut oil, etc. The quantities of agricultural wastes available in India are presented in Table 1.

Table 1: Availability of Agricultural Wastes in India

Type of Biomass wastes	Availability tonnes/year x 10^6
Rice husk	17.86
Bagasse	61.22
Coconut shell	1.12
Groundnut shell	2.41
Maize cobs	2.03
Wheat straw	33.00
Paddy straw	90.00
Sorghum sticks	10.50

Source: Sunavala, 1987

Agriculture wastes could be put to a wide range of uses such as extraction of edible and non-edible oils; manufacture of pulp and paper, soaps, cosmetics, medicines, biochemicals, building materials, silicates, varnishes, resins, coating materials and activated carbon; and as cattle feed, fertilizer, soil conditioner and fuel as illustrated in table 2.

Availability of animal wastes such as slaughterhouse waste, animal carcasses, fisheries waste, and leather and wool waste is estimated at 45 million tonnes per annum (Sunavala, 1987). These wastes could be utilized as fertilizers, and raw material for production of glue and gelatin, liquid soaps, lubricants, etc.

Table 2: Present Utilization and Alternative Economic Products Obtainable from Various Agricultural Residues

Agricultural Residue	Present Utilization	Economic Products Obtainable
Rice husk	Fuel, manure	Fuel in husk fired stoves/furnaces, paper & paper board, soil conditioner, animal feed, abrasives, insecticide, insulator, packaging and building material, activated carbon, furfural, oxalic acid silica
Bagasse	Fuel	Pulp & Paper, furfural, cattle feed
Coconut shell	Fuel, manufacture of fancy articles	Charcoal, activated carbon, coconut shell flour, furfural
Groundnut shell	Waste	Fuel
Maize cobs	Animal feed & fuel	Xylose, furfural and various oils & acids
Wheat straw	Fuel, animal feed, grain storage structure and plastering houses mixed with mud	Packaging materials, straw board, biogas,
Paddy straw	Mostly burnt, a small portion used for mulching and roofing	Paper, paper board & straw board, packaging material, biogas
Sorghum sticks	Cattle feed, hut making, fuel	Pulp & paper, Kraft paper, box boar, viscose rayon, fuel

Source : Shrivastava, 1985

The quantity of oil seeds of tree origin available in India per annum has been estimated at over 100 million tonnes. The utilization of oil seeds could lead to considerable savings in foreign exhange in view of the present edible and non-edible oil crisis in the country.

The quantity of industrial and mineral wastes, summarized in table 3, amounts to nearly 50 million tonnes per annum. These wastes include flyash from thermal power stations, blast furnace slag from steel mills, paper sludge from pulp and paper mills, baggasse from sugar industry, phosphochalk and phosphogypsum from fertilizer industry, red mud from aluminium industry, and low concentration ores as well as marginal remains of rich ores from mining operations. The industrial and mineral wastes find immense potential as raw materials for manufacture of building materials such as slag cement, portland pozzolana cement, lightweight aggregates, bricks, etc. as shown in table 4. The untapped ores could be effectively utilized if appropriate technologies are developed through a time-bound R&D endeavour.

The concept of low and non waste technology (LNWT), involving formulation of waste management strategies after consideration of the total cycle of industrial production in an integrated and systematic manner rather than imposing pollution control measures at the end-of-the-pipe, is widely administrated internationally for waste minimization. Such technologies are being used increasingly for the industry to reduce raw material, energy and water consumption, and to circumvent the need for treatment and disposal of large volumes of wastes. In many instances industry has found that such technologies

Table 3: Availability of Industrial and Mineral Wastes in India

Waste	Availability Million tonnes/year	
	Total	Usable form
Flyash	19.0	3.0
Blastfurnace slag	7.5	2.8
Ferro-alloys and other metallurgical slags	3.5	-
Other metallurgical slags	3.5	-
Lime sludge (from sugar acetylene, fertilizer, paper chrome and soda ash industries)	4.8	4.8
Byproduct gypsum	4.5	4.5
Red mud	1.5	-

Source : CRI, 1985

are proving to be an effective way of reducing the cost of production as well. Selected clean technologies of production are presented in table 5.

Major Issues In Waste Utilization

One of the major issues in waste utilization is market stability. Market forces favour waste utilization only in the event of shortage of raw materials of exorbitant prices. The prices of materials tend to fluctuate due to irregularity of supply and demand and this inhibits proliferation of waste reclamation industry. The other factors which lead to preferential use of virgin raw materials rather than wastes, include:

— Natural resources occur in concentrated form;

Table 4: Present Utilization and Alternative Economic Products Obtainable from some Industrial Wastes

Industrial Waste	Physical Form of Waste	Source Industry	Present Disposal Method	Potential for use
Flyash	Powder	Thermal Power Station	I. Pumped in the form of slurry to nearby lowlying areas in the wet system of disposal II. Flyash discharged from the precipitators is conveyed for disposal to the dumps in the dry method light weight aggregates	I. in portland pozzolana cement II. in construction industry III. a. dam construction b. land reclamation c. road construction IV. Cellular concrete V. lime flyash bricks VI. sintered light weight aggregates
Blast furnace i. granulated ii. ungranulated	Solid lumps	Steel Industry	Dumping in open area	I. in blast furnace slag cement II. as binding material I. Road aggregate II. Slag wool
Lime sludge	Slurry paste	Fertilizer Sugar, Paper & Acetylene industry	Stored in large outdoor settling ponds	I. as raw material in cement manufacture II. in lime pozzolana mixture
Chemical gypsum	Slurry/ paste	Fertilizer industry	Pumped in the form of slurry to the dumping ponds	I. as a set controller in the manufacture of cement in place of mineral gypsum II. for making gypsum block board
Red mud	Paste	Aluminium ndustry	Dumped in open area	I. as a component of raw mix in the cement industry II. in the manufacture of building bricks II. Light weight structural blocks

Source: Ganapthi, 1985

wastes are dispersed, and collection and transport costs are high.

- Primary resources are more homogeneous in composition; sorting and upgrading mixed wastes is costly.
- Existing production technologies were developed to use natural resources; waste processing requires different technologies.
- Raw materials are usually of higher quality than wastes and less contaminated; product specifications and quality are therefore easier to control.
- Existing industries are located to use natural resources; utilization of wastes may require compatibility between site of waste generation and plant location to avoid transport costs.
- Waste utilization requires co-ordination between different interest groups such as primary waste producer, waste collecting agency and waste reclamation industry.

Also, waste utilization is considerably impeded by lack of information exchange between various interest groups on opportunities for waste recycling and utilization. A centralized data base on availability and accessibility of wastes, technologies for utilization and their economic viability, and market demand for recovered materials does not exist in India. There is also lack of coordination and direction in R&D efforts and inadequate thrust for technology transfer from lab-to commercial scale. These problems arise mainly due to insufficient misssion oriented approach of laboratories; inadequacy of design, engineering and fabrication facilities; inadequacy of funds for pilot-scale demonstration of laboratory results: and low value placed on technology transfer by scientific and technological personnel engaged in R&D work.

Recommended Action

Waste utilization is a complex issue requiring consideration of a large number of technological, economic, informational, managerial and sociopolitical factors so as to enable a coordinated endeavor towards devising and implementing strategies for the minimization, storage, collection, transportation and processing of waste materials. The first step in this direction should be towards collection of information on following aspects:

- Nature, volume, location and accessibility of wastes.
- Available technologies for waste utilization in India and abroad, and their ecconomic viability.
- Potential market for recoverable materials, fluctuations in supply amd demand of waste materials, and enquiry into reasons for which the market may be failing to achieve a desired level of waste utilization.

Table 5: Clean Technologies of Production

Name of Industry	Steps towards Non-Waste Technology			
	Process Modification	Recycle/Reuse	Equipment Redesign	Product Formulation
Pulp and Paper	Removal of silica before evaporation process in cooking of rice straw	Whitewater recycling for Washing of pulp	Press drying technology for paper making	Brightness of pulp regulated to 75-80%
	Substitution of chlorine with chlorine dioxide or hydrogen peroxide in bleaching of pulp	Recovery of sodium sulfide/sodium carbonate in cooking		Separation of paper requiring permanent brightness
		Separation of lignin in bleaching process for use as adhesive agent and raw material for dyestuffs		
Textile	Thermal printing process for cotton cloth	Caustic soda recovery in mercerizing		
	CMC/PVA to replace starch in sizing	Solid cotton waste separation for use as stuffing for cushions and dolls		
		Counter current washing		
Tannery	Aluminium salts to replace chromium salts in pretaining	Cuttings, trimmings as raw materials for leather boards	Use of drums and mixers instead of pits	
	Batch washing of hides instead of continuous washing	Green scrappings from sawing for glue production		
	Enzymes to replace sulphate in unhairing	Tail and body hair for carpet industry		
Metal Finishing	Counter current washing for rinsing	Cadmium and cyanide recovery through reverse osmosis		
Chlor-alkali	Non-cyanide salts for nitriding Ion-exchange and electrolysis for production of chlorine and caustic soda	Recovery of noble metals through electrolysis		
Iron and Steel	Mechanical cleaning to Neutral electrolytic process for pickling	Blast furnace slag as construction material Recovery of hydrochloric acid from pickling process		
Fertilizer	Nitrophosphate process for NPK complex production	Nitric acid recovery in ammonia fertilizer plant		

— Fiscal/regulatory incentives/disincentives to facilitate waste utilization.

The seccond step should be information analysis for overcoming constraints to commercialization of available economically viable technologies, and identification of areas in which new technologies need to be developed.

A large number of research and academic institutions in the country as also the industries have been involved in research and development on waste utilization technologies. However, due to inadequacy of funds for pilot scale demonstration, lack of coordinated endeavor to evaluate market demand and lack of direction and motivation, the transfer of technology from lab to commercial scale has remained inadequate. Efforts should be made to coordinate these R&D activities and develop appropriate delivery systems. The focus in waste management needs to shift from waste reclamation to waste minimization by promoting development of low and non-waste technologies for industrial production. R&D programmes on the

subject warrant support from funding agencies. Steps are also needed to ensure smooth flow of wastes from source of generation to processing facility. There are many instances where the waste utilization technology itself is economical but actual utilization is impeded by high cost of collection and transportation. Therefore, effective strategies need to be formulated for storage, collection and transportation of wastes. Incorporating waste utilization considerations in the process of setting up the industry could be useful in this respect.

A stabilized market support needs to be developed for recovered materials by undertaking appropriate measures to ensure regularity of supply as well as demand. Development of a waste reclamation industry should be induced.

As market forces alone may not be successful in achieving a desired level of waste utilization, it is necessary to devise appropriate fiscal and regulatory measures to promote waste utilization. Fiscal measures may include incentives to local authorities to support reclamation activities, incentives/grants/ concessions to industries using recycled materials, awards to agencies for outstanding contributions to resource conservation, and financial support to R&D activities.

* Programmes should be undertaken for creating public awareness and for continuing education of professionals in the area of waste utilization.
* In order to deal with the diverse and inter-disciplinary issues concerning waste utilization in a concerted manner, there is a need to institute a National Waste Utilization Board (NWUB) with functions to:

— collate and promote exchange of information between various agencies involved in waste utilization

— review ongoing research and development on waste utilization, identify new research needs and promote the development of appropriate technologies for minimization, storage, collection, transportation and processing of waste materials

— induce the development of stable market for recovered materials

— develop appropriate regulatory and fiscal measures for promoting waste utilization

— define and coordinate the role of various agencies involved in waste utilization

— formulate programmes for public education and training of professionals

— undertake other necessary measures to ensure optimum utilization of resources and recycling of wastes

The Boards for Waste Utilization may be also instituted at the state level to undertake responsiblility of implementation of waste utilization programmes. An action plan for waste utilization is presented in fig. 2

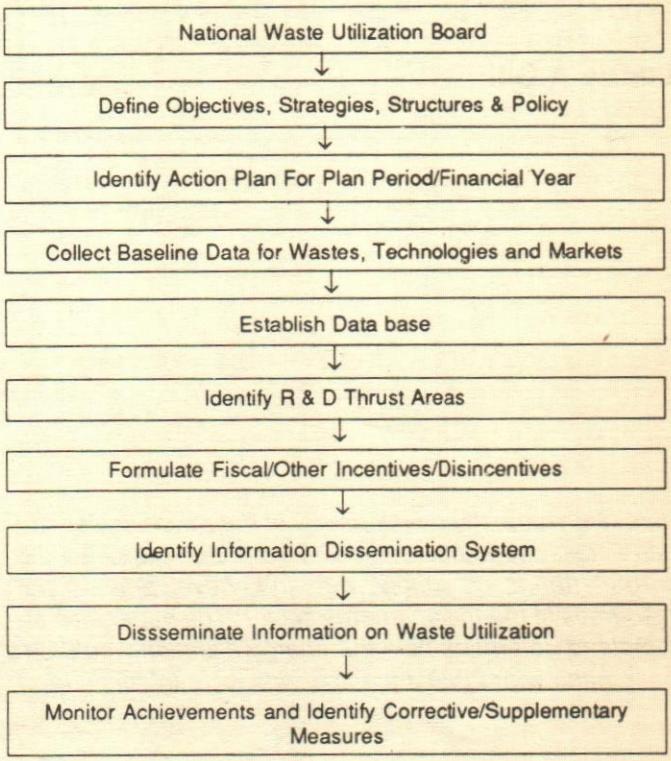


FIG. 2: ACTION PLAN FOR NATIONAL WASTE UTILIZATION BOARD

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Implications of Current Trends In The Indian Energy Sector

Laurie A.Gill

In recent years, the development of India's energy sector has accelerated considerably. This paper examines the current trends of supply, demand, development, and resources in the Indian energy sector. The paper also attempts to determine how the energy situation would appear in the year 2020 if these trends were to continue.

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India's energy sector has continued to grow rapidly since independence. In recent years, this development has accelerated. An increasing amount of resources is being spent, fossil fuels are being exploited at unprecedented rates, and immense power projects are being installed; all to help satisfy a continuously increasing demand. One result of this development has been the provision of energy to fuel India's rapid economic growth. Less favorable results of this development have been the submergence of millions of hectares of arable land, the displacement of hundreds of thousands of people from their homes, and emissions of a wide range of atmospheric pollutants. The purpose of this paper is to examine the current trends of supply, demand, development, and resources in the Indian energy sector, and to determine how the energy sector's situation would appear in the year 2020 if these trends were to continue. The "forecasts" made in this paper are not forecasts in the traditional sense. Rather they are simply projections of what will occur if current trends prevail into the future. We begin this paper with a statistical analysis covering government expenditures on the energy sector and demand and supply of electricity, coal, and oil/petroleum products. Using current growth trends, it is possible to extrapolate what will be happening in the future if these trends continue to a certain date, specifically, 2020. Based on these extrapolations of current trends, we can estimate the environmental and social impacts that might occur. Finally, we discuss how the Indian Government is currently planning to provide for these increases in demand.

Statistical Background and Forecasts

Plan Expenditures

Total Indian public sector spending has increased from Rs. 1,960 crores (one crore is equal to 10 million) in the First Plan (1951-1956) to Rs. 180,000 crores in the Seventh Plan (1985-1990) [CMIE, 1988, 1-3]. Total energy sector spending has also steadily increased over

this period. The First Plan included spending of Rs. 260 crores on the energy sector, or 13.3% of plan expenditures. The Seventh Plan included energy sector spendings of Rs. 55,130 crores or 30.6% of total plan expenditures [CMIE, 1988, 1-3]. Thus, not only is the amount of money being spent on the energy sector increasing, but so is the per cent of total plan's expenditures allotted to energy. The proportion of total plan outlays used for the energy sector rose steadily in each of the first seven plans. (table 1 and figure 1.)

Since the First plan, total plan expenditures have grown at an average annual rate of 15% per year. Over the same period, energy expenditures have grown at an average annual rate of 19.7% per year, while expenditures on all other sectors combined increased at the slower rate of 13% per year. If these growth rates continue for the next thirty years, then the public sector as a whole will spend Rs. 17,372,000 crores during the 13th plan (2015-2020) of which Rs. 11,839,000 crores will be spent on the energy sector. Thus, India will spend 68% of total 13th Plan outlays on the energy sector alone. Obviously, spending 68% of the national budget for the energy sector is problematic for other sectors of the economy. At the same time, failing to continue growth rates in spendings will make it increasingly difficult to maintain projected needs.

Table 1 : Total Plan Expenditures and Energy Expenditures Plan 1 (1951-1956) to Projected Plan 13 (2015-2020), in Rs. crores

Plan (Period)	Energy Expen.	Other Expen.	Total Exp.	Energy Exp. as a % of total
1(1951-56)	260	1,700	1,960	13
2(1956-61)	460	4,212	4,672	10
3(1961-66)	1,252	7,325	8,577	15
4(1969-74)	3,235	12,544	15,779	21
5(1974-79)	10,122	29,304	39,426	26
6(1980-85)	30,751	79,716	110,467	28
7(1985-90)	55,130	124,870	180,000	31
Average annual rate of growth	19.7%	13%		
8 (1990-95)*	134,909	235,000	369,909	36
9 (1990-2000)*	330,141	442,000	772,141	43
10(2000-05)*	807,896	831,000	1,638,896	49
11(2005-10)*	1,977,022	1,564,000	3,541,022	56
12(2010-15)*	4,838,018	2,941,000	7,779,018	62
13(2015-20)*	11,839,228	5,533,000	17,372,228	68

* Forecasts of future considering current trends
Source: Centre for Monitoring Indian Economy, 1988, 1-3.

Electricity/Power

Both electricity supply and demand in India have grown steadily since 1974. In 1974, total electricity production grew from 66.6 terawatt hours (TWh), to over 174

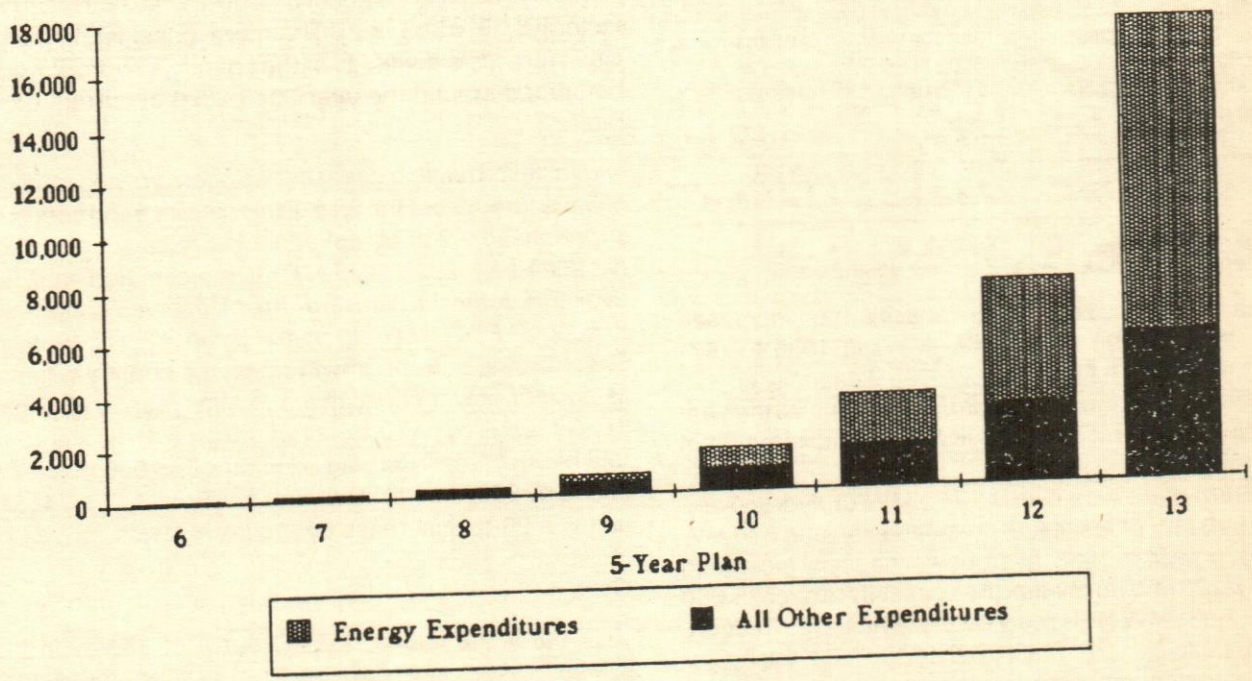


FIG. 1 PROJECTION OF PLAN EXPENDITURES ENERGY SECTOR VS. ALL OTHER SECTORS COMBINED (IN 1,000 CRORES RS.)

BTWh in 1987, at an average annual rate of 8.4%[1]. Similarly, electricity demand grew from 77.6 TWh in 1974, to over 192 TWh in 1987, at an average annual rate of 7.9% [CMIE, 1988, 2-18] (Demand is the estimated consumption that would have occurred had supply not been constrained). If the demand continues to grow at this rate, in 2020 India will be demanding over 2,300 TWh of power. If the supply of electricity continues to increase at an annual growth rate of 8.4% per year, the country will produce over 2,400 TWh in 2020, (table 2), resulting in a surplus of 130,800 TWh. The first year that supply exceeds demand will be 2009 (table 2).

Table 2 : Power Supply, Requirements, Deficits, 1974-1987, 2020, in GWh

Year	Supply	Requirement	+Surplus/-Deficit
1974-75	66,647	77,600	-10,953
1975-76	74,909	83,508	-8,599
1976-77	83,365	88,489	-5,124
1977-78	86,343	102,180	-15,837
1978-79	97,349	108,535	-11,186
1979-80	99,302	118,370	-19,068
1980-81	104,932	120,118	-15,186
1981-82	115,274	129,245	-13,471
1982-83	122,909	136,746	-13,837
1983-84	129,625	145,273	-15,648
1984-85	145,013	155,432	-10,419
1985-86	157,262	170,746	-13,484
1986-87	174,276	192,356	-18,080
Avg. annual rate of growth	8.4%	7.9%	
1994-95*	332,255	353,409	-21,154
1999-2000*	497,300	516,874	-19,574
2004-2005*	744,329	755,948	-11,619
2008-2009*	1,027,737	1,024,655	3,082
2009-2010*	1,114,066	1,105,602	8,464
2014-2015*	1,667,468	1,616,986	50,482
2019-2020*	2,495,766	2,364,903	130,863

*Forecasts of 2020 assuming current trends continue
Source: Centre for Monitoring Indian Economy, 1988, 2-18.

India's installed electrical capacity has increased steadily from 30,000 megawatts (MW) in 1980 to over 54,000 MW in 1988, [TERI, 1988, 69], If capacity continues to be added at a rate of approximately 9.9%, the year 2020 will see over 1,039,000 MW installed throughout India (table 3).

In 1980, there was over 11,700 MW of hydropower, over 17,500 MW of fossil-fuel fired capacity, and 860 MW of nuclear power. In 1988, hydropower capacity increased to over 17,200 MW; fossil-fuel fired capacity to over 35,600 MW; and 1,330 MW of nuclear power was installed throughout India (table 3) [TERI, 1988, 69]. In 1987-88, the hydro/fossil fuel/nuclear installed capacity power mix was 32%,

1. when referring to energy units, we use the following convention: $M=10^6$, $G=10^9$ and $T=10^{12}$.

Table 3 : Breakdown of Power Sector — Installed Capacity, in MW

Year	Hydel	Fossil Fuels	Nuclear	Total
1980-81	11,791	17,562	860	30,213
1981-82	12,172	19,312	860	32,344
1982-83	13,055	21,477	860	35,392
1983-84	13,855	24,388	1,095	39,388
1984-85	14,460	27,029	1,095	42,584
1985-86	15,471	29,967	1,330	46,768
1986-87	16,195	31,740	1,330	49,265
1987-88	17,215	35,650	1,330	54,195
Avg. annual rate of growth	5.6%	10.7%	6.9%	9.9%
1999-2000*	33,104	120,734	3,619	157,457
2004-2005*	43,470	200,710	5,492	249,672
2009-2010*	57,083	333,662	8,334	399,079
2014-2015*	74,960	554,684	12,648	642,292
2019-2020*	98,435	922,111	19,195	1,039,741

*Forecasts for the future considering current trends.
Source: Tata Energy Research Institute, 1988, 69.

66%, and 2% respectively. Once again, using average annual growth rates from the 1980's, forecasts can be made for the year 2020. If hydropower continues to grow at the rate of 5.6% per year, an additional 81,220 MW will be installed by 2020 for a total installed capacity in that year of 98,435 (table 3). Hydroelectric potential in the country has been estimated by the Central Electricity Authority (CEA) to be about 84,000 MW at a 60% capacity factor [CMIE, 1988, 2-2]. Therefore, considering the previous forecasts made, all of the country's hydropower will be tapped around the year 2015-2020 at current growth rates.

Installed nuclear capacity has been growing at the rate of 6.9% throughout the 80's. If this current trend continues, a forecasted 9,900 MW of additional nuclear capacity will be added by 2020 (table 3). It is estimated that, with available domestic natural uranium reserves, India is able to support 8,000 MW of nuclear power [TERI, 1988, 76]. Therefore, at current growth rates, the country will reach its nuclear power capacity around the year 2015. Finally, if fossil-fuel fired power continues to grow at the staggering rate of 10.7% per year, an additional 886,000 MW will be added by 2020. Installed capacity will total 1,039,741 MW, nearly a 20-fold increase over current levels.

Coal

Coal is the largest single source of energy in India [CMIE, 1988, 3-2]. Consequently, as energy demand grows, more and more pressure is put on coal to produce enough to meet public needs. In recent years, coal producers have been able to meet public demand fairly well, and

deficits have been either small or non-existent [CMIE, 1988, 3-12]. Current annual growth rates, however, indicate that the demand for coal is growing slightly faster than the supply of coal.

Demand for coal grew at a constant rate of 8.4% during the period 1984-88. At this rate, demand will increase from 180.4 million tonnes in 1987-88 to more than 2,300 million tonnes in the year 2020. Over the period 1984-88, the supply of coal has grown at a slightly lower rate of 7.3%. If production continues to grow at this rate for the next 30 years, then production will total slightly more than 1,700 million tonnes of coal in the year 2020 (table 4). This would leave India with a deficit of 660.4 million tonnes in 2020, equal to 28% of their total demand.

Historically, there has been a consistent gap between the selling price of coal and the cost to produce it. Throughout the 1980's, the cost of producing coal has been much greater than the market price [CMIE, 1988, 3-21]. Current growth trends indicate, however, that this gap is slowly closing. During this period, price of coal has risen at an annual rate of 10.6%, compared to a 9.5%

Table 4 : Demand, Supply and Deficit Figures for Coal, in million tonnes

Year	Demand	Supply	+Surplus/-Deficit
1980-81		109.10	
1981-82		122.50	
1982-83		128.40	
1983-84		136.30	
1984-85	143.1	147.41	+4.31
1985-86	157.2	154.24	-2.96
1986-87	164.7	165.79	+1.09
1987-88	180.4	180.76	+.36
Avg.annual growth rate	8.4%	7.3%	
1988-89 *	208.0	196.28	-11.72
1989-90*	220.0	220.56	+5.60
1994-95*	335.2	335.2	
1999-2000*	417.0	417.0	
2019-2020**	2,383.3	1,723.0	-660.30

* Estimates from CMIE
** Forecasts for 2020 considering current trends
Source : Centre for Monitoring Indian Economy, 1988, 3-12.

average annual increase in the cost of production. If the price of coal continues to grow at this rate, then the year 2020 will see a price of Rs. 4,975 per tonne of coal. If the cost of production continues to rise at the average annual rate of 9.5% per year, then in 2020, production costs will be Rs. 4,233 per tonne, resulting in a net economic return from sales.

Oil and petroleum Products

Petroleum production and consumption trends initially appear quite encouraging. Throughout the 1980's this portion of the energy sector has managed to keep demand and supply relatively close; and the deficit has remained low [CMIE, 1988, 4-1]. Production and consumption have grown quite steadily, at rates of 13.2% and 5.9%, respectively. Production of petroleum products has been growing at a very rapid rate of 13.2% over the 1980's. On the other hand, crude oil imports rose at a 15% annual growth rate during the 1980's, and are expected to double between now and the year 2000 [CMIE, 1988, 4-1]. The increased imports of crude oil to India are being used for the domestic production of petroleum products. Therefore, the small deficits of petroleum products are due to the increased imports of crude oil that are being used for the domestic production of petroleum in India. In 1986-87, India imported 15.5 million tonnes of crude oil, and it is predicted to import 50 million tonnes by 2000 [CMIE, 1988, 4-40]. At this rate of growth (about 8% annually), 167 million tonnes of crude oil will be imported in 2020 (table 5). The U.S. Department of Energy forecasts an average annual increase in international oil prices of 6.4% over the period 1990-2000. If these price trends continue, oil will cost U.S $98 per barrel in 2020 [DOE, 1989, xi]. India's total net imports of crude oil will therefore cost over Rs. 198,000 crores in that same year.

Table 5 : Crude Oil — Imports and Costs

Year	Net Imports (million tonnes)	Value of Imports (Rs. crores)
1980-81	16.25	3,349
1982-83	12.40	2,980
1983-84	10.44	2,310
1984-85	7.16	1,867
1985-86	14.62	3,552
1986-87	15.48	2,120
1989-90	15.00 *	2,749 **
1994-95	31.00 *	7,764 **
1999-2000	43.00 *	14,709 **
2004-2005	50.00 *	23,334 **
2019-2020	166.67 **	198,650 **

* Estimates from CMIE
** we assume that the average annual growth rate of the price of oil is 6.4% per year, using DOE's estimates of future oil prices.

Sources : Centre for Monitoring Indian Economy, 1988, 4-40 United States Department of Energy, 1989,

Impacts

Environmental and Social Implications of Hydroelectricity

India is one of the largest builders of dams in the world [Singh, 1990, 562]. By 1979, it had constructed over 1,500 large dams at a cost of Rs. 10,560 crore. Thus, hydroelectricity has been concentrated in the form of "highly visible

large dams" [CSE, 1985, 27-28]. All of the country's major rivers have been dammed or have proposals drawn up to be dammed; however, not all of the country's hydropower has been realized [CSE, 1985, 100]. Using figures that were given earlier in this paper, in 1987-88 India had tapped an estimated 20.5% of its total estimated hydropower potential.

Since 1951, not one hydropower project has ever been completed on time, or within the cost estimates [CSE, 1985, 119]. Not only are they costly, but hydropower projects in the past have caused immense social and environmental problems. In order to build each dam, thousands of hectares of land are submerged under the reservoirs and as a result thousands of people who live in the area have to be rehabilitated to new homes.

Dam waters now cover nearly 1% of India's total land area [CSE, 1985, 27]. Much of this land was once covered by forests. The construction of dams has denuded much of the forest lands. The forest is cleared not only for the dam, but for approach roads, offices, residential quarters, and storage. For these reasons, plus the entry of new people, pressure on the remaining forest increases. Their need for firewood leads to more denudation — and thus a multiplier effect [CSE, 1985, 102]. From 1951-1976, 500,000 hectares of forest land was lost to major dam projects alone [CSE, 1985, 102].

We can estimate the average number of hectares of land that are submerged per MW of hydropower installed by looking at a selection of major power projects that have been either installed or proposed (table 6. All projects for which adequate data were available are included.). An average of 83 hectares of land were submerged for each MW of hydropower from the 17 projects on our list. By using the earlier forecast of additional hydropower capacity that will be installed in 2020 (using current growth trends), a forecast can be made for the number of additional hectares that will be submerged in the year 2020 if these current trends continue.In 2020, with an additional 81,000 MW of hydropower capacity, an additional 6.7 million hectares of land would be submerged under the reservoirs of large dam projects. This is equivalent to 2.3% of India's total land area, in addition to what is currently submerged.

Many poor tribal people "suffer for progress" when their homelands are submerged by the giant hydropower projects, according to the Centre for Science and Environment [CSE, 1985, 99]. We can estimate the average number of people displaced per MW of hydropower installed by looking at a selection of various hydropower projects (All projects for which adequate data were available are included). For the 13 projects on our list, an average of 130 people were or would be displaced per MW of installed capacity (table 6). This will imply displacement of an additional 10.5 million people. This is approximately the present size of Bombay, India's most populous city.

Table 6 : Selected Hydro Projects, Capacity, Land Requirements, Persons Displaced

DAM	MW	AREA ('000 hectares)	HECTARE/MW
Pong	240	62.87	261.96
Rana Pratap Sagar	172	19.58	113.84
Rihand	300	46.80	156.00
Matatila	30	12.93	431.00
Ukai	300	60.13	200.43
Gandhi Sagar	115	68.00	591.30
Koyna	880	12.00	13.64
Nagarjunsagar	110	28.48	258.91
Tungabhadra	72	35.88	498.33
Idukki	390	5.78	14.82
Periyar	140	2.91	20.79
Bodhghat	500	12.64	25.28
Tehri	1000	5.20	5.20
Bansagar	315	51.65	63.97
Koel-Karo	710	20.24	28.51
Sardar Sarovar	415	25.06	60.39
Narmada Sagar	1000	85.00	85.00
TOTAL	6689	555.15	82.99
In 2020: an additional 6,740,810 hectares submerged*			

DAM	MW	People Displaced	People/MW
Gandhi Sagar	115	51,514	447.95
Pong	240	80,000	333.33
Ukai	300	80,000	266.67
Koyna	880	30,000	34.09
Nagarjunasagar	110	13,227	120.24
Tehri	1000	85,600	85.60
Bodhghat	500	8,350	16.70
Sardar Sarovar	415	90,000	216.87
Narmada Sargar	1000	120,000	120.00
Utayasu	900	60,000	66.67
Bansagar	315	127,000	403.17
Koel-Karo	710	100,000	140.85
TOTAL	6485	845,691	130.41
In 2020: an additional 10,591,900 people displaced*			

Sources: Singh; 1990, 566-571
Udall's Statement, 1989, 2.
Centre for Science and Environment, 1985, 99-120.

* figures calculated according to current trends considering there will be an additional 81,220 MW of hydropower in 2020.

Coal Burning Plants

The relative abundance of coal in India has led to increased installation and proposals of coal-burning power

plants. Currently, about 56 million tonnes of coal are used by coalburning power plants, while 195 million tonnes are expected to be used by 2000 [CSE, 1985, 134]. Along with these large power-producing plants come many environmental impacts and health risks for the people near them. These impacts include emissions of a variety of pollutants including oxides of carbon and nitrogen, and the use of large amounts of water and land. Using available data, we estimated the additional water requirements and emissions of carbon dioxide from coal-fired power plants in the year 2020.

Large amounts of water are used for cooling purposes in coal-burning power plants. A conventional coal-fired power plant with an installed capacity of 500 MW, operating at a capacity factor of 40%, uses 25 million litres of water per MW, per year, primarily for cooling [Padmanabhan, 1990]. In 1988, there were 35,600 MW of installed thermal capacity in the country. This means that during 1988, approximately 890 billion litres of water were used in thermal power plants alone. This water then becomes warm waste water [CSE, 1985, 29]. Using forecasts for thermal power generation in 2020, 922,000 MW of thermal power will be installed, given current trends. This means that 23 trillion litres of water will be used and discarded as warm waste water in that year.

Carbon Dioxide Emissions

The burning of coal results in the emission of carbon dioxide (CO_2) into the atmosphere. By 1986, close to 140 million tonnes of carbon had been emitted into the atmosphere due to the burning of fossil fuels in India [Ahuja, 1990]. India itself was responsible for 3.78% of the global release of CO_2 into the atmosphere during the period 1958-1980 [Hingane, 1990, 262]. Consumption of fossil fuels has been steadily rising in recent years. Between 1980 and 1988, consumption of natural gas has been growing at an annual rate of 25.9%. In 1980-81, 1,500 million cubic metres (mm^3) of gas was consumed. In 1987-88, that number had risen to over 7,800 mm^3 [CMIE, 1988, 1-1]. The consumption of petroleum products grew at an average annual rate of 6% between 1980-1987. In 1980, the country was burning 30.9 million tonnes of petroleum, and by 1987, this number grew to over 43.6 million tonnes [CMIE, 1988, 4-1]. Coal consumption grew at an average annual rate of 5% between 1951 and projected 1989 figures. In 1951, 31.8 million tonnes of coal were consumed, and figures projected that in 1988-89, 202 million tonnes of coal would be consumed [CMIE, 1988, 3-14].

Using the average annual growth rates for the respective periods, it is possible to forecast the consumption of these fossil fuels in the future. Assuming that current rates continue, in 2020, over 9.9 million cubic metres of gas, 296.8 million tonnes of petroleum, and 911 million tonnes of coal will be burned (table 7). The amount of carbon dioxide emitted for a certain amount of a fossil fuel burned varies from fuel to fuel. Our estimates of per unit emissions are drawn from standard references and are listed in table 8. In 2020, assuming that current trends continue, approximately 5,247 tonnes of carbon will be released into the atmosphere due to the burning of natural gas in India. Over 22.8 million tonnes of carbon will be released into the atmosphere due to the burning of petroleum products. Finally, over 519 million tonnes of carbon will be released as a result of coal burning (table 7).

Although these figures are startling ones, it is important to keep in mind that the majority of carbon dioxide emissions released into the atmosphere are released by the industrialized countries of the world, the United States in particular.

Near Term And Future Plans

The Indian government has outlined many plans for the future of the energy sector to try to meet the needs of the public. As of December 1987, projects totalling 23,400 MW had been sanctioned for the purpose of meeting the public demands for the Eighth plan (1990-95) [CMIE, 1988, 1-9]. (It should be noted that our figures for the consumption of coal were based on the amount of coal actually burned, and may not necessarily equal supply of coal or demand for coal).

Hydropower

The Planning Commission has been considering the possibility of installing 10,000 MW of hydropower during the 8th plan, compared to the 5,500 MW of the previous Plan [CMIE, 1988, 2-6]. A small fraction of this power addition — about 400 MW — will be from proposed

Table 7 : Consumption of Coal, Natural Gas and Petroleum Products and CO_2 Emissions (for 2020)

Year	Coal Consumption (10^6 tonnes)	Natural Gas ($10^6 m^3$)	Petroleum (10^6 tonnes)
1951	31.80		
1983-84		3,399	35.84
1984-85		4,141	38.80
1985-86		4,950	40.87
1986-87	162.69	7,058	43.66
1987-88		7,844	
2019-20**	911.29	9,900,519	296.80
	Co_2 emissions for 2020* (tonnes of Carbon)		
2020	519,435,000	5,247	228,536,000

CO_2 emission factors:
0.57 tonnes carbon per tonne of Indian coal
530 grams of carbon per cubic meter of gas
0.77 tonnes carbon per tonne of petroleum
Source: Masters and Rotty, 1985.
Forecasts for future based on current trends
Source: Centre for Monitoring Indian Economy, 1988, 1-1, 3-14, 4-1.

small-, mini-, and micro-hydropower projects that are being installed around the country. As of February, 1988, there were 105 existing small mini-micro-hydropower stations with an existing capacity of 196 MW, and 87 other under construction with a projected capacity of 218 MW [CMIE, 1988, 2-3].

Thermal Power/Coal

The planned total capacity addition for the Eighth plan (1990-95) includes nearly 25,000 MW of newly installed thermal power [CMIE, 1988, 2-6]. This will cause an increase in the demand for coal. As of December, 1987,290 coal mining projects costing Rs.7,516 crores had been sanctioned. When completed, they are estimated to have a mining capacity of 229 million tonnes annually [CMIE, 198, 3-25]. According to the estimates derived from current growth trends, demand will reach this amount around the year 1990-91 (table 4). An additional 106.2 million tonnes of coal would be needed to meet projected demands for the 8th plan (table 4).

Nuclear Power

The Indian government is rapidly expanding nuclear power capacity. As of December 1988, there were six nuclear power reactors operating with a capacity of 1154 MW, and eight others under construction with a capacity of 1760 MW [CMIE, 1988 2-38,].

Crude Oil/Petroleum Products

The Planning Commission feels that, if exploration efforts are successful, then there should be no problem meeting the demand for petroleum products until the end of the 8th plan (1994-95) [CMIE, 1988, 4-27]. However, the amount of crude oil that would be needed to make up for the gap between demand and supply at that time would be almost two times the present level of 15 million tonnes annually (table 5) [CMIE, 1988, 4-28].

Conclusions

Although new resources and technological advances have helped India to increase dramatically its supply of commercial energy in recent years, in most cases demand is growing just as quickly, if not more quickly. In this paper we have looked at current trends of the energy sector and used simple methods to make predictions about the future if these trends continue. We found that in 2020, if current trends continue, 68% of total public sector spending will be on the energy sector. All of India's hydro-power will be tapped, and all of the domestic uranium reserves will be exploited. In order to meet projected demands of petroleum products, over 166 million tonnes of crude oil will need to be imported at a cost of over Rs. 198,000 crores. If the 98,000 MW of projected hydro-power installation occurs, 2.3% of India's total land area will be submerged, in addition to the 1% that is already submerged. This will also cause the displacement of 10.6 million people — in effect creating a city of environmental refugees of the size of Bombay. The burning of coal, natural gas, and petroleum will emit over 542 million tonnes of carbon into the atmosphere.

This paper should not be taken as an indictment of providing much needed energy services to India's millions. The implication is that the goal should not be abandoned, but rather that new means must be adopted in order to achieve that goal. For example, improvements in the efficiency with which energy is produced, supplied and consumed are perhaps the most effective ways to provide immediate relief to the energy shortage problems and to maintain economic growth and social progress. The Indian government should investigate the possibilities of implementing policies to develop India's energy efficient resources. Renewable and decentralized energy resources also offer substantial economic, social, and environmental benefits over conventional energy resources. It would also be beneficial for the Indian government to implement a more long-range strategy. With such long gestation period for power projects, it is necessary to plan for increases in demands farther than 5-10 years in advance. This way, proper measures can be taken to investigate all relevant alternatives as well as any environmental, social and economic impacts that a proposed project may have.

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An Approach to Environment Awareness and Education Programmes

N.H. Ravindranath, R. Shailaja and Madhav Gadgil

In India degradation of environment continues unabated. Very few attempts have been made to educate and to involve the communities in environment related programmes. The awareness or education programmes should focus on local environment situation and problems. Cause-effect-solution aspects should be stressed. Pilot projects should be launched to identify the issues and develop methods, techniques and education material. Education should be the first step to effectively involve the communities in environment protection and development programmes.

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Environment is the physical, chemical and biological surroundings of an organism at any given time. Environment encompases everything, living and non-living, the interactions and the products of these interactions. The environment consists of soil, water, air, plants, animals, etc. and specifically forests, rivers, streams, ponds, deserts, grazing land, crop land, villages, towns, cities, farms, industries, etc. The quality of human life depends on the health of these components of environment. There is adequate awareness and knowledge about the relationship between the quality of human life and the status of environment. Inspite of this the degradation of environment continues unabated. Some of the major environmental problems are as follows:

1. Decline in biological productivity and biological diversity; due to deforestation, soil erosion, overgrazing, compaction of soil, water logging of soils, submergence and so on.
2. Depletion of natural resources both renewable and non-renewable due to less efficient and indiscriminate use; mining of oil, ground water and minerals and deforestation etc.
3. Growing inequity between and within rural and urban areas; given that socio-economic inequity and environmental degradation go hand in hand.
4. Pollution and generation of waste; water, air and soil pollution, examples; urban sewage, chemical wastes from industries, pesticides, fertilizers, plastics, detergents, etc.
5. Lack of awareness among the communities and non-involvement of the communities in conservation and development programmes thus degradation continues unabated.

Who is Responsible ?

Every one is responsible and everyone is contributing to environmental degradation; rural and urban communities, industrialists and farmers, affluent and poor, men and

women. However, the contribution of the affluent urban communities, urban centres and industrial centres is far higher than the poorer or rural communities for the simple reason that the urbanites use more of the natural (timber, minerals, petroleum oil) and man-made resources (electricity, detergents, plastics) and more often in an excessive and indiscriminate way. Excessive consumption of resources leads to depletion (e.g. deforestation) of resources on the one hand and waste generation (e.g. urban waste) and pollution (e.g. automobile pollution) on the other. In rural areas there are special problems like soil erosion, excessive grazing, loss of community lands, silting of water bodies, depletion of biomass resource, etc. which are very severe and which are caused by the absence of proper management of the natural resources. In addition several government projects and programmes like major irrigation and power projects also contribute to degradation of environment in several ways. Thus planners and administrators are also responsible for degradation of environment.

Target Groups

The real sustainable movement towards environment conservation and reconstruction is possible only by educating and involving the community at large. Many developmental programmes have failed due to the non-involvement of local communities; e.g. social forestry, soil and water conservation, community irrigation and community health and so on. Thus it is very important to educate and enable the community to participate in the environment protection and development programmes. In this report some aspects of programmes aimed at rural communities are considered, as the Centre for ASTRA (Application of Science and Technology to Rural Areas) and Centre for Ecological Sciences at Indian Institute of Science have gained some experience from field experiments on environment education and eco-development. Among the rural or urban communities the following groups could be considered :

1. School going children—primary, secondary
2. Non-school going children
3. Adult men (literate, illiterate)
4. Adult women (literate, illiterate)

These groups should be considered seperately as the environmental issue or problems involved and the approach and methods of communication would differ for each community.

Issues/Topics for Communication

Rural School Going Children

In rural areas children around 10 years also work in the field like collecting grass or twigs, taking cattle for grazing and fetching water etc. Even school going children assist their families in farm work. The ideal age group for the education programme is 10—13 years or standards 5—7. The current coverage of environmental issues or issues related to biological productivity is too inadequate. The education programme for school going children could be along the following lines:

1. The emphasis should be on the components of local environment; the irinterlinkages, status and their impact on quality of life. Examples:

Soil — soil formation, role of soil,
— soil erosion; causes and effects.

Water — sources and uses, availability,
— water runoff; causes and effects.

Trees — diversity, role, depletion levels.

Irrigation tank; causes and effects of silting.

Birds, insects; diversity, role.

2. A few environmental concepts could be included:

Examples: — Energy flow
— Food-chain and food-web
— Efficiency
— Conservation
— Self-reliance

3. Some local environmental problems have to be selected:

Examples: — Soil erosion
— Water pollution
— Biomass scarcity : fuel, fodder, timber
— Silting of water bodies

4. Children should become aware that the environmental problems could be solved through local action and improved technology:

Examples: — Afforestation
— Biomass conservation technologies
— Soil and water conservation techniques

The issues to be selected would depend on the local environment and would vary from region to region.

Adult Men and Women

The main aim would be to educate and sensitise the adults to environmental problems such that they get motivated to participate in programmes related to prevention of degradation of environment as well as development programmes. Almost all the households in rural areas depend directly or indirectly on agriculture which includes animal husbandry also. Another important characteristic is the excessive dependance of all rural households on biomass; as fuel, fodder, timber, manure, oilseeds, raw material for artisans etc. Thus the issues to be selected for communication should relate to agriculture and biomass. Health, nutrition and sanitation related issues are also important. An illustrative list of issues is:

I. Status, causes and effects of degradation of local environment.

Examples: — Soil erosion
— Water runoff
— Biomass scarcity
— Low productivity of grazing land

II. Examples of solutions :
— Tree planting in Wastelands
— Biomass conserving stove
— Soil conservation
— Biogas for cooking
— Contour bunding
— Stall feeding

The stress should be on cause, effect and solution aspects of local environmental problems. The list of issues to be selected for communication would vary for different ecological or agro-climatic zones and local resource situations. For example, coastal fishing areas, forest regions, arid zones, semiarid areas or tribal areas will have different problems as compared to each other. The topics or issues would differ for men and women. Generally the role of women in environment management is not recognised. Women are closely associated with nature and natural resources like water, grazing land, wood collection and burning, cattle rearing, compost preparation and afforestation. Thus, certain issues related to women should be included in the womens' programme. Examples could be:

1. Efficiency of use of biomass for cooking,
2. Improved cook stoves,
3. Alternate technologies; biogas, solar cookers,
4. Drinking water pollution—causes,
5. Prevention of water pollution,
6. Compost preparation,
7. Stall feeding.

Approach and Methodology

Approach and methodology for communicating the message will have to be different for different communities. Conventional methods of lecturing are least effective as an old chinese proverb goes,

— What I hear I forget
— What I see I remember
— What I do I understand

School going children

An activity based approach would be more effective for communicating the issues. Children should carry out a simple activity, record observations, analyse the observations and draw inferences. Some examples are.

Type of activity	Examples
Survey	— of listing of trees on farms, — of types of cooking fuels used, — of birds, their food habits, — of felling or planting of trees, — of electricity/kerosene use.
Measurement	— firewood use for cooking, — dung yield of cattle.
Field observation	— visit to a biogas plant, — visit to a forest or a plantation, — visit to silted irrigation tank, — visit to factory pollution site.
Experimentation	— soil erosion test, — stove efficiency test.
Work	— nursery raising, — contour trenching.

Students could carryout the activity during weekends, holidays and after school hours. The experience has shown that students enjoy such out-door activities. Care should be taken not to overload the students or teachers with too many topics. Every month 2 or 3 topics could be covered requiring 2 or 3 hours of school time.

Education material : Teacher training manuals, posters, charts etc. should be prepared in local languages.

Teacher training : There is a need to conduct teacher training programmes to acquaint them with the issues and methods.

Adult men and women

It is much easier to organize a communication programme for school going children than for adult. The first problem is to organize them to meet periodically. It is necessary to discuss and select appropriate time and meeting place in the village. It is a challenge to select appropriate communication methods which would sustain the interest on the subjects. Obviously the activity based approach is not appropriate for adults. Some of the following methods could be considered.

Methods	Examples
Narrating case studies	— successful community plantations
	— controlled grazing management
	— community irrigation programmes
Demonstrations	— contour lines or trenches
	— fuel efficient stoves
Field visits	— mixed tree plantation
	— farm ponds
	— community biogas systems
Slide shows, film shows	— deforestation and impacts
	— successful environment conservation programmes
Drama, dances, puppetry	— Stories on
	— Need for conservation
	— Examples from history or traditions

These programmes must be followed by question - answer sessions or discussions. There is a need to develop the education materials like posters, models, films and stories. The adult educators must be trained in the education materials and conducting the programme. Seperate sessions would be necessary for women. It is desirable to select lady instructors for women programmes.

Non-school going children

In rural areas non-school going children are actively involved in activities like agricultural operations, grazing cattle and bringing fuel wood. The issues to be included and the methodology adopted would more or less be same as those for adults. The stress should be more on immediate local problems and on cause-effect-solution aspects of the environmental problems. Literacy and environment education programme could be combined.

Adult literacy campaigns: Environment awareness campaigns could be successfully clubbed with literacy campaigns as the experience from Kerala shows. However, literacy is not a must for creating awareness regarding environment related issues. A good demonstration coupled with discussion could be effective in communicating the cause-effect-solution aspects of environment problems even to illiterate persons.

Massive awareness campaigns: Experience from Kerala shows a massive awareness campaign is necessary to prepare or motivate the communities before launching any systematic environment education programmes.

Role of Voluntary agencies : Voluntary agencies could play a vital role in organising the adult education programmes. They should be provided with all the infrastructure necessary like education materials, travel facilities and audio-visual kits.

Involvement of Communities

Creating awareness and sensitising the communities is the first step to be followed by implementation of environment restoration programmes through active involvement of communities, for example; fuel efficient stoves, afforestation, soil and water conservation, sanitation, etc. The local communities must be involved in planning, decision making, implementation and management of the programmes. The environment awareness and education programmes must motivate and prepare them for active participation.

Programme for Urban Areas

Children and adults in urban areas must be covered under the environment awareness campaigns and education programmes. Urban areas are the centres of industries and large human settlements causing massive air,

soil and water pollution and depletion of natural resources from large catchment areas. In urban areas the stress should be more on the following aspects.

- conservation of energy, water, biomass, paper
- efficient use of resources and use of efficient devices
- switch to renewable sources of energy
- waste treatment and recycling of wastes
- reduction of pollution
- sanitation

As far as communication methods are concerned, mass media like newspapers, radio, television and cinemas could be effectively used. In urban areas the issues and methods for urban school students could be along the lines of the rural school programmes. However, the issues related to urban environment and concepts should be stressed. As in rural schools, activity based approach should be adopted in urban schools also. Seperate teacher training manuals and education materials should be developed. The urban school teachers should be trained in conducting the programmes.

High School and College Students

College students could be involved in monitoring the status of local environmental parameters like soil status, ground water levels, use of biomass as fuel and fodder, area planted with trees, survival and growth of seedlings in plantations, infant mortality, depletion of tree resource, energy use and cattle population. Students of each college could select a region and monitor the selected parameters continuously. In the process students would be exposed to the dynamics of environmental degradation and its effects on human life. Teachers would have to be trained to conduct the programme. College students after adequate training could also be involved in environment awareness campaigns in their regions during holidays.

Selection of Issues and Methods

There is a need to initiate studies in different agro-climatic and ecological zones to select issues relevant to each region and to experiment with different methods. The agency (government or non-government or educational) should go to the selected location, interact with the local community, conduct simple investigations, understand the local environmental situation and problems and then should should decide on the issues and methods. Field experimentation of issues and methods is a must before launching the programmes. The local school teachers, voluntary agency workers and local knowledgeables must be involved at different stages. In each region the agency should also understand the past and current practices of environment conservation and environmentally sound development. It is important to select such traditional practices and reintroduce them with additional information.

Conclusions

Peoples' participation is a must for any programme of environment conservation or environmentally sound development. To enable people to participate actively, there is a need for creation of awareness and education. The issues to be selected and methods to be adopted would vary for different categories and for different regions. Voluntary agencies and school teachers could be effectively involved in the environment awareness campaigns. Teacher's training manuals and education materials (audio-visual aids) should be developed after field experimentation. Very few attempts have been made in India in this direction. Environmental degradation continues unabated. Thus, the need of the hour is to initiate a number of pilot programmes in different agro-climatic or ecological zones and in urban areas.

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Special Report

Contributions to Green House Gas Emissions

USAID

In July 1990, the USAID sent a Report to the Congress on climate change issues. The Report discusses the main sources of green house gas emissions and the countries and geographic regions from which these emissions emanate. The Report also discusses strategies which could be pursued to reduce green house gas emissions and attempts to estimate the effect such strategies might have on reducing atmospheric concentrations of those gases.

Excerpted from a Report on Green House Gas Emissions and The Developing Countries : Strategic Options and the USAID Response, Submitted by the USAID to the US Congress.

Greenhouse gases that affect the Earth's climate are released to the atmosphere through human activities. These activities, referred to as anthropogenic sources, include fossil fuel combustion, deforestation, land-use change, agriculture, and various industrial processes. The developed countries are presently the source of most greenhouse gas emissions, particularly carbon dioxide. In some cases, including carbon dioxide releases from deforestation and methane emissions from rice cultivation, developing countries contribute a sizable fraction of the global total. The relative contributions of present greenhouse gas emissions to climate change, by gas, sector, and region, are illustrated in figure 1.

The Concept of 'Global Warming Potential'

Global Warming potential[1], (GWP) accounts for differences in molecular structure and atmospheric lifetime of the various greenhouse gases, and expresses their "radiative forcing[2] relative to that of CO_2. Total and per capita emissions of the major greenhouse gases by region and key country, on a CO_2 equivalent basis, are presented in table 1.

Emissions of Major Greenhouse Gases

Carbon Dioxide

Global anthropogenic emissions of CO_2 in 1985, resulting from fossil fuel combustion, deforestation, and cement production, totalled 21,000-29,000 million metric tons (MMT). (Marland et. al. 1989; Houghton et. al. 1987; Detwiler & Hall, 1968; and Shine et. al. 1990.) Of the total emissions, fossil fuel combustion was responsible for

1. Technically, the GWP is defined as the time-integrated commitment to climate forcing from the instantaneous release of 1 kilogram of a green house gas expressed relative to that from 1 kilogram of carbon dioxide.
2. "Radiative forcing" is defined as a change imposed on the climate system that modifies the radiative balance of the climate system, i.e., that modifies the balance between incoming and outgoing radiation.

65-90%, cement production for 1.5-2%, and deforestation for 7-33%[3]. Commercial fossil fuel consumption accounts for 65-90% of the total CO_2 emissions from anthropogenic sources. The OECD accounts for almost one-half, and the A.I.D. designated key countries account for nearly 20% of global CO_2 emissions from commercial energy use (table 2). Deforestation from clearing of lands for agriculture, fuelwood, and other purposes is responsible for approximately 7-33% of the anthropogenic CO_2 emissions. About 95% of the CO_2 emissions from this source result from deforestation in the tropics. Six countries were responsible for over half of the tropical release in 1980: Brazil, Indonesia, Colombia, the Ivory Coast, Thailand, and Laos (Houghton et. al, 1987). Estimates of CO_2 emissions from deforestation range from about 8% to 50% of CO_2 emissions from fossil fuel combustion. Forests play a key role as a major reservoir of carbon. While forests can act as a sink for carbon, increased cutting releases carbon which contributes to greenhouse gas emissions.

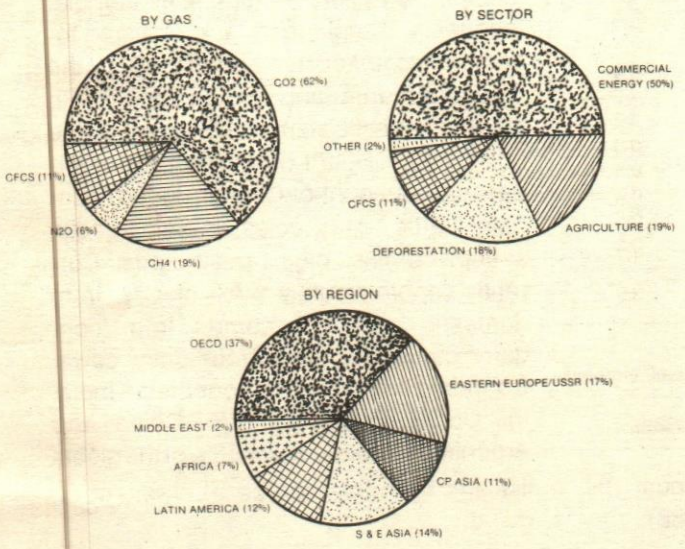


FIG. 1 RELATIVE CONTRIBUTION OF 1985 EMISSIONS TO RADIATIVE FORCING

Sources : Marland et at. (1989) ; Houghton et al. (1987); Cicerone and Oremland (1989); IRRI (1986); Lerner et al. (1987); Fung, pers. Communication; Crutzen et al. (1987); Bingemer and Crutzen (1987); United Nations (1987); Bolle et al. (1986); FAO (1987); U.S. EPA (1988); Shine et al (1990).

3. Preliminary results of the FAO 'Forest Resources Assessment 1990' project show that estimated 1981-1990 deforestation rates are 17.0 million ha/yr (42 million acres/yr). The recently published WRI World Resources 1990-91 report gives a somewhat higher rate of tropical deforestation of 20.4 million ha/yr (50 million acres/yr), which is based on recent data obtained from nine selected countries (Brazil), Cameroon, Costa Rica, India, Indonesia, Myanmar, Phillipines, Thailand, and Vietnam). These studies indicate that rates of tropical clearing have increased by as much as 50-90% over the last decade, and therefore that current emissions of CO_2 from deforestation are much higher than was estimated in 1980.

Table 1 : Anthropogenic Greenhouse Gas Emissions By Region/Key Country 1985 (MMT CO_2 Equilvalent)

Regions	CO_2[a]	CH_4[b]	N_2O[c]	CFC[d]s	Total Emissions	Per - cent	Emissions Per Capita
OECD	9,487	1,635	734	3,135	14,853	37.1	18.3
Europe/USSR	5,046	911	236	710	6,878	17.2	16.5
Poland	432	123	18	64	636	1.6	17.1
Centrally Planned Asia	2,775	1,284	224	90	4,369	10.9	3..8
China	2,168	1,028	160	55	3,410	8.5	3.3
Middle East	524	69	18	40	650	1.6	5.9
Africa	2,005	635	180	200	3,020	7.5	5.3
Zaire	132	28	15	11	186	0.5	6.1
Latin America	3,280	985	331	140	4,730	11.8	11.8
Brazil	1,394	482	155	46	2,077	5.2	15.7
Mexico	381	88	29	29	526	1.3	6.4
Rest of Central America	206	49	25	9	288	0.7	11.4
South and East Asia	2,832	2,187	296	270	5,572	13.9	4.0
India	495	1,011	56	39	1,602	4.0	2.1
Indonesia	789	294	93	58	1,234	3.1	7.5
Pakistan	50	81	7	34	171	0.4	1.8
Phillippines	240	101	27	19	387	1.0	7.1
Thailand	394	227	44	18	683	1.7	13.2
World	**25,949**	**7,707**	**2,020**	**4,580**	**40,270**	**100.0**	**8.3**

Note : Because of rounding, sums of regional emissions may not exactly equal totals shown.

[a]Includes emissions from fossil fuel use, tropical and temperate deforestation and reforestation, and cement production.

[b]Includes emissions from ice paddies, livestock, fossil fuel production, biomass burning, and landfills.

[c]Includes emissions from fertilizer use, land clearing, biomass burning, and fossil fuel combustion.

[d]Includes CFC-11, CFC-12, CFC-113, HCFC-22, Halon 1301, carbon tetrachloride, and methyl chloroform.

Sources: Marland et al. (1989); Houghton et al. (1987); Cicerone and Oremland (1989); IRRI (1986); Lermer et al. (1988); Fung and Matthews pers. communication; Crutzen et al. (1979); Bingemer and Crutzen (1987); United Nations (1987); Bolle et al. (1986); FAO (1987); U.S. EPA (1988); Shine et al. (1990); Zachariah and Vu (1988); FAO (1986).

Table-2 : Commercial Energy Consumption, CO_2 Emissions, and Carbon Intensity, 1985

Regions	Primary Energy Consumption (EJ)[a]				Fossil Fuel CO_2 Emissions (MMT CO_2)	Carbon Intensity (MMT CO_2/EJ)	Fossil Fuel CO_2 Emissions Per Capita (Tons CO_2/cap)
	Oil	Gas	Coal	Other[b]			
OECD	68.50	29.08	34.17	27.45	9,180	57.7	11.3
Europe/USSR	23.11	21.68	25.70	5.04	4,860	64.3	11.7
Poland	0.90	0.40	4.00	0.00	440	83.0	1.2
Centrally Planned Asia	4.56	0.50	18.01	8.19	1,990	63.7	1.9
China	3.97	0.50	16.89	7.68	1,940	66.8	1.9
Middle East	5.28	2.22	0.10	0.35	490	61.6	4.4
Africa	3.69	1.15	3.33	5.31	610	45.3	1.6
Zaire	0.03	-	0.01	0.39	3	7.0	0.1
Latin America	8.80	2.63	0.77	6.94	810	42.3	2.0
Brazil	1.67	0.05	0.37	3.86	150	25.2	1.1
Mexico	2.79	0.90	0.14	0.65	250	55.8	3.0
Rest of Central America	0.18	-	-	0.40	10	17.2	0.4
South and East Asia	7.56	1.26	4.37	8.45	980	45.3	0.7
India	1.62	0.14	2.62	3.74	360	44.3	0.5
Indonesia	0.96	0.21	0.04	0.61	80	44.0	0.5
Pakistan	0.32	0.32	0.05	0.54	40	32.5	0.4
Philippines	0.37	-	0.05	0.52	30	31.9	0.5
Thailand	0.45	0.10	0.06	0.02	40	63.5	0.8
World	121.49	58.50	86.44	61.72	18,900	57.6	3.9

[a] 1EJ = 1 Exajoule = 10^{18} joules = 0.95×10^{15} Btus.

[b]Others includes nuclear, hydro, geothermal, commercial and non-commercial biomass, and solar.

Sources: Marland et. al.. (1989); United Nations (1987); Meyers and Leach (1989); Zachariah and Vu, (1988).

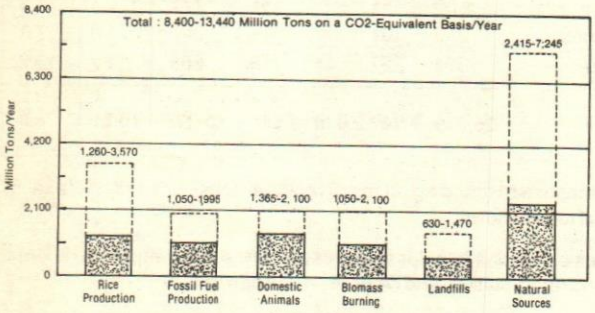


FIG. 2 CURRENT METHANE EMISSIONS

Note: The bars outlined with a dashed line illustrate the uncertainty in estimates of emissions from these sources.

Source: Cicerone and Oremland (1989); Shine et al. (1990).

Methane

Current emissions of methane are 8,400-13,440 MMT/yr on a CO_2 equivalent basis; approximately 60-70% is anthropogenic. (Cicerone & Oremland, 1989, Shine et. al, 1990). Natural sources include wetlands, termites, oceans, and freshwaters; anthropogenic sources include paddy rice cultivation, enteric fermentation in domestic animals, coal mining, natural gas leakage, biomass burning, landfilling of organic wastes, and a small amount from incomplete combustion of fossil fuels (figure 2).

Anaerobic decomposition of organic material in flooded rice fields and enteric fermentation in domestic animals are responsible for 20-50% and 20-35%, respectively, of the total annual anthropogenic CH_4 emissions. Over 90% of the global rice acreage and production occurs in Asia, primarily in the developing countries of this region. In 1984, China, India, Indonesia, Bangladesh, and Thailand together accounted for about 75% of the harvested area and production. (IRRI, 1986). Domestic animals that produce the bulk of the CH_4 are (in decreasing order, based on amount of CH_4 produced) non-dairy cattle, dairy cows, buffalo, goats, sheep, camels, pigs, and horses. Currently, approximately 57% of CH_4 from domestic animals comes from non-dairy cattle and 19% from dairy cows. Domestic animals in six countries—India, the USSR, Brazil, the U.S., China, and Argentina—produce over 50% of the global annual CH_4 emissions from this source. (Lerner, et al, 1988).

Nitrous Oxide

Nitrous oxide emissions levels are uncertain. Current global emissions are estimated at 5,000-7,750 MMT/yr on a CO_2 equivalent basis (Bolle et al, 1988; Shine et al 1990; USEPA, 1990.) Natural sources, which release about 60% of the emissions, include soils and the oceans. Anthropogenic emissions result from land-use modification (biomass burning and gain in cultivated land), use of nitrogen fertilizers, and fossil fuel use (figure 3). Aquifers and surface waters, contaminated from fertilizers and animal and human wastes, may also release significant amounts of N_2O. (Ronen et. al, 1988)

Use of nitrogen fertilisers, the most abundant fertiliser nutrient consumed worldwide, contributes 10-30% of the total anthropogenic N_2O emissions. Asia, Western Europe, Eastern Europe, and North America together consumed about 85% of the world's nitrogen fertilisers in 1985/1986. The twelve largest consumers (in decreasing order) are China, the USSR, the U.S., India, France, the

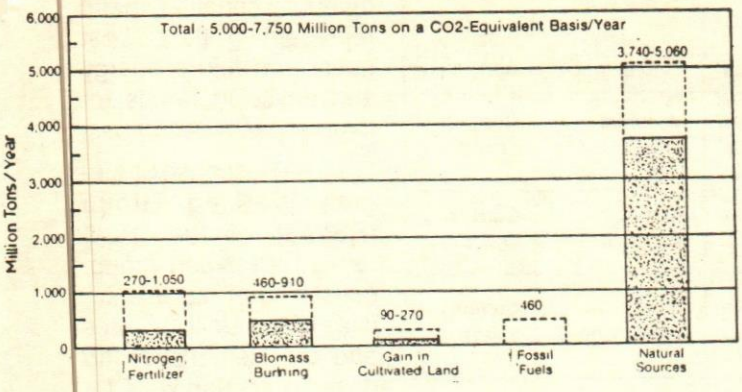


FIG. 3 CURRENT NITROUS OXIDE EMISSIONS

Note: The bars outlined with a dashed line illustrate the uncertainty in estimated emissions from these sources.

Source: Bolle et al. (1986); U.S. EPA (1990); Shine et al. (1990).

United Kingdom, West Germany, Indonesia, Poland, Mexico, Canada, and Italy. Together, these countries account for almost 75% of the annual nitrogen fertiliser consumption. (FAO, 1987)

CFCs and Halons

CFCs and halons are man-made chemicals that are produced and used almost entirely by the OECD countries (figure 4). CFCs are used to produce plastic foam, as aerosol propellants and refrigerants in medical sterilisation, and as solvents in the manufacture of electronic components. Halons are used principally in fire extinguishers. CFC demand in the developing world is expected to grow in the future as demand for refrigerators and air-conditioners grows.

Because of concern about the effect of these chemicals on stratospheric ozone, an international agreement to reduce their emissions (The Montreal Protocol on Substances that Deplete the Ozone Layer, or the Montreal Protocol) was signed in 1987. Under this agreement, developing countries with low levels of per capita use are permitted to delay their compliance for up to ten years. The Protocol was recently strengthened in June 1990, when an international agreement was reached to completely phase out production of the major CFCs and halons by 2000, and production of carbon tetrachloride and methyl chloroform by 2000 and 2005, respectively. Under this new agreement, developing countries will be allowed a 10-year grade period for compliance, and an international fund will be set up to assist them in their transition to CFC-free technologies.

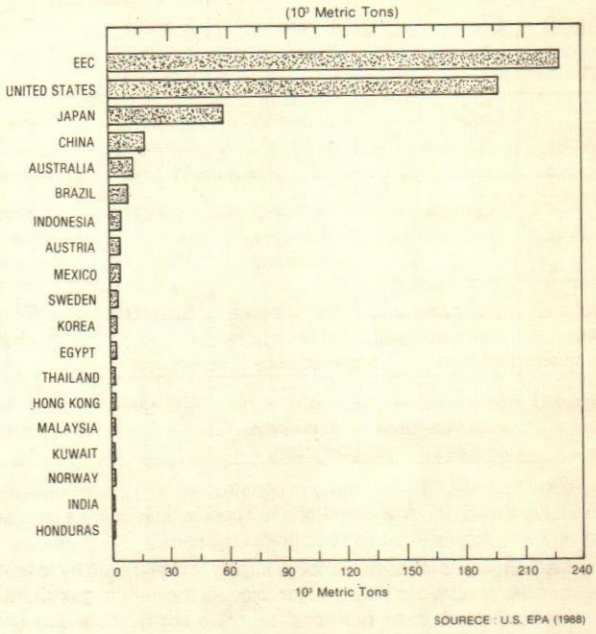


FIG. 4 CFC-11 AND CFC-12 PRODUCTION/USE FOR VARIOUS COUNTRIES IN 1985 (10^3 METRIC TONS)

Potential Contributions

This study uses the greenhouse gas emission scenarios developed by the Inter-governmental Panel on Climate Change. These scenarios were developed to evaluate the consequences of a wide range of future greenhouse gas emission projections. The scenarios were developed from two different sources:

*At an Inter-governmental Panel on Climate Change meeting held in Paris in April 1989, representatives of several countries agreed to prepare a study of future energy use and greenhouse gas emissions for their own countries, including an examination of potential policy options to reduce emissions. The IPCC refers to this scenario as the "EIS/AFOS Reference case. According to the IPCC, these studies have not been officially endorsed by the participating countries and, as

Table 3 : Characteristics of IPCC Scenarios

Scenario	Energy Supply[b]	Energy Demand[c]	Level of Greenhouse Gas Emission Controls[d]	CFC Status[e]	Deforestation[f]	Agriculture[g]
EIS/AFOS Reference Case[a]	Carbon-intensive	Business as usual	Modest business as usual	Protocol/low compliance	Moderate	Current trends
2030 Emissions	Carbon-intensive	Business as usual	Modest; business as usual	Protocol/low compliance	Rapid/ Moderate	Current trends
2060 Emissions	Major switch to natural gas	High degree of energy efficiency	Stringent	Protocol/ full compliance	Major reforestaion	Current trends
Control Policies	Major phase-in of non-fossil sources	High degree of energy efficiency	Stringent	Total phaseout	Major reforestation	Declining factors
Accelerated Policies	Major phase-in of non-fossil sources	High Degree of energy efficiency	Stringent	Total phaseout	Major reforestation	Declining factors

[a]Because the EIS/AFLOS scenario was constructed with the aid of experts from many countries, the assumptions as defined here may not exactly match the specific descriptions provided below. However, the assumptions are qualitatively very similar to these specific descriptions.

[b]For the Carbon-intensive cases, energy supply is dominated by fossil fuel technologies. For the 2060 Emission case, fossil fuels continue to play a major role, but the natural gas share of the energy supply market is increased. For the Control Policies case, non-fossil technologies become economic in the latter part of the next century an supply most primary energy needs after 2075. For the Accelated Policies case, non-fossil technologies play a much larger role starting in the early part of the next century.

[c]In the Business as Usual cases, the annual rate of improvement in energy intensity (or primary energy use per dollar of GNP) decreases from an initial value between 1.0% and 1.5% to an average value of 0.7% to 1.2% for the year 2075 to 2100. The average annual rate of improvement in energy intensity for the years 1985 to 2100 range between 0.8% and 1.3%. In the High Degree of Energy Efficiency cases, the annual rate of improvement in energy intensity decreases from an initial value between 1.5% and 2.5% to an average value of 1.1% to 1.8% for the year 2075 to 2100. The average annual rate of improvement in energy intensity for the years 1985 to 2100 range between 1.2% and 1.9%.

[d]In the Modest Controls cases, current emission control technologies are assumed. In the Stringent Controls cases, the following controls are assumed : more stringent NO_x and CO controls on mobile and stationary sources, including all gas vehicles using three-way catalysts (in OECD countries by 2000 and in the rest of the world by 2025); from 2000 to 2025 conventional coal burners used for electricity generation are retrofit with low NO_x burners, with 85% retrofit in the developed countries and 40% in developing countries; starting in 2000 all new combustors used for electricity generation and all new industrial boilers require selective catalytic reduction; in the developed countries and low NO_x burners in the developing countries, and after 2025 all new combustors of these types require selective catalytic reduction: other new industrial non-boiler combustors such as kilns and dryers require low NO_x burners after 2000.

[e]In the Protocol/Low Compliance cases, the Montreal Protocol is assumed to come into force and apply through 2100, with 100% participation by the U.S. and developed countries and 85% participation by developing countries. These assumptions are the same in the Protocol/Full Compliance case except that all countries participate. In the Phaseout cases, CFCs and halons are completely phased out by 2000, and productlon of CCl_4 and CH_3CCl_3 are frozen with 100% participation.

[f]Tropical deforestation increases gradually in the Moderate case, from 11 million ha/yr in 1985 to 15 million ha/yr by about 2100. Tropical deforestation increases exponentially in the Rapid case, reaching 34 million ha/yr in about 2050, with almost complete tropical forest deforestation by about 2075. In the Reforestation cases, deforestation stops by 2025, and about 1,000 millionha are reforested by 2100.

[g]Levels of activity for the major agricultural activities were not varied among scenarios, because population levels were not varied. Emission factors, however, were changed among scenarios. Current estimates of average emission factors were used in the Current Trends cases, while reduced factors (assuming technological and management improvements) were used in the Declining Factors cases.

a result, should be viewed as preliminary assessments by country experts representing their `best guess" on future energy and emission trends for their respective countries.

* The Response Strategies Working Group (RSWG) of the IPCC formed an expert group, consisting of representatives of the United States and the Netherlands, to develop scenarios of future emissions of greenhouse gases. These initial reference scenarios provided guidance for the various groups of the IPCC; they will be referred to as the "Task A" scenarios.

The Task A scenarios describe a series of alternative greenhouse gas emission trends that lead to different rates of atmospheric buildup of greenhouse gases and hence, differences in the rate and magnitude of climate change. The scenarios specify specific targets of atmospheric concentrations by certain future dates. They are:

* *2030 Emissions Scenario:* equivalent CO_2 concentrations reach a value double that of pre-industrial atmospheric concentrations of CO_2 by 2030.
* *2060 Emissions Scenario :* equivalent CO_2 concentrations reach a value double that of pre-industrial atmospheric concentrations of CO_2 by 2060.

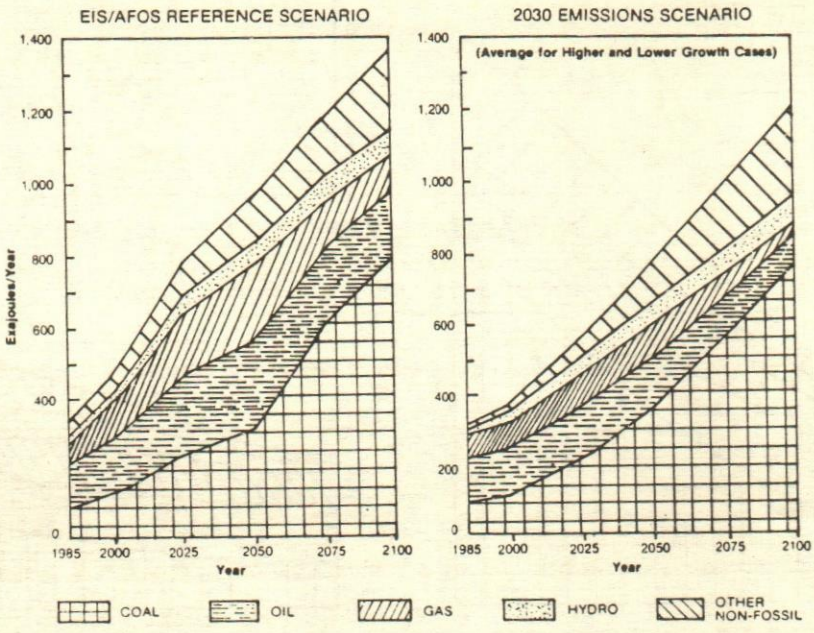


FIG. 5 GLOBAL PRIMARY ENERGY MIX : BASELINE CASES.

Sources : U.S./Japan Expert Group Report (1990); Task A Report (1990).

- *Control Policies Scenario* : equivalent CO_2 concentrations reach a value double that of pre-industrial atmospheric concentrations of CO_2 by 2090 and stabilize thereafter.
- *Accelerated Policies Scenario*: equivalent CO_2 concentrations stabilize at a level less than a doubling of pre-industrial atmospheric concentrations of CO_2.

For each of these scenarios, two cases were developed to reflect higher and lower rates of economic growth. These variants are referred to as the Higher Growth and Lower Growth cases. Key assumptions for each scenario are provided in table 3. Also included is the EIS-AFOS Reference case, which has the most rapid buildup of greenhouse gas concentrations. The IPCC has developed the EIS/AFOS Reference case and the 2030 Emissions case using baseline conditions that assume extrapolation of current trends and planned programs, while the remaining cases of 2060 Emissions, Control Policies, and Accelerated Policies assume some policy actions by the international community to reduce greenhouse gas emissions. The differences among these cases can be illustrated best by comparing the global primary energy mix reflected in each scenario. As shown in figure 5 the two "business-as-usual" scenarios indicate very rapid increase in energy demand, dominated primarily by the use of fossil fuels, particularly coal. Assuming that global policy actions are taken to respond to climate change, however, global energy demand grows much more slowly and is increasingly dominated by non-fossil fuels (figure 6)

Projected emissions for all five scenarios and the resulting atmospheric concentrations are shown in figure 7. Figure 7.b shows the year when the atmospheric concentration of CO_2 reaches twice the pre-industrial level. This is an arbitrary level often used by climate experts. Its choice reflects a series of reviews by the National Academy of Sciences (NAS, 1979; NAS, 1983, NAS, 1987) that concluded that the sensitivity of the climate system to a doubling of CO_2 is probably in the range of 1.5 to 4.5°C. The rate and magnitude of climate change[4] associated with the cases in which few or no steps are taken to reduce emissions—the EIS/AFOS Reference and 2030 Emissions cases—represent a significantly greater climate threat to the global community than the policy cases—2060 Emissions, Control Policies, and Accelerated Policies.

4. For example see US EPA (1989)

(AVERAGE FOR HIGHER AND LOWER GROWTH CASES

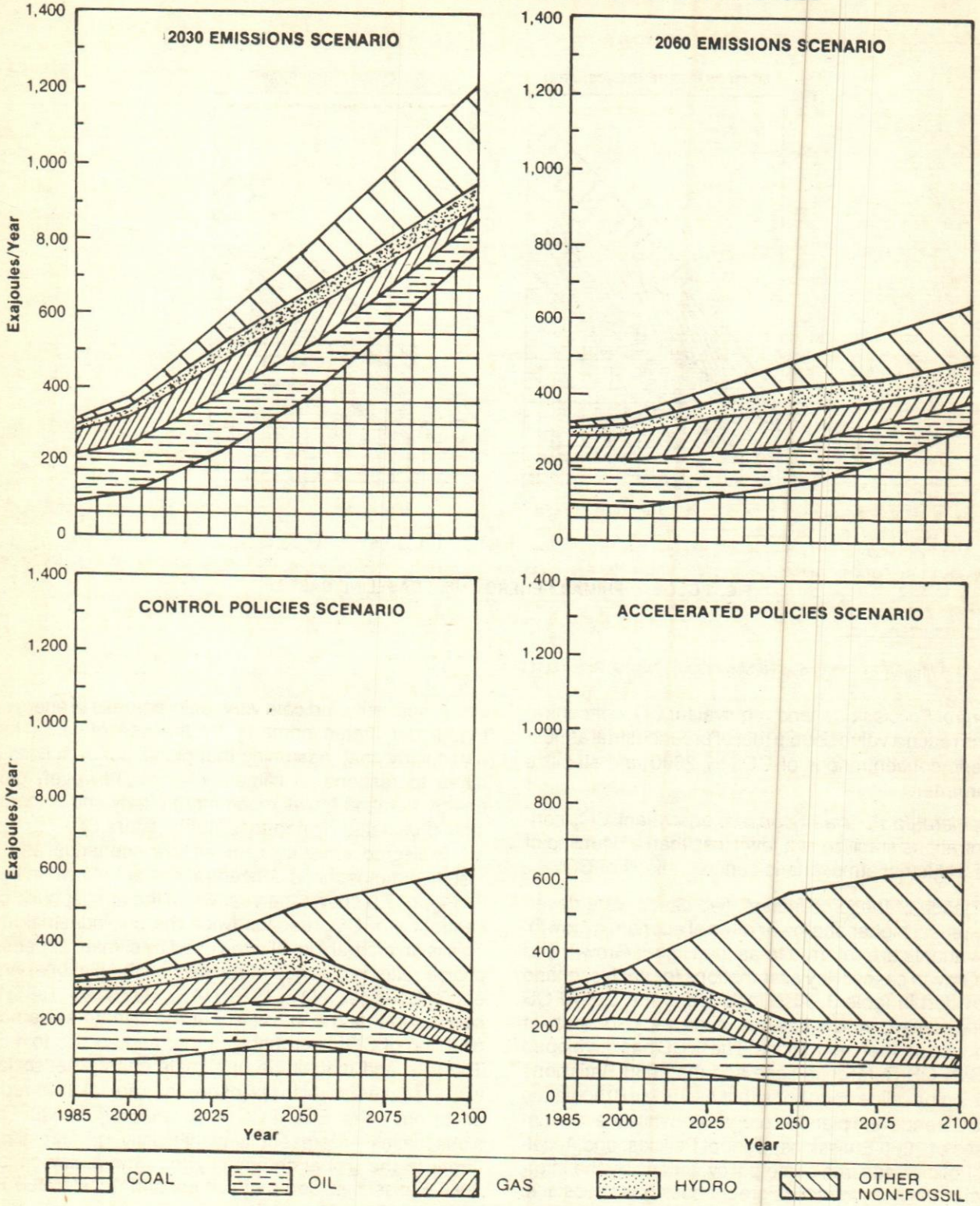
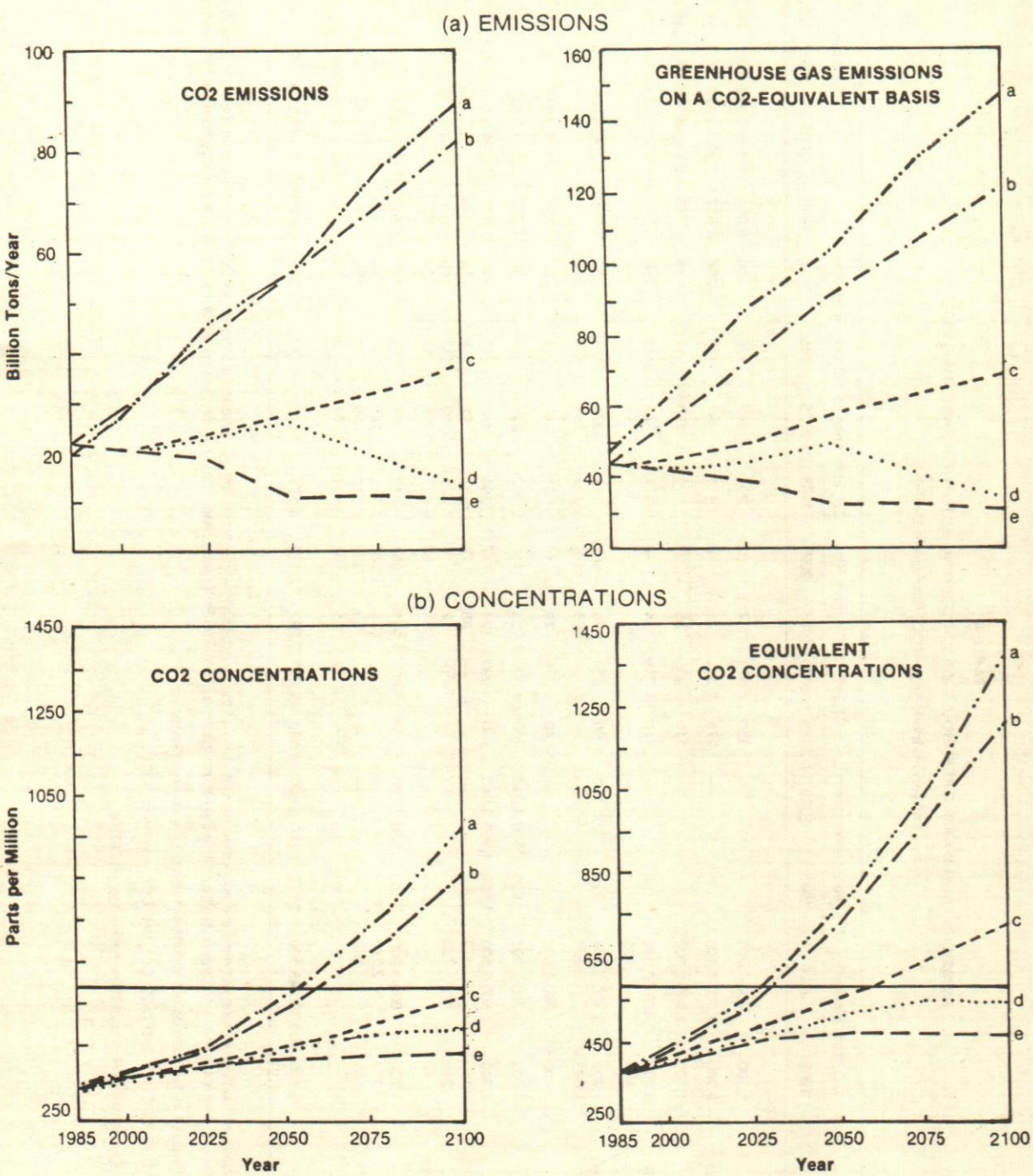


FIG. 6. GLOBAL PRIMARY ENERGY MIX : TASK A SCENARIOS

Source : Task A Report (1990)



(a) EIS/AFOS REFERENCE SCENARIO
(b) 2030 EMISSIONS SCENARIO
(c) 2050 EMISSIONS SCENARIO
(d) CONTROL POLICIES SCENARIO
(e) ACCELERATED POLICIES SCENARIO

FIG. 7. GREENHOUSE GAS EMISSIONS AND RESULTINNG ATMOSPHERIC CONCENTRATIONS

Source: U.S./Japan Expert Group Report (1990), Task A Report (1990).

TABLE 4

EMISSIONS FROM MAJOR GREENHOUSE-GAS-PRODUCING ACTIVITIES: BASELINE CASES

(million metric tones on CO_2-Equivalent Basis)

	CO_2 from Energy[a]		CO_2 from Deforestation		CFCs[b]		CH_4 from Rice		CH_4 from Animals		N_2O from Fertilizer		Total		Tones per Capita	
	1985	2025	1985	2025	1985	2025	1985	2025	1985	2025	1985	2025	1985	2025	1985	2025
United States	5,100	6,200-7,700	—	—	1,350	1,675	17	21	206	267	128	156	6,801	8,319-9,819	28	29-34
OECD Europe/Canada	2,900	4,000-5,100	—	—	1,275	2,340	15	15	311	397	136	268	4,637	7,020-8,120	11	14-17
OECD Pacific	1,100	1,500-2,200	—	—	510	935	38	27	97	168	11	16	1,756	2,646-3,346	12	16-20
Eastern Europe/USSR	5,100	8,400-10,300	—	—	710	1,735	34	38	277	344	142	266	6,263	10,783-12,683	15	21-25
Poland	436	935	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Centrally Planned Asia	1,900	3,700-7,300	220	250-660	90	650	674	687	145	279	139	230	3,168	5,796-9,806	3	3-6
China	1,844	6,303	—	—	—	—	561	571	134	254	129	211	—	—	—	—
Middle East	400	1,800-2,600	—	—	40	275	13	17	21	59	11	27	485	2,178-2,978	4	8-11
Africa	700	700-2,900	620	660-1,210	200	1,400	55	116	107	277	25	95	1,707	3,248-5,998	3	2-4
Latin America	700	1,500-3,300	1,280	1,950-3,040	140	990	124	147	200	441	33	93	2,477	5,121-8,011	6	7-11
Brazil	150	473	—	—	—	—	86	78	57	92	8	14	—	—	—	—
Mexico	249	730	—	—	—	—	2	4	23	63	13	46	—	—	—	—
Rest of Central America	—	—	—	—	—	—	34	63	59	176	12	28	—	—	—	—
South and East Asia	1,100	1,800-5,900	550	630-1,690	270	1,890	1,331	2,056	212	384	99	427	3,562	7,187-12,347	2	3-5
India	359	2,273	—	—	—	—	653	1,084	111	189	53	144	—	—	—	—
Indonesia	81	517	—	—	—	—	153	302	10	23	12	155	—	—	—	—
Pakistan	—	—	—	—	—	—	25	34	34	61	13	75	—	—	—	—
World	19,100	29,700-45,500	2,670	3,500-6,600	4,580	11,890	2,297	3,124	1,576	2,617	723	1,580	30,946	52,411-71,311	6	6-9

NOTE : Several major emissions-producing activities are accounted for, but many of the smaller source categories are not included. Estimates for 2025 are taken from the 2030 Emissions scenario, except for the CO_2 estimates from energy, which also include the results from the EIS/AFOS Reference case. The emissions estimates for 1985 may differ slightly from the 1985 estimat

[a] The CO_2 emissions itemized in this table do not include emissions from cement production.

[b] Include CFC-11, CFC-12, CFC-113, HCFC-22, CCl_4 CH_3 CCl_3, and Halon 1301.

Sources : U.S./Japan Expert Group Report (1990); Task A Report (1990)

Emissions Assuming No Response to Climate Change

Greenhouse gas emissions from non-OECD countries will continue to rise rapidly if no policy actions are taken by the international community. The two base case scenarios—the EIS/AFOS Reference case and the 2030 Emissions case—illustrate this. A summary of the emissions from energy use, deforestation, CFC use, and agricultural activities by region and key countries is shown in table-4 for 1985 and 2025. For the base case, by 2025 the global share of greenhouse gas emissions from developing countries increases from one-third to one-half. On a per capita basis, however, the developing countries still produce substantially less than the industrialised countries, e.g., 3-15 times less per capita than the US.

Emissions from Energy

The largest source of greenhouse gas emissions is fossil fuels. In the IPCC scenarios, annual global primary energy supply increases from about 306 exajoules (EJ) in 1985 to 473 EJ (2030 Emissions/Lower Growth) and up to 737 EJ (EIS/AFOS Reference) by 2025. Historically, global energy requirements have been met primarily with fossil fuels; in the IPCC scenarios presented here, where no actions to respond to climate change are assumed, fossil fuels continue to be the dominant energy source, supplying over 80% of total energy requirements through 2025. Energy consumption in the non OECD countries follows a similar pattern as their economies and population continue to expand: their percentage of global energy consumption increases from about 47% in 1985 to 59-66% by 2025 (table 5)

As a result of major increase in fossil energy consumption, CO_2 emissions from energy activities in non-OECD countries increases from 9,800 million metric tons (MMT) CO_2 in 1985 to 17,900-29,300 MMT CO_2 by 2025. This increase in the percentage of global CO_2 emissions is attributable to energy activities in non-OECD countries from just over 50% in 1985 to 60-68% by 2025, depending on the scenario. On a per capita basis, however, the developed countries continue to produce much higher levels of CO_2 emissions: 8-26 tons CO_2/capita for the OECD countries; 17-19 tons CO_2/capita for Eastern Europe and the USSR; and 0.5-9 tons CO_2/capita for the developing countries.

The only study for which analyses of greenhouse gas emissions from individual countries was provided was the EIS/AFOS Reference case. The study for China was prepared by government representatives on a preliminary basis, while the remaining country studies were prepared by independent experts and submitted to the IPCC for consideration at its proceedings. Table 6. summarizes major parameters for the key countries for which data were available.

Emissions from Detorestation

The CO_2 emissions resulting from tropical deforestation are summarized in table 5 Deforestation from temperate regions is assumed to be balanced by reforestation. In both of the scenarios developed by the IPCC, rates of deforestation were developed only for the broad regional groupings of Latin America, Africa, and Asia; no country-specific estimates were presented.

Emissions from CFCs

CFCs are controlled under the terms of the Montreal

Table 5 : Energy Use and Co_2 Emissions in the Baseline Scenarios

Regions	Energy Use (EJ/Yr) 1985	Energy Use (EJ/Yr) 2025			CO_2 Emissions (MMT/Yr) 1985	CO_2 Emissions (MMT/Yr) 2025			
			2030 Emissions				2030 Emissions		
		EIS/ AFOS Reference	Lower Growth	Higher Growth		EIS/ AFOS Reference	Lower Growth	Higher Growth	Tons CO_2/ Capita
United States	77.2	111	96.4	111.2	5,100	7,700	6,200	7,300	21-26
OECD Europe/ Canada	62.9	103	77.1	91.7	2,900	5,100	4,000	4,000	8-11
OECD Pacific	19.2	39	22.1	24.9	1,100	2,200	1,500	1,500	9-13
Eastern Europe/ USSR	74.9	166	128.5	143.2	5,100	10,300	8,400	9,900	17-19
Centrally Planned Asia	24.5	88	46.2	87.9	1,900	6,600	3,700	7,300	2-4
Middle East	7.7	43	28.6	34.4	400	2,600	1,800	2,200	6-9
Africa	8.7	46	12.8	31.6	700	2,900	700	2,200	0.5-2
Latin America	15.7	49	32.4	65.8	700	2,200	1,500	3,300	2-3
South and East Asia	15.1	92	28.6	66.4	1,100	5,900	1,800	4,400	0.7-2.4
TOTAL	305.9	737	472.7	657.1	19,100	45,500	29,700	42,900	4-6

Source: U.S/Japan Expert Group Report (1990); Task A Report (1990).

5. The level of CO_2 emissions from deforestation is subject to considerable uncertainty because of differing assumptions concerning the amount of carbon in the above-ground biomass and the use of the land after it is deforested, among other factors. For these scenarios the IPCC used a lower estimate of carbon stored in the biomass. For the EIS/AFOS scenario, a mid-range estimate was used beginning with 1985 emissions of CO_2 from deforestation at ca. 6,200 10^6 t CO_2. No regional estimates of deforestation were provided.

Table 6 : Summary Results from the EIS/AFOS Reference Case: Key Countries

Country	GDP Growth (index) 1985	2025	Primary Energy (Exajoules) EIS/AFOS 1985	2025	AAGR[a] (%) 1985-2025	CO_2 Emissions (million tons CO_2) EIS/AFOS 1985	2025	AAGR[a] (%) 1985-2025
Brazil	100	358	6.0	15.2	2.7	150	473	2.9
China[b]	100	877	29.0	86.0	2.8	1,844	6,303	3.0
India	100	669	8.1	36.6	3.8	359	2,273	4.0
Indonesia	100	332	1.8	9.3	4.2	81	517	4.4
Mexico	100	396	4.5	12.0	2.5	249	730	2.5
Poland	100	296	5.3	11.4	1.9	436	935	1.9

[a] AAGR - average annual growth rate in percent/year.
[b] China is not an A.I.D. designed "key country", but is included because of its size.
Source : U.S./Japan Expert Group Report (1990).

Table 7 : Net CO_2 Emissions from Tropical Deforestation (MMT CO_2/year)

REGION	1985	Rapid Deforestation 2000	2025	Moderate Deforestation 2000	2025
Latin America	1,280	2,160	3,040	1,720	1,950
Africa	620	840	1,210	660	660
Asia	770	1,250	2,350	880	880
TOTAL	2,670	4,250	6,600	3,260	3,500

Source : Task A Report (1990).

Protocol, which requires significant reductions in the use of these chemicals to reduce the threat to the stratospheric ozone layer. CFC emissions are expected to be greatly reduced in the future, although the amount in use will depend on the number of countries that sign the Protocol and the extent to which the signatories comply with its provisions. The emissions levels used by the IPCC are summarized in table 8. CFCs have been used primarily by the industrialized nations. Under the terms of the Montreal Protocol, developing countries are entitled to increase their CFC usage to meet their industrial requirements. As a result, the share of emissions attributable to the developing countries is expected to increase from less than 20% in 1985 to nearly 50% by 2025 (on CO_2 equivalent basis).

Emissions from Agriculture

Estimates for emissions from agricultural activities were developed by the Agriculture, Forestry, and Other Human Activities Subgroup (AFOS) based on an IPCC-sponsored workshop held in December 1989 and subsequent discussions. Only one scenario that assumed no response to climate change was identified. In this scenario, the rates of greenhouse gas emissions per unit of agricultural activity (e.g., CH_4 emissions per hectare of land used for paddy rice cultivation) were assumed to

Table 8 : Emissions from CFCs and Related Chemicals: Baseline Cases (MMT on a CO_2 Equivalent Basis)

REGION	CFC-11 1985	2025	CFC-12 1985	2025	Total CFCs 1985	2025
United States	170	65	790	520	1,350	1,675
OECD Europe/Canada	395	665	665	1,030	1,275	2,340
OECD Pacific	85	145	235	365	510	935
Eastern Europe/USSR	120	275	520	1,110	710	1,735
Centrally Planned Asia	20	85	60	450	90	650
Middle East	10	55	25	165	40	275
Africa	60	290	115	840	200	1,400
Latin America	40	205	80	590	140	990
South and East Asia	75	355	165	1,185	270	1,900
World	975	2,140	2,655	6,260	4,580	11,890

Source : Task A Report (1990).

remain constant over time. However, levels of agricultural activities (e.g., total area of land under paddy rice cultivation) changed through time as population and economic growth occured. The specific emission estimates resulting from these assumptions are summarized in table 9.

Table 9 : Emissions From Major Agricultural Activities: Baseline Cases (MMT on a CO_2 Equivalent Basis)

REGION	CH_4 from Rice 1985	2025	CH_4 from Animals 1985	2025	N_2O from Fertilizer 1985	2025
United States	17	21	206	267	128	156
OECD Europe/Canada	15	15	311	397	136	268
OECD Pacific	38	27	97	168	11	16
Eastern Europe/USSR	34	38	277	344	142	266
Centrally Planned Asia	674	687	145	279	138	230
China	561	571	134	254	128	210
Middle East	13	17	21	59	11	27
Africa	55	116	107	277	25	95
Latin America	124	147	200	441	33	93
Brazil	86	78	57	92	8	14
Mexico	2	4	23	63	13	46
Rest of Central America	34	63	59	176	12	28
South and East Asia	1,331	2,056	212	384	99	428
India	653	1,084	111	189	53	144
Indonesia	153	302	10	23	12	155
Pakistan	25	34	34	61	13	75
World	2,297	3,123	1,579	2,617	723	1,580

Source : Task A Report (1990)

INDIA : BASE CASE SCENARIO (1985-2025)

In the EIS/AFOS Reference scenario, GDP grows at an average annual rate of 4.9% from 1985 to 2025. The population growth rate is assumed to be 1.4%/year. This assumes that the government's policy of family planning will be moderately successful. Income per capita reaches $1,000 (U.S.) by 2025.

Recent history indicates that energy demand has increased somewhat faster than economic growth. This has led to a 40% increase in the energy/GDP ratio between 1970 and 1987. The increase was caused by substitution of biomass fuels by modern fuels and by increased use of oil for transportation and electrcity for agriculture. The unit energy consumption of most production processes is much higher than that of the industralized countries. For example, steel production requires almost twice as much energy per unit of steel output as that in the U.S. Similar differences exist for other industrial goods, household appliances, and other end uses. The potential for improving efficiency is substantial.

The scenario assumes that with efficiency improvements the energy intensity of the economy will decline to the same level as in 1984. Improvements in energy efficiency reduce unit energy consumption to below the levels seen in the industrialized countries today. Despite these improvements, the domestic resources of the country are inadequate to meet projected energy demand. Coal production increases to about 780 million tons, or about five times the amount mined in 1988. Oil demand is high enough to require increased oil imports, of the order of 5.8 million barrels of oil per year. The combustion of fossil fuels at this level is assumed to lead to serious environmental and capital availability problems.

Overall, primary energy grows at an annual rate of 3.8%, from 8.1 EJ in 1985 to 36.6 EJ in 2025. CO_2 emissions grow from 359 MMT CO_2 in 1985 to 2,273 MMT CO_2 in 2025. Most of the growth in final energy use is in the services, industrial, and transportation sectors, with energy use in the transportation sector growing from 0.9 EJ in 1985 to 7.3 EJ in 2025. The EIS/AFOS Reference case assumes only 15% improvement for the steel industry in India by 2025. Coal use grows from 32% of primary energy use in 1985 to 41% by 2025. Use of biomass, which accounts for 37% of primary energy in 1985, grows modestly through 2025 where it accounts for only 10% of primary energy use.

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Feature

Technology Innovation: Need for Compatibility with Psycho-social Systems

Amitava Chatterjee

Technology is an essential requirement for modern life. It is technology, with its advancing strides towards creation of new opportunities that caters to human needs. On the other hand, society channelises through its benefit trajectries the achievement of technology to human kind. Technology and Society are complementary to each other. This paper attempts to highlight the fact that neither of the two can be comprehended in the other or be reduced to the other. Both have to supplement each other.

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Technology is as old as humankind. For centuries humans and their ancestors have been using technology. The earliest examples are probably the use of stones for scraping and cutting and the discovery of fire. Without some form of technology it is virtually impossible to engage in work *vis-a-vis* living. Conversely, we cannot understand or adapt to a technology without knowing what purpose it would serve the human lives. This relationship between people and their machines has resulted in technological innovations and it has become an integral part of the social and economic system of human society. What distinguishes the present century from the earlier periods of human history is that the 'knowledge' revolution (Emery, 1981) related to human behaviour systems cannot keep pace with that related to technological growth.

All technologies are tools and have meaning only when being used and controlled by people. Engineering solutions are often designed to maximise the effectiveness of technology on the assumption that human beings are almost infinitely flexible and can be expected to make all necessary adaptations without too much disturbance in the system. We have seen that such an assumption has led to the idea of "technological determinism" as it has been developed in the literature.

Technological determinism, the way it affects human and societal systems comprises three basic principles (Davis and Taylor, 1976). In the first place, it asserts that technology develops on its own inherent inertia and according to its own laws, independent of its social and cultural environment. The second premise is that the designers and technocrats who are directly involved in the development of a specific technology are the best judges for an effective use that will benefit society. And no other considerations but theirs should stand in the way. In the third place, it asserts that plausible adaptive structures of human and social systems is dictated by technology. The last assertion, particularly, is important as it implies the extent to which adaptive systems can be manipulated so that the quality of human life can be improved.

The debate on deterministic approach to technological imperatives, considering social and human variables as constants, still continues to be a lively one, though with certain traditions. The staunch supporters of this hypothesis base their arguments on the premises and logic that are now exhausted. The hypothetical construct of determinism based on Newtonian mechanics gives promise of not only comprehending the present but also of forecasting the future. But as in physical sciences, so also in behavioural sciences the revolutionary changes of the present century has introduced elements of 'uncertainty' as a fundamental condition of knowing. "The evolution of any systems, be they life, physical, or technological, can give rise to novel conditions and emergent properties that were unpredicted and unpredictable from previous operative circumstances" (Gregori, 1988). The 200-year-old technological innovation has attempted at maximization of material production and measured by the narrow criteria of 'efficiency' with only optimization of productivity and product. Table 1 presents an illustrative list of examples of antecedentes that are thought to be associated with conditions of optimization of productivity. They are listed, as claimed by technology prophesier, to be indicators related to innovative practices, to individuals and to society-at-large.

Table 1. Objective indicators of technology-growth

Economic
Gross national product
Increased labour productivity
Poverty alleviation
Increasing value of manpower pool
Consumer orientation
Resource creation
Non-economic
Thrust towards welfare society
Better living standard rates in society
Increasing information network and communication systems
Societal adaptability
Better quality of life with regard to non-work roles and situations
Commitment/Alienation

The beneficiary effects of the indicators in real terms are questioned at every stage. It is evident, as cost-benefit analysis, that the utility function of exponential growth of technology is eroded by disutility functions caused in the form of social and ecological impact. Much of the debate on rapid technological change centres round developing 'hardware' sophistication for extensive material progress. Even if the objective gains of technological growth are indeed the same, the question remains whether their impacts on different human groups are the same as well. Empirical evidences suggest that the social as well as the technical system must relate to its environment and group if it is to function and develop (Cumming and Srivastava, 1977).

Both proponents and opponents of technological determinism can involve transformational indices to justify their respective positions. The essential aspect to note is that the present day technological changes are replete with more than one emergent possibility. The unfortunate tendency, of both pro-and anti-technology advancing group, for simple linear projection of these trends are based on closed systems approach which obviously is subjected to entropic barriers. Any social structure, on the other hand, is an open system which does not follow the traditional laws of nature. And thus the inputs to it in the form of random technological innovations will result in unpredictable non-linear outputs. Adherence only to technological commitment may maximise subsystem efficiency, but it may not, necessarily, be complimentary to societal development. The most fruitful models and analogies for portraying effective changes in society *vis-a-vis* technological growth, will have to be based on organic model such as socio-technical system (Emery and Marek, 1962).

Fundamental to socio-technical systems approach is the joint optimization' of the technical and social components. Each component moves in the direction of differentiation and elaboration which lead to social regulation; that is the system as a whole is capable of solving the problems that come up.

Technology and Human Needs

The impact of technology is not just unidimensional involving only the material one, but is much more complex and multidimensional. Technological changes have been accused of being responsible for environmental deterioration, causing health and safety risks, for social disintegration by breaking traditional cultural bonds (Schumacher, 1973). Moreover new technologies leave the individual with few options in day-to-day life and life goal (Keniston, 1963).

The best place to begin with the assessment of technological growth is to treat the subject that is central to societal systems and which is the focus for development: human nature and its behavioural implications. Human behaviour is not only stimulus-driven but is cognitive as well. Stimulus-driven behaviours are for the maintenance of physiological hemeostatis, satisfaction of innate drives and including random search processes. Human behaviour is also predicated by sequential or linear perceptual and conceptual data. In the latter cases behaviour is not only reactive, but is also proactive (Ackoff & Emery, 1972)

Behavioural sciences being too preoccupied with inductive method, seek to make human behaviour intelligible in the same terms as components of the physical world. In order to do this, it became necessary to deny man *a priori* any autonomy, self-will, inherent values or any behavioural predicate that is not external to the individual or amenable to usual experimental investigation.

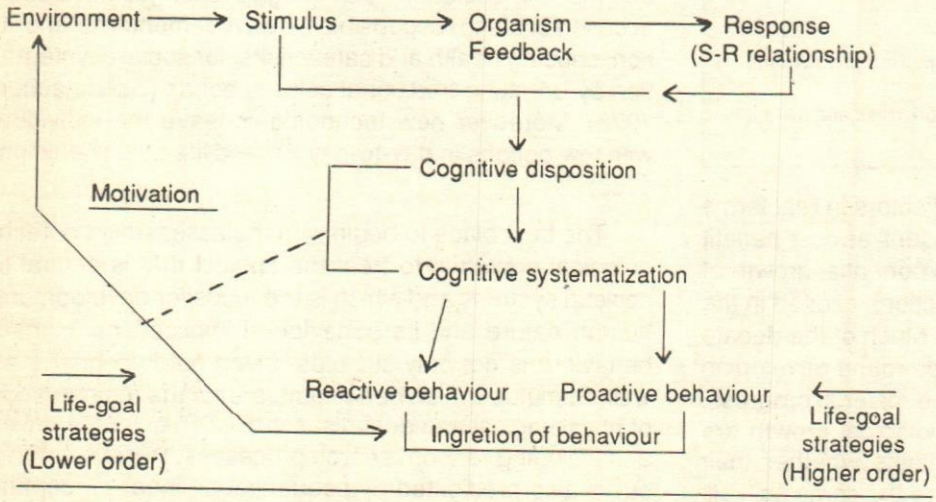
The general notion exists that all human behaviour is a product of experience. By enlarging and recreating the experiential world the behavioural repertoire can be differentiated. The more the development in technology, the better will be the behavioural quality. This sort of inductive model happens to be currently the popular concept of scientific method (Frese and Sabini, 1985). It essentially involves attempting to explain human behaviour as relationship between a stimulus and response (a predicate and behaviour) through an intermediate predicate. But there are certain behavioural phenomenon which the inductive model cannot explain at all, and others which it explains only so inefficiently that is unlikely to be true explanation.

In fact man at times responds to some circumstance, stimulus or event which is so unprecedented, that cumulative experience base is unlikely to offer any predicative behaviour. Here we get a situation where the stimulus bears little qualitative resemblance to outcome behaviour. Rather they involve the postulation of some unique element—they present a novel reality rather than reflecting the older one. Man internally generates a new stimulus-situation, a mechanism by which the individual, transcends reality—by which he rises above experience. The heart of the process is probably connected with the ability to-create, internally sequential cause-effect relationships, which remain obscure to all till explicitly propounded by the subject; these are the more expansive but intrinsic motivational dynamics of behaviour. (fig. 1)

This is what is known as open system model; the individual is in constant interaction with environment, and including feedback provision. In short, behaviour becomes a sequential process only with both fundamental motivational dynamics, extrinsic and intrinsic.

Despite all the evidence to the contrary behavioural interpretation often implies that there is a simple, one-to-one relationship between motivation and behaviour. It may, on a different note, be said that motivation alone may not explain all behaviour, but all behaviour is motivated. Human beings and animals undergo internal physiological changes related to the necessities of life which are the basis of much motivation. The behaviours arising out of such internal stimulation are directed toward the satisfaction of the organism in some particular way.

Motives or needs are the mainsprings of human action or behaviour. They arouse and maintain activity and determine the goal towards which the behaviour is directed. Needs which have a clear physiological basis, such as hunger, thirst and sleep are referred to as primary motives. They serve the homeostatic function of the body which helps to maintain a stable internal environment, particularly with regard to chemical composition of the body. In addition, there is another broad group of needs, known as secondary needs. These are not based in the biological nature of the organism, though they may be outgrowths of the individual's attempts to satisfy biological needs. They are learned or acquired during individual's life time. They are not essential to the organism's physiological balance. The individual attempts to satisfy acquired needs in order to achieve so to say, a psychological equilibrium. In conclusion it can be said that through the satisfaction of both primary and secondary needs the individual is able to maintain 'physio-psychological homoestatis'.



Originally after McDougall (1923). Motivational dynamics added by the author

FIG 1. MOTIVATIONAL DYNAMICS OF HUMAN BEHAVIOUR

Classification of Needs

Satisfaction of primary needs is fundamental to the existence of the organism. For this motivation related to such needs is for indi-

vidual survival. Compared to others they are least influenced by society or culture.

Needs are the sources for every conceivable behaviour and they, human beings can be described as possessing literally hundreds of needs. It becomes rather difficult to denote each needs generating a specific behaviour. The situation has prompted psychologists to develop categories or classification of needs. In one description human needs are classified in two main groupings, physiological needs and acquired needs. In this instance, they are referred to as *viscerogenic* and *psychogenic*, respectively, with subdivision in each case (Murray, 1938). Another widely recognised categorisation is the 'need hierarchy' theory of human motivation as propounded by Maslow (1954).

In this hierarchy, *physical* needs, occupy the lowest rung, followed in ascending order by *safety* needs; *social* needs to belong, to be accepted, to like and be liked; *esteem* needs to obtain respect and status; and finally at the top, the need for *self-actualization* which Maslow defines as "the desire to become everything that one is capable of becoming". In empirical situation the implication is clear that needs are like a ladder to be climbed one step at a time, that is if the satisfaction of a lower-level such as physical or security is threatened, higher-level needs will be ignored. In some respects, however, Maslow doesn't appear to be as monolithic in his thinking. More than one need may simultaneously motivate the individual and with higher-order needs Maslow departs from the rigid hierarchy and admits that different people may place higher-level needs in a different hierarchy.

We now come to conclude that the essential characteristics of behaviour are : (a) behaviour always occur in a particular environment; (b) behaviour is always directed (Lewin, 1938). The environment in which the specific behaviour of a person occurs is not only the physical environment as it might be described after precise observation and measurement. Instead, the environment must also be considered from the viewpoint of the person, 'as it exists for him at the time'. The concept of direction refers to change from one activity to another. The changeable direction may be towards or away from the new goal. It may also take the form of sustaining the present activity or for an escape from it depending upon the attractiveness-repulsiveness of the goal. The 'needs' represent the psychological forces acting on the individual to produce the changes in behaviour. The analysis of human needs allows one to quantify the requirements concerning the satisfaction, *vis-a-vis* goals, of particular categories of needs at a given period of time.

Human systems, as open systems, are essentially characterized by negative entropy and are dependent upon external source. These sources symbolise the life goal regions of the internal needs systems. A characteristic of this system is that they are cumulative combinations and appear to accelerate through time. And so they remain indeterminate. Nevertheless motivation to act in a specific direction depends upon the strength of need(s) at a particular time (t_1) and upon the goal attractiveness related to need satisfaction. The literature on motivation suggests that all actions of living beings and of human beings are directed towards certain categories of life-goal regions (Maslow, 1954). The taxonomic regions of life goals may be described under ECSIR (Chatterjee, 1990).

Satisfaction of innate physiological needs is fundamental to the existence of the organism. When an individual has been deprived of such basic necessities of life, as food, water and oxygen and the like, it develops tissue needs, which are the biochemical requirements of the body. Obviously, tissue needs results from the inherited life processes of the organism. Continued hunger, thirst or lack of oxygen eventually leads to organism's death. The survival needs motivate the individual for realization of the life goal of 'existence' (E). A balanced physiological condition is maintained by the process of hameostatis and an optimum disequilibrium may endanger the existence of the entire organism. The stability of internal environment is the primary condition of existence, nonetheless, many of the compensatory activities of hameostatis require relevant motivational behaviour on the part of the organism.

Another basic life goal of human being, though closely related to existence, but distinct from it to some extent, is 'continuation' (C) of the species. Sexual need or maternal motivation do not involve individual survival. They are beyond homeostatic interpretation, especially when considered from a physiological standpoint (Beach, 1956). Curiosity need driving the organism to novel situations and thus gaining mastery over the situation, in other words primary learning at least, may also be considered under this category. One useful distinction between the two categories of life goals, 'existence' and 'continuation', therefore may be to regard the former as only those which clearly prevent or remedy physiological imbalance.

The two categories of life goals as discussed so far are essentially inborn; the existence of these goals, are determined by our physiological inheritance, though interaction with environment may play a role in the motivated behavi-

our which accompanies them. The other three categories of goals, to which we now turn, seem to originate during our lifetime through personal and social contacts. In contrast to primary life goals the acquired ones are patterned to a great extent by individuals as well as group learning experiences and the cultural mileu of the individual.

In mental evolutionary process human beings discover that some of the life goals relating to existence and especially that to continuation can be satisfied through the acquisition of certain personal relations. The needs for love and belonging, affiliation and friendship can be satisfied by identification with a group and that in turn becomes a means for satisfaction of primary needs. The satisfaction of the coexistential and interpersonal needs pertain to the realization of life goal of 'sociability' (S).

In our scheme of things the fourth life goal is 'individuation' (I). Each goal has a definite point of origin and this specific goal of individuation may possibly be related to experiences in group life. In the group and through the group the individual desires to maintain his identity. The search for identity may possibly be at the root of longing for satisfaction of needs like esteem, status and freedom.

Table 2. Sets of needs and related goals

Need Category	Life goals				
	Existence	Continuation	Social	Individuation	Self-realization
Existence n- oxygen, water, food, rest and sleep, safety, shelter, etc.					
Continuation n- raising of family, procreation, avoidance of hazard, meeting novel situation, learning etc.					
Social n- affiliation, to love others and be loved, group conformity, belongingness, altruism, participation					
Individuation n- influence, status, esteem, power, achievement, happiness etc.					
Self-realization n- search for ideal, self improvement, innovation, creativity, aesthetics, sense of life, search for self potentiality, spirituality, bliss etc.					

Human beings are characterized as a perpetually "desiring" species. They strive to satisfy the desires at the physical plane (existence, continuation), those with more social orientation (sociability, individuation), and the striving does not end there. The complexities of ontogeny make humans more self-conscious. In philosophical connotation, it implies, the eternal quest of a thinking man for solution of the riddle : "who art thou? know thyself;". The goal for `self-realization' (R) represent, past four other life goals (E, C, S and I) in evolutionary order, the summit-level in motivational echelon. The concept, no doubt, is closer to an ideal than to an actuality, nevertheless to the pragmatic human it is not mere philosophic idealism excluding all cosmic realities. It is the desire to utilize one's personal capacities to develop one's potential to the fullest, and to engage in activities to which one is well suited. Particular life goals are not independent of each other, they may act as sources of satisfaction for multiple needs interacting in complex ways. On the basis of these considerations it is possible to design a matrix of human life goals in relation to different needs categories. The set of need categories and consequent motivational life goals are presented in table 2.

Society as an Open System

It is imperative that all the social institutions, the systems of technology included, should serve better to satisfy the needs of the society. The society is considered here as an organized set of relatively autonomous individuals. Normal human society starts from the interactions of individuals modified by a diversity and possible antagonism of interests. According to law of existence the individual cannot disregard the society nor can the latter ignore the individual as a non-significant entity.

In the previous placid environment it was good enough and effective enough to have standard plans and standard designs for all human beings and for all societies. Effectiveness in quantitative cost-benefit analysis seemed equally applicable to all human projects, ignoring the qualitative complexion of the uniqueness in values and style of functioning. But the

reactions to unprecedented consequences of accelerated technological growth resulting in total disequilibrium in ecological chains together with a reassertion of values, centered round burgeoning materialism, heralded in a turbulent social environment. The emergent changes in such an environment arise not only from the interactions of particular systems but also from processes that are set off in the environment itself. In other words current social field by its own dynamism produces changes creating relevant uncertainties for the increasingly inter-dependent systems within it. Out of this growing complexities and uncertainties a novel environment will be emerging, that again will be placid for time t_1 and will incorporate into itself, the recent awareness that has arisen. This is the systems concept. As the specific social system, again, interacts with the extended field of environment it generates potential for greater complexity and enhances the negative entropy of the system. Social system, thus, follows the open systems characteristics. In short this system is an interaction between components, each of which is related directly or indirectly to every other component and no sub-system of which is unrelated to any other sub-system (Ackoff and Emery, 1972).

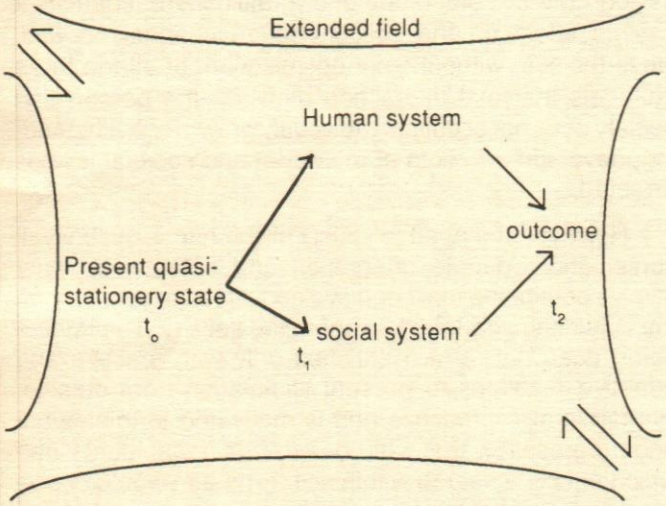


FIG. 2. THE MODEL OF INTERACTING HUMAN AND SOCIAL SYSTEMS

Because, the social system as open system is concerned with whole, including the organic sub-set which exists within as well as without, it is also by definition concerned with human values and ideals. "If material and symbolic cultures of a society were not connected by any simple principle of linear causality, they were nevertheless intertwined in a complex web of natural causality" *(Trist,* 1981). As new technologies develop, new societal policy may or may not develop. Nevertheless the 'synergy' affects each other which may be constructive or destructive.

Human Need and Societal Development

The primary impulse of life is individualistic and individual makes group and society as means for better satisfaction of the vital individual. In society human finds a less personalized but a larger expansion of person-self and of personal needs. Conversely social system as a collectivity of groups of individuals is the same phenomenon of intellect and cognition and not merely an adaptive mechanism to environment. Needs of a society are not a mere aggregate of the needs of individuals, but they correspond to the sum of these needs, plus those interjected by societal development minus those elements that come in conflict with the welfare of the community. Concluding, we assume that the needs of a society should be defined by individual needs as base and not *vice-versa.*

Society as a 'regulative institution' (Emery, 1976) is directly concerned with psychosocial ends of their members and serve those by its three major components of roles, norms and values (Allport, 1962). The ascription of these are achieved by installing, maintaining or changing cultural values and norms the role and power of interest groups or the social structure itself (Trist, 1981). Technological choices are the inputs from the extended environment as referrent. As new technologies develop new societal possibilities may or may not be taken up.

The life process in the cosmic universe governed by internal mechanism is a dynamic event that is self-governing and self-replicating. And it is so because life is an open system interacting constantly with immediate environment and society (Angyal, 1958). The individual has to grasp the truth that he is not only himself, but is in unison with all of his kind. That which we are has expressed itself not only through the individual, but also through the society, and though each has to fulfil itself in its own way, neither can succeed independently of the other.

A society is founded upon the gregarous motive modified by a diversity and possible antagonism of interests. By the process accommodation, both at individual and societal level develops converging of interests founded on a series of implied contracts in the form of social institution. The more the growth and advantages of civilization *vis-a-vis* technology, the greater the satisfaction and efficiency of objective and material lives of human kind. The mass of social institutions thus created and the habitual ways of people are thus justified at the cost of losses suffered in subjective life. The society employs all its institutional means for the survival and continuation of its members, in short, for the satisfaction of bio-social needs of human kind. In the process, it creates emergent

possibilities in need structure and simultaneous resource generation as well. The individual survives and develops in constant interaction with society. Association is the first necessity of humans for satisfaction of all needs. If a human being is supposed to be an evolution of cognitive being in matter and out of matter, we must assume that the person begins with uniformity and proceeds towards variety and freedom. The society, in its turn, in close relation with its boundary conditions and in interaction with extended environment develops certain generic resource categories for motivational satisfaction of its members.

Though any attempt to categorise societal resource creation is likely to suffer from over simplication, a taxonomic construct is preferred to appreciate and evaluate societal growth through technology innovation or otherwise. In real world such precise relationships between societal benefits and individual motivational states may or may not be established, but as generic categories they point to becoming 'directively correlated' to produce a given goal state (Somerhoff, 1969). The relationship between human motivational state, mediating societal channels and outcomes are shown in table 3.

Table 3. Societal Resource Model for Human Need Satisfaction

Critical motivational (life) goal	→ Mediating societal resource	→ Personal & societal outcomes
Existence (including continuation)	Gratification (primarily material in nature)	Adaptive reactions, institutionalized responses, satisfaction of physical and lower order needs, maximization of stimulation, frustration, guilt.
Social (including individuation)	Collectivisation	Belongingness, mutual acceptance interpersonal expansion, institution building, creator and carrier of culture and tradition conformity/alienation.
Self-realization	Spiritual	Role specialiazation, self development, creativity, intuitive, minimizes cognitive dissonance, calm renunciation, placidity.

Strength of trajectory being used

The individual is a reactive organism. But the person does not respond to environmental stimuli, both within and without, isolated as a separate entity isolated from the contextual factors. The human beings and the total environment are interdependent and inseparable parts of the cosmic whole. The development or decay of one affects the entropic process of the other.

The societal channels as depicted in table 3 mediating between psychological states and the outcomes cannot remain that procrustean. They undergo continuous changes by dynamic extrinsic and intrinsic forces. Each trajectory has its own opportunity and peril with regard to human satisfaction. Following 'learning curve' principle it can be assumed that as a specific trajectory is optimized maximally it reaches the ceiling, including the 'plateau', of its satisfactory benefits. Moreover, if the optimization is carried with a 'tunnel view', the individual in the absence of any escape route breaks down under its pressure causing turbulence and chaos in the field of existence.

Technological growth providing increased productivity and higher GNP is, no doubt, a convincing mode of satisfaction of physical and mental needs of man kind through the societal channel of gratification. Indirectly it has its effect on the collectivisation channel as well. Nevertheless, without 'joint optimization' of all the three channels the total interaction between the person and society does not occur and obviously growth notwithstanding, development, both at individual and societal level is arrested.

However, the need to satisfy all the needs of survival, continuation, people orientation and self-growth must involve continuing real cognitive and effective contact with the outside environment, in short, the society. The human being does not remain satisfied only with reactive and adaptive reactions to present stimulation from outside. Human is also proactive and is motivated to implement and progress towards what he regards as an ideal—one which entails a search within self. "The aim would not be to perfect life, body and mind in themselves, but to develop them so as to make a fit basis and fit instruments for the revelation in our inner and outer life of the luminous self. The ideal of human existence personal and social would be its progressive transformation into a conscious out flowering of the joy, power, love, light, beauty of the transcendent and universal spirit" (Sri Aurobindo, 1985). We need not consider this urge only in its mystical sense. In its pragmatic aspect the goal for self-realization arises out of the needs for full blossoming of whatever potentiality the organism is having. The needs for creativity innovation, autonomy and rational freedom, novelty, joy, beauty etc. fall in this category.

With open systems characteristics dynamic inter dependencies exist between individual and society : for satisfaction of life goals of the individual and for perfecting societal mediating channels. It is collective action that precedes individual action. It is the society that defines norms and expectations that in turn define societal benefit sets. But "The Yang having reached its climax retreats in favour of the Yin". (According to Tao philosophy, Yang the clear and rational male intellect, yin is the complex, female, intuitive mind) (Capra, 1985). So technological innovation unrelated to 'what the humans desire for' would be a mechanistic model of world view. It will not help the development of human kinds for which it is meant. "In everyday life, then, both the mechanistic and organic views of the universe are valid and useful; the one for science and technology, the other for a balanced and fulfilled spiritual life" (Capra, 1985). A society is no better than the quality of the people it produces.

New Approach to Societal Development

If technological growth is a means of societal development, such that quality of life of the people is improved, then our current stage of technology innovation is either almost totally lacking in that objective or are reinforcing dissociative and other maladaptive behaviours.

The particular vision of new approach is that of a genuinely humane, harmonious social design. As purposeful productive organism distinct from mere goal-seeking, people make choices rather than reacting to the blind forces of technology. The most fundamental choice we face is that of societal design principles.

In spelling out of the details of a societal culture for development vis-a-vis technological innovation the changes encompass most of what we have seen in the previous scenarios. A series of fundamental shifts is needed towards holistic function at the level of individual and society and these finally have to be ingrained in society through institutional changes for absorption. Table 4 sets out the key features of the new societal paradigm which can potentially lead to development and a high quality of life for all members of the group.

The new paradigm contrast strongly with those of the old societal paradigm, set out on the left. Our traditional society follows blindly the technological imperative which regards human as material goal-seeking and highly flexible and adaptive. Traditional society is also characterized by certain paradoxes. Such paradoxes abound innovative

Table 4. Old and new paradigm

Old paradigm	New paradigm
Technological imperative that maximizes gratification and collectivisation to some extent	Joint optimization which aims at maximising all the three benefit sets
Only 'hardware' measures like material production and efficiency as criteria of success	'Software' criteria that emphasizes more on psychosocial measures
Brings in disequillibrium in ecosystem and group turbulence	Harmony between ourselves and other people, between ourselves and nature
Material-based, empirical, objective, instrumental rationality	Subjective, sane, humane, value-oriented culture
Reductionism, linear cause-effect relationships based on Newtonian mechanics	Holistic, multi-causality, interrelatedness of events based on open systems approach
Suppression of individual and/or group feelings with its consequential impotence of multiple contribution	Capable of motivating individuals and groups for 'new vision based upon spirituality of human ideals and the concomitant form of knowing which is wisdon' (Sir Aurobindo, 1985)
Growth-oriented both at physical and social levels	Aims at all round development especially of human resources

approaches, in measures of growth and in metaphysical approaches. Technology provides the person with more equipment, convenience and comfort, more enjoyment, but the individual feels as if there is paucity of leisure. There is no synthesis between work and non-work activities. The alienated person does not have commitment for anything in life.

Societal Control for Development

Human existence is dynamic confrontation between individual aspirations (ideals) and achievements as provided by beneficial trajectories of the society (practices). Aspiration may be thought of as representing some set of properties that serve as referrent points of individual's behaviour. Aspirations, then, are set targets and achievements are the real or perceived positions one occupies at a specific point of time with respect to aspirations. Aspirations have to be socially approved and societal benefits may be then so arranged as to fulfil or if necessary stand in the way of individual aspirations.

The starting point is the turbulent causal texture of the extended social field. The transformation processes of the social system should aim at establishing 'quasi stationary equillibrium' (Lemin, 1951) within its boundary conditions, the incessant interactions with extended social field, notwithstanding. Again, by effective reciprocal actions

between the individual and societal benefits, the resillence of the boundary conditions may be so appropriated as to meet the challenges from outside and thus reversing the entropy. figure 3.

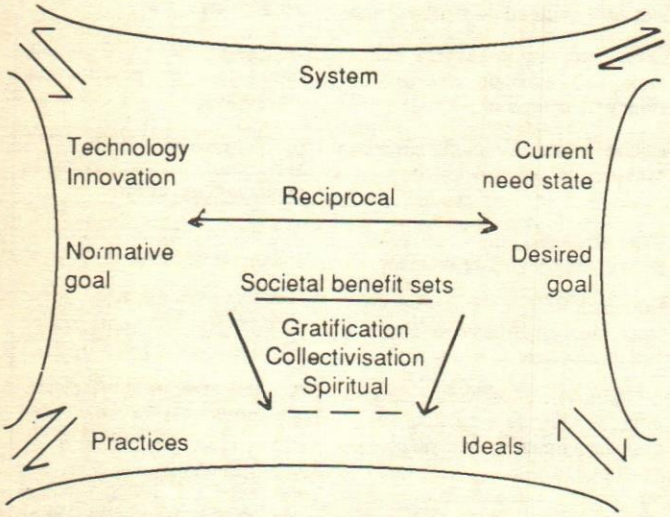


FIG. 3. THE MODEL OF SOCIETAL CONTROL

It is held that the nature of reciprocal relationship is a major determinant of creating distance between practices and ideals. It should be noted here, that the figure is slightly misleading in that the transformation to convergence ideally involves the whole system in its environment with all interrelatedness and interdependencies and not a part of the system as the visual representation may imply.

It is also important to note that both technology and individual need system enjoy their transaction in their own way through the societal trajectories and may do so either as ideals or practices. Thus for an effective reciprocal action to take place, the necessary steps suggested are:

1. An initial diagnosis of the sets of individual need satisfaction as a member of organized group.
2. Selecting target systems of technological innovations that is, individuals (category-wise) and groups to be affected.
3. The societal benefit sets—that is to what extent each is affected by the target system—are then identified.
4. An attempt is made to discover the *key variances*, and their interrelations. A variance is key if it significantly affects (i) either the quality or quantity of societal channel and (ii) either the physical or psychosocial costs.
5. A table of variance control is then drawn up to evaluate how far the key variances are controlled by (i) technology, (ii) economic criteria and (iii) psychosocial systems.
6. A separate enquiry is made into social-system members' perception of their benefits and benefit possibilities as well as constraining factors.
7. Forecasting is attempted of the viewpoint about (a) individuals (b) society and (c) environmental resources.
8. The forecasted missions are then considered in the context of interrelated total system with a view to generation of the set of acceptable opportunities in comformity with life goals.

It is clear that at this stage, the components of technology economic resource, R & D work on the one hand and supply-demand balance on the other, have to be considered simultaneously to optimize the benefit sets. The activities of human behaviour system may not always have a well-defined cause. We can never predict very precisely when and how a specific behavioural phenomenon is going to happen; we can only predict its probability. It does not mean that human behaviours occur in a random fashion; it means only that they cannot all the time be explained by immediate and localised cause—effect relationship. The human behaviour is more complex and can only be determined by its interrelated connection to the total system to which it belongs. And since we do not know these connections precisely we have to replace the mechanistic motion of cause and effect by wider concept of statistical causalty (Capra, 1985).

This formulation of joint optimization of technology and social system points that a reciprocal positive relationship must exist between the two if society is to absorb and distribute properly an innovation. For such a relation to be positive and reciprocal society has to, if necessary, adopt and adjust to its institutional changes which act as creator and carrier of emerging possibilities. The practice of establishing and maintaining such a relationship follow learning principles and so fall under the domain of educational systems.

We need technology for modern life. And technology, indeed, in its advancing strides is creating emerging and newer opportunities to cater to human needs. Society, in its turn, channelises through its benefit trajectories the achievements of technology to human kind. Unfortunately both seem to be working on a classical mechanistic world view. There may not be much unpardonable wrong in that. It is useful for dealing with our daily environment and for progress in the material world. But the individual also aspires to understand the deepest nature of things, for self-fulfilment, to come out with his/her potentiality to the fullest extent. Men and women need both material progress and self enlightenment.

It is not proper to put technology alone in the dock for all the evils of present civilization. It is also true that society with all the collective and institutional wills at its disposal failed to direct technology in the right pursuit. Technology and society are complimentary to each other. Neither is comprehended in the other, nor can either of them be reduced to the other. Both have to supplement their mechanistic approach with a cosmic view that can be epitomized as "organic". What we need, therefore, is not a synthesis but a dynamic interplay between technology and society. And within the society, we need, the art of related interface between all the societal channels for optimization of individual human development.

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Disagreement or a conflict is likely not to be about the answers or indeed anything ostensible. It is, in most cases, the result of incongruity in perceptions.

—Peter F. Drucker

We should refuse to tolerate poverty as a social institution not because the poor are the salt of earth, but because 'the poor in a lump are bad'.

—G.B. Shaw

Feature

Moderator Effects on the Occupational Stress - Job Satisfaction Relationship

Paramjeet Kaur Dhillon

Recently, there has been an increasing concern regarding the effects of occupational stress on job related behaviours. Today police job is considered to be one of the most stressful occupations. The present study is an attempt to investigate the effect of occupational strees on job satisfaction, and the moderator effects of age, education and hirearchy on this relationship.

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Police work has been claimed as one of the most stressful occupations today (Silbert, 1982; Goodin, 1975). Empirical evidence indicate that stress at work can affect the psychological and physical well being of an individual as well as his work, performance, job involvement, overall effectiveness and job satisfaction (Welford, 1977; Alkus and Podesky, 1983; Khanna, 1985; Srivastava, 1987; and Kedarnath, 1988). Review of literature reveals that most studies have attempted to explore the potential cases or consequences of stress among police personnel (French, 1975; Kores et al, 1974; Lasky et al, 1986; Somodevilla et al, 1978, Kores and Gould; 1979; Kores, 1983; Aldag and Brief, 1978; Smith, 1982; Violanti, 1982; Orth-Gomer et al, 1981; Resier and Geiger, 1984; Zamore de Alencar et al, 1981; Alkus and Podesky, 1983; Danto and Pittman, 1983). However, examination of the relationship between job stress and job satisfaction among police personnel has remained comparatively an ignored area, with the exception of studies by the present author (Dhillon, 1989a, 1989b) although job satisfaction of employees is one of the important objectives of every organization. Research evidence indicates that job satisfaction is an important behavioural variable as it is related positively, though moderately, with productivity (Vroom, 1964; Lawler and Porter 1968; Wanous, 1974), and job involvement (Lodah land Kejner, 1965). On the other hand job dissatisfaction has been found to be correlated positively with avoidable turnover (Porter and Steers, 1973) and absenteeism (Nicholson et al, 1976). Keeping the importance of job satisfaction in mind researchers in other settings have investigated the effect of job stress on job satisfaction. Pestonjee and Singh (1981) investigated the role stress and job satisfaction relationship on role incumbants of a Private Electricity Supply Company and found that of the 63 coefficients of correlation calculated between role stress and job satisfaction variables, 50 were found to be negatively and significantly correlated. Singh (1987) in a study

of computer professionals examined the relationship between role stress and job satisfaction variables and reported that several role stress variables were associated negatively and significantly with job satisfaction. However, as Lazarus (1976) points out "stress is not simply out there in the environment, it depends not only on external conditions but also on the constitutional vulnerability of the person and the adequacy of his cognitive defence mechanism." Therefore, the relationship between job stress and job satisfaction would hypothetically be mediated by many factors. Individual differences in personality, motivation, job involvment, sex, job level, age, educational level, etc. (Sharma, 1985) are some of the important mediating factors. Keeping in mind review of literature on police stress and stress in other organizations, importance of job satisfaction and other aforesaid observations, the present study was designed to ascertain the relationship between occupational stressors and job satisfaction, relationship between age, educational level, hierarchy and job satisfaction; and to determine the moderator effects of age, educational level and hierarchy on the relationships between occupational stressors and job satisfaction. These objectives were further elaborated in the form of hypotheses.

The following hypotheses were formulated:

(1) Overall occupationl stress and all components of job related stress is negatively related to job satisfaction (Pestonjee, 1981; Khanna, 1985).

(2) The relationship between age and job satisfaction is positive and significant (Khanna, 1985).

Age will significantly moderate the relationship between overall occupational stress, other dimensions of job stress and job satisfaction.

(3) Education has a significant positive relationship with job satisfaction.

Educational level of police personnel will significantly effect the occupation stress-job satisfaction reltionships.

(4) There will be a significant positive relationship between hierarchy in the police organization and job satisfaction. Hierarchy in the organization will significantly moderate the relationships between occupational stress and job satisfaction (Dhillon, 1989a; 1989b).

Method

Sample

The sample comprised 296 male Delhi police personnel from different hierarchical ranks. Assistant Police Commissioners, Inspectors, Sub-inspectors, Assistant Sub-Inspectors, Head Constables and Constables. The age of the police personnel ranged from 20 to 52 years.

Measures

1. Occupational Stress: Occupational stress was measured with the help of the 'Occupational Stress Index' developed by Srivastava and Singh (1984). It is a self report questionnaire and measures the extent to which employees perceive stress arising from 12 constituent conditions of their job. It gives on overall occupational stress score and separate scores for the 12 dimensions of occupational stress: Role Overload (RO); Role Ambiguity (RA); Role Conflict (RC); Unreasonable Group and Political Pressure (UGPP); Responsibility for Persons (RP); Underparticipation (UP); Powerlessness (P); Poor Peer Relations (PPR); Intrinsic Impoverishment (II); Low Status (LS); Strenuous Working Conditions (SWC); and Unprofitability (UN).

2. Job Satisfaction: Job satisfaction was measured with Brayfield and Rothe's (1951), 'An Index of Job Satisfaction'. It is a self report questonnaire that assumes that job satisfaction can be inferred from an individual's attitude towards various aspects of his work. The index consists of 18 statements rated on a five point scale. The range of possible total scores is from 18 to 90 with the undecided or neutral point at 54 (average). It gives an index to 'over-all' job satisfaction rather than to specific aspects of the job situation. The authors have reported a reliability coefficient of 0.87 and reasonable evidence of content and construct validity of the scale.

3. Background Variable: A Personal Data Schedule was devised to obtain information about the subject's age, education, hierarchical rank, etc.

Procedure

After obtaining persmission from the Police Headquarters the police personnel were approached personally and on assurance of confidentiality they were requested to fill the questionnires anonymously. Then the personal data sheet together with the two measures were administered to them.

Results

The data were analyzed using Hierarchical Regression Analysis. The choice of this method has been dictated by its superiority in calculating the moderator effects (Cohen & Cohen, 1975).

The results of the hierarchical regression analysis of variables related to job satisfaction are displayed in

Table 1.* Hierarchical Regression Analysis of Variables Related to Job Satisfaction

Step	Independent Variables	β	ΔR^2	R^2 (Cumulative)
1.	Overall occupational stress	- .30	.160*	.160
2.	Age	+ .21	.097*	.257
3.	Education	- .03	.003	.260
4.	Hierarchy	- .11	.077*	.337

* Significant at P < .05 and above

table 1. The order in which variables were entered into the hierarchical table I regression analysis reflects an implicit hypothesis regarding the significance/importance of the variables in explaining job stress-job satisfaction relationship. Occupational stress was entered first, for it is the primary variable, age and education were entered next, being the personal/individual characteristics and job level or hierarchical position of the individual in the organization represents the organizational-individual interface (March and Simon, 1958) it was therefore, entered last. The table indicates that all these variables together account for 33.7% variance in job satisfaction, occupational stress accounting for 16% of the variance, age 9.7%, education 0.3% and hierarchy 7.7%. It is also observed that occupational stress and hierarchy have a significant negative relationship and age a significant positive relationship with job satisfaction.

To examine the moderator effects of age, education and hierarchy the interaction effects of these variables with job stress on job satisfaction were examined. The results of the moderated hierarchical regression analysis are presented in table 2. It shows that the interaction of stress and age and stress and hierarchy affect the job stress-job satisfaction relationship negatively. The results indicate that the observed strength of the negative relationship between job stress and job satisfaction is reduced as age increases. Similarly, as hierarchical position of police personnel increases the job stress becomes progressively less effective in reducing job satisfaction. The results also denote that education moderates the job stress-job satisfaction relationship positively. This implies that higher the educational level of police personnel the more likely it is that stress would have a greater degree of adverse effect on job satisfaction.

Table 2: Results of Moderated Hierarchical Regression Analysis

Step	Independent Variables	β	ΔR^2	R^2 (Cumulative)
1.	Overall occupational Stress (OS)	- .31	.161*	.161
2.	Age	+ .21	.097*	.258
3.	OS x age	- .14	.041*	.299
1.	Overall occupational stress (OS)	- .31	.161*	.161
2.	Education	+ .19	.080*	.141
3.	OS x Education	+ .11	.062*	.202
1.	Overall occupational stress (OS)	- .31	.161*	.161
2.	Hierarchy	- .17	.110*	.271
3.	OS x Hierarchy	- .15	.072*	.342

* Significant at P · .05 and above.

Table 3 presents the moderator effects of background variables on the relationship between components of job stress and job satisfaction. The results indicate that of the 12 job stress components only 5 have a significant relationship with job satisfaction. These are Role Overload, Role Ambiguity, Role Conflict, Responsibility for persons and Unprofitability.

Role overload has been found to have a significant negative relationship with job satisfaction and contributes 42.1% of the variance in job satisfaction. Age and educational moderate Role overload-job satisfaction relationship positively, whereas, hierarchy moderates the relationship negatively.

It is observed that Role Ambiguity and Responsibility for police personnel have a significant positive relationship with job satisfaction and contribute 45% and 63.2% variance in job satisfaction, respectively. Education and hierarchy moderate the relationship between Role Ambiguity and Job Satisfaction positively, whereas, age moderates the relationship negatively. On the other hand, the relationship between Responsibility for persons and job satisfaction is moderated positively by age, education, and hierarchy.

Role conflict and Unprofitability have a significant negative relationship with job satisfaction. On the role conflict-job satisfaction relationship, age and hierarchy have significant negative moderating effects and education a significant positive effect. Hierarchy moderates the relationship between unprofitability and job satisfaction significantly and positively, whereas, education moderates this relationship significantly and negatively. Age has no moderating effect on the unprofitability-job satisfaction relationship.

The other seven stress components have no significant direct relationship with job satisfaction. However, the results show that hierarchy has a significant positive moderating effect on the stress component, unreasonable group and political pressure and job satisfaction relationship. Similarly, age has a significant positive moderating

Table 3: Moderator Effects of Background Variables on the Relationship between Components of Occupational Stress and Job Satisfaction.

Sl. No.	Independent Variables	β	ΔR^2
1.	Role Overload (RO)	- .141	.421*
	Role Overload x age	+ .218	.027*
	RO x Education	+ .133	.076*
	RO x Hierarchy	- .126	- .038*
2.	Role Ambiguity (RA)	+ .177	.450*
	RA x age	- .152	.062*
	RA x Education	+ .135	.111*
	RA x Hierarchy	+ .134	.042*
3.	Role Conflcit (RC)	- .186	.253*
	RC x age	- .120	.083*
	RC x Education	+ 158	.124*
	RC x Hierarchy	- .099	.032*
4.	Unreasonable Group & Political Pressures (UGPP)	- .003	.001
	UGPP x Age	+ .063	.000
	UGPP x Education	- .119	.002
	UGPP x Hierarchy	+ .168	.071*
5.	Responsibility for persons (RP)	+ .882	.632*
	RP x Age	+ .102	.051*
	RP x Education	+ .167	.033*
	RP x Hierarchy	+ .126	.028*
6.	Underparticipation (UP)	+ .001	.003
	UP x Age	- .07	.000
	UP x Education	- .13	.001
	UP x Hierarchy	+ .12	.000
7.	Powerlessness (P)	- .001	.001
	P x age	+ .072	.000
	P x education	+ .091	.002
	P x Hierarchy	- .099	.007
8.	Poor Peer Relations (PPR)	+ .201	.010
	PPR x Age	+ .013	.007
	PPR x Education	- .021	.006
	PPR x Hierarchy	- .077	.006
9.	Intrinsic Improverishment (III)	+ .071	.003
	II x Age	+ .31	.062*
	II x Education	- .132	.032*
	II x Hierarchy	+ .133	.001
10.	Low Status (LS)	- .002	.005
	LS x Age	+ .071	.003
	LS x Education	+ .72	.003
	LS x Hierarchy	- .041	.000
11.	Strenuous Working Conditions (SWC)	+ .032	.006
	SWC x Age	+ .121	.008
	SWC x Education	+ .112	.002
	SWC x Hierarchy	+ .091	.002
12.	Unprofitability (UN)	- .341	.391*
	UN x age	+ .072	.000
	UN x education	- .091	.100*
	UN x hierarchy	+ .241	.180*

*P < .05 and above.

effect on the relationship between Intrinsic improverishment and job satisfaction and education has a negative significant moderating effect on this relationship.

Discussion

The results indicate (tables 1 & 2) that overall occupational stress is negatively and significantly related to job satisfaction as hypothesized. This is consistent with the results of Dhillon (1989a; 1989b), Singh (1987), Khanna (1985) and Pestonjee (1981). However, it is also observed that all individual components of occupational stress (table 3) are not negatively and significantly related to job satisfaction. In fact, the results show that among police personnel only 3 job related components like Role overload, Role conflict and Unprofitability are negatively and significantly related to job satisfaction and are perceived as stressors, whereas, two job components, Role ambiguity and Responsibility are found to be positively and significantly related to job satisfaction and therefore would enhance job satisfaction. These findings are somewhat unexpected as Pestonjee (1981) and Khanna(1985) found that all factors of role stress correlated negatively with job satisfaction. Therefore, from the findings of this study, it can be suggested that job related components perceived as stressors that affect job satisfaction will depend upon the type of work and organization. These findings only partially support the hypothesis formulated regarding the negative relationship of job factors and job satisfaction.

Examining the relationship of background variables with job satisfaction, the results show (tables 1 & 2) age to be related positively and significantly with job satisfaction as hypothesized. This implies that as age increases job satisfaction also increases. Khanna (1985) on executives also found age to have a positive relationship with job satisfaction.

However, the direction and degree of relationship of education with job satisfaction is not quite clear from the results of this study. When educaton is entered into the hierarchical regression along with stress, age and hierarchy it does not emerge as a significant correlate of job satisfaction at the conventional 5% level of statistical significance though it has a tendency to be negatively associated with job satisfaction. The inference regarding the relationship between education and job satisfaction has to be made with caution for when education was entered into the regression with job stress alone, excluding age and hierarchy, to examine its moderator effect (table 2), the beta weight associated with education emerged as positive (β = .19). This implies that if age and hierarchy are controlled, education has the tendency of affecting job

satisfaction negatively, otherwise its association with job satisfaction is positive. This suggests that as education increases job satisfaction also increases. These results are consistent with the findings of an earlier study by the author and also, to some extent, prove the hypothesis.

Regarding hierarchy the findings are contrary to our hypothesis; for instead of a positive relationship between hierarchy and job satisfaction as hypothesized, the results show a negative significant relationship with job satisfaction. This implies that as one moves up the hierarchy in the police organization, job satisfaction decreases. These findings are also contrary to those by earlier studies. Dhillon (1989a) found job level to be related significantly and positively to job satisfaction and also to expectation, for as one moves up the hierarchy one gets more pay, recognition, power, prestige, etc., which usually enhance satisfaction on the job. It seems that in the police organisation as one moves up the hierarchy certain factors become predominant which reduce job satisfaction.

An attempt has been made in this study to examine the moderator effects of age, education and hierarchy on the occupational stress-job satisfaction relationship. The negative moderating effect of age on overall occupational stress-job satisfaction relationship implies that among police personnel as age increases occupational stress does not effect job satisfaction as adversely as it would at a younger age. This is probably because older employees learn to handle diverse work situations that confront them without getting too worked up or experiencing too much stress. It is also possible that older employees learn to accept them and so do not perceive them as too stressful. In other words, as age increases, it buffers the effect of occupational stress. This finding is consistent with the findings of Pestonjee and Singh (1987) who found that among top management younger age group significantly scores higher on overall role stress as compared to the older age group. Khanna (1985) also reports age to be negatively related with role stress.

Examining the moderator effects of age on the individual components of occupational stress and job satisfaction relationships it is observed that age moderates three of these relationships positively and two of them negatively. The positive moderating effect of age on Role overload implies that among police personnel as age increases Role overload will have a greater adverse effect on their job satisfaction. On the other hand, as age increases Responsibility for persons increases job satisfaction, for responsibility for others connotes power and perhaps this feeling contributes towards enhancing satisfaction on the job. With increase in age Intrinsic Improverishment would have also had a positive effect on job satisfaction but because of the non-significance its effect is not very clear. The negative moderating effect of age on Role ambiguity suggests that as age increases, less the Role ambiguity more the job satisfaction and younger the age more the role ambiguity more the job satisfaction. Role ambiguity becomes a stressor as age increases probably because tolerance for ambiguity decreases with age and one desires adequate information and clarity of work objectives associated with one's role. However, with increase in age the adverse impact of Role conflict decreases on job satisfaction. This seems to imply that older police personnel either learn to deal with conflicting work demands or accept them in one's stride without experiencing too much stress.

The results seem to imply that with increase in age overall occupational stress and role conflict decrease their adverse effect on job satisfaction, but Role overload increases its effect on job satisfaction.

The moderator effect of Education is negative on the occupational stress-job satisfaction relationship which indicates that as education increases the effect of overall occupational stress also increases on job satisfaction. This finding seems to suggest that with increase in education people become more sensitive and therefore, perceive more stress in their work situations which is likely to affect their job satisfaction. The results by Bhasker (1986) also show that among police personnel, educational qualifications and overall job stress are negatively and significantly related. The moderator effect of education is positive and significant on four relationships between individual components of occupational stress and job satisfaction. the positive moderating effect on Role overload, Role ambiguity, Role conflict, Responsibility for persons, and job satisfaction relationships denotes that as education increases greater the adverse effect of Role overload and Role conflict on job satisfaction and greater the positive effects of Role ambiguity and Responsibility for persons on job satisfaction. This seems to suggest that among police personnel as education increases, there is less tolerance for Role overload and Role conflict as they are perceived as stressors which affect their satisfaction on the job, whereas, highly educated personnel prefer ambiguity in their role and roles which involve responsibility for persons, for both enhance job satisfaction. This seems to imply that as education increases people desire roles that give them power, for role ambiguity gives scope to interpret roles as one desires and responsibility gives a certain amount of control over others. The negative moderator effect on Intrinsic Impoverishment, Unprofitability, and job satisfaction relationships indicate that as

education increases the effect of Intrinsic Impoverishment and Unprofitability is reduced on job satisfaction. These findings suggest that as education increases one becomes more sensitive and perceive job factors like Role overload and Role conflict as more stressful as to affect their job satisfaction. However, as educational level increases there is a greater preference for work with more ambiguity and responsibility for persons.

Hierarchy has a significant negative moderating effect on overall occupational stress-job satisfaction relationship which denotes that as police personnel move up the hierarchy the negative effect of occupational stress on job satisfaction is weakened. In other words, hierarchy buffers the effect of occupational stress on job satisfaction.

Scrutinizing the moderator effects of hierarchy on the relationship between individual components of occupational stress and job satisfaction, the results show that hierarchy moderates significantly six of these relationships. Role overload, Role conflict and job satisfaction relationships are moderated negatively, implying, that as one moves up the hierarchy the strength of role overload and role conflict in effecting job satisfaction adversely is reduced, whereas, at lower ranges of the hierarchy Role overload and Role ambiguity will have greater adverse effects on job satisfaction. On the other hand, positive significant moderating effect of hierarchy on Role ambiguity, Responsibility for persons, Unreasonable group and Political pressure, Unprofitability and job satisfaction relationships indicate that as one moves up the hierarchy, the positive effects of Role ambiguity and Responsibility for persons increase on job satisfaction, and also the adverse effect of Unprofitability increase on job satisfaction. In this study, hierarchy has no significant effect on Unreasonable group and Political pressure and job satisfaction relationship as the relationship is negligible and non significant. These findings seem to suggest that as one moves up the hierarchy job related factors causing stress either are not perceived as stressors or the stress arising from these components decreases its severity. These findings seem to be somewhat contrary to the results obtained by Palnitkar (1987) who found that occupational stress was significantly higher in Class I than among Class II officers.

Conclusions

From the findings of this study, the following conclusions could be drawn:

(1) Job related factors that are perceived as stressors vary according to the occupation and type of organization;

(2) All job related factors are not perceived as stressors, in fact, some factors even enhance satisfaction on the job; and

(3) The occupational stress-job satisfaction relationship is not a simple straight one but is mediated by individual factors such as age, education and hierarchy.

Implications of the Study

The findings of the study regarding job conditions perceived as stressors and the effect of job stressors and personal factors on job satisfaction have some implications for job redesign and job enrichment. For example, too many job demands (Role overload) and conflicting job demands (Role conflict) should be minimized. It is equally important that efficient performance and quantum of labour be recognised and rewarded (reduce Unprofitability) and responsibility for the functioning and well-being of personnel be enhanced. The effect of mediating variables on the occupational stress-job satisfaction relationship also have some implications for criteria selection of police personnel.

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Feature

Oilseeds Projections For Punjab

I.S. Chatha, Joginder Singh & R.S. Bawa

With shortages in the production of vegetable oils for the last few years, imports worth crores of rupees had to be resorted to leading to a drain on valuable foreign exchange. To meet this situation the government is making all efforts to increase the production of oilseeds in the country; pinning great hopes on Punjab for enhancing production of edible oils. This paper attempts to project the supplies of and demand for vegetable oils/oilseeds upto the end of the twentieth century.

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Punjab is agriculturally the most advanced state in the country and has been making a significant contribution of foodgrains to the central pool. However, production of oilseeds in the state has remained stagnant till recent past. The country has been facing serious shortages of vegetable oils for the last few years and imports worth crores of rupees had to be resorted to which lead to a drain on the country's valuable foreign exchange resources. To do away with the imports and meet the shortages from within the country, the government is making all efforts to increase the production of oilseeds in the country. The government is pinning a great deal of hope on Punjab for its contribution towards oilseeds production as in the case of foodgrains production. Therefore oilseeds production in the state has received the attention of the planners, policy makers, experts and executors. Notwithstanding the concerted efforts being made to increase the production of oilseeds in the state, it may not be possible to achieve the set goals in this field in the near future owing to lack of improved technology. The main objective of this paper is to project the supplies of and the demand for vegetable oils/oilseeds in the state upto the end of the twentieth century.

Supply Projections

The supply of a commodity invariably depends upon its production which in turn depends upon the acreage and productivity of the crop. Therefore, first of all, the projections of area under and productivity of different oilseed crops were obtained upto the year 1999-2000. Then the estimates of production were obtained by multiplying the area and yield.

The major oilseed crops in the state are rapeseed/mustard, groundnut, sesamum and linseed. All these crops were taken up for this study. Cotton seed is another important source of oil in the state. Therefore, the cotton crop was also considered for its indirect effect on the parameters to be studied. Since the oilseeds are mainly grown for human consumption in the form of vegetable oils or in small quantities otherwise (both for food and non-food

uses), the estimates of net available supplies of different oilseeds for human consumption were arrived at after accounting for the quantities required for both seeding and feeding purposes.

The Data base: The data pertaining to area, production and yield of these crops from 1960-61 to 1984-85 were collected from the Statistical Abstracts of Punjab. Similarly, data regarding prices, income, total cropped area, irrigated area, rainfall, etc., were collected from various secondary sources, such as the office of the Economic Advisor to Government of Punjab, Director of Land Records (Punjab), Director of Agriculture, Director of Marketing, (Punjab) FAO and other publications.

Acreage projections: The projections of acreage were worked out on the basis of regression models given in Appendix I. However, in the case of cotton, a modification had to be incorporated. Although, log-linear model gave the best fit in this case, the projections of acreage derived from it did not correspond with the real situation as it gave explosive results. So, while projecting the area of cotton, a restriction on the basis of compound growth rate worked out for the period 1970-71 to 1983-84 which was 3.6582 per cent per annum, was imposed.

Yield Projections: For projecting the yields of different oilseeds, various forms of functions were fitted to the actual data of yields. Those functions that stood the test of prediction and also which gave the good fit were selected. Except linseed, all the crops showed linear form to be the most relevant considering the logic and statistical significance of the coefficient of determination. Therefore, for projecting yield the functional forms.

$$Y = a + bt + bt^2$$

for linseed and for other crops

$$Y = a + bt$$

were used; Where, t represents time and Y the productivity, a and b are the parameters.

Estimates of net supplies available for human consumption: The estimates of net available supplies for human consumption were made after deducting the quantities of seeds required for feeding and seeding from the total production. In case of oilseed crops viz., groundnut, sesamum, rapeseed/mustard and linseed, the quantities required for feeding were estimated at the rates based on cross-sectional data (groundnut nil.; sesamum 3.56; rapeseed/mustard seed 1.51 and linseed 10.98 per cent of total production) and the quantities required for seeding were estimated by multiplying the recommended seed-rates[1] per unit area for different oilseeds by the PAU with the acreage to be covered during the ensuing year. However, in the case of cotton, the seed of which is fed to cattle in large proportion in this state, it was assumed that 50 per cent of the total production of Desi cotton seed was used both for feeding and seeding and the rest 50 per cent was available for extracting oil and about 10 per cent of the total production of American cotton seed was utilised for feeding in addition to the actual quantities required for seed purposes.

Demand projections

To identify the gap between the net availability and requirements of oilseeds in the state, it is imperative to examine the factors affecting demand for oilseeds. The demand for oilseeds is primarily a derived demand—derived mainly from the demand for vegetable oils. So, it was considered appropriate to analyse the demand for vegetable oils. Since the specific end uses of different vegetable oils could not be made out and in view of the fact that most of the vegetable oils are substitutable with each other in both food and non-food uses, the demand for all the vegetable oils was viewed together rather than for each oil in isolation.

Obviously, the demand for vegetable oils depends upon population and the per capita consumption. The per capita consumption further depends upon a variety of factors such as income of the consumers, price of the oilseeds/ oils, price of substitutes, etc. Therefore, the population of the state and per capita consumption for vegetable oils in the past were analysed to project the population and per capita consumption in future. Then the projections of aggregate demand for vegetable oils were arrived at by the interaction of projected population and projected per capita consumption in the respective years.

Population projections: The population was projected keeping in view the compound growth rates for the period 1951-61, 1961-71 and 1971-91 worked out to be about 1.97,1.98 and 2.16 per cent per annum. Although there has been an intercase in the growth rate, yet in the light of the slogans of the government to check population, it is anticipated that the growth rate of 2.16 per cent per annum will prevail in the next two decades.

[1]Seed rates recommended by the PAU were :

1. Groundnut	1.5 kg per ha
2. Sesamum	2.5 kg per ha
3. Rape/mustard	3.7 kg per ha
4. Linseed	37.5 kg per ha
5. Cotton (Am)	25.0 kg per ha
6. Cotton (Desi)	12.5 kg per ha

Per capita consumption: The net per capita consumption of total vegetable oils was regressed against per capita income and price index of total oilseeds to know the relative effects of these variables on consumption. But the composite function of both these variables did not turn out to be appropriate due to the problem of multicollinearity. Then, these variables were regressed individually in the following form:

$$C_t = f(Y_t)$$
$$C'_t = f(P_t)$$

Where, C_t is per capita consumption for the year t and $C'_t=(C_t-bY_t).Y_t$ and P_t are per capita income and price index of oilseeds respectively in year t; and b is the regression co-efficient of income. The results of both these functions were then integrated to project per capita consumption. The linear form of the functions gave the best fit and thus, the ultimate equation used for projections was:

$$C_t = a + b_1 Y_t + b_2 P_t$$

The time-series data on estimated per capita consumption of vegetable oils for the period 1960-61 through 1984-85 were used for analysis. The variables included in the function are :

Per-capita consumption (C_t): In view of the non-availability of the data on per capita consumption of vegetable oils for the period under study and scarcity of the oils in the state, the net available supplies of total vegetable oils were assumed to represent demand. The net availability was worked out by deducting the quantities of oilseeds required for seeding and feeding purposes from the total production, and as also accounting for the quantities imported into and exported from the state. The per capita consumption was arrived at by dividing the net available vegetable oils with population during different years.

Per capita income (Y_t): The per capita income was taken at constant prices with base of 1960-61.

Price index of oilseeds (p_t): The data on prices or price index of vegetable oils were not available. Therefore, the weighted index numbers of harvest (wholesale) prices of oilseeds available from the secondary source, were considered as a proxy for the oil prices.

Results

Production estimates: The estimates of area, productivity and production of major oilseeds crops pertaining to the base year (1984-85) and projection year (1999-2000) have been presented in table 1.

Table 1. Area, yield and production of major oilseeds in Punjab in 1984-85 and projections for 1999-2000

Oilseed crop	1984-85			1999-2000		
	Area ('000 ha)	Yield (kg per ha)	Production ('000 tonnes)	Area ('000 ha)	Yield (kg per ha)	Production ('000 tonnes
Groundnut	45.0	989	44.0	33.0	876	29.0
Sesamum	13.8	362	5.0	23.7	298	7.1
Cotton seed	472.0	892	421.0	739.0	732	540.0
Rapeseed/mustard	138.0	1066	147.0	186.0	1011	188.0
Linseed	102.0	583	0.7	0.8	808	0.6
Total	670.0	—	617.7	982.5	—	764.7

The total production of oilseeds is projected to increase from the base level production of 617.7 thousand tonnes in 1984-85 to 764.7 thousand tonnes by the end of the twentieth century (1999-2000). The production of groundnut is likely to fall owing to a decline in both area and productivity and it may come down from 44 thousand tonnes in 1984-85 to 209 thousand tonnes in 1999-2000 (a fall of about 34 per cent). The acreage under groundnut is expected to fall because of its low productivity and consequently very poor economics *vis-a-vis* that of its competing crop, i.e. paddy. As the soil conditions go on improving and more irrigation facilities are being created, the area under groundnut is being diverted to paddy which is the most remunerative crop except sugarcane in the kharif season. Under 'Barani' conditions, groundnut commanded a big chunk of the area in the state during kharif season. So, unless some technological breakthrough is brought about in the cultivation of groundnut, the area under this crop is expected to fall further. So, is the position of productivity of groundnut. The production of cotton seed, sesamum and rapeseed/mustard seed respectively was estimated to increase from the base levels of 421.5 and 147 to 540, 7.1 and 188 thousand tonnes in 1999-2000. This was mainly due to likely increase in area under them though their productivities were projected to fall because of exceptionally high levels attained by these crops during the base year. The area under cotton is expected to increase over the base year area of 472 thousand hectares to 739 thousand hectares during 1999-2000. The area in the base year had gone sufficiently down as compared with that during the years in the recent past. This happened because of the appearance of a cotton pest in the epidemic form in the preceding year (1983-84) which resulted in drastic fall in area under cotton in the base year. Cotton is an area specific crop and no other crop competes well with it under the given agro-climatic conditions. The area under sesamum, another kharif oilseed is expected to rise from

the base level area of 13.8 thousand hectares in the year 1984-85 to 23.7 thousand hectares during the year 1999-2000. Sesamum does not find favour with the farmers from economic angle and the expected increase in area is within limits touched in the past. The area under rapeseed/mustard is expected to increase from 138 thousand hectares in 1984-85 to 186 thousand hectares in 1999-2000. This expected increase seems to be in line with the development efforts initiated recently by the government for increasing the production of this most important 'rabi' oilseed. On account of recent introduction of better yielding varieties of rapeseed/mustard and initiation of price support programme for oilseeds also, the increase in area of rapeseed/mustard is imminent. Linseed production is also expected to fall from 0.7 thousand tonnes in 1984-85 to 0.6 thousand tonnes in 1999-2000 due to a considerable fall in its area. Like sesamum, this oilseed crop also does not find favour with the farmer from the economic angle and covers only an insignificant proportion of the total area under oilseeds.

Net available supplies of different oilseeds for human consumption: The estimates of net available supplies of different oilseeds for human consumption have been arrived at after deducting the quantities required for seeding and feeding purposes during different years from the total presented in table 2.

Table 2: Estimated Net Available Supplies of Different Oilseeds for Human Consumption, 1984-85 and 1999-2000 (Tonnes)

Oilseed	1984-85	1999-2000
Groundnut	37400	24200
Sesamum	4787	6786
Cottonseed	352867	448122
Rapeseed/mustarseed	144334	184908
Linseed	567	504
Total	539955	664520

Net availability of vegetable oils: The estimates of net availability of vegetable oils were made by applying the conventional oil recovery rates (groundnut kernel 44%, rapeseed/mustard seed 34%, sesamum 40%, linseed 33% and cotton seed (undecorticated) 12% oil) (Pavaskar, 1979) to the net available supplies of different oilseeds given in table 2. The quantities of oils that would be available during the projection years are in table 3.

It would be observed that the net availability of total vegetable oils over the year 1984-85 would increase by about 21 per cent by the year 1999-2000. The major contributors in this increase would be rapeseed/mustard and cotton seed. The production of sesamum oil is also likely to increase substantially but its relative contribution to the total oils is small. The supplies of groundnut and linseed oils may fall consistently till the end of twentieth century.

Table 3: Estimated Net Availability of Indigenous Vegetable Oils in Punjab during 1984-85 and 1999-2000

Year	Groundnut oil	Sesamum oil	Rapeseed/mustard oil	Linseed oil	Cotton seed oil	Total
1984-85	10971 (100.00)*	1915 (100.00)	49074 (100.00)	187 (100.00)	42324 (100.00)	104471 (100.00)
1999-2000	7099 (64.71)	2714 (141.72)	62869 (128.04)	166 (88.77)	53775 (127.00)	126623 (121.18)

*Figures in the parentheses are the indices.

Demand Estimates

The per capita demand model arrived at was:

$$C_t = 0.3427 + 0.0169^{***} Y_t - 0.0037^{**} P_t \quad (R^2 = 0.5999^{***})$$

*** Significant at 1 per cent level.
** Significant at 5 per cent level.
* Significant at 10 per cent level.

The projected population, per capita consumption and the demand for total vegetable oils in the state have been shown in table 4.

Table 4. Projected Population, Per Capita Consumption and Aggregate Demand for Vegetable Oils in Punjab, 1984-85 and 1999-2000

Year	Population	Per capita consumption (kg)	Aggregate demand (tonnes)
1984-85	17900504	11.85	212037
1999-2000	24664854	11,37	280521

Obviously, the demand for total vegetable oils would rise consistently and may go upto about 2.81 lakh tonnes by the end of twentieth century as against the total consumption of about 2.12 lakh tonnes during the base year (1984-85)

Supply and Demand gap

Thus, only 45 per cent of the total demand for vegetable oils in the state in 1999-2000 would be met from the indigenous supplies. Unless a real breakthough is achieved in the production technology, large scale imports of oilseeds/vegetable oils shall have to be arranged for meeting the total demand.

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Appendix-I Results of Selected Regression Models Showing Acreage Response of major Oilseed Crops in Punjab, 1960-61 Through 1984-85

Parameter	Rapeseed/ mustard	Groundnut	Sesamum	Lineseed	Cotton
Intercept or constant	15.2545	14.6757	—42.3117	9.9995	-1.2623
Regression coefficients of:					
i. Lagged area	0.4054**	0.8368****	0.7066***	0.0857	1.1465****
	(0.2240)	(0.0813)	(0.2468)	(0.1418)	(0.1511)
ii. Percentage irrigated area	-1.1285	-0.7413	0.536**	-0.1061****	-0.4446**
	(0.8868)	(0.8868)	(0.2552)	(0.0182)	(2.2499)
iii. Rainfall	0.852	0.0145	0.0149*	0.0178**	-
	(0.1475)	(0.0375)	(0.0097)	(0.0094)	
iv. Relative productivity	27.9604	58.226*	71.6666***	-	0.5492***
	(131.581)	(38.4957)	(28.901)		(0.2032)
v. Relative risk in productivity	-8.8469*	-5.2617*	-8.98	-	0.0144
	(6.139)	(3.5142)	(7.4197)		(0.0244)
vi. Relative price	57.7996***	11.5746**	-1.3668	-	0.0866
	(24.0736)	(6.2939)	(1.0692)	-	(0.0698)
vii. Relative risk in price	0.0139	0.0042	0.0013	-	0.0177
	(0.0128)	(0.0035)	(0.0011)	-	(0.0179)
viii. Relative gross profitability	-	-	-	0.1845	-
				(0.5)	
ix. Relative risk in gross profitability	-	-	-	-0.0174*	-
				(0.0116)	
R^2	0.4234	0.9562****	0.6261***	0.9458****	0.9120****
Functional Form	Linear	Linear	Linear	Linear	Log-Linear

Note : 1. Figures in parentheses indicate standard errors.
2. In case of cotton, its own productivity, risk in its own productivity, its own price and risk in its own price were the variables in place of relative productivity or price, etc., in case of other oilseed crops.

**** *** ** *indicate significant at 1, 5, 10 and 20 per cent level of significance, respectively.

Form IV

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Japanese Training Practices

Training constitutes a major factor in the phenomenal rise of Japanese productivity and quality in recent decades. It would thus be worthwhile for Indian managers to acquaint themselves with the system of training prevalent in Japan and try to determine which aspects could be profitably adopted in the Indian context. Traditionally, the Indian (and also the Western) manager viewed expenses incurred in developing human resources with a sense of unease, as something he would rather avoid.

The reluctance of the Indian manager to invest in human capital springs mainly from the uncertainty regarding the returns to be obtained from such investments. First, the manager is not sure as to what extent the training itself would be effective. Second, he does not know whether the employee will remain long enough for the organization to benefit from his newly acquired skills.

The typical manager of a large Japanese firm feels no such apprehensions. The so-called life-time employment system ensures that most young recruits will remain in the company till retirement. Moreover, as employment in Japan is not viewed in contractual terms alone and as employees possess sentiments of loyalty and belongingness to the firm, the manager is not overly concerned about the cost/benefit of training. He knows that whatever training is provided, it will be taken seriously and will be put to use for the organization's benefit.

In most Indian organizations too, a certain form of life-time employment prevails. A large majority of employees-particularly blue-collar employees-remain in the same firm throughout their working lives. But the difference from the Japanese system lies in the assumptions behind employment, which are entirely different in the two countries. Though the Indian company cannot easily retrench its employees it nevertheless likes to believe that it possesses the power to do so, whenever it desires. The employee, on the other hand, unlike his typical Japanese counterpart, feels completely free to leave the firm and join some other organization even for minor pecuniary benefits.

This eventuality is prevented in Japanese organizations through the unwillingness of companies to recruit personnel from other organizations except under unusual circumstances. Any new induction is likely to disrupt the entire remuneration structure based on seniority. The employee, on his part, does not usually stand to gain by mid-career transfers since pay in most large organizations is at par, and remuneration is likely to be reduced by his moving to another company.

Indian companies could also adopt a similar procedure. An agreement could be arrived at through the various chambers of commerce to avoid mid-carrier recruitments, under ordinary circumstances, to value loyalty and service to the organization and to desist from usually placing newcomers in positions which would be viewed unfavourably by existing personnel. At the same time, since life-time employment remains a fact, this could be declared a policy objective with employers expressing their commitment to provide employment for life. Such a statement would increase the loyalty of employees, thereby prompting them to view the welfare of the organization as their own welfare. They would thus become more interested in improving productivity and performance.

Learning Programmes

All well-established enterprises in Japan have elaborate education and training programmes of their own which all employees must undergo. Some firms even have their own technical institutes to support in-plant training. Hitachi, for instance, has three such institutes, where members of the its workforce may develop, upgrade and expand their skills. The company provides opportunities for production workers, who have graduated from senior high school and who have a minimum of two years of work experience, to undertake a 15-month full-time engineering course. In fact many big organizations are so confident of their development programmes that they shy away from recruiting Ph.D.s. for their R & D departments, preferring to hire Bachelor's degree holders instead, and train them up.

Though qualifications received outside the organisation receive some consideration, what major corporations value is training within the enterprise. Most in-company

training programmes are highly standardized in the number of lectures, demonstrations, duration of learning and the level for which it is intended, having been specified in detail. As such, there hardly exists any need for identification of training requirements. New recruits start with orientation, consisting of lectures on company history, policy, products etc. Then, step by step they go through a series of similar courses, irrespective of their backgrounds.

The training sessions utilize all principles of learning —lectures, conferences, discussions, role-playing; practice on models, and learning by doing. Particularly, on-the-job training is greatly emphasized at every level. The question always asked is, "What have we learned that we can do the job better?" And the organization provides ample opportunities through job rotation and enrichment, for newly-acquired knowledge to be put into use.

It is suggested that Indian companies resort more to job enrichment and rotation, thereby giving rise to multi-function workers. (This trend is also noticeable in the United States where narrow job descriptions are no longer favoured). Following the Japanese practice, a blue-collar worker could be asked to change his job after every 5 to 6 years at the same level.

Presently, whenever training is imparted the Indian worker expects to gain some positive benefit out of such learning, in the form of promotions or higher pay. These expectations are unlikely to change, unless the very concept of training changes, unless Indian managers and workers, conceive training, as the Japanese counterparts do, i.e. as a regular life-time activity. It has been estimated that a Japanese employee spends on an average about 8 hours per week on activities related to learning, half of which is his own time. Indian organizations could similarly emphasize training as a part of the job, a condition which the employee must agree to, before he is recruited.

Along with on-the-job training, Japanese employees receive a considerable amount of instruction in theoretical subjects. Detailed basic courses are available in every big company. In an iron and steel plant, for example, all junior blue-collar workers go through a number of papers in mathematics, physics and chemistry as well as papers on the fundamentals of mechanical engineering, electrical engineering, measurement and microcomputers. They must be well-versed in the methods of iron and steel production and be able to read engineering drawings. Teachers are drawn from within the organization and from universities. After a few years the workers attend senior non-supervisory training of one or two weeks duration.

QC circle members too undergo intensive training in QC techniques such as Pareto curves, frequency histograms, control charts, cause-and-effect diagrams, etc. Such coaching, to a large extent, explains the superior performance of the average Japanese QC circle as compared to circles elsewhere in the world. The rather indifferent performance of QC circles in India may be attributed, largely to inadequate training programmes.

Continuous Cross-Training

In Japan, learning does not cease when a person acquires proficiency in a certain skill. He continues to train in other areas, beyond the point where further learning would be considered unnecessary elsewhere in the world. Thus, a welder would not only train in welding but strive to become familiar with all operations, at a similar level, in his shop. Workers are rotated among allied jobs, the extent and frequency of rotation varying from plant to plant and depending upon the nature of the process involved. The Japanese seem to have out-grown the ideology of the division of labour to which India still remains committed.

Perhaps the Indian employee's strong commitment to a single task springs from the philosophy of the caste system, transferred to the industrial sphere. This is particularly evident in factory workmen's reluctance to perform cleaning jobs associated with low caste status-resulting in the neglect of functions of maintenance and housekeeping. Besides, Indian workers express great unwilllingness to do any job except what they believe to be their job description, which in many cases is unwritten.

The borrowing of the Japanese concept of continuous cross-training may help in countering these tendencies. Following the Japanese practice it is further suggested that Indian companies begin recruiting employees simply as factory workers or office workers or managerial staff instead of categorizing them as fitters, mechanics etc. It is necessary to make the prospective employee agree to the condition that he/she would work in any area assigned by the employer after undergoing the required training.

Cross-training has several advantages. One is transference. As learning curve theory stipulates, job efficiency reaches a plateau after a certain number of cycles have been performed. This happens in Japan as well as in India. But since the Japanese worker continues to train in other areas as well, transference from those skills to his work occurs and he soon breaks through the plateau (at which workers in other countries stabilize) acquiring a higher degree of proficiency and productivity.

In situations where production requirements fluctuate, the advantage of the worker trained in different functions

become obvious. If, due to decrease in demand, the number of operators in a shop need to be reduced, then the excess manpower may be easily transferred to areas where their services can be utilized.

As workers are well-trained and know all aspects of their jobs intimately, the need for supervision reduces greatly. They can act independently in a variety of situations and be responsive to changing conditions. This has a direct impact on the size of the workforce and on the number of levels between the operator and top management. The organizational hirearchy of a typical Japanese company tends to be flat with a wide span of control. Workers' training thus has an impact not only upon productivity and quality but on almost every aspect of organizational functioning.

Since companies normally seek to promote supervisors from among blue-collar workers, the employee, having spent about ten years, begins to undergo supervisory training. Topics covered in supervisory training usually include work design, human relations, problem-solving and job safety. The prospective supervisor learns how to train junior workers, how to arrive at the best method of doing a job, the scientific way of tackling problems, how to plan and how to motivate subordinates. Since ensuring safety in the workplace is part of the supervisor's responsibilities, he becomes acquainted with the principles of safety.

Managers and Professionals

Like workers managerial and professional staff pass through a substantial learning experience. Beginning with introduction to business, all university graduates—whether engineers, accountants or salesmen—spend a year or more working in different departments. Manufacturing enterprises particularly consider experience in the production and marketing divisions essential for all prospective managers.

Management trainees work for a few months in one of the company's factories. There they are involved directly in the manufacturing process and develop an understanding of the basics of production; they learn to communicate with people of different backgrounds, working with them and eating in the same canteen.

Accounts is another important area of executive training. This is partly because of the nature of the accounting function. In Japan, a qualified accountant seldom participates in the preparation and maintenance of departmental accounts. Each section administers its accounting system in its way based on principles close to management accounting. It does the household book-keeping, prepares budgets, compares actual performance against budgets and against past performance. The accounting department simply offers overall training, makes comments or suggestions and consolidates the work so that it can be presented to the plant manager. In this way operating departments gain a closer understanding of costs and strive to effect savings on every possible expense item.

Even after formal training ends, there is considerable mobility for managers and professionals. An engineer may spend some time in the purchase department and then be transferred to R & D; and an accountant may find himself doing a stint in production control. University graduates with non-specialised degrees are subject to still greater job rotation. During a normal career a manager will work in many diverse fields within the organization.

By the time the university graduate receives his first major promotion, becoming a section chief at the end of around ten years, he is acquainted will all aspects of the business. Most managerial personnel will rise no higher than this level, unless they display unusual talent, in which case they may be inducted into the ranks of upper management. All along his career path, the typical executive continues to learn through a variety of correspondence courses, as well as by attending formal company programmes. He gathers a great deal of information from all kinds of sources, with or without immediate relationship to his work, but which may become useful in future.

The question naturally arises, "What benefits does non-specialised training offer?" In most countries training, when undertaken, tends to be in the direction of greater specialization. To be sure, even in Japan, not all professionals relish being away from their areas of expertise. Howerver broad-based, multi-faeted training does fetch returns in terms of greater understanding among different company departments, rendering group decision-making easier, as one participant can appreciate the other's prespectives. Managers are also able to locate better solutions to problems facing the organization as a whole, when they know the working of its parts. Above all, it facilitates harmony, the quality Japanese value most.

Indian companies could also follow the procedure for management training as is found in Japan. Indian managers and engineers are particularly prone to eliticism avoiding "getting their hands dirty" which could, to a certain extent, be counteracted by requiring them to spend sometime working on production jobs along with workers. Moreover, the intense identification of Indian managers with their own departments, and all the interdepartmental battles waged with ferocity in numerous Indian organizations

could be greatly reduced if the Japanese example of multi-disciplinary training and short-time placements in various functional areas is followed.

Sometimes non-specialised training may even help a specialist perform his job better. A case in point is that of the design engineer. As regards the technological disciplines there is hardly any difference in the training levels of designers in Japan and in the West. However, Japanese designers acquire some additional experience in the production department, enabling them to have an understanding of how to design parts for greater produceability. The trainee designer also spends some time in the marketing department and in field service work, so that he is exposed to the actual conditions of use, to the problems of diagnosing field failures and to the difficulties encountered in making repairs. A third area of designer training is quality control. It is not surprising therefore that Japanese product designs tend to be superior with respect to function, reliability and the ease with which they can be maintained.

Conclusion

The Japanese seem to have found a solution to their problems of competition and growth in education and training. For a long time —since the Meiji Restoration of 1868—they learnt from the West. This included theoretical knowledge as well as practical skills. Then, having caught up with the West, they turned their attention to learning from their own experience. They analysed their failures, successes and the weaknesses of the Western approach, and derived useful lessons from them.

Underlying both these phases has been a constant effort at becoming better and better. This striving for improvement has to be seen both from the point of view of the individual firm seeking to enhance its competitive position and from the point of view of Japan as a country in competition with other nations.

India provides virtually a contrast to Japan. On account of its early and prolonged association with Great Britain, India was one of the first non-Western countries to industrialise. In fact, at the turn of the century, India's industralization was more advanced than that of Japan. But the country's industrial position regressed gradually, with the passage of time, and continued declining at an accelarated pace after independence when many Asian nations, including China, left India behind.

Among the numerous factors underlying this phenomenon an important one is the low emphasis on training. Probably training is neglected because human resources are mistakenly considered to be abundant. Furthermore, training in Indian companies has been attuned to system maintenance rather than to improvement. The objective in most cases is to bring new employees to a certain pre-existent level, who then settle down to routine production chores. The drive to constantly develop and improve through a continuous learning process is conspicuous by its absence. As a result, Indian industry, despite substantial experience, has remained permanently dependent on foreign sources for technology and know-how. The country's share in world trade in manufactured goods amounts to a mere 0.4 per cent. Japanese management practices and particularly training practices, if adopted by Indian industry, will certainly go a long way in improving productivity and quality in manufacturing.

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That the unexpected may be resented is not the important thing; what is truly important is that the unexpected is usually not perceived at all. It is ignored.

—Peter F. Drucker

Communication

River Water Quality Management and Wastewater Disposal Standards

River water quality management involves a multi-disciplinary approach, in which the required water quality is related to different incompatible uses (e.g., Municipal, Industrial, Agricultural and or Recreational). The components to be considered, while developing an effective water quality management programme - establishing the most economic long term solution for achieving the desired water quality are shown in fig.1:

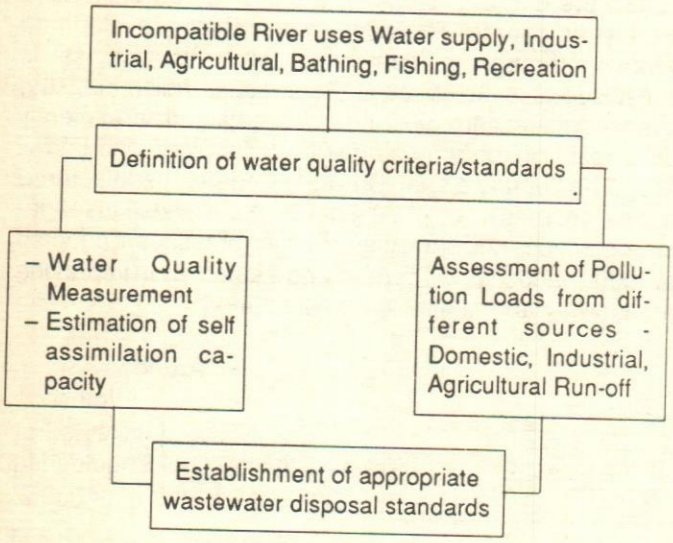


FIG 1: DEVELOPMENT OF A WATER QUALITY MANAGEMENT PROGRAMME

Existing Water Quality Standards

River water quality criteria, in respect of eight basic parameters for the following five beneficial uses have been specified by the Central Pollution Control Board (CPCB) in 1979:

Class A: drinking water source without conventional treatment but after disinfection

Class B: organised outdoor bathing

Class C: drinking water source with conventional treatment followed by disinfection

Class D: propagation of wildlife, fisheries, and

Class E: irrigation, industrial cooling and controlled waste disposal.

Prescription of stream standards is directly based on the beneficial uses. However, they are difficult to administer and control in an expanding industrial and urban area. Often, the equitable allocation of pollution loads between the polluters faces political and economic difficulties. Hence it is more common to prescribe wastewater disposal standards based on the maximum concentraton of a pollutant (mg/l) or maximum pollution load (kgs/day) discharged in to a receiving water. These standards in turn can be related to a stream classification as discussed above.

In our country, under the Water Pollution Control Act (1974), effluent standards, based on the maximum concentraton of a pollutant (mg/l), have been prescribed. These concentration based wastewater disposal standards, are uniform and common for all types of polluters, irrespective of their location, size of operation, beneficial use of the recepient stream etc,. Subsequently, even when the Minimum National Standards (MINAS) for specific industrial sectors were developed, the main consideration was on the capital and operating costs of treatment to a most stringent level - eg., 30 mg BOD per litre and the consequent financial burden on the industry concerned.

Disposal Standards Based on Recepient Water Quality

At present, the relationship between the desired water quality objectives and the river's dilution and self assimilation capacities are not used advantageously. With the result, a river can still be polluted or the river water quality standards may be violated even with a strict compliance of the prescribed disposal standards by each polluter. On the other hand, it is also possible that the industries/polluters are forced to incur the avoidable expensive wastewater treatment practices by not fully utilising the river's dilution and self assimilation capacities. Therefore, it will be prudent to evolve wastewater disposal standards based on the river water quality objectives and the best available

economically feasible treatment technologies (BAET) in our country. The steps involved in evolving such pragmatic wastewater disposal standards are discussed below:

Selection of the most important beneficial use: The increasingly varying uses of water have brought conflicts in the water quality demands for each beneficial use. Normally, the objective for drinking water is considered to be the primary and most essential quality. Such water courses may be provided with highest degree of sanitary protection. But other beneficial uses may have far more stringent water quality requirements, for example; softened water is detrimental for irrigation and many industrial processes cannot use the domestic drinking water without further treatment. Thus, by preserving and protecting the water resource for drinking water supply through expensive means, will not necessarily warrant it's use for the other beneficial uses. Therefore, the most stringent drinking water quality objectives should not always be accepted as the river standard except where no alternative supply can be provided for a sizeable population. Priorities on water uses however must be set and this must be based on the public's interest in a particular region, for example, the water quality objective for river Ganga as defined by the Ganga Project Directorate is based on the bathing water quality creteria - class 'B'.

Collection of relevant information/data: In order to fully exploit the river's dilution and self assimilation capacities, it is essential to understand the mechanisms governing pollution and self purificaton processes. The interactions, which are physical, chemical and biological processes are complex and hence predicting the impact of an effluent on river water quality is rather difficult. The typical effects of an organic wastewater discharge on water quality and the changes occuring in the river down stream, are shown in fig 2.

Water velocity and stream flow regimes determine the dispersion, movement of pollutants and the dilution properties of the river system. Stream flow is not constant and varies significantly throughout the year. In periods of low flow, for example, dilution of pollutants is reduced, self purification process is retarded and sediments settle in the river bottom, together with adsorbed pollutants. During the periods of high flow, natural aeration process is enhanced, by the increased turbulance and thereby self purification is improved.

Inorder to establish the river's dilution and self assimilation capacities, it is necessary to collect all relevant information like inventory of various sources of industrial and domestic pollution, quantity and quality of pollution load generated by these sources, hydraulic and hydrological data, water shed area, time taken by the river to flow from it's origin to it's final destination, background pollution levels etc. To arrive at reliable values, it is necessary to generate and compile information/data for a sufficiently long period of time (10 years) and use the 90 percentile or average data for computing the self-assimilation and dilution capacities.

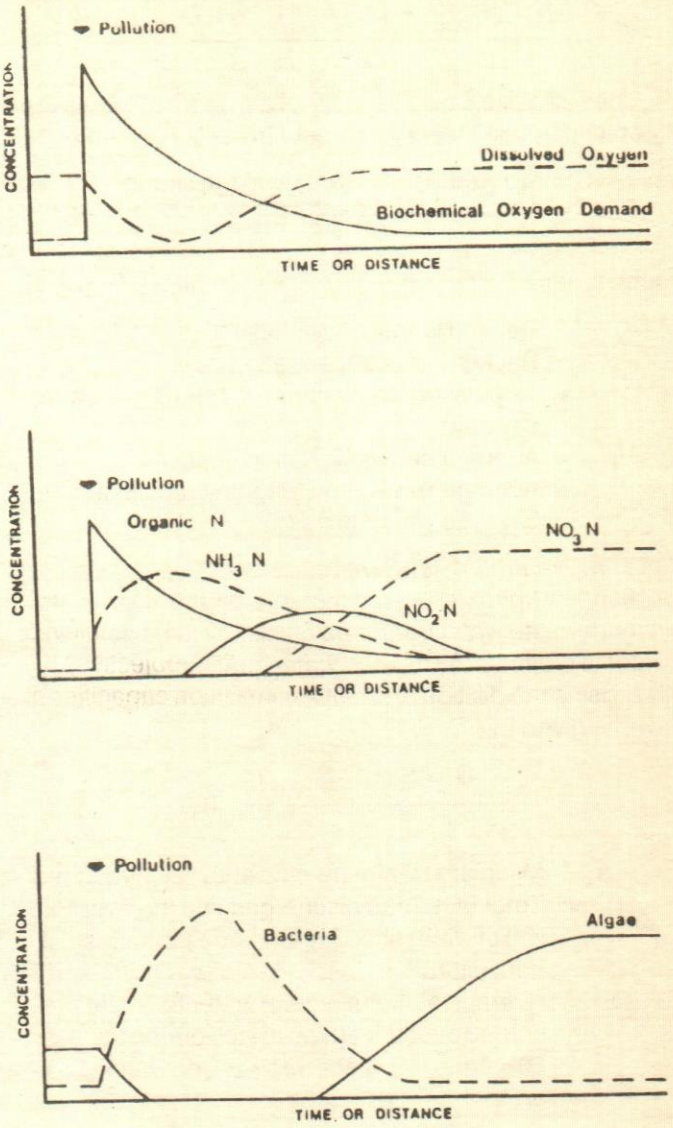


FIG. 2: CHANGES IN STREAM QUALITY DOWNSTREAM OF A WASTE OUTFALL

Source: UNESCO/WHO 1978, Water Quality Surveys.

Assessment of dilution and self assimilation capacities: The dilution capacity of a river (S_{DIL}), in terms of population equivalent (PE) per litre - second, is given by:

$$S_{DIL} = \frac{(BOD_{OBJ} - BOD_{BG}) * 86.4}{PE}$$

The self assimilation capacity of a river (S_{SAC}), in terms of population equivalent (P E) per litre-sec, is given by:

$$S_{SAC} = \frac{a\,(BOD_{OBJ} - BOD_{BG})\ 86.4 * T_D}{PE}$$

where:

BOD_{OBJ} = Desired water quality objective mg/l
BOD_{BG} = Background concentration mg/l
PE = Population equivalent gms BOD per capita per day
a = Average self assimilation capacity
T_D = Average travel time taken by a pollutant - in days, to reach the sea

Minimum treatment level requirement: The maximum pollution load permissible/acceptable by the river or the minimum waste water treatment efficiency to be achieved in order to maintain the desired water quality objectives, by fully utilising the dilution and self assimilation capacities of a river is given by

$$n = \frac{T_L - Q_c\,(S_{DIL} + S_{SAC})}{T_L} * 100$$

n = Minimum treatment efficiency level required
TL = Total BOD load discharged into the river PE/Km of water shed area.(domestic, industrial, agricultural)
Q_C = Average of the minimum water flow rates recorded over the entire stretch during the past 10 years - liters/Sec.Km² of water shed area.

Standards setting: The next step is to identify the best available economically feasible treatment technology (BAET) to achieve the minimum treatment efficiency . The financial implications - in terms of capital, operation and maintenance costs of the identified treatment-technology, on the industry concerned should be evaluated. If the computed financial burden is within the acceptable limits e.g., if the annualised cost of the BAET is < 5 % of the annual turn over of the industry under consideration, then the standards corresponding to the minimum treatment level should be prescribed. In cases, where the financial implications are not within the acceptable limit a phased programme for achieving the minimum treatment level should be evolved through negotiations/discussions with the polluters, treatment plant/equipment manufacturers, consultants and the regulatory authorities.

Effluent Standards For The Ganga Basin - A Case

As an example, after utilising the dilution and self assimilation capacities advantageously, the minimum wastewater treatment level required to achieve the desired bathing water quality objective for river Ganga is computed below. The following computations should be considered only as an example and not as a basis for fixing up the national environmental standards.

Basis for computation:

Based on the information/data reported in the CPCB's publication on inventory of water pollution - the Ganga basin - Part II the following values/factors have been arrived at:

BOD_{OBJ}	Desired water quality objective	3 mg/l
BOD_{BG}	Background concentration	1 mg/l
PE	Population equivalent	45 gms BOD/ capita. day
a	Average self assimilation capacity	0.7
T_D	The average time taken by the pollutants to reach the final destination i.e., 50% of time taken by the river to flow from it's origin to destination	40 days
T_L	Average daily BOD generation rate, both industrial and domestic over the entire Ganga basin area is 9.1 kg BOD/km².day, equivalent to 204 P E/Km². It is estimated that only about 50% of this pollution reaches the river	102 PE/km²
Q_c	Average of the minimum water flowrates recorded over the entire stretch during the past 10 years.	0.58 litres/ Sec.Km² of water shed area.

The computed dilution (S_{DIL}) and self assimilation (S_{SAC}) capacities are 3.8 and 107.5 PE/l.sec respectively. For only 50 % of the computed self assimilation capacity i.e., 53.8 PE/l.sec, the minimum treatment level required is 67.3 %.

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Industry Review

Indian Computer Peripherals Industry: Printer

Directorate General of Technical Development

During recent years office automation has been undergoing massive changes and improvements across the world. India has also been witnessing major changes in this sector. In this report, the existing technology in the computer peripherals has been studied in terms of quality of design and manufacturing techniques vis-a-vis the present international scenario. Technology gaps has been identified so that the long term and short term technology goals for upgradation can be arrived at:

Excerpts from a recent Report by the DGTD.

Broadly, printers can be classified into seven categories roughly falling along technology lines. They are :

(i) Serial Fully Formed Character Printers
(ii) Serial Dot matrix Printers
(iii) Serial Non-Impact Printers
(iv) Page Non-Impact Printers
(v) Line Non-Impact Printers
(vi) Line Dot Matrix Printers
(vii) Line Fully Formed Character Printers

Within each of these classes, a number of different technologies are prevalent. Despite the variety and diversity of available technology, only a few classes are popular in the market. Some of these technologies have an international presence and have not yet found a place in the Indian market.

Serial Fully Formed Character Printers

Serial fully formed character printers were perhaps the earliest of the computer printers. It was only after the introduction in 1970 of Diablo's daisywheel printer that this technology emerged as a viable option for the computer printer industry. Daisywheel printers remained dominant in the computer industry for nearly one-and-a-half decades. The first signs of a declining market appeared in 1984 and by 1985, the market for daisywheel printers had collapsed. By 1988, daisywheel priinters accounted for a meagre 1.5% of the US printer market.

The steep decline of this technology can be traced to its limitations. Though the print quality was excellent, the drawbacks of this technology left it vulnerable to other technologies. Printing speeds were very slow, rarely above 60 cps. The printers were expensive; the lowest priced models cost at least $900. Further, graphics capability was lacking since daisy wheel printers could print only text. Even the limited market of word processing was eroded with the introduction of 24-pin dot matrix printers, ink-jet printers and laser printers by 1988.

Serial Dot Matrix Printers

Serial dot matrix printers are presently the dominant technology in the international and Indian markets. A dot matrix printer is one of the simplest, most rugged and most serviceable machines in the computer industry. It consists

of casing (usually plastic) containing very few moving parts, plus a microprocessor that communicates with the PC to control the printer.

Since dot matrix are very versatile, they are excellent general purpose business printers and are used for a variety of applications like data processing, wordprocessing and other office automatin purposes. The low cost of these printers also makes them eminently suitable for extensive use in the office environment. However, their limitations preclude them for use in applications requiring very high print quality (both text and graphics) like Desk Top Publishing or applications requiring very high positioning accuracy like CAD/CAM drawings.

Serial Non-Impact Printers

Serial non-impact technology incorporates four different technologies - direct thermal, thermal transfer, ink jet and electrosensitive. Each of these four technologies are in different stages of maturity. At an overall level, the growth rate of these four technologies shows a negative trend in 1988 in the US market. However, this trend has to be viewed cautiously since the performance of the individual technologies are vastly different.

Although thermal printing was potentially seen as a very promising technology, the development has been disappointing. Direct thermal printers were used in portable teleprinting, scientific instrumentation and laptop systems. Of these, only the laptop segment still uses direct thermal printers in large numbers. Thermal transfer printers were used as home computer printers and dedicated printers with laptop systems but the usage, in recent years, has been dwinding.

Ink jet printers are used as office printers where their high quality output and noiseless operation are great advantages. They are also ideal for colour applications. Of late, a number of other applications are cropping up-use with laptop systems, use in fax machines etc.

Electrosensitive printing technology is practically extinct today. At one time it showed promise of being a highspeed output option for scientific data logging and ticket applications but its print quality limitations and the pressure of improving competitive technologies effectively shut it out of the market.

Non-Impact Page Printers

Non-impact page printers were first introduced into the market in 1973 by copier giant Xerox. Since that time, the technology has seen dramatic changes. In the initial stages, non-impact page printers were high-speed, high-cost devices intended for DP applications. Later, low-end models (0-10 ppm) appeared for the high print quality market.

The early non-impact page printers were based on optics. Later, a laser beam was substituted for the light beam. A laser printer is a complex system of electronic, chemical, mechanical and optical parts.

Laser printers produce output of high resolution (typically 300dpi). The operation is quiet and the throughput is in the region of four to two hundred pages per minute. It has multiple font capability and the ability to mix text with bit-mapped graphcs.

Laser printers are typically used in applications where a high quality output is necessary. Desk Top Publishing is a market where the laser printer has a near monopoly. Other applications are in the office environment for producing reports, important documents etc. The advantages of laser printers lie in their graphics quality output and the range of font capabilities supported by software.

Line Non-Impact Printers

The Line Non-Impact Printer category includes two basic technologies-direct thermal and thermal transfer. Although the basic principles of the technologies are similar to serial non-impact printers involving direct thermal and thermal transfer methods of printing, an important difference exists. In the case of line non-impact printers, the thermal head is fixed rather than moving as in the serial printers.

The line thermal printers are used in a wide range of applications which include non-computer applications like scientific chart recorders, facsimile systems and copyboards. Computer applications include barcode printing, colour printing and presentation graphics.

Line Dot Matrix Printers

Line dot matrix printers were the first to use dot matrix technology, predating the first serial dot matrix printer by over 15 years. The technology changed to using drum and band printers for data processing. The technology changed again to its present form due to Mannesman Tally and Printronix.

Line dot matrix printers are mainly used with medium-range and high-end computer systems like supermicros, minis and mainframes because of their high speeds. Line dot matrix printers are also versatile machines and are used in applications like data processing, mass mailing and barcodes. However, the low-end line printers (upto 300 1pm) are facing strong competition from high speed serial dot matrix printers.

Line Fully Formed Character Printers

There are three basic variants of this technology - Drum printers, Chain-Train printers and Band printers.

Like the Line Dot Matrix printers, Line Fully Formed Character printers are used with high - end systems. They are mainly used for DP applications where their high speeds are an advantage. Of late, their market share has been declining because of the limitations inherent in this technology. They are more expensive than serial dot matrix printers and less flexible than line dot matrix printers.

Preferred Technologies

Customer preference for the appropriate technology is largely dependent on the applications involved since each technology has its own inherent strengths. The diversity of requirements of current applications and the current state of the prevailing technologies ensure that multiple technologies can co-exist in the market.

Table 1 gives a summary of the major applications for which printers are currently used. This list is illustrative and not comprehensive in nature. Further, the applications listed are relevant in the Indian and International context. The mapping of application to technology is based on international trends since the available technology in India is limited and users are forced to accept compromises in terms of products. An important factor not plotted on this chart is cost. This is often the deciding factor in the choice between products or technologies. For instance, the success of dot matrix printers in a variety of segments can be attributed to its affordability.

The existing range of applications in any market will determine the success of different technolgies. Technology shifts will also be governed by the changing nature of the applications or by a change in priority of the applications.

Table 1. Currently Preferred Technologies

Technology / Application	Serial dot matrix		Serial NI	Line Non-Impact		Line F.F.	Line DM	Page	Plotter
	9-wire	>9-wire	Inkjet	T.T.	D.T.				
OFFICE AUTOMATION :									
Word processing									
• Internal memos etc.	Hi	Hi	Lo	—	—	—	—	Lo	—
• External correspondence	Med	Hi	Hi	—	—	—	—	Hi	—
• Reports	Lo	Hi	Hi	—	—	—	—	Hi	—
Presentation graphics	Lo	Med	Hi	Med	Med	—	—	Hi	—
Colour printing	Lo	Lo	Hi	Hi	—	—	—	—	—
Facsimile	Med	Med	Med	—	Hi	—	—	Med	—
Transparencies	Med	Med	Med	—	—	—	—	Hi	—
Indian languages	Med	Hi	—	—	—	—	Hi	Med	—
DATA PROCESSING :									
Financial accounts	Med	Med	—	—	—	Hi	Hi	—	—
• Payroll	Med	Med	—	—	—	Hi	Hi	—	
• Invoicing	Med	Med	—	—	—	Hi	Hi	—	—
• Shares/FDs	—	—	—	—	—	Hi	Hi	—	
• Cheques	Med	Med	—	—	—	Hi	Hi	—	
Multi-part printing	Hi	Hi	—	—	—	Hi	Hi	—	—
ENGINEERING APPLICATIONS:									
Check plots	Lo	Med	Med	—	—	—	Med	Med	Hi
Final plots	—	—	—	—	—	—	—	—	Hi
SPECIAL PURPOSE PRINTING :									
Ticketing	Hi	—	—	—	—	—	—	—	—
Point of sale	Hi	—	—	—	—	—	—	—	—
Labels	Hi	—	Med	Med	—	—	—	Med	—
Instrumentation	Hi	—	—	Med	Med	—	—	—	—
Barcode	Lo	Med	Med	Med	—	—	Hi	Med	—
DTP	—	—	Med	—	—	—	—	Hi	—

Hi-High preference : Med-medium preference : Lo-Low preference : DM - Dot Matrix : NI - Non-Impact : T.T.-Thermal Transfer : D.T.-Direct Thermal: F.F.-Fully Formed.

International Trends

It is increasingly evident that the computer hardware and printer industry is a global industry with a few select regions having the lion's share of consumption. In terms of consumption of hardware, and therefore printers, USA is by far the largest market. Other assessments indicate that the US is also the most mature market worldwide. Markets like the European are still relatively in the development phase (table 2), USA would still be the dominant printer market in 1993 though the Western Europe market is fast catching up with it. It must be noted that the printer demand does not mirror PC demand exactly since the usage ratio (printer : PC) varies from 1988 to 1993. Therefore, an apparent stagnation in unit sales is more due to shifts in technology rather than the peak of the market.

Table 2 : Estimated worldwide printer demand. (millions of units.)

Country / Year	U.S.A	Canada	W. Europe	Japan	Rest of World	Total
1988	6.9	0.6	3.6	1.0	1.3	13.4
1989	7.3	0.8	4.1	1.3	1.3	14.9
1990	7.9	0.9	4.5	1.4	1.4	16.1
1991	8.3	1.1	5.2	1.4	1.4	17.4
1992	8.5	1.4	5.6	1.5	1.4	18.4
1993	8.6	1.7	5.9	1.5	1.4	19.1
CAGR	4.5%	23%	10.3%	8.4%	1.5%	7.3%

Different markets are in various stages of development. Western Europe emerges as a high growth market, following closely on the heels of the US market. Interestingly, the printer market in the US is dominated by Japanese manufacturers (table 3).

Due to the fact that different markets are in diverse development stages, an overall study of technology trends and advances would yield inconsistent results, depending on the market region. It would, therefore, be more relevant to study the most mature market from where changes in technology would percolate to the other markets. Since the printer industry is global in nature and the US market is the most mature, having gone through the various stages of development, trends in this market are a clear reflection of international trends.

Table 3 : U.S. Printer market. Market share by country of origin

Country	1986	1987	1988
Japan	75%	76%	81%
U.S.A.	23%	21%	19%
Rest of World	2%	3%	<1%

Figure 1 shows the performance of the US printer industry for the three years 1986-88. Though the overall growth rate of the industry is reasonably steady, the various technologies show diverse performances. Table 4 shows the projections for the different technologies till 1994.

Computing Environment

These trends have to be viewed in conjunction with the application scenario and the trends in the computing environment to understand the technology shifts occurring in the market. The degree and nature of technology shifts occurring in the market are primarily governed by changes in the computing environment. In the US market, there is a perceptible shift in the computing environment which is

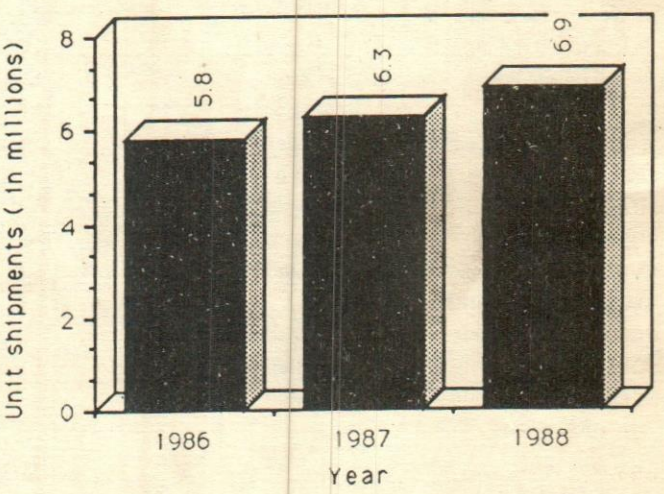


FIG 1: U.S. PRINTER MARKET SHIPMENTS

Table 4 : U.S. Printer market. Shipments (in '000s) by technology, 1987-94.

Technology	1987	1988	1989	1990	1991	1992	1993	1994	CAGR* 89-94
Serial fully formed character	306.5	107.9	56.8	37.9	27.0	21.1	15.9	10.1	-29.2%
Serial dot matrix	4,731.5	5,160.0	5,224.4	5,083.3	4,770.9	4,345.5	3,996.4	3,616.8	-7.1%
Serial non-impact	654.0	616.9	797.5	919.9	1,199.6	1,586.3	20,41.5	2,448.4	25.1%
Non-impact page printers	573.4	856.4	1,112.1	1,704.7	1,954.6	2,186.6	2,401.7	2,613.2	18.6%
Line non-impact printers	17.9	24.9	30.6	38.2	47.5	56.5	63.9	70.3	18.1%
Line dot matrix	50.8	53.6	54.5	54.3	52.5	50.8	47.5	44.1	-4.1%
Line printers fully formed	43.5	31.5	29.9	27.8	25.9	23.8	21.9	19.4	-8.3%

* Compounded Annual Growth Rate

leading to a realignment of the relative importance of the available technologies. The major trends taking place in the US are :

Graphics Functionality : The increasing need for graphics functionality has been a recent phenomenon in the US market. This has spurred the need for high quality printing systems and dot matrix technologies dependig on the stringency of the graphics requirement. The application areas opening up are :

- Industrial graphics applications particularly bar-code printing. Tecnologies that have been bolstered by this trend are line dot matrix, serial dot matrix and line non-impact.
- Electronic forms generation is gaining popularity with the availability of suitable packages on the PC and Macintosh. As a result, page printers have gained importance for this market segment.
- Desk Top Publishing is gaining growing awareness and use in organisations. This has prompted the growth of page printing technologies, particularly laser printers.
- Business graphics involving colour are being used to a greater extent as a way of presentation. The market for colour printers has been an upswing due to this trend.

Distributed Processing : As the PC moves into the mainstream of business environments, there is a move towards shifting traditional DP applications into distributed environments. Thus, DP now moves into office settings. This has two important implications : quietization of printers is an important consideration. Secondly, high quality or high speed printers are now becoming a shareable resource accessible to multiple users.

This drive towards distributed processing and printing has been spurred by the increasing use of Local Area Networks and the introduction of powerful systems like the EISA bus systems and the 1486 systems which promise to bring the processing power of minis to PCs. With the emergence of networking standards, LANs are becoming a growing business necessity thanks to the access they provide to high integrity databases. The number of PCs in networks, as a percentage of installed base, was 19% in 1988. This is expected to grow to 55% by 1993.

Multiple printers of various technologies used in a network would give greater printing capabilities optimised for specific applications to all nodes. The increased flexibility of printer usage in LANs imposes additional demands on the printers used. The following characteristics are essential for LAN printers :

- Heavier duty cycles and higher speeds
- Paper handling to handle larger volumes and variety-wide formats, letterheads and envelopes.
- Remote operation. Need for sheet feeders. Software control of all functions.
- Greater built-in font and graphics capability to maintain configuration.
- Support for multiple page description languages.
- Quieter operation as it moves closer to end-users

A number of technologies are suitable for diffeerent applications in the LAN environment. Table 5 summarises the key advantage of various technologies.

Table 5 : Features and performance of LAN printers

Type	Key Advantages
Page printers DMPs	Flexibility. Output quality. Speed (11-20 ppm) DP output. Wide format capability. Multi-part form printing. Barcode.
Serial non-impact Line impact	Letter quality output. Colour capabilities. DP output. Heavy duty cycles.

A quick summary of the specifications of the various technologies, is given in table 6. The products considered here are representative products in their categories.

Trends in the US market could be summarised as follows:

- Office Automation applications are on the increase. PCs are increasingly being used for data processing with the increase of LANs and the introduction of powerful systems like the EISA and 1486. As a result, distributed data processing is replacing traditional central processing.
- The need for graphics functionality in business is increasing.
- The overall growth rate of DMPs is decreasing. It will still account for 41% of US printer market by units in 1994. Some segments like 24-wire printers (<200 cps) and high speed (>400 cps) printers have shown a high growth rate in recent years.
- Inkjet technology is the fastest growing single segment with a growth rate of 29.8%.
- Non-impact page printers are showing a high growth potential with an estimated growth rate of 18.6% overall. Within this segment, the very low-end (<6 ppm) 'personal' printer shows the maximum poten-

Table 6 : Typical products of various technologies

Technology / Features	Non-Impact page		Non-Impact serial		High speed serial DMP	Line matrix
	IBM 4019 Laser	HP Laserjet IIP	Tektronix 4697 Colour inkjet	HP Deskjet + inkjet	C-Itoh CI-5000	Mannesman Tally MT-645
Basic specifications			4-colour, 48-nozzle	80 col, 50 nozzle, 4kHz	132 col, 18-wire	132 col, 66 print elements
Speed	10 ppm	4 ppm	0.5 ppm	240 cps @ 150 x 300 dpi	450 cps draft	450 lpm
Resolution	300 dpi	300 dpi	216 x 216 dpi	300 dpi	330 x 216	120 x 144
U.S. List price	$2,595	$1,495	$2,495	$995	$1,995	$4,995
Typical OEM price	$1,050	$ 700	$1,000	$450	$ 900	$2,000
Printhead/Engine life				60,000 pages	280,000 pages	
Duty cycle	5000 pages/ month	2500 pages/ month				50,000 pages/month
Consumable cost/pages	2 cents/page	2.7 cents/page	60 cents/page	4.8 cents/page	0.4 cents/page	0.2 cents/page
Emulation	Laserjet II, HPGL, PPDS	PCL4, IBM/ Epson	Tek 4696	PCL III, Optional Epson FX	DECLA 210/75/50, Epson, Proprinter	Epson, Proprinter
Interface		RS232 serial, Centronics par,	Centronics, SCSI	Centronics RS232 C serial	RS232/423	RS232, Centronics, Dataproducts
Other features	50dB noise 512K memory, 3.5 MB upgrade, 200 sheet input tray, 100 sheet output tray	47dB noise 512K memory, 4 MB upgrade, 50 sheet input, 50 sheet output	55dB noise, 128K buffer, 100 sheet input tray	44dB noise, 16K buffer	55dB noise 6-part form, 8K buffer	60 dB noise 6-part form, Optional twinax/coax

tial with a growth rate of 56%. Medium range printers (20-40 ppm) also has a high growth rate of 39.4%.

- Line fully formed and line matrix printers are declining in volume with decline rates of -8.3% and -4.1%. However, in line matrix printers, the very high end (850 1pm +) is growing at 14.6%.

Indian Scenario

Prevailing technology

The prevailing technology in India is limited to a few of the internationally available options. Till 1987-88, the main technologies in use were serial dot matrix, line matrix, line fully formed, daisy wheel and laser. Since then, daisy wheel has declined considerably in volume and is no longer present. Laser printers were and are imported. Only dot matrix printers and line printers are being manufactured in India as of today.

Line printers: Band line printers are dominating the present high printing throughput scene in India (fig. 2). It has gained high acceptance due to reliability and economy. The cost of ownership (product cost and running cost) is very low.

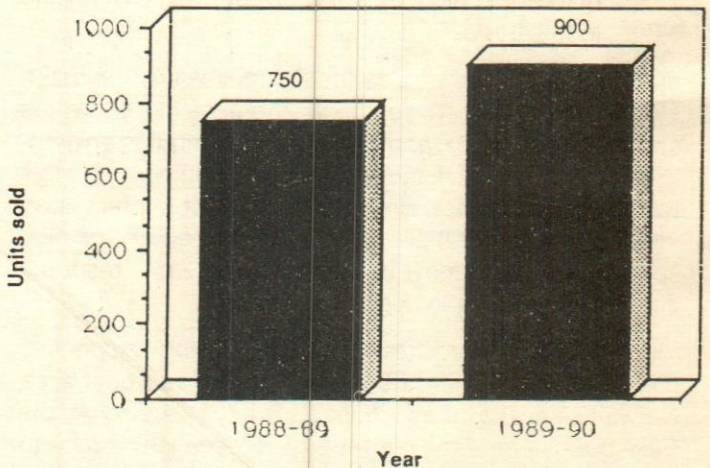


FIG 2: SALES FIGURES FOR LINE PRINTERS IN INDIA IN 1988-89 AND 1989-90

Table 7 gives the split up of line printers sales in terms of speed. The low end line printer market would depend not only on the sales of mid-range systems like supermicros and minis but also on the development of high end dot matrrix printers.

Table 7: Line printer sales by speed in India in 1988-89 and 1989-90

Speed	88-89	89-90
300 lpm	350	250
600 lpm	350	550
1000 lpm	50	100

Daisy wheel printers : Daisy wheel printers are essentially used for a restricted application on PCs-wordprocessing. With the advent of 24-wire serial dot matrix printers, the daisy wheel printer market is shrinking very rapidly. Even internationally, the daisy wheel technology is facing extinction. It is estimated that 500 units each were sold in India in 1987-88 and 1988-89.

Laser printers : Laser printers first found use in India with desk top publishing systems. This segment still remains the major market in India for laser printers. IDC (India) estimates that about 1500 laser printers were sold with desk top publishing systems in 1987-88 and about twice the number in 1988-89. Firm figures for laser printer sales are, however, not available. Internationally, the prices of laser printers have been plummetting. If this trend continues, laser printers will pose a serious threat to the high quality dot matrix printers.

Dot Matrix printers : Serial dot matrix printer technology is the dominant technology in the Indian market accounting for over 85% of unit sales of all printers in 1988-89. The demand for dot matrix printers is heavily dependent on the demand for PCs. Various segments within the dot matrix printer market have emerged. An emerging segment is with respect to the print quality catered to by 24-wire printers (fig. 3).

Table 8 shows the sales of dot matrix printers split up in terms of speed. Current indications are that the printer market is moving towards higher speeds. According to IDC (India), by 1991-92, printers of 250 cps and higher speed will constitute 40% of the market.

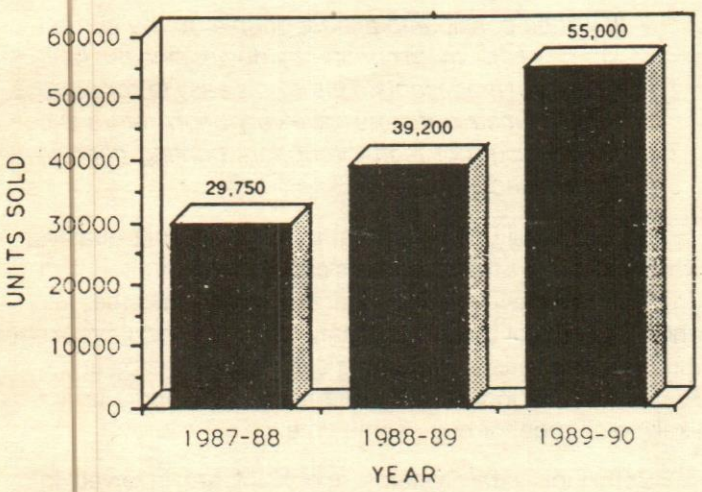


FIG 3: ESTIMATED SALES OF DOT MATRIX PRINTERS IN INDIA IN 1987-88, 1988-89 AND 1989-90

Table 8: Estimated DMP sales by speed of printer in India

Year	160 to 250 cps	250 cps & above
1987-88	94%	6%
1988-89	89%	11%
1989-90	81%	19%

Table 9: Split-up of 80 & 132 column printers in India

Year	80 col	132 col
1987-88	30%	70%
1988-89	25%	75%
1989-90	25%	75%

There are two major types - 80 column and 132/136 column. The sales split up in 1987-88 and 1988-89 is given in Table 9.

The future of 80 col printers in India will be largely determined by the success of low-cost PCs. An 80 col printer is more attractive to one-off buyers of PCs for reasons of economy and the fact that their need is often limited to obtaining a printed record of their work. 80 col printers are also ideal for special purpose applications like instrumentation, ticketing, billing etc. where the printer needs to perform a single specific function only.

On the other hand, 132 col printers are general purpose business machines with sufficient flexibility and capabilities to fulfil the needs of a number of applications at a reasonable price. The excellent price-performance offered by 132 col dot matrix printers have been the key to their popularity in the international market and their near monopoly in the Indian market.

However, with the increasing range of applications using computers in India, the need for other printer technologies suited to specific applications will emerge. It is possible that this need already exists but is being strangulated by the high price that the user has to pay for other technologies. (table 10).

Developmental Efforts

Though all the major manufacturers have started with a foreign collaboration, they have succeeded, in varying degrees, in absorbing the technology and moulding it to suit Indian needs. Godrej has developed an indigenous low speed printer. Sold as Model 918 DMP, it is a 9-wire, 136-column, 160 cps printer. TVSE recently introduced Calligra, a 24-wire, 136-column printer-the result of in-house R&D efforts. L&T developed an 80-column printer, 32M, based on the

Table 10: Indian Scenareo for 1989-90

Hardware type	No. of units
PCs	65,000
DMPs	55,000
- Domestic	45,000
- Exports	10,000
- Imports	10,000
- 9-wire	49,000
- 24-wire	5,000
Line printers	900
Laser printers	5,000

132 column printer. L&T has also developed a 24-wire printer, L32/324 indigenously.

L&T and Wipro have successfully implemented ISCII (Indian Language Capability) character set in some of their printers. L&T has developed emultions for OKI and DEC Printers. TVSE has developed Diablo emulation and has also implemented custom solutions for demand printing applications. Godrej has developed OKI, DEC, Diablo and Burroughs emulations.

Wipro and Godrej have developed IEEE 488 interface for their printers.

L&T has improved the performance of one of its models by increasing the speed from 160 cps @ 10 cpi to 200 cps @ 10cpi. Additional features like italics and double height have also been implemented by L&T. TVSE enhanced its 200 cps printer, MSP 45, by adding features like paper parking, high speed draft mode and copy mode.

Indigenisation of certain components often involves redesign of the components through reverse engineering since the appropriate materials are not available in India. To integrate indigenously available materials, some redesign would be necessary. Such efforts have been carried out by all the manufacturers.

High end printing technology in India is emerging on three paths :

- Upgradation in Band Technology printers
- Emergence of Line Matrix pritners
- Emergence of Non-Impact printers

Band technology is still growing throughout the world and at high speeds of 1000 lpm and above, reliability and economy are still unmatched. With this in view, Lipi Data Systems plans to bring to Indian users a new family of band line printers - the "LB Series" from Dataproducts. LB Series offers higher speeds upto 1500 lpm and higher reliability, superior paper handling system, more user-friendly features, lower cost of ownership and rationalised configurations into standard features. For normal DP applications, this series is now replacing the previous one in the international market.

Line printers will replace dot matrix printers for heavy duty applications. For example, in India, printing of Share Certificates, Warrants for stock exchange, Premium notices of Insurance companies, reservation listing by Railways, Bill printing by Telephone and Electricity Boards, Reports of Parliament, Land Records of State governments are but some direct areas where heavy printing by line matrix printers shall be found advantageous.

Further, printing of Hindi and other Indian languages has special significance in India, especially if computers are to be productive tools for the masses. For this reason, the Government has given special emphasis on the development of computers for all Indian languages/official languages. CDAC (a DoE organisation) has done pioneering work in Indian languages and computers suitable for this are now available. CDAC has extensively worked on line matrix printers to gain higher speeds for printing in Hindi and State languages. CDAC has given excellent reviews on this printing technology after test and evaluation. The salient points made by CDAC in regard to Line Matrix printers are as under :

- *After optimising the line-printer performance, it is three times faster than the 24-pin printer, for a typical data processing application. Moreover, since it can be used continuously, the actual throughput is much higher.*
- *A typical file containing data processing printouts in Devanagri took the following time to print :*
  Fujitsu DL 3400 85 seconds
  MT 660 Line Matrix 24 seconds
- *As the horizontal density of printing decreases, the line printer throughput increases, while that of the DMP decreases.*
- *As the width of printing increases, the time taken by the line printer remains same, while that of dot matrix printer increases.*
- *The speed of the DMP, while printing graphics may slow down to half, while the head heats up. The line printer can be used continuously at the rated speed, since it is designed for heavy-duty printing.*
- *It will be possible to almost double up the current speed of line matrix printer by developing the half-space pot mode fonts. This is now easy to conclude that line matrix printers have very bright future and fill a vaccum of high throughput printing need in Indian languages.*

It is generally believed that in terms of print quality, whatever the line matrix printers can do, laser printers can do better. However, reliability and economy tilts the balance in favour of the former. Only major technical breakthroughs in non-impact printing can change the balance. Present trends indicate that the scenario in India is not likely to change for quite some time.

Both Lipi Data Systems and ICIM are involved in efforts to further indegenise, improve and interface their respective products. Also for the emerging need of regional language support through matrix Line printers and

non-impact printers, the following developments through technical tie-ups have taken place :

Company	Technical tie-up
ICIM	• Rank Xerox for Laser Printing Systems
Lipi DATA Systems	• Dataproducts for new LB Series/Band Line Printers - High speed • Mannesman Tally for Shuttle/Line Matrix Printers.

This would bring Indian Line Printer Industry on par with international technology.

Industry Capacity : Indian serial dot matrix and line printer production are well below international levels. For instance, in 1989-90, Indian manufacturers produced 55,000 serial dot matrix printers for the domestic as well as the export markets. By contrast, international serial dot matrix printer production was estimated to be about 10.5 million units. Thus, Indian production constituted 0.52% of the world production in this category. By 1993, it is estimated that this proportion would rise to 1.66% of the world production. Though the demand in the Indian market is far below international levels, Indian manufacturers have made substantial investments in their facilities. As the following section shows, there is strong focus on indigenisation. Due to the low volumes of the Indian market, the amortisation of the investments is much lower than international levels. Therefore, Indian manufacturers are at an inherent disadvantage in the international market in terms of competitiveness. Despite this severe handicap, the Indian printer industry has been offering competitive prices, as Figures 3.8 and Figure 3.10 confirm.

Indigenisation of DMPs

Recognising that indigenisation affords greater self-reliance, Indian printer manufacturers have made significant efforts in this regard. Indigenisation is also crucial for long-term competitiveness in global markets and permits faster reaction times to market forces. Keeping this in mind, the Indian manufacturers have succeeded in building up an ancillary base as well as advanced in-house facilities for manufacture of components. However, a number of factors in the Indian scenario have been acting as obstacles in this path. Some of the more significant hurdles are listed here. For ease of understanding, the listing is in terms of component-type.

Though the indigenisation of mechanical components has been implemented to a large extent by most of the manufacturers, some problems hamper total indigenisation. Since printers are highly sophisticated machines, the design standards in terms of raw materials and precision manufacturing are necessarily very stringent for high quality of the final product. The problems in the Indian context are:

* Vital raw materials with the desired characteristics are often not available indigenously. For instance, spring grade stainless steels of low thickness, engineering plastics with properties of high strength, ridgidity, self lubrication, dimensional stability and fire retardancy. Ink jet printers are competing with serial DMPs on noiseless operaition. Professional grade engineered noise-absorbtion material is not available in the country.

* Certain mechanical components need to meet high level specifications of surface properties and tolerances. To produce components meeting such specifications, sophisticated manufacturing processes are absent in India. For instance, there is a need for micro-processor controlled injection moulding machines, processing know-how for precision parts such as moulded gears, finishing processes such as electroless nickel plating and burnishing.

* Sourcing of certain components is hampered by the vendors' inability to appreciate or match the rigorous requirements of components. Growth of ancilliaries is the key to success. This takes time and effort.

* In the case of electronic components, the country faces a shortage of reliable electronic components. Even passive component like resistors are inconsistent batch to batch. As a result most of these components have to be necessarily imported. As examples consider the following cases :

  - Non-availibility of many international standard grades of diodes, zeners and transistors. These have to be custom manufactured.
  - Form factor of indigenous electronic components is much larger than standard imported parts leading to difficulties in compact design.
  - Most components are not rated for agency regulations such as UL, VDE and FCC leading to potential problems in export.
  - Most ICs including memory chips are not manufactured in India.

Proprietory components such as print head and stepper motors are components specific to product and are often the core of the product technology. These have to be custom made for each manufacturer. Most of these components are not manufactured in India.

Despite the problems outlined above significant progress has been made in this direction. Table 11 presents indigenisation status of the serial dot matrix printer industry. The formula used is :

Total material cost = CIF + Indigenous + Duty = 100%

Table 11 : BOM cost break-up as percentage of total material cost for DMPs

Description	CIF	Indigenous	Remarks
Print head	8-13%		Assembly level manufacture may be encouraged.
Motors	4-8%		Independent manufacture may be encouraged
PCBs	—	4-7%	Totally indigenised
ICs	4-8%	0.1-1.3%	Outside scope of printer manufacturers
Magnetics/Electricals/ Electronics	2.5 to 10.5%	7.13%	Import variations due to different phases of indigenisation of the manufacturers.
Mechanicals	2.5-4%	23-32%	
Total	26.5 to 37%	37 to 49%	

Indigenisation of Line Printers

Manufacturing of line printers is based on the Phased Manufacturing Programme covering electronics, subassemblies, simple mechanical assemblies, housings, plastic and fibre glass parts etc. Printers being manufactured in India are meeting all requirements of the computer industry in terms of volumes, prices, quality, print speed, configuration and interfaces. Substantial progress has been made on the indigenisation of line printers by both manufacturers. Based on the maximum indigenisation achievable, the break-up of Bill of Materials cost, given in table 12, would typically hold for line printers.

Many of the problems indicated for serial dot matrix printers hold for line printers too. Specific problems are mainly due to inadequate volumes combined with high investment required in high-tech materials/processes for procurement of print bands, hammer modules, hammer banks, stepper motors, actuators, mouldings in nylon with pan carbon/ polycarbonate/noryl, Hall-effect sensors, high-precision parts etc.

- Lack of good quality raw material.
- High capital investment needed for precision part development and inspection.
- Absence of quality consciousness and zero-error concept causes delays in development cycle.
- Lack of interest from ancillaries due to low-volumes but high complexity.

Technology status of DMPs

Table 13 illustrates the presently available product range in the dot matrix printer class. Also given is the average street price of internationally available products in the same categories. All the Indian products provide centronics parallel interface. Additional interfaces like RS 232 serial or IEEE 488 are offered by some as built-in and some as options. All printers carry adequate buffers, Epson/IBM emulation, NLQ and draft modes at multiple pitches. Dip switches are provided for default settings. Other features provided by some manufacturers include long life print head, ISCII capability, Ergonomic operation panels with LED indicators, Diagnostic capabilities, Paper parking, IC cards for fonts and emulation, OKI, Diablo and DEC emulations, Quiet mode of operation, Push/pull trac-

Table 12 : BOM cost break-up for line printers

Description	CIF	Indigenous	Remarks
Hammer Mechanism	19-31%	——	Hammer mechanism at highest level of indigenisation.
Motors	4-11%	——	Not made in India.
PCBs	——	5-11%	All indigenised.
ICs	2-11%	1-2%	Costlier ICs such as Microprocessors, memories, ASICs need to be imported.
Magnetics/Electricals/ Electronics	3-12%	6-12%	High-quality, heavy-duty, non-standard connectors, switches, transducers etc; LCD displays certain transistors, diodes, capacitors, relays. circuit breakers not made in India.
Mechanicals	8-12%	21-32%	High-tech material and process generated parts such as print bands, metal composite plastic are not available in India.
Total	46-62%	38-55%	

Table 13 : Indian dot matrix product range and prices

Prices	160-250 cps	250-300 cps	24-wire, 132 col, 200-250 cps	80 col,-160 cps
Indian prices to OEMs (in Rs.) inclusive of excise	9,000-10,500	12,500-14,500	19,800-23,000	-6,100-7,000
List price abroad	$400	$750	$900	$250
OEM price abroad	$260	$390	$590	$165
Landed price (Rs.)	10,000	15,000	22,500	6,250

tor, Rear/bottom/front paper paths, Automatic cut-sheet feeder etc.

Three clear conclusions can be drawn:

- The finished product price in India is highly competitive. Indian printer prices are equivalent or less than the landed cost of imported printers for comparable volumes. Further, the dot matrix products available in India are contemporary, with a host of internationally available features. As seen in the section on 'Industry capacity', the volumes of production are far below international levels.
- The above has been achieved despite cost of inputs in terms of raw materials in India as compared to international price levels as shown in table 14 which lists some typical raw materials.
- The country is saving a significant amount of foreign exchange by indigenous manufacture of printers. The foreign exchange outflow from the current manufacturing activity is only around 50% of what it would have been had the printers been imported. In 1989-90, the printer industry saved the country nearly $10 million of foreign exchange due to indigenous manufacture. Further, the end-user is getting the same quality of products as at the international level. The reason for comparing landed cost of foreign models is because of higher raw material cost and low capacity for plant in India.

Though the existing product range is contemporary, there are a few gaps in the product range when compared to international levels. For instance high speed dot matrix printers (400 cps + for 9-wire and 300 cps + for 18/24-wire) are not yet being manufactured. Since these are high growth segments abroad Indian users should have access to such products. Since existing manufacturers have already established a skill base, they should be allowed to absorb this technology through foreign collaborations.

Table 14 : Raw material cost comparison

Category	Intl. price (FOB Rs.)	Local price	Ratio
4-layer PCB	0.65-0.70 per sq. cm.	2.00/sq.cm.	3x
2-layer PCB	-0.30/sq. cm.	0.56-0.63 per sq. cm.	2x
ABS-plastic	40.00/Kg	74.00/Kg	1.85x
Noryl	63.00/Kg	90.00/Kg (Landed)	1.4x
Plain acetals/Nylon	45.00/Kg	75.00/Kg	1.6x
SAN (acrylic)	43.00/Kg	70.00/kg	1.6x
74 LSICs eq. LS 04,LS 32	1.80	4.50	2.5x
Steel	11.70/Kg	23.00/Kg	2x

Technology status of Line Printers

Band Line printers are manufactured by Lipi Data Systems and ICIM. Technology from the world leaders for proven products is being made available to Indian users at international quality level by these companies. ICIM manufactures models LW 400 and LW 800 in collaboration with Genicom Corporation of USA and Lipi Data Systems manufactures models B300, B600 and B1000 in collaboration with Dataproducts of USA.

Costs in India are approximately comparable to international prices. Import content is currently in the neighbourhood of 45% by value. Table 15 gives the international and Indian prices of some line printer models.

Table 15 : International and Indian prices of line printers

Prices	300 lpm	600 lpm	1000 lpm
Price to OEM (inclu-cluding CED) in Rs.	1,28,000	1,62,000	2,48,000
International price			
USD	3,800	4,800	7,500
INR	1,52,000	1,92,000	3,00,000

Assumption : CED = 15.75% : Frt & insurance = 10% : 1 USD = INR 17.5 : customs duty = 108%. (Net Conversion ratio Rs. 38.4 per US $)

Technology status of sub-systems

In the following section, the major subsystems and consumables of serial dot matrix printers are discussed. The main sub-system considered is the stepper motor. Print heads are high-cost consumables and are not being manufactured in India. Ribbons are dealt with elsewhere in this Report.

Stepper motors form the heart of PC subsystems, peripherals and other office automation equipment because of their easy digital control and their accurate positioning capability under open loop. With the demand for PCs and computer peripherals rising and office automation gaining increasing importance, the demand for stepper motors is bound to grow rapidly. Stepper motors represent a potential market, yet to be tapped by Indian manufacturers. The pressure on Indian manufacturers to indigenise components and the expected cost savings from indigenisation are additional factors for the stepper motor market in India. The manufacture of stepper motors involves acquiring skills in the areas of design, testing, high precision lamination manufacture and magnetisation

of the latest megnetic materials like plastic bonded magnets and rare earth magnets.

One of the major characteristics of the Indian market is that the electrical specifications and performance characteristics of the motors used by different manufacturers and for different models are unique in one respect or another. As a result, though the total volumes are high, individual model-wise volumes tend to be low. This will necessitate :

- Complete absorption of design know-how so as to independently design as per customer requirements.
- Modification of the manufacturing technology used by Japanese/Taiwanese manufacturers to suit Indian market conditions of large variety and low volumes.

Hybrid stepper motors find application in a variety of computer peripherals and office automation products. Some of these are listed below.

1. Floppy disk drives
2. Dot matrix printers
3. Winchester disk drives
4. Electronic typewriters
5. Electronic teleprinters
6. Copiers
7. Laser printers
8. Fax machines
9. Plotters
10. Video cameras
11. CD-ROMs

Tables 16 & 17 indicate the types of stepper motors used by various Indian manufacturers in their printers. The specifications of carriage motors as well as paper feed motors are given.

Carriage motors : A comparison of the carriage motors of four serial dot matrix printer manufacturers reveals that seven motors are 1.8 degrees step angle, hybrid type while three are 7.5 degrees step angle, permanent magnet type. Of the hybrid motors, four are 38.8 mm square and two are 56/57.2 mm size. In the motor industry, these are known as sizes 39 and 55. This indicates the possibility of two sets of lamination toolings satisfying the bulk of the demand. The prmanent magnet motors are usually used for paper feed application but are used for carriage feed applications in low speed printers. All three Permanent Magnet stepper motors are of 7.5 degrees step angle and of dia 42.

Paper feed motor : In the case of the paper feed motors, there is a much larger degree of common features. There are primarily two size ranges - dia 55.6/57.2 and dia 42. The former size covers two motors and the latter right motors. The four low speed carriage motors also fall into the latter category. All the paper feed motors have a step angle of 7.5 deg. The electrical specifications vary while the performance characteristics fall within a range. These differences may have to be tailored for each application.

The printer stepper motors fall into 4-6 conventient sizes. The size-wise break-up of the motors in 1989-90 are on next page.

Table 16 : Carriage stepper motor specifications of Indian manufacturers.

	Hybrid Motors							Permanent Magnet Motors		
Specifications	Sandur	L&T	Wipro EX-1000	Wipro LQ-1050	TVSE Calligra	TVSE MSP-55+	TVSE MSP-45	Wipro FX-105	Wipro LX-86	TVSE LSP-100
Mechanical										
Frame size	49.5ϕ	57.2sq x 51	56sq x 46	38.8sq x 37	38.8sq x 37	38.8sq x 37	38.8sq x 31	ϕ 42 x 23.3	ϕ 42x 15	ϕ 42 x 22
Step angle	1.8 deg.	1.8 deg.	1.8 deg	1.8 deg	1.8 deg.	1.8 deg.	1.8 deg	7.5 deg	7.5 deg	7.5 deg
Type	Hybrid	Hybrid	Hybrid	Hybrid	Hybrid	Hybrid	Hybrid	P.M.	P.M.	P.M.
Shaft	Integral pulley	6.35ϕ	—		ϕ 5 shaft	ϕ 5 shaft	ϕ 5 shaft	ϕ 3 shaft	—	ϕ 3 shaft
Mounting	31.0 sq.	47.14sq	—	—	31 sq	31 sq	31 sq	—	—	ϕ 49.5 pcd
Electrical										
Voltage	12V	35V	24V	35V	32V	25V	25V	24V	24V	24V
Coil resistance	5 ohms	2.2ohms	37 ohms	11.6ohms	6.6ohms	5.0ohms	3.8ohms	12.5ohms	39.5ohms	—
Inductance	2.3mH	7mH	5.8mH	14mH	7.8mH	—	—	—	20mH	—
Current	—	1.4 amp	—	—	0.6 amps	0.7 amps	0.7 amps	—	—	—
Drive type	2-phase unipolar	2-phase unipolar	4-phase unipolar	4-phase unipolar	4-phase unipolar	4-phase unipolar	4-phase unipolar	unipolar	unipolar	unipolar
Insulation class	E	B	—	—	B	B	B	—	—	E
Performance										
Hold torque	500 gcm	50N.cm	—	—	>900gmcm	>1700gmcm	>1200gmcm	—	—	—
Pullout torque	—	—	2Kgcm	850gmcm	—	>1100gmcm	>880gmcm	230gmcm	215gmcm	>200gmc
No load pullout rate	>2500pps	>10000	—	—	>3600	>3800	>4500	—	—	>750 pps
Pullin torque	—	—	—	—	—	—	—	—	—	—
No load pullin torque	>850 pps	>1150	—	—	>1500	>1600	>1700		—	— —

Table 17 : Paper feed stepper motor specifications of Indian manufacturers

	Permanent Magnet Motors									
Specifications	Sandur	L&T	Wipro EX-1000	Wipro LQ-1050	TVSE Calligra	TVSE MSP-55+	TVSE MSP-45	Wipro FX-105	Wipro LX-86	TVSE LSP-100
Mechanical										
Frame size	ϕ 55.6 x 26	ϕ 57.2 x 25.4	ϕ 42 x 23.3	ϕ 42	ϕ 42 x 22	ϕ 42 x 22	ϕ 42 x 22	ϕ 42 x 23.3	ϕ 42 x 15	ϕ 42 x 22
Step angle	7.5 deg	7.5 deg	7.5 deg	7.5 deg	7.5 deg	7.5 deg	7.5 deg	7.5 deg	7.5 deg	7.5 deg
Type	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.
Shaft	ϕ 4	6.35 ϕ	—	—	ϕ 3 shaft	ϕ 3 shaft	ϕ 3 shaft	—	—	ϕ 3 shaft
Mounting	PCD 66.7ϕ	PCD 66.7ϕ	—	—	PCD 49.5	PCD 49.5	PCD 49.5	—	—	ϕ 49.5 pcd
Electrical										
Voltage	28V		24V	35V	32V	25V	25V	24V	24V	24V
Coil resistance	48 ohms	35 ohms	5 ohms	79 ohms	100 ohms	33 ohms	33 ohms	46 ohms	58 ohms	50 ohms
Inductance		35mH	—	—	—	—	—	—	35.5 mH	—
Current		0.33 amp	—	—	0.32 amps	—	0.76	—	—	0.52
Drive type	4-phase unipolar	4-phase unipolar	4-phase unipolar	4-phase unipolar	4-phase unipolar	4-phase unipolar	4-phase unipolar	unipolar	unipolar	unipolar
Insulation class	B	B	—	—	—	B	B	—	—	E
Performance										
Hold torque		8.5 N.cm	—	—	200 gmcm	350 gmcm	—	—	—	450
Pullout torque		—	230 gmcm	400 gmcm	—	>315 gmcm	>200 gmcm	320 gmcm	300 gmcm	>210 gmcm
No load pullout rate	>500pps	>480	—	—	1900	—	>750	—	—	>840 pps
Pullin torque	—	—	—	—	—	>330	—	—	—	>300
No load pullin torque	>500 pps	—	—	—	1200	650	—	—	—	>800

Hybrid size 55	15%
Hybrid size 39	22%
Permanent magnet size 55	13%
Permanent magnet size 42	50%

Problem of Exports

Exports to Western countries is riddled with problems for Indian manufacturers. The problems stem at a basic level. The problems are basically in three aspects :

Cost aspects : There are three further divisions of this issue :

- The present production volumes of the Indian printer industry are in no way comparable to international levels. As a result, the cost structures are in favour of high-volume international manufacturers, particularly the Japanese, due to economies of scale.
- The capital cost in India is also very high. Most of the critical toolings and equipment have to imported. In addition to the cost of the toolings and equipment, a duty needs to be paid on them. Further, due to low volumes, the capacity utilisatin of such equipment is lower leading to higher operating costs.
- The raw material cost of inputs is higher than at international levels. Many components and raw materials need to be imported, resulting in further escalation of costs.

As a result of the inherent cost structure within which Indian printer manufacturers are operating, international competitiveness is very difficult.

Business aspect : There are a number of hurdles in operating abroad :

- Success in marketing products interntaionally requires a strong marketing infrastructure abroad. Establishing and maintaining this kind of infrastructure is expensive. Given the present volumes of Indian manufacturers, investment in establishing an infrastructure abroad is not affordable by individual manufacturers.
- Selling of stand-alone printers is a difficult task in many markets. This is further complicated if the brand name is internationally unknown. The solution may lie in bundling the printers with systems and selling a comprehensive solution to the customer.

Availability of certified components. Most of the semiconductors have to be imported. Direct sourcing from manufacturers with batch identity is not possible for low volumes.

- Passive components available in the country do not meet all quality and reliability requirements. Apart from reliability issues, cost and delivery performance of the local vendors is very poor. Even if the above requirements are met by local vendors, export to the West is still not possible because requirements of safety and EMI/EMC are not certified or met. For compliance Certification items like wire, fuses, transformers, cables and fusible resistors, some capacitors, PCBs, power handling components, cable ties etc. should be 'recognised' by agencies like UL; else, these items should be imported, used and submitted for equipment certification.
- Certification by agencies like UL is a time consuming process. STQC/BIS are now taking steps to speed up this process. The current process still requires re-certification abroad. It may take some time before the Indian agencies are authorised to certify here itself.

Whether we choose to go through certification abroad or through local sources, the first priority is to built component base such that enough components are available with quality, cost and delivery performance comparable to that of imported components and having safety requirements certified.

Despite the problems involved in exports, some possibilities can be explored by Indian manufacturers.

- Internationl printer manufacturers who concentrate on the leading edge of emerging technologies, generally vacate the market for the products which start declining in the world market. This needs to be carefully worked on and the vacant slot could be filled up by the Indian manufacturers while the returns are still attractive.
- Indian manufacturers could explore the possibility of setting up venturers in other countries. In this way, the manpower resource and the capability to supply kits could be exploited.
- Brandname is still a key factor in product acceptance internationally. However, manufacturers could come to an understanding with their principals to explore the possibility with regard to 'branding' some of the models which are in the non-economic range of production for them.

Table 18 lists the Indian printer manufacturers and their respective collaborators. Table 19 gives the specifications of popular Indian serial dot matrix printer models.

In short, mainly three printer technologies are present in India:

- *Line printers* - mainly used in DP environment with minis supermicros where the print volume is large. Nine hundred units of line printers of 300 lpm-1000 lpm speed range were manufactured in India in 1989-90. This segment continues to grow. Manufactures are gearing up to meet emerging requirements with line matrix printers and page printers, providing the flexibility of dot matrix with high speed and volume printing capabilities.
- *Laser printers* - In 1989-90, 5,000 units were imported for DTP applications. These are not manufactured in India.
- *Serial Dot Matrix Printers* - Mainly used with PCs in the Office Automation and distributed Data Processing environments. About 55,000 units were manufactured in India in 1989-90 consisting mainly of 9-wire, 160-250 cps printers. New developments include indigenous version of 160 cps DMP, 80 column versions and 24-wire printers besides many emulations, interfaces, ISCII capability and additional features.

Table 18 : Indian printer manufacturers & their collaborators

S.No.	Company	Collaborator	Country	Type
1.	Aptek	Star Micronics	Japan	DMP
2.	Godrej	North Atlantic (Not current)	U.S.A.	DMP
3.	ICIM	Genicom Corporation, Rank Xerox	U.S.A. U.K.	Line-Band, Laser
4.	Larsen & Tubro	Bull HN Information Systems Compuprint division	Italy	DMP
5.	Lipi Data Systems	Data products, Mannesman Tally	U.S.A. W. Germany	Line-Band, Line Matrix
6.	Modi Business Machines	Olivetti	Italy	DMP
7.	Sandur Electronics	Nakajima ALL	Japan	DMP
8.	Sierra Micro Electronics	KDC	Japan	DMP
9.	Sujata Data Products	Printek	U.S.A.	Daisy-wheel
10.	TVS Electronics	Citizen Watch Company	Japan	DMP
11.	Wipro Information Technology	Seiko-Epson Corporation	Japan	DMP

Table 19 : Specifications of Indian DMP modes

Specification	L&T 32M	Wipro LX-86	TVSE LSP-100	L&T 32E	Wipro FX-105	Godrej 918	TVSE MSP 45	L&T 32/300	Wipro EX1000	TVSE MSP 55 Plus	L&T 32/324	TVSE Calligra	Wipro LQ 1050
Speed (in cps)													
-Draft (@ 10 cpi)	160	120	150	160	160	150	200	200	250	250	266	200	220
-NLQ (@ 10 cpi)	50	19	29	50	25	37.5	40	67	50	50	89	66	73
Resolution (V x H)													
-Draft	9x12	9x12	9x12	9x12	9x12	9x12	9x12	9x12	9x12	9x12	24x12	24x12	24x12
-NLQ	18x36	18x24	18x24	18x36	18x24	18x24	18x24	18x36	1824	18x24	24x36	24x36	24x36
-Graphics resolution (dpi)													
-V	144	144	144	144	144	216	144	144	144	144	180	180	360
360													
-H	240	240	240	240	240	240	240	240	240	240	360	360	360
Number of pins	9	9	9	9	9	9	9	9	9	9	24	24	24
Line width (no. of columns @ 10 cpi)	80	80	80	132	136	136	136	132	136	136	132	136	136

Indigenisation - This is one of the major developmental activities. The following environmental problems are faced:

- Volumes in India are less than 1% of world volumes.
- High capital costs for the corresponding volumes lead to higher cost structures.
- Input costs for many materials are higher than international levels.
- Problems of non-availability of many special raw materials, sophisticated manufacturing processes, variety of high value electronic components such as ICs, memories, processors.
- Ancillary industry not yet upto the mark in terms of quality-consciousness and delivery.

Despite all this, Indian manufacturers have made products of specifications comparable to international level at prices which are comparable to the landed cost of such products to the Indian OEMs. The Indian DMP industry saved the country nearly $10 million of foreign exchange by manufacture of printers in 1989-90.

The serial DMP industry imports 26.5-37% of its total material cost. The line printer industry imports will amount to 46-62% of its material cost under maximum achievable indigenisation. The high cost imported components are print heads, motors, ICs, hammer mechanisms, print bands and metal composite plastic parts.

Exports - Currently, the Indian industry is exporting to the Eastern Block and Lesser Developed Countries. Environment for export to hard currency areas is yet to evolve. The difficulties are three-fold :

- Cost aspect-lower volumes, high capital costs, higher raw material costs.
- Business aspect-absence of marketing infrastructure, lack of a recognised brand name to be able to export stand-alone products.
- Availability of good-quality, safety/regulatory agency certified electronic components.

Business Forecast

The demand estimates given here are for the period of the Eighth Five Year Plan (1990-91 to 1994-95). The figures for printer demand are based on the estimates of computer sales during this period. Since the demand for printers is primarily a derived demand, a usage factor for printers with respect to computers is taken based on experience (usage factor is the ratio of printers sold to computers sold).

Table 20: Estimated Demand for PC Based system & Minis (000)

Year	PC Based system	Minis
1989-90	70	2.5
1990-91	91	3.25
1991-92	118	4.23
1992-93	150	5.50
1993-94	195	7.15
1994-95	253	9.00

Note : PC Based systems include PC, PC XT, PC AT, 386 and super Minis.

Serial Dot Matrix Printers

Table 20 shows the estimates of PC-based systems and mini sales for the period 1990-91 to 1994-95.

The usage factor considered varied from 1989-90 and 1994-95 due to the expected influence of LANs. In 1989-90, the usage factor taken for PCs is 0.7 and that for minis is 1. In contrast, for 1994-95,

Table 21: The Estimateed of Domestic demand and Export potential for DMPS

Year	Domestic	Exports
1989-90	55,000	10,000
1990-91	74,000	14,000
1991-92	96,000	20,000
1992-93	120,000	24,000
1993-94	150,000	30,000
1994-95	180,000	36,000

the assumed usage factor for PCs is 0.6 and that for minis is 2.

Table 21 Shows the estimated domestic demand and export potential for dot matrix printers during the Eighth Plan period. In arriving at the above demand pattern, the effect of low cost PCs has been incorporated by adding 10% to the demand as calculated using usage patterns with respect to PCs and minis. The above figures for printer demand are for domestic sales only and include replacement demand. Assuming that the export volumes in 1994-95 would be about 20% of the domestic sales, the total production in 1994-95 would be 216,000 units.

Considering that the printer market would be fragmented in terms of the type of dot matrix printers available and the different segments in the market, Table 22 shows shares of the various technologies. The overall figrues for demand are based on DOE estimates. However, individual segment demands are based on an extrapolation of technology and applications from the world market to the Indian market.

Table 22 : Market Shares of Various Segments and Technologies. (Nos.)

	1989-90	94-95
High speed	500	18,000
24-wire	5500	54,000
Lower speed	49,000	108,000
Total	55,000	170,000
High speed DMP	500	18000
Line	900	3,000
Laser	5,000	17,500
24-wire DMP	5500	54,000
Low speed DMP.	49,000	108,000
Total	60900	200,500

The projection of growth of line printers for the next five years is based on projected sales of PCs, Minis and changes in applications. Even though world-wide sales of line printers are declining, India is different. We are today experiencing steady growth. In fact, it is likely to peak in the 90s. This is mainly due to steady progress in computerisation of applications requiring line printers. Saturation in computerisation of these applications and resultant decrease in demand for line printers is not expected for the next ten years (table 23).

Table 23 : Estimated Demand for Line Printers and Laser Printers (000)

Year	Line Printers	Laser Printers
89-90	0.90	5.00
90-91	1.20	7.00
91-92	1.50	9.00
92-93	2.00	12.50
93-94	2.50	14.00
94-95	3.00	17.50

Currently laser printers in India are used for DTP applications and in small numbers in offices. The lack of local availability of laser printers in India is hampering the widespread use of this technology. However, despite market limitations, about 5000 laser printers were estimated to have been sold in 1989-90.

Laser printer demand in India would be primarily confined to lower speed lasers (0-20 ppm), which are used for office automation applications. The demand for higher speed laser printers would be in the area of data processing.

As computer usage intensifies in Indian offices, the need for laser printers will be felt to a greater extent. Since this need is not being serviced by the Indian printer industry, valuable foreign exchange is being spent on importing laser printers. For instance, in 1989-90, it is estimated that over $4.5 million was spent on imports of laser printers. In view of the fact that the demand for this technology is growing rapidly and that page printers will be the dominant technology internationally in the next 4-5 years, it is essential that Indian manufacturers acquire this technology.

Since inkjet printers are virtually non-existent in India, it is difficult to estimate exact figures for its demand. Inkjet printers occupy a niche between 24-wire DMPs' and low-end page printers. The problem area is the consumable cost. Therefore, the demand would strongly depend on ink costs in the future. On an approximate level, the demand would vary from 20,000 units to 30,000 units in 1994-95.

Serial Dot Matrix Printers Serial dot matrix printer technology is expected to remain the dominant technology in the Indian market for the next five years. In fact, this technology will continue to grow for a number of reasons :

- The PC market in India is still in its growth stage. The evolution of computer applications in most organisations begins with computerising requirements involving large data, i.e. data processing. As computerisation progresses, it moves onto basic office

automation like wordprocessing and then into areas like business graphics, presentations, colour printing etc. Fundamental uses like data processing and wordprocessing can be adequately met by dot matrix printers since they are economical and flexible.

- The affordability and versatility of dot matrix printers make them an attractive proposition as general purpose printers within organisations.
- The gap between the print quality achieved on a 9-wire printer and that achieved by letter quality technologies is partially bridged by the emergence 24-wire printers. These can be used as 'personal' printers in certain cases.
- Dot matrix printers can handle multi-part forms and wide format continuous stationery - an essential requirement for many of the applications in India.
- High speed dot matrix printers can replace low end line printers because of their greater flexibility.
- The performance, security and integrity levels achieved in Client-Server architecture of LANs are of the same level as in minis. Hence, LANs are poised for tremendous growth. The emergence of distributed processing in the LAN environment could mean that high speed 18/9 wire dot matrix printers and high resolution 24 wire printers will be used as shareable resources while lower speed, low cost dot matrix printers are used with the nodes.
- Since dot matrix technology is the lowest cost technology, it would appeal to users like small business units whose printing requirements are low.

Although dot matrix technology would constitute a major portion of the Indian printer market for the next few years, the composition of the market would see a change.

High speed printers. Low-speed (160-250 cps) dot matrix printers dominated the Indian market. This trend is expected to change significantly. For general purpose business applications, higher speed (250 cps and above) printers will take over this market. This trend would occur because :

- Computer usage is becoming more intensive and as a result, speeds of the machines and associated peripherals are becoming highers.
- The prices of printers are dropping in the Indian market. 250 cps printers are now affordable for intensive users.

Another significant trend is in the region of high speed dot matrix printers (400 cps and above). In India, such products are not freely available. High speed printer segments would consist of 9/18/24-wire products. In 24-wire products, LQ speed would go up. These are not normally used for heavy draft printing. With the growth of distributed processing, thanks to Client-Server Architectures, LANs will require a high speed printer as a shareable resource. The versatility of 24-wire printers to operate in multiple modes will be useful and draft printing applications would also be present for these printers. The high speed printers would also begin to replace low end line printers (0-250 lpm) since they are more flexible and are becoming cost-competitive in the international market. The market for these printers has not yet been tapped in India.

24-wire printers. These priters overcome the print quality limitations of traditional 9-wire dot matrix printers, without sacrificing the flexibility and low cost associated with this technology. Two trends would emerge here. Both these shifts are the result of migration from 9-wire printers especially in office automation applications.

- High speed (300 cps and above), 24-wire printers can be used as a shareable resource in LANs. They deliver high print quality at reasonable speed.
- Narrow carriage (80 column), 24-wire printers would be used for word processing applications. They would eventually be used as "personal printers" either with stand-alone PCs or at the nodes of a network.

Line printers The main trends of line printers in India are as follows:

- The current Band line printer technology is highly suitable as there would always be demand for high-speed, low-cost, multiple-copy, fixed-font, English-only printing. Demand for higher speeds would emerge from heavy duty users.
- Band line printers would continue to be most affordable of stable and mature technology and lowest TCO (Total Cost of Ownership) followed by Matrix line printers and Non-Impact printers in the respective order and affordability.
- Band printer technology being matured and time-tested is not likely to have any breakthough abroad rendering technology in India obsolete. Moreover, the demand for this technology would not disapper in the foreseeable future due to major benefits to users like very low TCO and ruggedness.

- Demand for Matrix line printers would go up. Given the choice, the end-user would opt for Matrix line printer due to its flexibility of applications (multi-font, copy and merged text and graphics). The need to print in regional languages would boost requirements further.
- Dot matrix printers and Non-Impact printers are cutting into demand for Band line printers at the lower end (300 lpm). However, there are applications requiring lowcost, high-speed, fixed-font text only in English such as Data Processing in payroll, shares, FDs, Electricity Boards, MTNL etc. This results in a stable demand for Band printers.

Inkjet printers Ink jet printers are a rapidly growing product category in the international market. The strong performance of ink jet printers in the international market is due to the fact that they bridge the gap between 24-wire dot matrix printers and laser printers in terms of price and performance. Further, a number of technological advancements in this area, especially in ink technology and plain paper printing capability, have given a boost to this category.

Ink jet printers can be used in a number of applications. The main advantages of ink jet printers are :

- Noiseless operation
- High resolution
- Low-cost colour capability
- Indian language capability

The demand for ink jet printers in India will depend on factors like the future price, consumable cost, price of laser printers and the applications shift especially in terms of colour applications. Inkjet printers typically have 48 nozzles and offer 360 dpi resolution in the vertical direction. This will enable complex Indian language characters to be printed at high resolution in one pass.

International trends in inkjet printers indicate that the price of consumables is reducing as more companies are focussing R & D efforts in this field. As a result, it is estimated that inkjet technology will have the fastest growth in the US market.

Mini Printers Mini printers are currently not being manufactured in India. Current requirements are being met through calculator kit imports, ET & T and some direct imports. The market is not fully developed due to high unit price for direct imports. Further, technical support and information required to integrate mini printers with user equipment is not available. Since mini printers are not available, their use is often substituted by 80 column printers. Though the market is yet to develop, some estimates are available for this market as shown in table 24. With the increased penetration of PCs into speciality markets due to dropping prices, this market could show signs of growth.

Table 24: Estimated Demand for Mini Printers (000)

Year	Nos (000)
1990-91	20
1991-92	50
1992-93	75
1993-04	97
1994-95	117

Forecast summary

Table 25 summarises the overall demand pattern for the printer industry for the Eighth Plan period. Though the volumes, by Indian standards, are impressive in 1994-95, it must be stressed that by international standards, India still accounts for a very small percentage of world production. While in 1990, Indian printer production accounts for 0.52% of world production, in 1993, it will account for 0.93% of world production. Therefore, in comparison to the world market, Indian manufacturers are still operating at sub-optimal volumes of production.

Consumables and Subsystems

In this section, the current status of consumables and subsystems for computer printers will be discussed. The

Table 25 : Overall demand table for the Indian printer industry

Category	89-90	90-91	91-92	92-93	93-94	94-95
PCs	70,000	91,000	118,000	150,000	195,000	253,000
Minis	2,500	3,250	4,230	5,500	7,150	9,300
Dot matrix printers						
- Domestic units	55,000	74,000	96,000	120,000	150,000	180,000
- Export units	10,000	14,000	20,000	24,000	30,000	36,000
- Total value (Rs.cr)	75	101	134	166	207	249
Line Printers						
- Units	900	1,200	1,500	2,000	2,500	3,000
- Value (Rs. cr)	14.5	19.5	24.5	32.5	40.5	48.5
laser printers						
- Units	5,000	7,000	9,000	12,500	14,000	17,500
- Value (Rs. cr)	18.7	26.2	33.7	47	52.5	65.5
Mini printers						
- Units	—	20,000	50,000	75,000	97,000	117,000
- Value (Rs. cr)		3	7.5	11	15	18
Total Value (Rs. cr.)	108.4	149.7	199.7	256.5	315	381

Note : The price/unit has been calculated at OEM prices and has been held constant throughout the six years (i.e. present prices). The growth rate assumed for PCs is 30%.

forecast for such subsystems will also be examined. The main subsystems discussed will be stepper motors and print heads for serial dot matrix printers. The consumables discussed are ribbons for serial dot matrix printers.

Stepper motor demand - The stepper motor industry does not depend only on the printer industry for volume. The demand for stepper motors from the printer industry is given in table 26. It is clear that the motor demand from the

Table 26: Stepper motor demand generated from the printer market

Type \ Year	89-90	90-91	91-92	92-93	93-94	94-95
Hybrid	41,000	66,000	93,000	115,000	144,000	175,000
Permanent Magnet	69,000	110,000	139,000	183,000	216,000	257,000

printer industry would be 14,98,000 motors during the Eighth Plan period. The printer motors fall into 4-6 convenient sizes. However, a change in model configuaration would affect this distribution. Therefore, though the overall volumes are in keeping with dot matrix printer estimates, individual size demands could have a different distribution depending on the success of various models and the introduction of fresh models. The need to indigenise hybrid stepper motors is greater since they are higher value items.

Table 27 gives an approximate calculation for the value of the stepper motors consumed by the printer industry.

It is appearent that nearly 1.5 million units of stepper motors at a value of $11.66 million are needed during the 8th plan period. It would be safe to assume that at least 50% of this would be saved by encouraging indigenous manufacture of these motors. Therefore, by indigenising stepper motors, at least $5.8 million of foreign exchange would be saved by the printer industry alone during the Eighth Plan period. However, the indigenisation of stepper motors may not take place overnight because of the variety of stepper motors required by each manufacturer. The process of customisation for specific requirements may take upto 3 years considering the complexity involved.

Print head

The print head is a high precision component. Unlike stepper motors, these cannot be partially standardised in terms of tools and raw materials. Every printer manufacturer has a different type of print head for different products. Being a very large value sub-assembly (8-13% of CIF value) which is closely linked to performance, it is price-sensitive and for each segment, a different model is typicallly required.

In calculating the demand for print heads for the Eighth Plan period, the following assumptions have been made :

1. Life of printer = 5 years
2. Print head life = 2 years

The basis of calculating the installed base of printers at any point in time is table 28. Based on the printer demand pattern, the print head demand in units, both for replacement and fresh printers, are given in table 29. The demand in value terms is given in table 30.

Although total production of printers during the Eighth Plan period is 749,000 units, the demand for print heads is much higher at 13,70,000 units due to the replacement demand.

It is difficult to estimate the total foreign exchange outflow for all the manufacturers since the print head cost

Table 27 : Stepper motor demand during the Eighth Plan period by sizes

Type	Size	Typical Cost	89-90		94-95		90-95	
			Nos.	Value	Nos.	Value	Nos.	Value
Hybrid Motors	55	$18	16,500	$0.30 m	82,000	$1.48 m	254,000	$4.57 m
	39	$10	24,200	$0.24 m	121,000	$1.21 m	375,000	$3.75 m
Permanent Magnet Motors	55	$5	14,300	$0.07 m	56,000	$0.28 m	195,000	$0.98 m
	42	$3.50	55,000	$0.19 m	173,000	$0.61 m	674,000	$2.36 m
Total			110,000	$0.80 m	432,000	$3.57 m	14,98,000	$11.66 m

Table 28 : DMP Domestic consumption and exports (000 Nos.)

Year	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95
Printer type										
9-wire DMP										
- Imported	10	10	15	13	5	—	—	—	—	—
- Indigenous	10	10	15	25	44	59.5	67.5	82	93.2	108.5
- Exports	—	—	—	—	10	11.5	16	16	18.8	21.5
24-wire										
- Imported	—	—	—	2	4.5	—	—	—	—	—
- Indigenous	—	—	—	—	1	12.5	21	32	42.5	54
- Exports	—	—	—	—	—	2.5	5	6	8.5	11
18-wire										
- Imported	—	—	—	—	—	2	—	—	—	—
- Indigenous	—	—	—	—	—	—	6.5	10	13	17.5
- Exports	—	—	—	—	—	—	—	2	2.7	3.5

Table 29 : Print head demand in thousands of units

Year	9-wire	18-wire	24-wire	Total
90-91	106	00	15	121.0
91-92	152.5	6.5	27	186.0
92-93	194	12.0	53	259.0
93-94	249	22.7	83	354.7
94-95	299	33.0	117	449.0

Table 30 : Print head demand in thousands of dollars (FOB)

Year	9-wire	18-wire	24-wire
1990-91	3180	0	1200
1991-92	4575	455	2160
1992-93	5820	840	4240
1993-94	7485	1589	6640
1994-95	8970	2310	9360

is different for each type of print head. However, some assumptions for the cost of various categories of print heads have been made and the value calculated. The assumptions for print head cost (FOB) are :

Cost of 9-wire print head = $30
Cost of 18-wire print head = $70
Cost of 24-wire print head = $80

The value of the print head requirement for the Eighth Plan period using the above figures is $58.8 million. However, this demand is spread across 15-20 different models.

The ribbon accounts for most of the consumable cost of the printer. The demand for serial dot matirix printer ribbons is given in table 31 below.

Table 31 : Ribbon demand in thousands of units

Year	9/18-wire	24-wire	Total
90-91	1592	160	1752
91-92	2024	328	2352
92-93	2520	584	3104
93-94	3072	904	3976
94-95	3680	1292	4972

Taking an average retail value for the ribbons as follows:

Low density ribbons (9/18-wire) = Rs. 125.00
High density ribbons (24-wire) = Rs. 150.00

The turnover for the ribbon industry (at retail prices) during the period of the Eighth Plan is about Rs. 210 crores.

Summary

The technology trend forecast shows that the expected shift is towards matrix technologies and non-impact technologies and high-resolution technologies.

- Office Automation applications will find 24-wire printers, inkjet printers and low-end page printers (<20 ppm) emerging.
- Data Processing applications will find high speed serial DMPs, line matrix printers, band printers and medium speed page printers (21-40 ppm) emerging.

The growth rates projected are based on PC and peripheral sales projections given in the Eighth Plan. The growth rate for PCs is 30%. The printer projections are corrected for exports and low-cost PC volumes. The printer industry is expected to grow from Rs.108 cr in 1989-90 to Rs. 381 cr in 1994-95 (the prices assumed are OEM prices). The high growth segments are :

- 24-wire DMPs will increase from 5,500 units in 1989-90 to 54,000 units in 1994-95.
- High speed serial dot matrix printers will increase from 500 units in 1989-90 to 18,000 units in 1994-95.
- High speed line printers (1000 lpm and above) are expected to show a high growth rate.
- The stepper motor demand will increase from 110,000 units at a value of $0.8 million (FOB) in 1989-90 to 432,000 units at a value of $3.57 million (FOB) in 1994-95 for the serial dot matrix printer alone.
- Print head demand will come from new printers as well as replacement units since it is a consumable. The demand is expected to grow from 121,000 units at a value of $14.38 million (FOB) in 1990-91 to 449,000 units at a value of $20.64 million (FOB) in 1994-95.
- The dot matrix printer industry is expected to grow from 1.75 million cartridges in 1990-91 to 4.97 million cartridges in 1994-95.
- Exports of dot matrix printers will increase from 10,000 units in 1989-90 to 36,000 units in 1994-95.
- Foreign exchange savings in the region of $60 million will be realised over the Eighth plan period from serial dot matrix printer manufacture alone without considering exports.
- The potential for saving in foreign exchange in page printers if taken up for manufacture would be of the order of $12-15 million.

□

Industry Review

Productivity in Edible Oils & Vanaspati Industry

NPC Research Section

The Edible Oils and Vanaspati Industry is today a major organised sector with over 110 units licenced to refine edible oils or manufacture vanaspati. The industry employs about half a lakh people directly and also provides indirect employment to approximately 15 lakhs people. Although, India is a leading producer of oilseeds, its domestic production has not shown any impressive improvements. To make up for the shortfalls, imports have become a regular feature. The present study examines the main problem areas in the working of the industry.

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Within the Food Processing Industry, Vanaspati & Edible Oils constitutes a major group; it ranks next only to the Sugar Industry. Being an essential food item for the general populace, its importance can be gauged from the fact that it is utilized all over the country as a major source of nutrition for the humans as well as domestic animals; for the latter in the form of oilcakes. While edible oils or vegetable oils are consumed directly or after refining, in the case of vanaspati it is both refined, hydrogenated, deodorized and also vitaminized. Hydrogenation makes it look similar to ghee or butter oil, the primary cooking medium traditionally used by a large section of Indian households. Vanaspati was introduced in India after World War I through imports from Holland. It took a long time for the people to accept it as a substitute for ghee and/or other cooking oils. Its low price was one major factor which helped it to gradually replace ghee as a cooking medium.

The edible oils & vanaspati industry, starting from 1930, is today a major organized sector with over 110 units licensed to refine edible oils and/or to manufacture vanaspati, spread all over the country. The growth in this sector has been somewhat sluggish in recent years as can be seen from the production figures of the past few years (tables 1 and 2). During the past 19 years (1970-1989), the production of vanaspati has doubled but the demand continues to outpace production even today.

The edible oils and vanaspati industry employs about half a lakh people directly and also provides indirect employment to approximately 15 lakh people according to one estimate.

The edible oil industry's fortunes are linked with the output of oilseeds. Even though India is a leading producer of oilseeds holding the top rank in the World for groundnut, rapeseed, mustard and sesamum (Kothari, 1990), its total domestic production of oilseeds has not shown much improvement so far. To make up for the shortfall, imports

of edible oils have become a regular feature. Despite this, the per capita consumption of oils remains even today far below the sustenance level.

Table 1 : Production of Vanaspati in India

Year	Production (tonnes)	Growth %
1970	521,275	-
1971	590,172	13.2
1972	602,245	2.0
1973	465,329	-22.7
1974	354,105	-23.9
1975	453,427	28.0
1976	544,820	20.0
1977	579,000	6.3
1978	657,270	13.5
1979	636,741	-3.1
1980	705,427	10.8
1981	848,060	20.2
1982	886,849	4.6
1983	890,510	0.4
1984	901,563	1.2
1985	896,353	-0.5
1986	921,475	2.8
1987	947,181	2.8
1988	996,121	5.2
1989	949,645	-4.7
1990 (upto July,90)	541,516	-

Source: Indian Vanaspati Producers' Association
Directorate of Vanaspati

Table 2 : Production of Edible Oils in India 1980-81 to 1988-89 (000 MT)

	Oil Year (Nov.- Oct.)								
Oil Source	1980 -81	1981 -82	1982 -83	1983 -84	1984 -85	1985 -86	1986 -87	1987 -88	1988 -89
Groundnut	1129	1656	1216	1631	1481	1277	1352	1347	2197
Mustard	708	731	675	798	940	807	797	1057	1350
Sesamum	138	180	172	154	162	154	139	181	208
Sunflower	24	57	83	108	158	108	151	229	143
Safflower	66	82	77	98	101	63	69	90	84
Niger	29	32	25	37	31	40	28	38	36
Soyabean	40	32	44	55	86	88	80	81	135
Cottonseed	249	282	266	226	301	305	244	226	307
Coconut	174	165	188	172	204	196	188	224	224
Total*	2959	3776	3226	3913*	4106	3619	3739	4197	5505

* Also includes non-edible oils

Source : Industrial Data Book 1988
Indian Vanaspati Producers' Association
Directorate of Vanaspati

Oilseeds & Edible oils

The production of edible oils fluctuates according to the size of the oilseeds crop from year to year (table 3). The output of oilseeds in 1970-71 was 9.63 million tonnes and was largely sufficient to meet the domestic needs. Only a small quantity of edible oils was imported to keep market prices under check, during that year, at a cost of about Rs. 23 crores. While the production of oilseeds rose to about 10.61 million tonnes in 1975-76, it dropped down sharply to 8.43 million tonnes in 1976-77 necessitating import of about 1.7 lakh tonnes of oils costing a whopping amount of Rs. 100 crores. The position went on worsening as the years rolled and by 1988-89 even with an oilseeds output of 12.38 million tonnes the country's import bill on this account went up to Rs. 1000 crores. Unlike the foodgrains production which has steadily been growing over the years, the oilseeds production has suffered wide fluctuations and shown only marginal improvements. It has increased at an annual compound growth rate of 1.3 percent as against 2.2 percent in the case of foodgrains. (Chhatarapati, 1990). With the national income growing at about 5 percent per annum from 1980-81 onwards and the population growing at the rate of 2.2 percent per annum the demand for edible oils has been increasing at a much faster rate than its production, thus, leaving a yawning gap between demand and domestic availability of edible oils. Even with the anticipated imports amounting to 2.24 million tonnes in 1989-90, the demand-supply gap is in the range of 1.29 lakh tonnes of edible oils (NPC, 1990).

Table: 3 Area and Yield per hectare for Nine oilseeds

Year	Area (Million hectares)	Production (Million tonnes)	Yield Kgs/Hectare
1970-71	16.64	9.63	579
1978-79	17.71 (6.4%)	10.10	570
1979-80	16.94 (-4.3%)	8.74	516
1980-81	17.60 (3.9%)	9.37	532
1981-82	18.91 (7.4%)	12.08	639
1982-83	17.76 (-6.1%)	10.00	563
1983-84	18.69 (5.2%)	12.69	679
1984-85	18.92 (1.2%)	12.95	684
1985-86	19.02 (0.53%)	10.83	570
1986-87	18.62 (2.1%)	11.27	605
1987-88	20.13 (8.1%)	12.66	629
1988-89	21.64 (7.5%)	17.89	826

Note: Figures in brackets indicate % increase or decrease in area under oilseed cultivation.

Source: Indian Vanaspati Producers, Association (1989 & 1990), Ministry of Agriculture (1989-90).

India has all along faced a chronic deficit of edible oils which is being met by imports drawing heavily on the none-too-happy foreign exchange resources of the country (table 4). The reasons ascribed for this are many but the

Table 4 : Import of Edible Oils

Year	Total Import (Lakh Tonnes)	Value (Rs. Crores)	% change in Qty	% change in Value
1978-79	8.21	480	-	-
1979-80	11.49	617	+ 39.9	+ 28.5
1980-81	10.74	516	- 6.5	- 16.4
1981-82	9.95	450	- 7.4	- 12.8
1982-83	11.50	507	+ 20.0	+ 12.7
1983-84	16.34	1319	+ 42.1	+ 160.0
1984-85	13.68	1123	- 16.3	- 15.9
1985-86	11.79	489	- 13.8	- 56.5
1986-87	16.45	612	+ 39.5	+ 25.2
1987-88	18.19	920	+ 10.6	+ 50.3
1988-89	8.50	650	- 53.3	- 29.3
1989-90(E)	10.00	800	+ 17.6	+ 23.1
Annual Average (1978-1989)	12.44	698	-	

Source: Govt. of India, Economic Survey
Kothari's Industrial Directory,1990
'Facts for you', Dec. 1989.

major ones as listed in the Seventh Plan are;

a. Cultivation of oilseeds is largely on unirrigated land; more than four-fifth of oilseeds are grown in rainfed marginal land.

b. Farmer's inability/hesitation to use modern inputs due to high risk of crop yields and prices. Most of the oilseed growers are small and marginal farmers who cannot be expected to invest in such inputs as fertilizers, pesticides and agro equipment.

c. High cost and inadequate availability of certified seeds. The total distribution of certified seeds for oilseeds was of the order of about 6.29 quintals in 1986-87 and 6.54 in 1987-88. It is anticipated that this will grow to about 10.73 quintals in 1988-89(Ministry of Agriculture, 1989-90)

d. Inadequate use of improved agricultural implements for proper placement of seeds & fertilizers.

e. Susceptability of oilseeds crops to pests and diseases which cause substantial losses at times.

f. Current price support measures, particularly during bumper years, do not provide enough incentive for oil-seeds producers. Oil markets are controlled by middlemen and speculators.

Besides these, lack of R&D in the area of oilseeds; low yield per hectare, and inefficient extraction also add to the problems.

Despite constant exhortations and persistent Govt. efforts,the area under oilseeds has increased only at negligible rates (table 5) with the result that the domestic production of oilseeds has not risen to required levels. In the years 1988-89 and 1989-90 the rainfall was particularly good which helped to raise a more plentiful crop. Agricultural experts believe that the good monsoon during these two consecutive years is likely to help maintain the oilseeds production at 15.0 million tonnes during the subsequent years 1990-91 and 1991-92, because of the residual moisture in the soil.

Table 5 Increase in Area Under Oilseeds and Yield

Oilseed Crop	Area under Crop		Productivity	
	Sixth Plan	Seventh Plan**	Sixth Plan*	Seventh Plan**
	(lakh ha.)		(Kg/ha)	
Groundnut	76.4	86.0	955	1089
Mustard/Rapeseed	38.9	45.0	668	850
Sesamum	21.8	25.0	275	296
Safflower	8.0	10.0	625	725
Niger	6.0	7.0	333	357
Soyabean	8.2	13.0	731	981
Sunflower	6.7	9.0	447	670
Linseed	14.6	18.0	342	365
Castor	6.4	7.0	307	800
Total	187.0	220.0	695	818
% Increase	-	17	-	17

* Actual at the end of 6th Plan
** Anticipated at the end of 7th Plan
Source: Ministry of Agriculture

Although during recent years, the average yield per hectare of oilseeds has gone up to some extent, it is still far from satisfactory when compared with the highest yields achieved elsewhere in the world (table 6). To give a thrust to oilseeds production, the Govt. had set up an Oilseeds Technology Mission in 1986 with a view to raising both the productivity and production of oilseeds. While the Mission's efforts seem to have yielded some beneficial results it cannot still be said to have achieved its primary objective of reaching a production figure of about 18 million tonnes of oilseeds by 1989-90 or is likely to reach the target of about 26 million tonnes by the end of the century . No doubt the production of oilseeds in 1988-89 improved to about 17.89 million tonnes (from 12.66 million tonnes in 1987-88), it is doubtful if it can be attributed to anything other than the good monsoons during the year. The target now

set for 1989-90 by the Ministry of Agriculture as per their annual report of 1989-90 is only 16.50 million tonnes.

Table 6 : Average Yield Per Hectare of Oilseeds in Different Countries

Oilseed Crop	No. of Varieties	Indian Average Yield Kg./ha	Highest Yield	
			Kg/ha	Country
Groundnut	30	756	5784	Israel
Rape Seed/ Mustard	28	589	2826	W. Germany
Sesamum	17	181	2000	Yugoslavia
Sunflower	5	522	2209	Italy
Safflower	5	493	-	-
Soyabean	2	863	4500	USA
Niger	8	236	-	-

Source : Ministry of Agriculture

Efforts towards bridging the wide gap between the domestic availability and demand for oilseeds so far have been primarily confined to the following main schemes.

* Intensive oilseeds development.
* Development of soyabean cultivation.
* Extension of oilseeds cultivation to new irrigated areas.
* Development of sunflower production.

However, the wider strategy adopted for 1989-90 to increase oilseeds production, according to the Ministry of Agriculture, consists of the following further steps:

a. Increasing production and availability of seeds.

b. Organizing Seed Villages for production of seeds of soyabean and groundnut.

c. Distribution of input kits to propagate seeds of newly released varieties.

d. Distribution of plant protection chemicals in endemic areas.

e. Providing improved farm implements in groundnut growing areas to help achieve uniform and economic irrigation.

f. Demonstration of improved technology to farmers.

g. Improving the quality of groundnut and soyabean by the use of chemicals and minerals.

In addition to govt. efforts to improve oilseeds production, some private organizations namely, IVPA and IVMA, are also organizing research and extension services on a limited scale towards the same end.

Although the yield per hectare in 1987-88 had increased by about 8.6% over 1978-79 and further by another 30% in 1988-89, (Kundu,1990), there is still considerable scope for further improvement if we aim at reaching world standards. The real test of the effectiveness of the improvement strategies will however come only in a year of poor monsoons, notwithstanding the claims made by the Technology Mission and others.

Alternatives

Alternative solutions are often proposed to augment the oilseeds supplies such as: (i) Intercropping of sunflower with groundnut sown with wide spacing, so as to help increase total oilseeds production without in any way jeopardising the groundnut yield (ii) Expansion of soyabean cultivation to overcome the edible oil shortages (ii) Encouraging solvent extraction from waste products such as rice bran, groundnut and cotton seed oil cakes (iv) Popularizing sunflower cultivation in different states, particularly in areas subject to occasional droughts (Sunflower is said to be drought tolerant).

Another aspect which needs equal attention is the improvement in the quality of oilseeds. The oilcontent of various oilseeds grown in the country is generally very low as compared to those grown in some of the European countries. This means a much bigger size of oilseeds crop to obtain the same amount of oil. The need for developing better quality seeds and adoption of improved and more effective extraction processes therefore are equally important. An integrated oilseeds policy which will take care of all facets of oilseeds production and oil extraction process must be evolved urgently to bring the goal of self sufficiency closer. Since any increase in the production/ productivity of oilseeds will tell upon the country's economy, it is a matter which brooks no further slackness or prevarication. Our estimates show that the per capita consumption of edible oils is likely to grow at an average rate of 7.5 percent per annum through out the nineties based on the asumption that the growth in real NNP will be in the range of 5 percent per annum and the population growth rate will continue to hover around 2 percent per annum. (For details see Annexure 1). This also implies that the total demand for edible oils is likely to grow from about 6.10 million tonnes in 1988-89 to about 8.90 million tonnes in 1994-95 and further to about 12.06 million tonnes in 1999-00 (table 7).



Table 7 : Estimated Demand for Edible Oils In India (1989-2000)

	Per Capita NNP (As at 1980-81 prices)*	Estimated Per capita Edible oil consumption (Kgs)**	Population*** (Million)	Total Demand for Edible oils (Million tonnes)
1989-90	2144	7.77	829	6.44
1990-91	2208	8.09	854	6.91
1991-92	2275	8.44	871	7.35
1992-93	2343	8.79	888	7.80
1993-94	2413	9.16	906	8.30
1994-95	2486	9.54	933	8.90
1995-96	2560	9.94	952	9.46
1996-97	2637	10.36	971	10.06
1997-98	2716	10.79	990	10.68
1998-99	2798	11.24	1010	11.35
1999-00	2882	11.71	1030	12.06

*Assumed to grow at the rate of 3 percent per annum.
**Details of the estimation method are given in Annexure I.
***Assumed to grow at the rate of 2 per cent per annum.

Supplementary Sources of Oils

Rice bran oil (RBO) offers one alternative source to supplement domestic supplies. If rice bran available from the rice mills in the country can be suitably processed, this can become a fairly good supplementary source of edible oils. It is estimated that India's realisable potential in this area is as high as 6,00.000 tonnes per year (Kundu,1990). Besides ricebran, the solvent extractions of other oils, if properly exploited, can also help reduce the country's import bill. According to the Department of Civil Supplies, (Govt of India) there is considerable untapped potential of various edible oils from other sources, (table 8). Table 9 shows the production of solvent extracted oils from 1982-83 onwards. It will be observed that a considerable amount of oil available from secondary sources remains unrealized and further efforts are needed so as to augment the total availability of edible oils within the country.

Table 8. Supplementary Sources of Edible Oils (lakh Tonnes)

Commodity	Realizable Potential	Current Production	Untapped Potential
Rice bran	6.0	3.2	2.8 (46.7%)
Cottonseed	4.5	2.8	1.7 (38%)
Oil Seeds of tree & forest origin	6.0	1.2	4.8 (80%)
Oil Cake	5.5	1.9	3.6 (65.5%)
Total	22.0	9.1	12.9 (58.6%)

Table 9 : Solvent Extracted Oils - Output ('000 tonnes)

Type of Oil	1982 -83	1983 -84	1984 -85	1985 -86	1986 -87	1987 -88	1988 -89
Groundnut	22.5	42.1	28.9	20.7	33.7	24.9	55.4
Cottonseed	15.2	15.9	7.4	7.7	8.6	9.1	8.5
Ricebran	145.3	106.3	187.0	202.5	279.5	290.7	316.3
Soyabean	29.6	40.1	94.3	138.5	100.0	108.2	194.6
Salseed	17.9	18.1	11.5	8.1	10.4	6.5	9.2
Sunflower	6.8	11.8	16.3	12.7	22.1	35.7	25.2
Safflower	4.7	6.1	3.1	3.7	2.5	2.8	2.0
Coconut	1.8	2.2	2.1	3.4	4.4	3.6	4.1
Sesamum	1.0	0.8	0.3	1.1	1.5	2.4	2.7
Nigerseed	0.2	0.7	-	0.7	0.4	0.3	0.1
Linseed*	0.6	0.9	0.1	0.4	0.2	-	0.1
Castor *	2.3	3.7	3.3	1.6	1.7	2.6	4.3
Neem *	5.0	7.7	8.7	5.8	9.3	8.9	9.8
Mahua	5.2	4.8	4.4	4.4	6.1	9.6	6.1
Mango Kernal	1.9	0.4	1.1	1.1	1.0	3.7	4.2
Mustard	9.1	8.2	9.1	22.8	32.9	26.1	78.3
Others	3.0	4.5	4.1	2.2	4.6	7.1	9.0
Grand Total	273.3	375.3	381.7	437.6	518.9	542.3	730.0

* Non-edible
Source : IVPA - 1989-1990
SEA, Bombay

Research & Development

Another area which calls for greater attention is the application of improved technologies to the cultivation of oil seeds; oil extraction as well as research for improving the oil content. For nine oilseed crops covering an area of 18 million hectares, investment on R&D has been minimal as the following figures will show (Ministry of Agriculture, 1989-90)

Plan Period	Outlay
Second Plan	Rs. 2.60 crores
Third Plan	Rs. 2.66 crores
Fourth Plan	Rs. 7.75 crores
Fifth Plan	Rs. 10.15 crores
Sixth Plan	Rs. 100.00 crores
Seventh Plan	Rs. 200.00 crores

In recent years there has been a significant stepping up of the allocation of funds for research in oilseeds. However, considering the nature and size of the problem, it still seems grossly inadequate. Since there are resource constraints, it would be particularly welcome, if other interests could supplement Govt. efforts in R & D by making available funds of a matching level. So far the oil producers seem to have done little in this direction.

Vanaspati

Vanaspati is nothing but an edible oil hydrogenated by the fat modification technology. The process of hydrogenation does not change the essential characteristics of the oil. Vanaspati, therefore, remains an oil after this process. Since vanaspati is an oil in another form, its production is also affected by the same factors on which the production of edible oils depends. Over the years, vanaspati has become popular as a cooking medium even in the rural areas. Although initially there was considerable consumer resistance to vanaspati, this has gradually worn off largely because of its comparative cheapness and nutritious and hygeinic qualities. Vanaspati is now a mass consumption item throughout the country unlike certain vegetable oils which are used in some specified regions e.g. mustard in West Bengal, coconut in Southern States and til oil etc. in the Western region (NCAER,1983). In their study on 'household consumption of edible oils and vanaspati, NCAER reveals that 54% of vanaspati is now consumed in rural areas; 69% consumption is by households with per capita incomes below Rs.24,000 per annum and 86% vanaspati is purchased loose in small quantities by the poor(NCAER,1983).

Initially, only groundnut and/or coconut oil were used for hydrogenation but later on, as the demand for these edible oils increased and prices went up, other cheaper oils also began to be taken into use e.g. cotton seed (1960), soyabean oil(1970) and rice bran oil (1980). Besides, some other minor oils as well as solvent extracted oils are also now being used by the vanaspati industry. Due to the chronic shortage of edible oils, in the country vanaspati industry has largely become dependent on the use of imported oils such as palm and soyabean oils, besides some of the indigenously available oils. A statement showing percentages of various oils used by the vanaspati industry during the past few years is contained in table 10.

Table 10 : Per cent of Imported and Indigenous Oils used for Vanaspati Manufacture .

Oils used	1982 -83	1983 -84	1984 -85	1985 -86	1986 -87	1987 -88	1988 -89	1989 -90
Imported								
RBO Palmoil	7.6	2.6	3.7	0.4	-	1.5	-	-
Soyabean	37.4	50.5	35.9	24.3	21.7	31.0	2.7	-
Palm	10.8	4.6	7.6	14.5	17.1	8.6	1.6	-
Rapeseed	1.3	0.4	9.0	4.8	4.9	9.0	1.4	-
Palmolein	1.0	0.1	-	0.3	-	-	-	-
Sunflower	-	-	-	-	-	1.2	0.8	-
Other imported Oils	7.9	17.1	9.1	6.9	5.8	7.3	4.7	3.9
Total % age	66.0	75.3	65.3	51.2	49.6	58.7	11.2	3.9
Indigenous								
Sesamum	5.2	5.3	5.2	5.2	5.2	5.9	5.7	5.1
Cotton seed	17.4	11.9	17.0	18.3	18.1	10.8	26.2	29.9
Soyabean	4.8	3.9	7.5	6.9	5.1	3.9	15.2	18.2
Sunflower	0.8	0.7	0.8	0.7	1.8	2.6	3.0	2.0
Rice Bran	2.9	2.2	2.2	6.8	11.9	13.5	14.4	16.5
Maize	0.4	0.3	0.3	0.2	9.4	0.3	0.5	0.4
Niger	0.1	0.1	-	0.2	0.5	0.7	0.6	0.3
Mahua	2.2	0.2	0.5	1.2	1.2	1.0	1.4	1.0
Watermelon	-	0.1	-	-	-	-	-	-
Safflower	-	-	-	-	-	-	-	-
Kardi	0.1	-	-	0.1	-	0.1	0.1	-
Mangokernal	0.1	-	-	-	-	-	-	-
Salseed	-	-	-	-	-	-	-	-
Mustard(Exp.)	-	-	-	6.7	1.9	-	10.8	10.4
Mustard(SE)	-	-	1.0	2.2	3.8	2.3	8.1	8.1
RS Off.spec.	-	-	-	0.1	0.1	-	-	0.4
RBD Off spec.	-	-	-		0.3	-	0.1	1.1
NPO Off.spec.	-	-	-	-	-	-	0.3	0.8
Palmolein off spec.	-	- *	-	-	-	-	-	0.2
SBO Off. spec.	-	-	-	-	-	-	-	-
Groundnut	-	-	-	-	-	-	2.0	0.5
Others	-	-	-	-	-	-	0.3	1.1
Total % age	34.0	24.7	34.7	48.8	50.4	41.3	88.8	96.0

* Compulsory use.
Source: IVPA, (1989 & 90)

It may be observed that

- vanaspati production is largely dependent on imported oils.
- cottonseed oil is still the prefered indigenous oil for vanaspati manufacture.
- amongst imported oils, soyabean and palm oils seem to be the main ones in use.
- the use of indigenous rice bran oil for vanaspati manufacture has been steadily rising although the government would like the industry to increase its utilization still further.

For various reasons, government has been regulating the use of edible oils by vanaspati industry particularly because of perenial shortages and the constantly rising home demand for edible oils. At times, changes in the govt. policy therefore do cause some readjustment difficulties. Vanaspati industry, it is claimed, tries to optimise cost reduction of its inputs by utilizing the cheapest oils available by imports. In conformity with govt. directives, the industry also uses some of the minor oils thus helping to release equivalent quantity of essential oils for distribution through the public distribution system (PDS). The industry claims now to be in a position to utilize any oil through the use of appropriate technology for the manufacture of

vanaspati. Besides, the industry believes that it has been able to provide marketing support to certain oils which could not have been used as such even after refining due to their unpalatable taste/odour.

The production of vanaspati has been steadily increasing. From an output of mere 300 tonnes in 1930, the production has now reached 10 lakh tonnes. The total licensed capacity of vanaspati at present (1989) stands at 20.60 lakh tonnes (Times of India, Nov. 7,1990) and the present capacity utilisation is around 58%. The govt. has recently issued additional licenses for another 2.80 lakhs tonnes of capacity for the manufacture of vanaspati in the joint, public, and co-operative sectors.The use of imported edible oils by the vanaspati industry has brought in its wake, problems relating to the pricing of vanaspati, mix of indigenous and imported oils and excise concessions etc. The market price of vanaspati seems particularly difficult of solution, because of the unfavourable impact of unhealthy market practices. It should be noted that the domestic output of oils has been on the increase at moderate rates in recent years. These have been supplemented by impressive quantities of imports, in the range of 1-1.5 million tonnes, during all the years in the eighties. Normally, stable levels of prices should have been the outcome. On the contrary, except during 1985-86, and 1988-89, the wholesale prices have been rising throughout the period at hyper inflation rates. As long as scarcity conditions continue to prevail, government control and regulation of the industry cannot perhaps be avoided. The solution, therefore, would seem to lie in improving the output of oilseeds/ edible oils so as to make the country self sufficient in oils like what the country has been able to achieve in the case of foodgrains.

Capacity Utilization

Capacity in the vanaspati and solvent extracted oil industry is very much underutilized. While the average capacity utilisation in vanaspati has hovered around 70% as against an average of 88% in the total Food Processing Industry, (CMIE, 1987)the position in the solvent extracted oils is much worse, the average capacity utilization being only about 4 to 6%.Cottonseed oil which is the main raw material used by the vanaspati industry, however, shows slightly better capacity utilisation of 21-31% during the period 1980 to 1984.

Table 11 shows capacity utilization in some of the major production units in the country. The information/data taken for computing capacity utilization pertains to the latest accounting year for which the company's accounts are available. Capacity utilisation varies from company to company. While in some cases it is as high as 100%(TOMCO),in a number of cases it is as low as 3-4% (Coromandal & Vegetable Products). It can also be seen that capacity utilisation in smaller units is comparatively poor, while in most of the bigger and perhaps better

Table 11 : Capacity Utilization in Some Edible Oil/Vanaspati Companies

Company	Product	Capacity (tonnes)	Production (tonnes)	Capacity Utilization %
Amrit Banaspati	Vanaspati	90,000	58,000	65.0
1250 tonnes per day	Refined Oil	40,000	3,000	7.5
Bombay Extra-cation	Veg.Oil etc.	6,000	3,740	62.0
	Refind Oil	7,000	460	6.5
IVP	Vanaspati	30,000	8,000	33.0
Kusum Products	Vanaspati & refined Oil	30,000	12,000	40.0
Modern Mills	Vanaspati	9,000	3,000	33.0
Wipro	Vanaspati	67,000	48,000	71.6
Tata Oil Mills	Vegetable Oils	3,000	3,000	100
Madhusudan Veg. Products	Vanaspati & refined Oils	22,000	17,000	77.3
	Refined Veg.Oil	7,000	2,000	28.6
Rasoi	Vanaspati	45,000	31,000	68.8
Malwa Vanaspati	Vanaspati	36,000	17,000	47.2
Motilal Padmapat	Vanaspati	18,000	11,000	61.1
Premier veg. Products	Vanaspati	11,000	5,000	45.5
Tungbhadra	Vanaspati	62,000	33,000	53.2
HVOC	Vanaspati	1,05,000	45,000	43.0
	Refind Oil	3,45,000	71,000	21.0
Rajasthan Vana-spati	Vanaspati etc.	18,000	7,303	41.0
Swarup Veg. product	Vanaspati	9,000	6,000	66.6
Oswal Agro Mills	Edible Oils	25,000	15,000	60.0
Tri Star Soya	Crude Oils	1,50,000	61,000	40.6
	Refined Oils	15,000	3,000	20.0
Coromandal Agro	Minor Oil	61,200	2,002	3.3
Kediya Vanaspati	Refined Oil	36,000	2,188	6.0
Ramnugger Cane & Sugar Co.	Vanaspati	18,000	5,000	28.0
Vegetable Pro-ducts	Vanaspati	16,500	6,787	41.0
Shree Man Singhka	Vanaspati	18,000	1,477	8.2
Sukhchain Oils & Fats	Refined Oil	10,000	530	5.3

Source: CMIE (May & Nov. 1990 Volumes.)

Notes:

1. Most are multi-product units. Some have diversified into non-oil business also.
2. Wherever capacity is quoted in tonnes/day has been converted into annual figures based on 30 days working per month.
3. Soaps, detergents, fatty acids etc. are by-products in most cases which have not been taken into account.
4. Figures are for the latest available year.

Table 12 : Capacity Utilizsation in Some Selected Units≤1984-1990

Name of Unit	Product	Year	Capacity (000'MT)	Production (000'MT)	Capacity utilizaton %	Avge Cap. utilization %
Premier Industries	Solvent Extracted /Refined oils etc.	1984	41	18.9	46	
		1985	53	25.1	47	
		1986	53	37.2	70	45.5
		1987	53	18.0	34	
		1988-89*	59	26.6	45	
		1989-90	59	18.2	31	
Rasoi Limited@	Vanaspati Refined oil.	1984	36	17.6	49	
		1985	36	22.1	61	
		1986	36	21.5	60	56.6
		1987	36	22.1	61	
		1988-89*	36	26.2	58**	
		1989-90	36	18.2	51	
Mansinghka Industries	Vanasati /Refined oil	1984-85	16.5	11.0	67	
		1985-86	16.5	13.9	84	
		1986-87	16.5	6.1	37	51.2
		1987-88	16.5	5.6	34	
		1988-89	16.5	5.6	34	
	Seed Crushing	1984-85	33	33.9	103	
		1985-86	33	35.8	108	
		1986-87	33	31.7	96	80
		1987-88	33	23.3	71	
		1988-89	33	7.3	22	
	De-oiled Cakes	1984-85	33	36.9	112	
		1985-86	33	41.5	126	
		1986-87	82.5	29.7	36	71
		1987-88	82.5	37.8	46	
		1988-89	82.5	28.8	35	
Motilal Padmapat Udyog Limited	Vanaspati	1984-85	18.0	14.9	83	
		1985-86	18.0	16.3	91	
		1986-87	18.0	14.5	81	78.7
		1987-88	18.0	14.6	81	
		1988-89@@	18.0	11.9	88**	
		1989-90	18.0	8.6	48	
Malwa Vanaspati & Chemical Co.	Vanaspati	1984	36.0	12.5	35	
		1985	36.0	14.7	41	
		1986	36.0	16.2	45	42.8
		1987	36.0	17.6	49	
		1988-89*	36.0	19.6**	44	
		1989-90	36.0	-	-	
	De-oiled Cakes	1984	36.0	5.7	16	
		1985	36.0	11.3	31	
		1986	36.0	12.1	34	30.4
		1987	36.0	10.3	29	
		1988-89*	36.0	19.1**	42	
		1989-90	36.0	-	-	
NDDB (Bhavnagar Veg. Products Unit)	Vanaspati	1985-86	36.0	9.3	26	
		1986-87	36.0	11.1	31	
		1987-88	36.0	13.0	36	29.2
		1988-89	36.0	10.1	28	
		1989-90	36.0	9.0	25	
	Refined Oil	1985-86	16.2	7.2	44	
		1986-87	16.2	11.0	68	
		1987-88	16.2	8.0	49	38.4
		1988-89	16.2	3.8	23	
		1989-90	16.2	1.3	8	
	Solvent Extra-ction	1985-86	54.0	7.0	13	
		1986-87	54.0	9.9	18	
		1987-88	54.0	7.7	14	22.4
		1988-89	54.0	10.6	20	
		1989-90	54.0	25.2	47	
	Oil Seed Crushing	1985-86	72.0	10.4	14	
		1986-87	72.0	20.2	28	
		1987-88	72.0	12.2	17	27.2
		1988-89	72.0	18.8	26	
		1989-90	72.0	36.9	51	

Source: Information supplied by the Units.

*15 Months @ Diversified. Also produces Soap, Oxygen and Tin Containers

**On annualised basis

@@ 9 Months

managed units, it ranges between 60 and 75%. However, table 12 giving detailed information on capacity utilisation of a few selected units shows a somewhat different and a slightly more encouraging picture. The average capacity utilisation in these units ranges from 27 to 80 percent for all types of operations including solvent extraction and seed crushing. However, in the case of vanaspati manufacture and refined oil production, capacity utilisation is below the average and except for one unit (Motilal Padmapat) it generally ranges between 29% and 56%. According to IVPA, overall capacity utiiization in the vanaspati industry is around 58%. Looking at it from any angle, it is clear that capacity utilization in the edible oils & vanaspati industry is unsatisfactory and needs to be improved considerably to be able to meet the rising demand for this essential food item in the country.

The contributory causes for low capacity utilisation are several but the one that stands out most is the deficient output of oilseeds. There are, no doubt, other reasons also such as inefficient process technology; old vintage plants, and uneconomical plant capacity etc. which also contribute to low capacity utilisation in the edible oils industry as a whole. Currently, it seems, everyone connected with the oil industry is more concerned with the need to find ways & means to meet the shortfall in the domestic availability of edible oils. Little attention is, therefore, being given either to improve the plant productivity and efficiency or to modernize the existing plants and/or to induct latest technologies developed and available within or outside the country. It is clear therefore that only a holistic approach touching all aspects of the industry can be of a lasting benefit. Such an approach presupposes full cooperation between concerned groups—the industry, the farmers, the government and also the research institutions.

Productivity in Edible Oil Industry

To assess the state of productivity obtaining in the edible oil industry/vanaspati industry we have used a set of seven main parameters. These include:

a. Ratio of Total Earnings to Conversion Cost.

b. Ratio of Purchased Services to Total Earnings.

c. Percentage of Wages/Salaries etc. to Sales.

d. Ratio of Profit to Conversion Cost.

e. Percentage of Profit to Sales.

f. Profit per Employee.

g. Sales per Employee.

h. Value Added per Employee

The results obtained are presented in Appendices 1 to 8. The averages for the past five/six years are shown in table 13.

Out of over hundred edible oil/vanaspati units, a sample of 22 has been taken for evaluation of the industry's performance. These 22 units include solvent extraction plants, crushing, processing and refining units as well as vanaspati manufacturers. A number of them are multi product units and a few are highly diversified ones. The state of productivity of these 22 units should, therefore, be fairly representative of the edible oil/vanaspati industry in general. The basic data has been obtained directly from some of the enterprises although in a few cases it has been culled out from the published information.

Ratio of Earnings (TE) to Conversion Cost

As a primary productivity ratio, it gives a clear indication about the general state of performance of a company. Of the 22 units, there is only one unit (Mansinghka) whose TE to cost ratio is very low. In fact the company had made negative earnings in the year 1987. NDDB leads all the other units in this ratio (2.7) indicating satisfactory operational efficiency & managerial control. Rasoi, Oswal & Malwa (1.7 each) also seem to have performed well with IVP following closely behind with a ratio of 1.4. Most of the other units are operating at unity or slightly below or above unity. Fig.1 shows at a glance where the 22 companies stand with respect to each other in this respect. There is, however, one disquieting feature of TE to cost ratios. Some companies ended up with negative earnings in some of the years giving an impression that managerial control on spendings & resource utilization was lax, if not totally lacking during the period. Such a situation could have perhaps been forestalled, if a regular productivity & resources audit had been in use.

Table 13 Averages of (1984-89) of Productivity Ratios of Edible Oil/Vanaspati Units

	Total Earnings to conversion cost	Purhased Services to total Earnings	Wages to to sales %	Profit to conversion cost	Profit to sales %	Profit per Employee (Rs. Lakhs)	Value Added per Employee (Rs. Lakhs)	Sales per Employee (Rs Lakhs)
Amrit	1.23	0.51	7.5	0.04	1.2	-	-	-
Bombay Extraction	0.93	0.73	5.6	(0.27)	(6.5)	-	-	-
IVP	1.4	0.41	4.9	0.19	2.7	-	-	-
Kusum	0.93	0.6	8.2	(0.007)	(0.15)	-	-	-
Modern Mills	0.87	0.57	11.8	(0.32)	(8.7)	-	-	-
Wipro	1.15	0.66	3.1	0.11	2.4	-	-	-
Tomco	1.15	0.55	18.4	0.12	7.7	1.7	7.2	22.1
Rasoi @	1.7	0.39	1.7	0.4	3.0	0.36	0.84	11.8
Premier	0.9	0.9	1.7	(0.1)	(1.3)	-	-	-
Tunghbhadra	1.04	0.5	5.8	(0.08)	(1.2)	-	-	-
HVOC	1.1	0.6	2.7	0.34	3.2	0.39	0.39	12.2
Swarup	1.05	0.6	8.7	(0.025)	(0.7)	-	-	-
Oswal Agro	1.7	0.45	2.1	0.55	8.8	-	-	-
Tristar Soya	1.2	0.66	1.1	0.007	0.8	-	-	-
Premier Industries**	1.25	0.87	0.76	0.13	1.5	0.26*	1.0*	17.0*
Mansinghka	0.4	1.9	1.9	(0.125)	(1.9)	(0.13)	-	6.97
Motilal Padmpat@	1.2	0.6	1.6	0.28	2.28	0.28	-	12.5
Malwa	1.7	0.36	2.1	0.15	1.2	0.11	0.45	9.0
NDDB@@	2.7	0.27	2.9	1.12	1.2	0.09	-	7.2
Coromandal	1.0	0.7	3.5	(0.04)	(0.9)	-	-	-
Bhopal Sugar	0.96	0.6	9.3	(0.05)	(1.2)	-	-	-
Rajasthan	0.92	0.95	2.0	(0.09)	(2.0)	-	-	-

@ 6 Years average
** 7 Years average
* Avge of four years
@@ Bhavnagar unit only

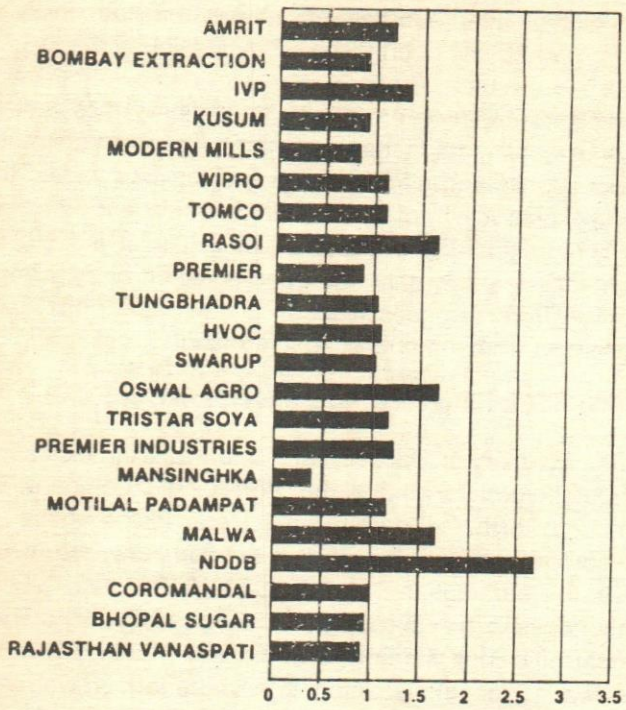


FIG. 1. TOTAL EARNINGS TO TOTAL CONVERSION COST

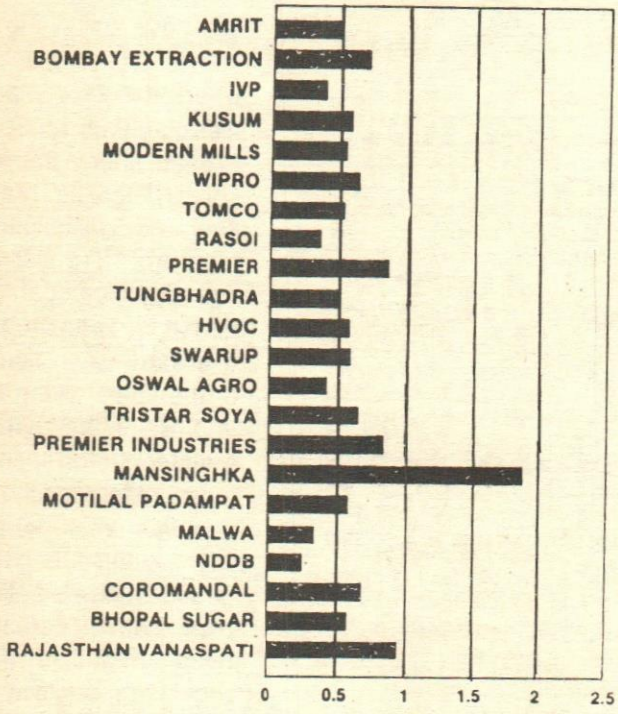


FIG. 2. RATIO OF PURCHASED SERVICES TO TOTAL EARNINGS

Purchased Services to Total Earnings Ratio

This is a general indicator of how purchased services like power, water,steam, gas, air, telephones, telex etc. are being utilized. The results show that atleast some companies like Rajasthan Vanaspati, Mansinghka, Premier Veg. Products, Premier Industries and Bombay Extractions need to be vigilant in this (fig. 2) area. Their ratios seem to be much above the general average indicating wastages and/or inefficient utilisation of various resources. Here again NDDB has scored over other companies with as low a ratio as 0.27. Malwa with a ratio of 0.36 and Rasoi with 0.39 follow just behind. The rest of the fraternity seem to be operating at just around the average of the industry. There are atleast three companies-HVOC, Coromandel & Mansinghka which due to negative earnings during one of the five years have produced a negative ratio of purchased services to total earning during that year.

Wages/Salaries to Sales Percentage

The ratio shows wide variations among the companies. While a company like Tomco spends as much as Rs. 18/ for every hundred rupees of sales, there are others like Tristar Soya,Rasoi, Premier, Motilal and Mansinghka who spend even less than Rs. 2/ each on wages/salaries etc.for securing sales of Rs. 100/. Fig.3 shows how the 22 Cos. stand in comparsion with each other on this parameter.

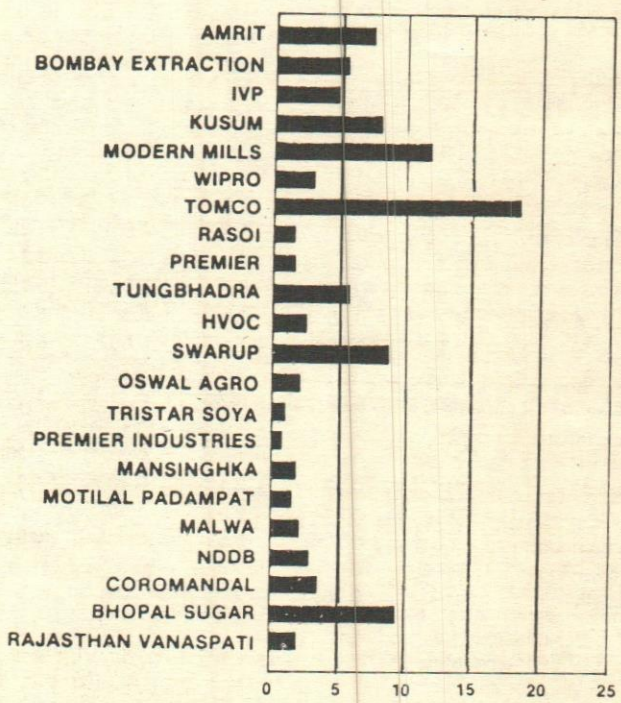


FIG. 3. WAGES AND SALARIES TO SALE %

Despite being a high wage company, Tomco's sales per employee sets a very high standard. So is also their profit to sales percentage; an ideal situation which can be gainfully emulated by others.

Profit Contribution Ratios

The two measures of profit performance are:

* Profit to Conversion Cost Ratio

* Profit to Sales Percentage

Out of the 22 companies as many as ten have, on the average, incurred losses. Of the remaining 12, many show very low profit earnings. For example, the profit earnings for every rupee of conversion cost is less than 15 paise in as many as seven companies. Only five companies present a satisfactory picture with Oswal showing a high profit ratio of as much as 55 paise per rupee of conversion cost followed by HVOC and Motilal who have a ratio of 0.34 and 0.28 respectively. The profit to sales percentages, however, reveal a slightly different picture. While the ten companies incurring loss remain (fig.5) on the bottomline, of the remaining 12 companies Oswal and Tomco top the list with higher percentages of 8.5 and 7.7 respectively. Profitability is a commonly used yardstick for judging the performance of a company. Assessed on the above two parameters it would appear that the profit performance of the edible oil industry leaves much to be desired.

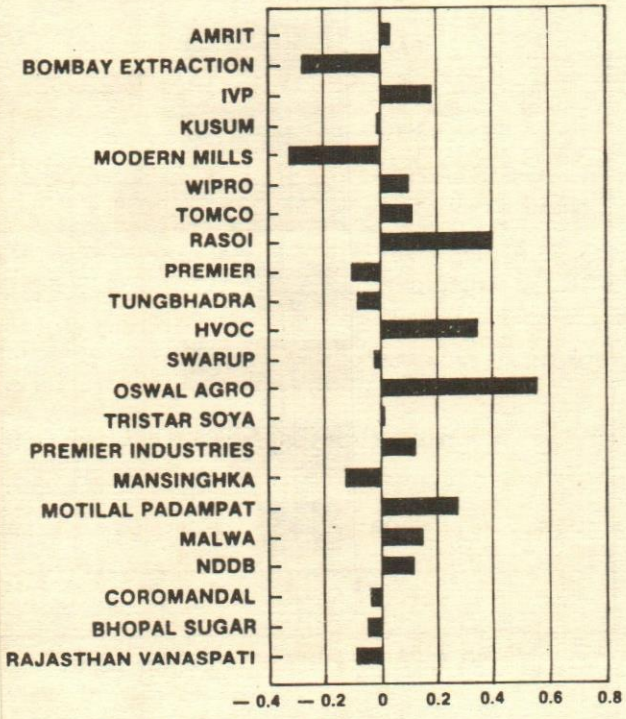


FIG. 4. RATIO OF PROFIT TO CONVERSION COST

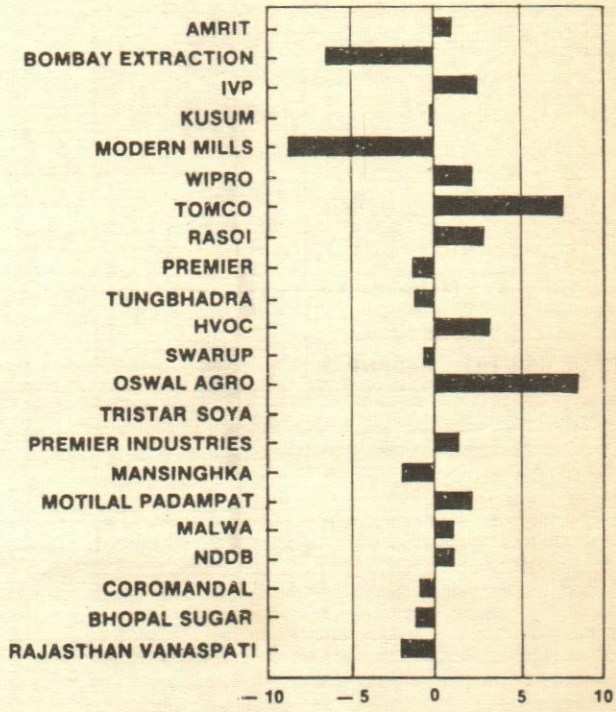


FIG. 5. RATIO OF PROFIT TO SALES (PERCENTAGE)

People Productivity

To assess employee productivity in the industry, we have utilized the following three ratios:

* Profit per Employee (Rs. Lakhs)

* Value added per Employee (Rs. Lakhs)

* Sales per Employee (Rs. Lakhs)

Each of the above three parameters gives slightly different *inter-se* position. Unfortunately, the basic input/output data needed for these measurements could not be obtained for all the sample companies. The eight companies from whom the required information could be secured show a wide variation (fig. 6). While Tomco, and Premier Industries have a high figure of sales per employee, the three which in comparison are low on this parameter, are Mansinghka, NDDB & Malwa. The remaining three companies, however, show a fairly satisfactory sales per employee. The results obtained in the case of sales per employees are largely repeated in the other two parameters, leading to the inference that employee productivity is

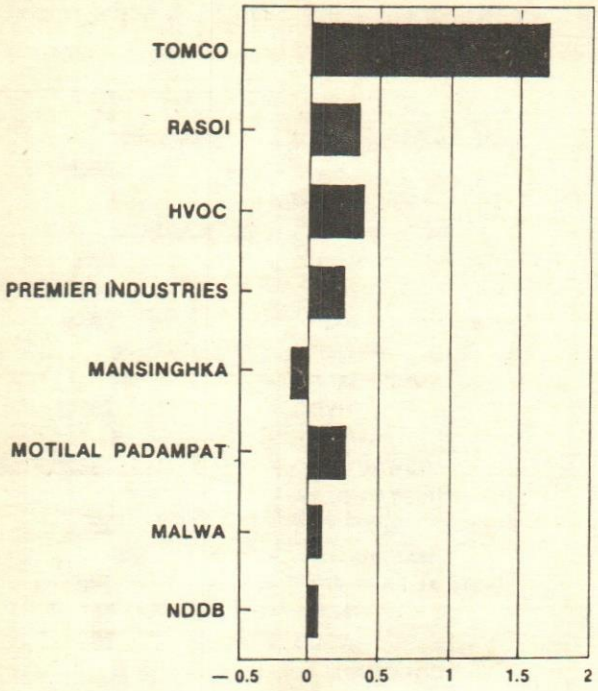


FIG. 6. PROFIT PER EMPLOYEE (Rs. in Lakhs)

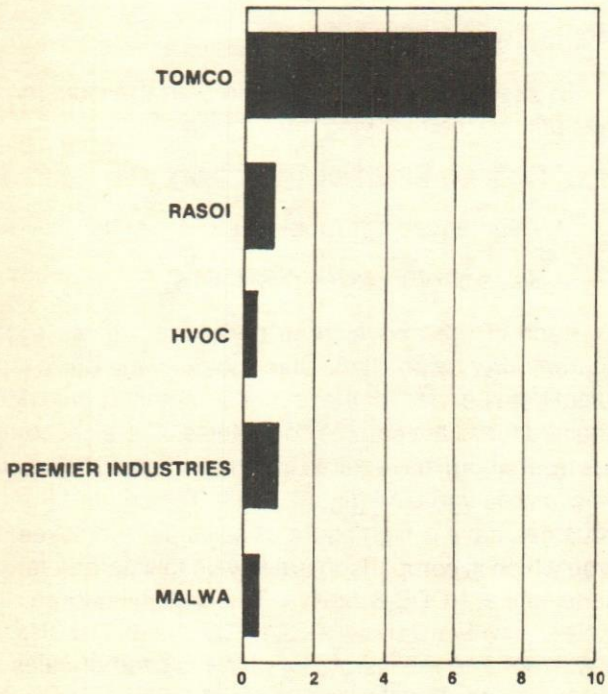


FIG. 7. VALUE ADDED PER EMPLOYEE (Rs. Lakhs)

generally unsatisfactory in the industry. This is also borne out by the analysis of another productivity parameter — earnings per employee (table 14). Total earnings being the basic fund, this parameter is also indicative of the state of employee productivity in a company. As in the case of earlier parameters, Tomco is far ahead of others in the matter of employee productivity with Mansingka remaining at the bottom. Though Premier Industries is the second highest on this parameter, it is nowhere near the leader - Tomco. In fact, (fig. 8) barring Tomco and Mansinghka the remaining seven companies are fairly close to each other on this parameter. This overall picutre leads to the conclusion that the employee productivity is generally unsatisfactory in the edible oil industry as a whole. The mixed picutre presented by these three parameters is in line with the generally felt poor impression about the employee productivity in the indian industry at large. Clearly, there is a much greater need for managerial attention being focused on the efficient utilisation of this important input viz. human resoures.

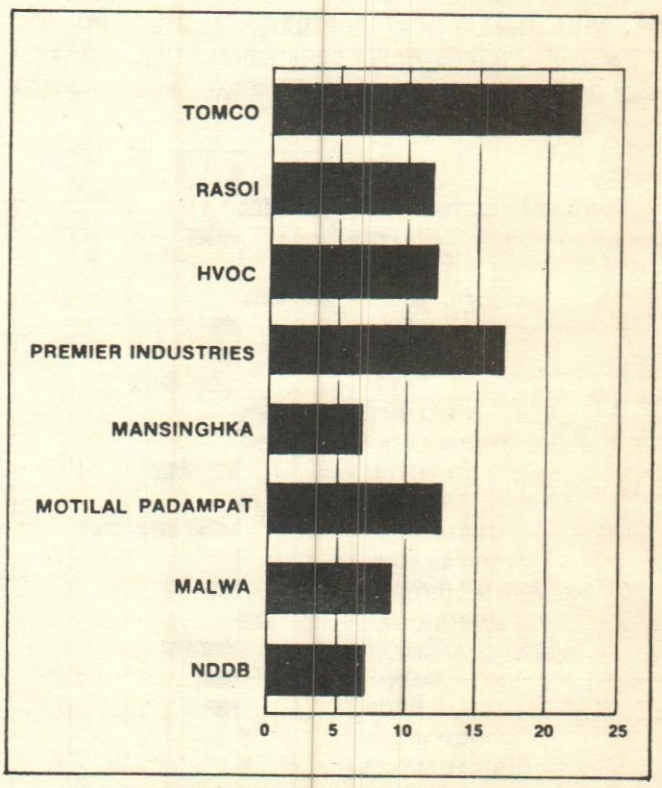


FIG. 8. SALES PER EMPLOYEE (Rs. lakhs)

Table 14 : Earnings per Employee:(average for 5 years)

Company	Total Earnings (Rs. Lakhs)	No. of Employees	Earnings per Employee	Remarks
Tomco	98882	6011	16.45	Highly diversified
Rasoi	471	346	1.36	
HVOC	2778	2205	1.26	
Premier Industries	244	100	2.44	
Mansingka	179	413	0.43	
Motilal Padmapat	243	204	0.84	Vanaspati Branch
Malwa	492	407	1.21	
NDDB	894	458	1.95	Bhavnagar Unit

The overall analysis of all the eight productivity parameters, is a clear pointer to the edible oil industry's poor management of its major resources - particularly the human resource. The industry must therefore, seriously consider taking stock of the overall performance with the help of a well planned productivity audit so that it can devise and install an appropriate productivity improvement scheme. There may, no doubt, exist a few disabling factors affecting the industry as a whole, but these need not hold back individual units from undertaking an intensive study of their present status of productivity in different areas, with a view to improving their overall performance.

Technology

Technology, both for crop cultivation and oil extraction plays a very important role in improving productivity in the edible oil sector. To hasten towards the goal of self-sufficiency in edible oils the Oilseeds Technology Mission was set up with the following two main objectives:

a. To achieve a production level of 26 million tonnes of oilseeds by the year 2000.

b. To raise oil recovery level to 5 million tonnes by about the same time.

The achievement of these two objectives is as much dependent on improved crop and process technologies as on other factors like development of better quality seeds, incentive prices to oilseeds producers and dependable quality of extension services and inputs. In other words, self-sufficiency in edible oils will depend not only on their production but also on process modernization. Energy conservation, cost reduction and diversification are some of the areas in which the edible oil industry can concentrate to raise productivity without tears.

The existing processing facilities of the order of about 35 million tonnes are large enough to take care of processing needs of the projected increase in oilseeds production. Most of these units are however both old and inefficient. The oil recovery percentages are low,and the energy costs in the form of electricity, steam etc. are high. The inevitable result thus is poor capacity utilisation, poor product, low productivity and a constant demand for concessions from the government. It is estimated that due to inefficient processing of oilseeds, the country is still losing about 3 to 4 percent of edible oils (PTI, 1990) which could be recovered through improved technologies and better extraction processes. Improved expellers, better solvent extraction processes and allied facilities should enable the country to recover an additional quantity of edible oils running into several lakh tonnes per year. We have also a few lessons to learn from others who have, with the help of better 'pre-pressing and expander technology', by and large, overcame oil shortages to a large extent and are poised even for exports to other countries. Another area of great potential where improved technology can help bridge the gap between supply of and demand for edible oils is the solvent extraction from rice bran oil(RBO) & other minor oils. At present only about 23 lakh tonnes of rice bran is being processed annually (PTI,1990)and about 3 lakh tonnes of RBO is recovered from this source. With improved hullers and better extraction technology not only an improved quality of rice bran oil can be obtained but the recovery of RBO can also be substantially increased. Solvent extraction process for the production of edible oils from oilseeds of tree origin and oil cakes etc. can further supplement the availability of edible oils to some extent.

Imports

It is somewhat ironical that even as a leading producer of oilseeds in the world, India has to meet a fairly large part of its requirements of edible oils by imports spending in the process an average amount of about Rs. 800-1000 crores annually. The gap between the projected demand and the estimated supplies (table 15) has been growing during the period 1975-76 to 1988-89. Demand estimates for the period 1989-90 to 1999-00 presented in table 7 further focus on the need for acheiving a breakthrough in oil production. If we take into account the estimated peak production of 3.68 million tonnes in 1989-90, the gap between the demand and domestic supplies is likely to grow from 3.23 million tonnes in 1990-91, to 5.32 million tonnes in 1994-95 and further to 8.38 million tonnes in 1999-00. Some alternative estimates of domestic demand

Table 15: Demand and Production of Edible Oils (1975-76) to (1988-89) (Lakh Tonnes)

Year	Production	Demand	Gap.
1975-76	28.02	45.06	17.04
1976-77	23.65	46.09	22.44
1977-78	26.18	47.14	20.96
1978-79	27.62	48.20	20.58
1979-80	24.12	49.29	25.17
1980-81	25.57	50.39	24.82
1981-82	32.17	51.53	19.36
1982-83	27.46	52.69	25.23
1983-84	32.99	53.87	20.88
1984-85	34.87	55.05	20.18
1985-86	33.21	56.04	22.83
1986-87	34.11	57.15	23.04
1987-88	35.01	58.26	23.25
1988-89	35.91	59.38	23.47
1989-90	36.81	60.49	23.68

Source: Agricultural Situation in India, Feb 1990.

Table 16: Alternative Estimates of Demand & Supply of Edible Oils

Year	NCAER			Tata Consultancy Services			OTA INDIA			Study Group		
	De-mand	Supply	Max. Gap	De-mand	Supply	Max Gap	De-mand	Supply	Max Gap	De-mand	Supply	Max Gap
1985-86	42.3	28.9	13.4	44.0	15.1	5.6	44.45	30.2	14.2	47.0	38.4	8.6
1990-91	53.1	32.9	28.2	59.8	26.9	12.9	55.7	33.4	22.3	57.8	46.9	10.9
1995-96	56.7	37.9	28.8	81.2	43.3	23.1	69.8	36.1	33.7	71.3	58.1	13.2
2000A.D	-	-	-	-	-	-	87.5	51.5	36.0	-	-	-

Source: Sah et al. (1985)

arrived at by other studies are given in table 16. . Similarly the expected offtake under the PDS during the 8th plan is also likely to increase @ 5% per annum as the following estimates projected by the Deptt. of Civil Supplies show:

Year	Likely off take (Lakh Tonnes)
1990-91	10.90
1991-92	11.50
1992-93	12.10
1993-94	12.70
1994-95	13.30

Considering the persistant gap of 20-23 lakh tonnes over the past 12-15 years it is not unlikely that imports may have to continue atleast till the turn of the century, unless, in the meantime the measures adopted by the Technology Mission and the reseach institutions become fully effective and the domestic supplies go up dramatically to equal, if not exceed, the demand. Currently it is estimated that only about 50% of the available potential is being tapped for the production of edible oils from various sources including secondary sources such as solvent extraction and non-traditional oilseeds. (Kundu, 1990). Such pre-emptory imports undoubtedly strain the country's meagre foreign exchange resources. Despite all attempts in the past to overcome shortages, the problem, it seems, has only worsened due to the constantly rising demand. It is evident that to cut down imports substantially which have already cost the country about Rs. 4,600 crores over the last five years (SBI Newsletter, 1989), the annual output of oilseeds will have to be raised to about 200 lakh tonnes in the next one or two years. Low productivity, rapid industrialization and the non availability of additional land for cultivation of oilseeds also contribute to the widening of the gap between demand for and supply of oils. Unless therefore more vigorous efforts are made on a war footing to combat the growing shortages in edible oils, the country may not be in a position to dispense with imports of edible oils or reach the goal of self sufficiency for a long time to come. The two simple measures suggested in this connexion are (i) higher productivity and (ii) a fair price to the growers (NDDB, 1990).

The govt. policy for imports is also affected by seasonal upsurge of market prices of edible oils. While imports are often resorted to with the object of holding the priceline, inequitable distribution/allocation of imported oils to different consumers & states and vanaspati industry results very often in achieving the opposite results. Delays in contracting purchases from abroad due to various internal cumbersome procedures and inter-ministry consultations often neutralize the impact which imported oil supplies are expected to exercise on market prices.It may be recalled that in the model on demand estimates (Annexure I) price of edible oils was not an acceptable variable in explaining the variations in the consumption of the product.

According to a recent news item (Times of India, Oct 15, 1990) the Govt. has decided to export large quantities of rice, wheat, sugar and some other agricultural products to bring in an extra bit of foreign exchange estimated at about Rs.2000 to 2500 crores. Part of these earnings would be utilized to offset the cost of importing edible oils during the year. Whether the import of edible oils will ultimately cause a lowering of the sky- rocketing prices of edible oils, however, remains to be seen.While the industry presses the govt. for increasing imports, it is feared that if a balance is not maintained between domestic availability and imports, this may lead to malpractices. According to NDDB sources, 60% of groundnut & coconut oils sold in loose form is adulterated with palm and palmolein oils (the two most favoured oils for imports). NDDB, which also acts as the market intervention agency on behalf of the government in the case of edible oils, feels that 'excessive imports may depress the domestic procurement prices and act as a disincentive to domestic production, making self-sufficiency in edible oils impossible'. Besides, with its role of a market intervener, NDDB has also been recently assigned the task of importing & marketing of edible oils through the public distribution system. To finance the imports NDDB has been authorised to export 30,000 tonnes of milk powder & 5000 tonnes of milk fat using STC channels for imports. NDDB will work jointly with STC to strengthen its market intervention operations (Times of India, Aug.26,1990).

Some experts favour legalizing the mixing of various edible oils(more particularly groundnut and coconut oils) with low-cost imported palmolein/palm oil (Times of India, Dec. 12,1990).This, it is argued, would help stabilize prices of edible oils and prevent much of the adulteration of oils and discourage hoarding and adulteration. Since such mixing of oils is legally sanctioned elsewhere in the world there should normally be no objection to accept this suggestion provided adequate safeguards are adopted to prevent consumer being taken for a ride.

Exports

India has been exporting deoiled meal, oilseeds and fats for the past several years, the major export item being the oilcakes. The world trade in oilseeds/oleginous fruits is in the range of about $8.34 billion and India's share is a meagre $ 5 million (1986). Acording to official estimates, the country expects to harvest an oilseeds crop of 17-18 million tonnes this year (Times of India, July 14th 1990) which should enable exports from this sector to grow. Table 17 gives details of the exports of oilcakes and oilseeds over the past few years. It will be seen that exports of solvent extractions, oilseeds and minor oils have recorded a big jump from Rs. 219.0 crores in 1987-88 to Rs. 821 crores in 1989-90. With the monsoons having behaved favourably there is a genuine expectation of another bumper crop this year. Therefore, the trade circles hope to achieve exports of about Rs.1000 crores from this sector during the current year. However, trade circles also fear that this target may not be achieved as overseas buyers are reluctant to enter into fresh commitments (Economic Times, Sept.4,1990), because of the Gulf imbroglio .

Earnings through exports of oilcakes have risen steadily from Rs. 163.65 crores in 1985-86 to Rs. 420 crores in 1988-89 and again to Rs. 595.0 crores in 1989-90. Similarly the exports of oilseeds have also gone up quite impressively. With soyabean, sesamum, mustard and groundnut showing a much better output this year, there is enough reason to believe that the exports of oilseeds will bring in a much higher foreign exchange earnings in the coming years. (Times of India, Dec.12,1990) A proposal has been mooted by some export houses to export 40,000 tonnes of coconut and mustard oils in view of the expected bumper crop.

Since NDDB's efforts to export 25,000 tonnes of mustard oil have not made much headway so far. The proposal is likely to go through for the export of at least 10,000 tonnes of the two oils. It is expected that if this proposal meets govt. approval mustard oil can fetch about $12,00 per tonne and coconut oil about $ 1000 per tonne — all in hard currency. However, the proposal is to export the two oils in small packs for which a ready market is said to be available in the USA and West Asian countries.There are, however, some misgivings about the extractions of groundnut, cottonseed and mustard. Their demand in the international market is limited because of the presence of toxic materials which render them unfit for use as animal feed. Unless, therefore, the industry can induct suitable technology and install detoxifier process, the growth of exports from this segment may remain restricted (Directorate of Vanaspati,1990.) Clearly in the present state of the country's balance of payments position, maximizing exports and minimizing imports should be our foremost task.

Currently all exports from the edible oil sector are being handled by various trade/industry organisations such as SEA,SOPA, GEEDA, IOPEA and AICOSCA. These associations handle & promote exports as well as monitor the entire process on their own. The govt. has now decided to revive an old proposal of setting up an Export Promotion Council with the primary objective of boosting

exports from the edible oil sector to the maximum extent. This has given rise to some apprehensions, for right or wrong reasons, within the trading circles that this move may cause a setback to exports from the oil sector. In their opinion there may be a duplication of efforts and a slowing down of the country's export promotion efforts. Of course, the prevailing economic circumstances do not permit either duplication of efforts directed to achieve the same objective or a reduction in the quantum of exports. It would perhaps be worthwhile looking into the exporters' grievance and providing them succour to the extent the current situation would permit. It is not unusual for the industry to exaggerate their fears and forebode disaster when no such premonition may be valid. All the same, the country can ill afford different bodies working at cross purposes.

Table 17 : Export of Oilcakes, Oilseeds and Fats: (Qty. Lakh tonnes/Value. Rs Crores)

Commodities	1985-86		1986-87		1987-88		1989-90		1990-91 (Estimates)	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Extractions										
Soyabean	4.81	99.00	5.77	131.00	3.07	89.00	8.55	330.75	10.00	385.0
Groundnut	1.64	28.25	2.87	53.70	2.65	65.00	4.30	85.00	6.50	143.0
Rice Bran	2.98	15.50	3.90	29.10	3.46	27.40	6.10	63.00	6.50	70.0
Repeseed	1.35	11.05	1.24	11.35	0.44	3.95	7.00	89.00	8.00	103.0
Cottonseed	0.36	4.05	0.53	6.80	0.23	4.50	0.37	7.00	0.75	14.0
Sunflower	0.23	1.40	0.19	1.70	0.39	3.90	0.66	9.50	1.00	14.0
Salseed	0.15	0.40	0.20	0.95	0.23	1.45	0.72	6.00	1.00	9.0
Others	0.25	4.00	0.25	4.00	0.30	4.50	0.25	4.75	0.75	15.0
Total	11.77	163.65	14.95	238.60	10.77	199.70	27.95	595.00	34.50	753.0
Oilseeds										
HPS										
Groundnut							0.25	26.00	0.70	82.0
Sesame							1.38	178.00	1.00	133.0
Niger							0.11	10:00	0.10	10.0
Minor Oilseeds & fats										
Total							0.05	12.00	0.15	36.00
							1.79	226.00	1.95	261.00
Grand Total							29.74	821.00	36.45	1014.00

Source : Industrial Data Book 1988-89
Economic Times July 14th 1990

India being one of the World's largest rice producing countries, the possibilities of building exports of RBO are extremely bright provided suitable steps are taken in the right direction to maximize its production. By the end of this century paddy output in India is expected to be about 130 million tonnes (PTI,1989). The potential of bran production from this quantity of paddy may be in the neighbourhood of about 5.7 million tonnes which should yield 8.5 lakh tonnes of RBO oil. To achieve this, would call for modernization of huller mills which constitute about 30 per cent of the total rice milling capacity and also an improvement in the extraction process. Rice bran oil, it is said, sells at a premium in the West over other oils because of its nutritional value & medicinal properties. Since the RB cake is also in great demand, it will be ideal to invest in this area with a view to exploiting the full potential of exports of RB Oil.Castorseed, which is one of the non-edible seeds, also holds great export potential. In 1983-84 about 80,000 tonnes of castor oil worth Rs. 105 crores was exported. Besides we have been exporting every year another 20,000 tonnes of hydrogenated castor oil. In 1989-90 castor oil exports touched Rs. 192 crores (PTI, 1990).

The Future

The future of the edible oil industry depends largely on how the oilseed crop management develops in the coming years and to what extent both the primary and secondary sources of edible oils can be exploited. The induction and application of technology into the pre-harvest and post-harvest infrastructures of the edible oil industry is another aspect which would demand better management than it has been hitherto.

Both the government and the industry are aware of the need for a much higher output of oilseeds to meet the growing domestic demand. The government on its part took a concrete step by setting up an Oilseeds Technology Mission in 1986 with a clear mandate to:

a. make the country self-sufficient as early as possible in edible & non-edible oils by augmenting indigenous production of oilseeds, and

b. reduce the imports of this single food commodity through an integrated project approach involving different developmental, scientific, banking, marketing and processing agencies.

The Mission had then set for itself very ambitious targets as follows (Kothari, 1990)

1989-90 - Oilseeds - 18 MT Edible Oils 5 MT

2000 A.D. - Oilseeds - 26 MT Edible Oils 8 MT

However, what has been realized so far does not seem to inspire the confidence that the country is anywhere near achieving these targets. It must be conceded that there has been quite a substantial improvement in oilseeds/oils output,but self sufficiency is nowhere around. The Ministry of Agriculture has set a target of 172.40 lakh tonnes of oilseeds for the year 1990-91 which is about 8% more than what was achieved in 1989-90 and about 3.5% less than the ouput of 1988-89 the best year for oilseeds production so far. The breakup of this tentative target over nine major oilseed is as under (Times of India, July 21,1990):

	(Lakh tannes)
Groundnut	84.00
Rape/Mustard	42.20
Soyabean	16.00
Sesamum	5.40
Sunflower	6.00
Safflower	6.80
Niger	1.90
Linseed	5.00
Castor	5.10
Total	172.40

Preparatory to the achievement of these targets, the government has approved an outlay of Rs. 30.08 crores which will be spread over 146 districts of 17 states selected on the basis of their past contribution to oilseeds production. In addition, ICAR has also been allocated Rs. 200 lakhs for developing/production of breeder seeds. The government seems to be optimistic that the target for 1990-91 will be achieved as a result of good monsoon during the year. The acreage under oilseeds cultivation is also likely to increase, because of the higher support prices announced by the government recently.

The three main strengths on which the Technology Mission on Oils seeds has relied so far are:

* India's vast crop base of a very large variety of oilseeds
* An extensive research & development structure with as many as 90-100 research centres/institutes.
* A successful system of co-operatives floated on Anand pattern, which could be replicated in the oil sector.

However, the advantages flowing from these strengths are largely offset by a number of factors affecting productivity in the oil sector unfavourably which will have to be taken care of while developing a long term strategy. Some of these are:

* Utilization of marginal/unirrigated land for oil seeds cultivation, which renders the output of oilseeds uncertain.
* Low level crop technology in use which results in poor yield per hectare & makes crops susceptible to pests etc.
* Unremunerative support prices making oilseeds farming a risky affair for marginal and low income farmers.

The short term strategy adopted by the Technology Mission is to encourage high yielding varieties of seeds with a view to raise output through input management and subsidies. The long term ones include (1) improvement of current crop technology simultaneously augmenting output & boosting farmers' incomes (ii) improving post harvest infrastructures through modernization (iii) sprucing up extension service & providing service support to farmers to ensure the use of right inputs at the right time (iv) coordinating application of research to farming techniques.Although the Mission is only five years old, it has been able to bring about a perceptable change in the oil sector but much more remains to be done particularly in the allied areas like scientific storage, improved packaging and other post-harvest operations. Considering the success the country has achieved in the foodgrains area, one can reasonably hope that similar success will come our way in the oilseed/edible oil sector, sooner rather than later. The Government of India has recently (Jan 1990) signed an agreement with the FAO for formulating a long term policy for vegetable oils. The FAO Project seeks to evaluate alternative strategies for the development of oilseeds sub-sector upto the year 2000 A.D. Work on the project has already commenced and is expected to be completed soon so as to put into use all the new strategies which are consistent with the country's agricultural objectives.

Ministry of Agriculture lays down annual targets for oilseeds production. To achieve these targets, two centrally sponsored schemes, NODP-National Oilseeds

Development Project and OPTP-Oilseeds Production Thrust Project-are in operation in 18 states. The main purpose of these projects is to improve oilseeds output. These two projects are now being merged under one programme - Oilseed Production Programmes (OPP) with an outlay of Rs. 72.00 crores of which 25% will come from the concerned state governments. The success achieved by the two projects so far appears to be quite satisfactory. In this connexion a comparison between the production target and achievement during the past few years is relevant (table.18).In addition to the above development projects, there are two other schemes - namely NDDB's oilseeds project and National Oilseeds and Vegetable Oils Development Board's Project (NOVODP), also in operation. While NDDB's project which is funded by Co-operative league of USA (CLUSA) and Canadian Co-operative Association (CCA) aims at development of production, procurement, processing and marketing of oilseeds and vegetable oils through co-operative societies in seven states, the NOVODP's main thrust is on demonstration of appropriate crop production technologies for potential oilseed crops outside NODP and OPTP areas of operation.

Table 18 : Target and Achievement in Oilseeds (Lakh tonnes)

Year	Target	Production	% Achived
1984-85	130	129.5	99.6
1985-86	138	108.3	78.5
1986-87	147	112.7	76.7
1987-88	157	126.6	80.6
1988-89	155.6	178.8	114.9
1989-90	165.0	159.6(E)	96.7(E)
1990-91	172.0	-	-

Source : Ministry of Agriculture -1989-90

Summary & Conclusions

Being an important item of consumption, edible oils/ vanaspati have rightly acquired considerable importance. In this context, the productivity of the edible oil/vanaspati industry has assumed vital relevance to the country's economy. This industry is now a major organized sector with over 100 units in operation all over the country providing direct or indirect employment to over a million people.

A major producer of oilseeds, India holds first position in the production of groundnut, rapeseed, mustard and sesamum although the quality of its products is considerably below the world standards, particularly in respect of the oil content. As a result of concerted efforts over the past few years, the output of oilseeds has improved to some extent, but even today, mostly unirrigated marginal land is being used for raising oilseeds crop; leaving the resultant output to the mercy of monsoons.

Low level crop technology, reluctance to use fertilizers and modern farm implements and susceptability of oilseeds crop to pests & diseases, contribute largely to the continued low yield per hectare. Although, in the last two to three years, the yield has shown a rising trend, it would be difficult to attribute this solely to large scale development projects in operation, as the rainfall has been quite plentiful in recent years.

The per capita consumption of oils/fats, after many years of development, stays much below the recommeded nutrition standards, although there is a wide variation in the consumption of the urban and rural population. Largely due to income disparities vanaspati, the hydrogenated form of edible oils, has gradually become quite popular, particularly in rural areas, because of its comparative cheapness. The use of cheaper oils for vanaspati manufacture in preference to more expensive groundnut and coconut oils, has led to better capacity utilization in the industry but it still continues to be generally on the low side.

By and large, the entire edible oil/vanaspati industry suffers from both low capacity utilization and poor productivity, though some of the better managed units show encouraging results. Lower capacity utilization and to some extent even lower productivity in the industry can be attributed directly to deficient production of oilseeds. The gap between the current production of edible oils and the ever increasing demand remains unbridged even today after years of development efforts at various levels. Even the efforts of the Technology Mission, constituted specially for raising the domestic ouput of edible oils have not so far met with unqualified success and the goal of self sufficiency remains a distant dream. Industry's preoccupation with the continued shortfall of edible oils, its main input, leaves them little room for improving its productivity through operational efficiency and better management of its resources.

Exports and imports from this sector are also affected by the overall unsatisfactory production of oils & oilseeds. With persistent shortfalls the scope for exports is extremely limited, although some export earnings have been trickling in from the export of oilmeal/extractions. In the wake of an improved crop of oilseeds, some efforts are on to go in for the export of mustard & coconut oils. Imports have been a regular feature of the edible oil scene. Recently, attempts are being made to enter into barter

deals in return for surplus milk powder and/or trading expensive oils to import cheaper ones. The escape from imports, resorted to as the available soft option, is unlikely at present, as the efforts to improve output of oilseeds have not as yet succeeded to the expected extent nor seem likely in the near future.

The future of edible oil industry is dependent, in a large measure, on how the oilseeds scenario takes shape. With a burgeoning population, the demand for edible oils seems to be ever growing and whatever little improvement comes from the developmental efforts is neutralized by a corresponding growth of demand. The potential for growth in the industry will continue to rise. If only we can manage our priorties and resources in the right manner, the industry can cope with the rising domestic demand for edible oils and vanaspati.

Abbreviations Used

AICOSCA	-	All India Cottonseed Crushers Association
CMIE	-	Centre for Monitoring Indian Economy
FAO	-	Food and Agriculture Organization
GEEDA	-	Groundnut Extractions Export Development Association
HVOC	-	Hindustan Vegetable Oil Corporation
ICAR	-	Indian Council for Agricultural Research
ICMR	-	Indian Council for Medical Research
IOPEA	-	Indian Oil & Produce Exporters' Association
VMA	-	Indian Vanaspati Manufacturers' Association
IVPA	-	Indian Vanaspati Producers' Association
NCAER	-	National Council for Applied Economic Research
NDDB	-	National Dairy Development Board
NNMB	-	National Nutrition Monitoring Board
NODP	-	National Oilseeds Development Programme
OPTP	-	Oilseeds Production Thrust Project
OTAI	-	Oil Technologists Association of India
PDS	-	Public Distribution System
PTI	-	Press Trust of India
RBO	-	Rice Bran Oil
SEA	-	Solvent Extractors' Association
SOPA	-	Soyabean Processors' Association
STC	-	State Trading Corporation of India
TCS	-	Tata Consultancy Services
TOMCO	-	Tata Oil Mills Company

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Annexure 1

Demand for Edible Oil in India: An Estimate

Despite being a major oilseeds producer in the world (approximately one tenth of the produce comes from India) per capita consumption of edible oils in the country has been one of the lowest in the world. (Table A1 and A2). The consumption of edible oils has also been found to be highly income elastic (Table A3). Such a low per capita consumption of 4-6 kgs per annum (as against 20 kgs/year recommended by the WHO for average nutrition and 6.5 kgs/year as minimum per capita requirement) may imply that any increase in the per capita incomes may be accompanied by a more than proportionate increase in the per capita demand for edible oils. Increase in the prices of edible oils on the other hand, may be hypothesised to be a deterrent force, restraining the increase in the per capita consumption of oils in India.

Based on this theoretical framework, an emperical model of demand for edible oil in India was formulated and estimated as follows:

PEROIL = F(PERINC, PRIOIL)

PEROIL = Percapita oil consumption per annum (kgs)

PERINC = Average annual per capita income (NNP per capita at 1980-81 prices) (Rs.)

PRIOIL = Wholesale Price Index of Edible Oil (1970-71=100) relative to the Wholesale Price Index of All Commodities (1970-71=100)

The required data for this purpose was obtained from the National Accounts Statisties of the CSO and the Index Number of Wholesale Prices of the Economic Adviser (Ministry of Industry). The study was confined to 18 annual observations during the period 1971-72- 1988-89.

In a bid to capture the likely positive impact of the redistribution of incomes through anti-poverty measures on the consumption of edible oils, we also included in our emperical exercise a variable called the PERSDY (Per Capita Total Food Subsidy by the Central Government). However this variable could not be found acceptable based on emperical grounds. We tried the linear, semi log and double log variants of the formulated model, while estimating the demand function through Ordinary Least Squares (OLS) method; but only the double log variant came out successful on empirical grounds. The obtained results are shown in table A.4. It may be observed that the relative price of edible oils yields, as expected, a negative

coefficent; but it cannot be accepted on emperical grounds. This is, perhaps, due to the fact that edible oils, being an essential household consumption item, may not be sensitive to price changes. It is very important, here, to note that what we considered as edible oils has not been constituted by units which are of uniform characterestics. It might, therefore, be possible that any increase in the price of oil may be met by households by shifting themselves to lower qualities of the product. Since, the estimated equation is not for different quality grades, the extent of such shiftings could not be captured by the model. Further, the stabilising impact of imports on edible oil prices is a doubtful matter, due largely to the delays in decision making and also inequities in the distribution of imported quantities across the markets and regions. However, in view of the non-acceptability of PRIOIL as an explanatory variable, we accepted equation 2 in table A4 with only one explanotory variable, per capita income,(PERINC), as the demand equation for edible oils in India.

In order to project the demand for edible oils for years 1989-90 to 1999/00, we assumed that the national income in real terms will be growing at a compound rate of 5 percent per annum. With an assumed rate of growth in population of 2 percent per annum, this would imply a 3 percent growth per annum in per capita income in real terms.

Table A 1 : Per Capita Consumption of Edible Oils in India (kgs.)

	Per Capita Consumption *
1971-72	4.90
1972-73	4.11
1973-74	4.76
1974-75	4.59
1975-76	5.08
1976-77	4.63
1977-78	4.80
1978-79	5.79
1979-80	5.27
1980-81	5.26
1981-82	5.98
1982-83	5.41
1983-84	6.40
1984-85	6.46
1985-86	6.12
1986-87	5.98
1987-88	6.64
1988-89	7.52

* Aggregate consumption includes domestic production and imports. Population figures are those arrived at by the CSO as mid year estimates

Table A 2 : Per Capita Consumption of Oils/Fats in Various Countries (grams per day)

Brazil	50
South Korea	41
Pakistan	43
China	37
India	11.24
Developed Countries	110-140

Source : Kothari (1990)

Table A.3 : Average Consumption of Fats/Oils by different Groups (Unit-adult male)

	Daily Consumption (gms)	Annual Consumption (kgs)
Urban Areas		
High income Group	46	16.8
Middle Income Group	35	12.8
Low Income Group	22	8.0
Industrial labour	23	8.4
Slum Dwellers	10	3.6
Rural Areas (general)	10	3.6

Table A 4 : Demand Function Estimates (Dependant Variable: Per Capita Consumption of Edible Oils, kgs.) (N=18)

Regresion Equation (Double log)	Constant	Co-efficent PERINC	Co-efficent PRIOIL	$\bar{R}^2$	D.W. Statistic
1.	(-) 8.7503	1.3639* (8.0872)	(-) 0.7365 (0.4214)	.814	1.94
2.	(-) 8.5955	1.3879* (8.9761)	-	.824	1.95

* Significant at 1 percent level
Figures in parentheses are the 't' values.

Appendix 1 : Ratio of Total Earnins to Conversion Cost

	1984	1985	1986	1987	1988	1989	
Amrit	0.72	1.28	1.11	1.62	-	1.22(15 m)	m=months
Bombay Extrations	-	1.3	1.05	1.7	0.31	0.27(9 m)	
IVP	1.6	1.4	1.3	1.5	-	1.26(15 m)	
Kusum	-	0.84	0.77	0.92	1.09	0.09(9 m)	
Modern Mills	-	0.94	0.82	1.02	0.47	0.92(9m)	
Wipro	-	1.28	1.6	1.03	1.1	1.13(9m)	
Tomco	-	1.2	1.19	1.25	1.1	1.14	
Rasoi	1.6	1.9	2.2	1.5	1.7(15 m)	1.4	
Premier Veg. Products	0.8	1.1	0.7	1.4(15 m)	0.6	-	Relates to 1983-1987
Tungbhadra	1.0	1.0	0.7	1.25	-	1.1	
HVOC	-	(0.18)	0.5	1.7	1.8	1.2	
Swarup	1.09	1.06	1.15	1.08	0.88	-	Relates to 1982-1987
Oswal Agro	-	1.4	1.6	1.8	1.6	1.9	
Tristar Soya	-	0.97	1.2	1.7	0.03	1.7(8 m)	
Premier Industries	1.5	1.3	1.1	1.5	1.08(15 m)	1.27	
Mansinghka	0.6	1.0	0.4	(0.24)	0.16	-	
Motilal Padampat	1.5	1.2	1.7	0.3	1.9(8 m)	0.7	
Malwa	1.08	1.86	2.1	1.86	1.53(15 m)	-	
NDDB	-	3.8	2.3	2.8	3.5	0.96	
Coromandal	1.2	(0.2)	1.5	1.1	1.4	-	Relates to 1983-1987
Bhopal Sugar	1.2	1.0	0.99	0.9	-	0.7(18m)	
Rajasthan Vanaspati	0.98	0.76	0.92	0.94	0.98	-	Relates to 1982-1986

Source : Annual Reports/Data from Companies
CMIE - Key Financial Data Nov. 1989 & May 1990.

Appendix 2 : Ratio of Purchased Service to total Earnings

	1984	1985	1986	1987	1988	1989	
Amrit	0.58	0.48	0.56	0.39	-	0.53	m = months
Bombay Extractions	-	0.56	0.69	0.35	2.0	2.7(9 m)	
IVP	0.35	0.42	0.43	0.36	-	0.47(15 m)	
Kusum	-	0.6	0.6	0.5	0.5	0.75(9 m)	
Modern Mills	-	0.48	0.56	0.48	1.3	0.69(9 m)	
Wipro	-	0.5	0.4	0.7	0.7	0.7(9 m)	
Tomco	-	0.53	0.54	0.52	0.56	0.55	
Rasoi	0.38	0.34	0.31	0.43	0.39(15 m)	0.5	
Premier Veg. Products	1.1	0.8	1.2	0.6(15 m)	1.4	-	Relates to 1983-1987
Tungbhadra	0.6	0.5	0.75	0.4	-	0.5	
HVOC	-	(3.9)	1.2	3.7	0.34	0.48	
Swarup	0.7	0.7	0.5	0.5	0.7	-	Relates to 1982-1987
Oswal Agro	-	0.5	0.45	0.4	0.5	0.5	
Tristar Soya	-	0.7	0.7	0.5	22.0	0.5(8 m)	
Premier Industries	0.9	0.9	0.9	0.8	0.8(15 m)	0.8	
Mansinghka	1.3	0.83	1.7	(3.0)	4.3	-	
Motilal Padampat	0.5	0.6	0.4	2.2	0.4(8 m)	0.96	
Malwa	0.5	0.35	0.31	0.3	0.4(15 m)	-	
NDDB	-	0.17	0.22	0.25	0.18	0.80	
Coromandal	0.7	(0.5)	0.5	0.6	0.5	-	Relates to 1983-1987
Bhopal Sugar	0.57	0.7	0.6	0.4	-	0.66(18 m)	
Rajasthan Vanaspati	0.9	1.1	0.9	0.9	0.9	-	Relates to 1982-1986

Source : Annual Reports/Data from Companies
CMIE - Key Financial Data Nov. 1989 & May 1990

Appendix 3 Wages and Salaries to sales - Percentage

	1984	1985	1986	1987	1988	1989	
Amrit	6.8	7.5	8.5	6.9	-	7.6(15 m)	m = months
Bombay Extraction	-	4.0	7.2	4.6	7.1	5.5(9 m)	
IVP	4.5	4.9	5.0	5.1	-	4.9(9 m)	
Kusum	-	9.1	13.5	7.9	6.8	7.0(9 m)	
Modern Mills	-	13.5	15.7	12.5	4.6	5.3(9 m)	
Wipro	-	3.2	3.4	3.0	2.9	3.3(9 m)	
Tomco	-	17.4	17.6	17.2	20.0	19.1	
Rasoi	2.1	1.7	1.6	1.5	1.6(15 m)	1.8	
Premier Veg. Products	1.6	1.3	1.2	1.8(15 m)	3.1	-	Relates to 1983-1987
Tungbhadra	5.4	5.8	6.0	5.5	-	6.3	
HVOC	-	1.5	3.4	2.7	2.5	3.3	
Swarup	8.3	9.0	2.8	8.5	8.9	-	Relates to 1983-1987
Oswal Agro	-	3.4	1.9	1.7	2.0	2.3	
Tristar Soya	-	1.1	1.5	1.3	1.2	0.6(8 m)	
Premier Industries	0.75	0.81	0.74	1.0	0.66(15 m)	0.79	
Mansinghka	2.1	1.8	2.4	1.9	1.6	-	
Motilal Padampat	1.5	1.4	1.5	1.7	1.4(8 m)	2.3	
Malwa	2.3	2.2	2.1	1.7	2.3(15 m)	-	
NDDB	-	3.5	2.9	3.4	3.3	2.0	
Coromandal	2.6	3.8	3.9	3.5	3.6	-	Relates to 1983-1987
Bhopal Sugar	7.5	9.8	11.9	11.0	-	8.6(18 m)	
Rajasthan Vanaspati	2.0	1.8	1.7	2.8	2.0		Relates to 1982-1986

Source : Annual Reports/Data from Companies
CMIE- Key financial data Nov. 1989 & May 1990 Volumes

Appendix 4 : Ratio of Profit to Conversion Cost

	1984	1985	1986	1987	1988	1989	
Amrit	0.01	0.1	(0.2)	0.17	-	0.08(15m)	m = months
Bombay Extractions	-	0.008	0.04	0.09	(0.53)	(0.86)(9m)	
IVP	0.07	0.19	0.12	0.22	-	0.29(15m)	
Kusum	-	0.06	(0.19)	0.05	(0.02)	0.03(9m)	
Modern Mills	-	(0.22)	(0.12)	(0.31)	(0.85)	(0.86)(9m)	
Wipro	-	0.32	0.31	0.02	0.08	0.09(9m)	
Tomco	-	0.16	0.17	0.10	0.07	0.12	
Rasoi	0.5	0.7	0.7	0.6	0.2(15m)	0.2	
Premier Veg. Products	(0.01)	(0.09)	0.02	0.05(15m)	(0.5)	-	Relates to 1983-1987
Tungbhadra	0.02	(0.08)	0.08	(0.09)	-	(0.27)	
HVOC	-	0.15	0.31	0.45	0.52	0.21	
Swarup	0.07	0.04	(0.34)	0.6	(0.1)	-	Relates to 1982-1987
Oswal Agro	-	0.24	0.35	0.6	0.52	0.69	
Tristar Soya	-	0.3	0.1	(0.2)	(0.9)	0.5(8m)	
Premier Industries	0.18	0.12	0.33	0.02	0.07(15m)	0.27	
Mansinghka	0.01	0.01	(0.2)	(0.04)	(0.4)	-	
Motilal Padampat	0.75	0.55	0.5	0.03	0.28	(0.26)	
Malwa	(0.11)	0.35	0.33	0.15	0.07(15m)	-	
NDDB	-	0.29	0.27	0.11	0.02	0.02	
Coromandal	0.1	(0.02)	(0.05)	0.03	(0.2)	-	Relates to 1983-1987
Bhopal Sugar	0.05	(0.06)	(0.1)	0.06	-	0.02(18m)	
Rajasthan Vanaspati	0.008	(0.23)	(0.17)	(0.14)	0.04	-	Relates to 1982-1986

Source: Annual Reports/Data from Companies
CMIE - Key financial data Nov. 1989 & May 1990 Volumes

Appendix 5 : Profit to Sales - Percentage

	1984	1985	1986	1987	1988	1989	
Amrit	0.27	2.8	6.3	4.1	-	2.1 (15m)	m = months
Bombay Extractions	-	0.17	1.2	1.8	(12.4)	(23.5) (9m)	
IVP	0.9	2.8	1.8	3.2	-	4.5 (15m)	
Kusum	-	1.25	(5.2)	0.81	(0.30)	0.82 (9m)	
Modern Mills	-	(6.0)	(3.8)	(8.4)	(17.3)	(18.0) (9m)	
Wipro	-	4.2	4.0	0.6	2.0	2.3 (9m)	
Tomco	-	9.7	10.2	6.5	4.9	7.8	
Rasoi	3.5	4.7	4.6	3.4	1.6 (15m)	1.7	
Premier Veg. Products	(0.15)	(1.13)	0.24	0.6 (15m)	(12.3)	-	Relates to 1983-1987
Tungbhadra	0.2	(1.2)	1.1	(1.2)	-	4.0	
HVOC	-	1.4	3.8	4.2	4.4	2.0	
Swarup	2.6	2.0	(7.6)	1.4	(2.6)	-	
Oswal Agro	-	5.0	3.9	6.5	9.0	11.7	
Tristar Soya	-	4.5	1.5	(2.9)	(10.4)	5.7 (8m)	
Premier Industries	2.4	1.5	2.7	0.3	0.6(15m)	2.9	
Mansinghka	0.19	0.19	(3.4)	(0.5)	(0.6)	-	
Motilal Padampat	5.6	4.3	3.9	0.28	2.0(8m)	(2.8)	
Malwa	(0.95)	3.1	2.3	1.0	0.6 (15m)	-	
NDDB	-	3.0	3.0	1.3	2.1	2.0	
Coromandal	3.0	(4.3)	(1.3)	0.6	(3.6)	-	Relates to 83-87
Bhopal Sugar	1.3	(2.3)	(3.5)	1.4	-	0.4 (18m)	
Rajasthan Vanaspati	0.2	(4.3)	(2.7)	(4.7)	1.0	-	Relates to 1982-1986

Source : Annual Reports/Data from Companies
CMIE - Key Finanical Data Nov. 1989 & May 1990 Volumes

Appendix 6 : Profit per Emloyee-Rs. lakhs

	1984	1985	1986	1987	1988	1989	
Wipro	-	0.166	-	-	-	-	
Tomco	-	1.64	2.05	1.41	1.16	2.2	
Rasoi	0.245	0.447	0.503	0.451	0.282 (15m)	0.216	
Tungbhadra	0.01	(0.05)	-	-	-	-	
Hvoc	-	0.17	0.29	0.50	0.68	0.28	m = months
Premier Industries	0.22	0.18	0.52	0.05	0.17 (15m)	0.69	
Mansinghka	0.012	0.013	(0.23)	(0.04)	(0.5)	-	
Motilal Padampat	0.551	0.519	0.551	0.043	0.271 (8m)	(0.288)	
Malwa	0.055	0.213	0.2	0.108	0.081 (15M)	-	
Nddb	-	0.135	0.187	0.087	0.015	0.021	

Source : Annual Reports/Data from Companies
CMIE - Key Financial Data Nov. 1989 & May 1990 Volumes

Appendix 7 : Sales per Employee - Rs. Lakhs

	1984	1985	1986	1987	1988	1989
Wipro	-	3.99	-	-	-	-
Tomco	-	16.9	20.1	21.7	23.4	28.1
Rasoi	7.02	9.51	10.84	13.24	17.26(15m)	13.04
Tungbhadra	4.5	4.4	-	-	-	-
HVOC	-	11.6	7.7	11.9	15.7	13.9
Premier Industries	9.1	11.7	19.6	14.5	30.5(15m)	23.7
Mansinghka	5.95	6.89	6.58	7.38	8.24	-
Motilal Padampat	9.8	12.0	14.1	15.1	13.7(8m)	10.4
Malwa	5.85	6.91	8.63	10.47	12.62(5m)	-
NDDB	4.5	6.2	6.8	7.4	-	11.7

m = months

Source: Annual Reports/Data from Companmies
CMIE - Key Financial Data Nov. 1989 & May 1990 Volumes

Appendix 8 : Value Added per Employee - Rs. Lakhs

	1984	1985	1986	1987	1988	1989
Wipro	-	0.422	-	-	-	-
Tomco	-	5.7	7.3	6.4	7.3	9.1
Rasoi	0.65	0.89	0.85	0.90	0.87(15m)	-
Tungbhadra	0.32	0.27	-	-	-	-
HVOC	-	0.51	0.72	1.2	0.68	0.28
Premier Industraies	0.68	0.66	1.5	1.1	-	-
Padampat	-	-	-	-	-	-
Malwa	-	0.48	0.48	0.39	-	-

m = months

Source : Annual Reports/Data from Companies
CMIE - Key Financial Data Nov. 1989 & May 1990 Volumes

Energy Intensity Ratios in The Indian Economy

NPC Research Section

In earlier reports, we have arrived at labour productivity ratios, capital productivity ratios and total productivity indices for broad economic sectors of the Indian economy for all the years from 1950-51 to 1988-89 [Productivity, 31(1), Productivity 31(3)]. In the present study, the attempt is to arrive at energy productivity ratios for the same broad economic sectors for the corresponding period.

The major energy consuming sectors are indentified as:

(i) Agriculture (including Forestry and Fishing)

(ii) Mining and Manufacturing

(iii) Transport (including Communication)

(iv) Commercial (including Services sector activities)

For purposes of the present study, energy consumption covers only the following commercial sources :

(i) Coal (excluding consumption in Power utilities)

(ii) Oil

(iii) Electricity

Energy intensity is defined as energy consumed per unit of value added. While coal intensity is measured in terms of Million Metric Tonnes (MMT) per crores of rupees; oil intensity, Million Tonne Coal Replacement (MTCR) per crores of rupees; electricity intensity, Million Kilowatt Hrs: (MKWH) per crores of rupees; total energy intensity of the sector is measured in terms of Million Tonne Coal Replacement (MTCR) per crores of rupees. For computation purposes, the following conversion factors are used :

MTCR = 1.5 MMT of Coal

$$\text{MTCR} = \frac{\text{MKWH}}{1000}$$

Value added for the purpose of the present study has been measured at 1980-81 base prices.

Energy consumption data has been taken from the following sources:

(i) Fuel Policy Committee Report (1973)

(ii) Report of the Working Group on Energy Policy(1979)

(iii) Central Electricity Authority; 11th & 13th Electric Power Survey of India.

(iv) Department of Petroleum; Indian Petroleum and Petro-chemicals Statistics, various issues;

(v) Coal Controller's Organisations; Monthly Coal Statistics, various issues.

Coal consumption figures exclude those used for electricity generation in the power utility sector. Oil consumption figures exclude products used for non-energy purposes.

The value added figures (at 1980-81 base prices) for various sectors and for the total economy are taken from the Central Statistical Organisation, National Accounts Statistics, various issues.

All information for the year 1988-89, are provisional.

Table 1 : Energy Intensity In Agriculture Sector

	GDP (Rs. Cr)	Sectoral Energy Consumption				Intensity ('000 Units/Cr Rs.)			
		Coal (MMT)	Oil (MTCR)	Elect. (MKWH)	Total (MTCR)	Coal (MMT)	Oil (MTCR)	Elect. (MKWH)	Total (MTCR)
1953-54	26769	0.00	1.61	200	1.81	0.00	0.060	7.471	0.068
1954-55	27556	0.00	1.63	200	1.83	0.00	0.059	7.258	0.066
1955-56	27318	0.00	1.72	300	2.02	0.00	0.063	10.982	0.074
1956-57	28803	0.00	1.92	340	2.26	0.00	0.067	11.804	0.078
1957-58	27509	0.00	2.17	600	2.77	0.00	0.079	21.811	0.101
1958-59	30281	0.00	2.35	600	2.95	0.00	0.078	19.814	0.097
1959-60	29976	0.00	2.58	700	3.28	0.00	0.086	23.352	0.109
1960-61	31995	0.00	2.74	800	3.54	0.00	0.086	25.004	0.111
1961-62	32022	0.00	2.92	990	3.91	0.00	0.091	30.916	0.122
1962-63	31385	0.00	3.17	1100	4.27	0.00	0.101	35.049	0.136
1963-64	32119	0.00	3.60	1150	4.75	0.00	0.112	35.804	0.148
1964-65	35082	0.00	3.60	1400	5.00	0.00	0.103	39.907	0.143
1965-66	31208	0.00	4.41	1890	6.30	0.00	0.141	60.561	0.202
1966-67	30764	0.00	5.13	2110	7.24	0.00	0.167	68.587	0.235
1967-68	35339	0.00	5.27	2580	7.85	0.00	0.149	73.007	0.222
1968-69	35283	0.00	6.85	3460	10.31	0.00	0.194	98.064	0.292
1969-70	37551	0.00	4.54	3770	8.31	0.00	0.121	100.397	0.221
1970-71	40214	0.00	4.51	4470	8.98	0.00	0.112	111.155	0.223
1971-72	39459	0.00	5.32	5090	10.41	0.00	0.135	128.995	0.264
1972-73	37479	0.00	6.17	5920	12.09	0.00	0.165	157.955	0.323
1973-74	40178	0.00	7.85	6310	14.16	0.00	0.195	157.051	0.352
1974-75	39566	0.00	8.93	7760	16.69	0.00	0.226	196.128	0.422
1975-76	44666	0.00	9.40	8721	18.12	0.00	0.210	195.249	0.406
1976-77	42085	0.00	12.46	9620	22.08	0.00	0.296	228.585	0.525
1977-78	46309	0.00	15.92	10110	26.03	0.00	0.344	218.316	0.562
1978-79	47375	0.00	19.37	12830	32.20	0.00	0.409	270.818	0.680
1979-80	41323	0.00	24.50	13450	37.95	0.00	0.593	325.485	0.918
1980-81	46479	0.00	28.70	14990	43.69	0.00	0.617	322.511	0.940
1981-82	49139	0.00	33.00	15234	48.23	0.00	0.672	310.019	0.982
1982-83	48358	0.00	37.68	17857	55.53	0.00	0.779	369.267	1.148
1983-84	53473	0.00	39.60	18282	57.88	0.00	0.741	341.892	1.082
1984-85	53502	0.00	42.00	21438	63.43	0.00	0.785	400.695	1.186
1985-86	53652	0.00	44.60	23533	68.13	0.00	0.831	438.623	1.270
1986-87	52426	0.00	45.84	26447	72.28	0.00	0.874	504.463	1.379
1987-88	53053	0.00	46.85	30290	77.14	0.00	0.883	570.938	1.454
1988-89	62277	0.00	46.90	33028	79.92	0.00	0.753	530.340	1.283

1. GDP in Rs. crores at 1980-81 prices
2. MMT = Million Metric Tons
3. MTCR = Million Tons of Coal Replacement
4. MKWH = Million Kilowatt Hours
5. Agriculture sector includes Agriculture, Forestry & Logging and fishing

Table 2 : Energy Intensity In Mining And Manufacturing Sector

		Sectoral Energy Consumption				Energy Intensity ('000 Units/Cr. Rs.)			
	GDP (Rs. Cr)	Coal (MMT)	Oil (MTCR)	Elect (MKWH)	Total (MTCR)	Coal (MMT)	Oil (MTCR)	Elect (MKWH)	Total (MTCR)
1953-54	6149	9.200	3.65	5000	22.45	1.496	0.594	813.140	3.651
1954-55	6565	9.200	4.24	5600	23.64	1.401	0.646	853.008	3.601
1955-56	7044	8.867	4.70	6300	24.30	1.259	0.667	894.378	3.450
1956-57	7559	8.933	5.05	6900	25.35	1.182	0.668	912.819	3.354
1957-58	7866	11.067	5.54	7700	29.84	1.407	0.704	978.897	3.794
1958-59	7244	11.733	5.95	8800	32.35	1.620	0.821	1214.798	4.466
1959-60	8793	11.200	6.44	10300	33.54	1.274	0.732	1171.386	3.814
1960-61	9569	13.933	7.23	11600	39.73	1.456	0.756	1212.248	4.152
1961-62	10364	16.133	7.69	14460	46.35	1.557	0.742	1395.214	4.472
1962-63	11157	18.667	9.33	16500	53.83	1.673	0.836	1478.892	4.825
1963-64	12151	18.000	6.56	19130	52.69	1.481	0.540	1574.356	4.336
1964-65	12938	18.133	7.15	20920	55.27	1.402	0.553	1616.942	4.272
1965-66	13165	20.067	8.09	22620	60.81	1.524	0.615	1718.192	4.619
1966-67	13286	20.267	9.06	24380	63.84	1.525	0.682	1835.014	4.805
1967-68	13367	22.000	9.85	26790	69.64	1.646	0.737	2004.189	5.210
1968-69	14076	21.267	10.39	29930	72.22	1.511	0.738	2126.314	5.131
1969-70	15517	20.867	9.36	32340	73.00	1.345	0.603	2084.166	4.705
1970-71	15769	20.713	10.90	34300	76.27	1.314	0.691	2175.154	4.837
1971-72	16277	21.000	10.60	35350	77.45	1.290	0.651	2171.776	4.758
1972-73	16939	21.147	9.00	44870	85.59	1.248	0.531	2648.917	5.053
1973-74	17653	24.300	8.72	46000	91.17	1.377	0.494	2605.789	5.165
1974-75	18193	30.467	8.62	45000	99.32	1.675	0.474	2473.479	5.459
1975-76	18712	34.007	8.50	44380	103.89	1.817	0.454	2371.740	5.552
1976-77	20274	33.800	8.55	43300	102.55	1.667	0.422	2135.740	5.058
1977-78	21487	33.733	8.40	46300	105.30	1.570	0.391	2154.791	4.901
1978-79	23985	33.667	8.50	52500	111.50	1.404	0.354	2188.868	4.649
1979-80	23284	34.000	9.00	53900	113.90	1.460	0.387	2314.894	4.892
1980-81	23531	35.200	10.19	52600	115.59	1.496	0.433	2235.349	4.912
1981-82	25523	39.287	11.20	52033	122.163	1.539	0.439	2038.671	4.786
1982-83	27295	44.240	11.23	52054	129.644	1.621	0.411	1907.089	4.750
1983-84	30063	46.780	11.48	56205	137.855	1.556	0.382	1869.574	4.586
1984-85	32127	45.640	12.27	61613	142.343	1.421	0.382	1917.795	4.431
1985-86	34969	49.553	13.05	65795	153.175	1.417	0.373	1881.524	4.380
1986-87	38246	50.513	13.54	74052	163.362	1.321	0.354	1936.202	4.271
1987-88	38968	53.453	14.77	92540	187.490	1.372	0.379	2374.769	4.811
1988-89	42170	54.000	15.60	100354	196.954	1.281	0.370	2379.749	4.670

1. GDP in Rs. crores at 1980-81 prices
2. MMT = Million Metric Tons
3. MTCR = Million Tons of Coal Replacement
4. MKWH = Million Kilowatt Hours

Table 3 : Energy Intensity In Transport Sector

	GDP (Rs. Cr)	Sectoral Energy Consumption				Energy Intensity ('000 Units/Cr. Rs.)			
		Coal (MMT)	Oil (MTCR)	Elect (MKWH)	Total (MTCR)	Coal (MMT)	Oil (MTCR)	Elect (MKWH)	Total (MTCR)
1953-54	1173	8.067	8.76	600	21.46	6.877	7.468	511.509	18.295
1954-55	1232	7.800	9.36	600	21.66	6.331	7.597	487.013	17.581
1955-56	1319	8.200	10.37	700	23.37	6.217	7.862	530.705	17.718
1956-57	1427	9.133	11.51	700	25.91	6.400	8.066	490.540	18.157
1957-58	1517	9.800	12.94	800	28.44	6.460	8.530	527.357	18.748
1958-59	1630	9.867	14.14	800	29.74	6.053	8.675	490.798	18.245
1959-60	1730	10.133	15.53	900	31.63	5.857	8.977	520.231	18.283
1960-61	1849	10.667	17.37	800	34.17	5.769	9.394	432.666	18.480
1961-62	1976	11.133	19.47	850	37.02	5.634	9.853	430.162	18.735
1962-63	2130	11.600	21.78	900	40.08	5.446	10.225	422.535	18.817
1963-64	2266	11.600	25.35	960	43.71	5.119	11.187	423.654	19.289
1964-65	2380	11.600	27.51	1000	45.91	4.874	11.559	420.168	19.290
1965-66	2506	11.533	31.26	1160	49.72	4.602	12.474	462.889	19.840
1966-67	2585	11.267	33.35	1270	51.52	4.358	12.901	491.296	19.930
1967-68	2744	11.133	35.29	1380	53.37	4.057	12.861	502.915	19.450
1968-69	2885	10.867	39.72	1320	57.34	3.767	13.768	457.539	19.875
1969-70	3047	10.747	43.35	1450	60.92	3.527	14.227	475.878	19.993
1970-71	3155	10.607	47.23	1430	64.57	3.362	14.970	453.249	20.466
1971-72	3256	9.333	51.90	1450	67.35	2.867	15.940	445.332	20.685
1972-73	3493	9.267	39.20	1630	54.73	2.653	11.222	466.648	15.668
1973-74	3637	9.133	41.70	1830	57.23	2.511	11.465	503.162	15.735
1974-75	3992	9.400	44.80	1890	60.79	2.355	11.222	473.447	15.228
1975-76	4324	9.730	49.60	2160	66.35	2.250	11.471	499.537	15.346
1976-77	4633	9.130	56.70	2290	72.68	1.971	12.238	494.280	15.689
1977-78	4751	9.730	62.30	2360	79.25	2.048	13.113	496.738	16.682
1978-79	5077	8.130	69.29	2580	84.06	1.601	13.648	508.174	16.558
1979-80	5364	8.330	78.18	2290	92.96	1.553	14.575	426.920	17.331
1980-81	5724	9.450	90.70	2270	107.14	1.651	15.846	396.576	18.719
1981-82	6189	9.010	101.80	2535	117.85	1.456	16.449	409.598	19.042
1982-83	6641	8.760	106.10	2707	121.94	1.319	15.977	407.619	18.363
1983-84	7104	8.560	114.80	2802	130.44	1.205	16.160	394.426	18.362
1984-85	7645	7.570	122.80	2970	137.12	0.990	16.063	388.489	17.937
1985-86	8409	7.690	131.90	3134	146.56	0.914	15.686	372.696	17.430
1986-87	8978	6.290	142.10	3299	154.83	0.701	15.828	367.454	17.246
1987-88	9232	6.040	155.40	3974	168.43	0.654	16.833	430.459	18.245
1988-89	9894	6.000	166.00	4417	179.41	0.606	16.778	446.432	18.134

1. GDP in Rs. crores at 1980-81 prices
2. MMT = Million Metric Tons
3. MTCR = Million Tons of Coal Replacement
4. MKWH = Million Kilowatt Hours
5. Transport Sector includes Transport, Storage and Communications (Code - 7 of National Accounts Classification)

Table 4 : Energy Intensity In Commercial Sector

	GDP (Rs. Cr)	Sectoral Energy Consumption				Energy Intensity ('000 Units/Cr. Rs.)			
		Coal (MMT)	Oil (MTCR)	Elect (MKWH)	Total (MTCR)	Coal (MMT)	Oil (MTCR)	Elect (MKWH)	Total (MTCR)
1953-54	13596	0.400	0.00	1100	1.70	0.029	0.000	80.906	0.125
1954-55	14351	0.400	0.00	1200	1.80	0.028	0.000	83.618	0.125
1955-56	15280	0.467	0.00	1300	2.00	0.031	0.000	85.079	0.131
1956-57	16066	0.467	0.00	1400	2.10	0.029	0.000	87.141	0.131
1957-58	16274	0.333	0.00	1600	2.10	0.020	0.000	98.316	0.129
1958-59	17032	0.400	0.00	1800	2.40	0.023	0.000	105.683	0.141
1959-60	17901	0.467	0.00	2100	2.80	0.026	0.000	117.312	0.156
1960-61	19118	0.467	0.00	2200	2.90	0.024	0.000	115.075	0.152
1961-62	20068	0.267	0.00	2140	2.54	0.013	0.000	106.637	0.127
1962-63	21078	0.333	0.00	2150	2.65	0.016	0.000	102.002	0.126
1963-64	22480	0.467	0.61	2110	3.42	0.021	0.027	93.861	0.152
1964-65	23841	0.200	0.65	2190	3.14	0.008	0.027	91.859	0.132
1965-66	24562	0.200	0.85	2530	3.68	0.008	0.035	103.005	0.150
1966-67	25481	0.333	0.95	2820	4.27	0.013	0.037	110.671	0.168
1967-68	26514	0.333	1.55	3080	5.13	0.013	0.058	116.165	0.193
1968-69	27670	0.267	1.55	3570	5.52	0.010	0.056	129.021	0.199
1969-70	28984	0.200	7.26	3970	11.53	0.007	0.250	136.972	0.398
1970-71	30215	0.200	6.97	4500	11.77	0.007	0.231	148.933	0.390
1971-72	31187	0.267	6.50	3940	10.84	0.009	0.208	126.335	0.348
1972-73	31923	0.267	6.00	3780	10.18	0.008	0.188	118.410	0.319
1973-74	32483	0.444	5.50	3480	9.64	0.014	0.169	107.133	0.297
1974-75	33248	0.384	4.50	3510	8.58	0.012	0.135	105.570	0.258
1975-76	35779	0.347	3.52	4140	8.18	0.010	0.098	115.710	0.229
1976-77	37630	0.393	4.10	4420	9.11	0.010	0.109	117.459	0.242
1977-78	39935	0.359	4.90	4330	9.76	0.009	0.123	108.426	0.245
1978-79	42132	0.281	5.82	4190	10.43	0.007	0.138	99.449	0.248
1979-80	42306	0.295	6.70	4230	11.37	0.007	0.158	99.986	0.269
1980-81	44503	0.320	7.40	4270	12.15	0.007	0.166	95.949	0.273
1981-82	46753	0.340	8.20	4300	13.01	0.007	0.175	91.973	0.278
1982-83	49223	0.327	8.60	4280	13.37	0.007	0.175	86.951	0.272
1983-84	51594	0.353	8.70	4320	13.55	0.007	0.169	83.731	0.263
1984-85	56823	0.340	8.90	4300	13.71	0.006	0.157	75.674	0.241
1985-86	60062	0.333	9.00	4270	13.77	0.006	0.150	71.093	0.229
1986-87	65843	0.320	9.60	4310	14.39	0.005	0.146	65.459	0.219
1987-88	70843	0.307	10.10	4300	14.86	0.004	0.143	60.698	0.210
1988-89	75843	0.300	10.50	4360	15.31	0.004	0.138	57.487	0.202

1. GDP in Rs. crores at 1980-81 Prices
2. MMT = Million Metric Tons
3. MTCR = Million Tons of Coal Replacement
4. MKWH = Million Killowatt Hours
5. Commercial sector includes Trade; Hotel & Restaurents; Finance, Insurance & Real esates; Community, social & personal services; construction etc. (Code nos. 5, 6, 8, 9, as per National Accounts classification)

Table 5 Total Energy Intensity Of Indian Economy

		Sectoral Energy Consumption				Energy Intensity ('000 Units/Cr. Rs)			
	GDP (Rs. Cr)	Coal (MMT)	Oil (MTCR)	Elect (MKWH)	Total (MTCR)	Coal (MMT)	Oil (MTCR)	Elect (MKWH)	Total (MTCR)
1953-54	47863	19.133	23.78	7600	60.080	0.400	0.497	158.787	1.255
1954-55	49895	19.000	25.77	8400	62.670	0.381	0.516	168.354	1.256
1955-56	51173	19.200	30.30	9410	68.510	0.375	0.592	183.886	1.339
1956-57	54086	20.467	31.18	10240	72.120	0.378	0.576	189.328	1.333
1957-58	53432	23.067	33.93	11800	80.330	0.432	0.635	220.841	1.503
1958-59	57487	24.067	36.40	13200	85.700	0.419	0.633	229.617	1.491
1959-60	58745	23.800	40.07	15400	91.170	0.405	0.682	262.150	1.552
1960-61	62904	26.933	43.91	16900	101.210	0.428	0.698	268.663	1.609
1961-62	64856	29.400	48.51	20140	112.750	0.453	0.748	310.534	1.738
1962-63	66228	32.733	54.53	21670	125.300	0.494	0.823	327.203	1.892
1963-64	69581	32.400	56.37	25410	130.380	0.466	0.810	365.186	1.874
1964-65	74858	32.200	60.57	27760	136.630	0.430	0.809	370.835	1.825
1965-66	72122	34.533	64.61	30560	146.970	0.479	0.896	423.726	2.038
1966-67	72856	34.867	69.07	33210	154.580	0.479	0.948	455.831	2.122
1967-68	78785	36.333	73.35	36760	164.610	0.461	0.931	466.586	2.089
1968-69	80841	35.267	82.27	41460	176.630	0.436	1.018	512.859	2.185
1969-70	86109	35.013	90.06	45020	187.600	0.407	1.046	522.826	2.179
1970-71	90426	34.233	97.19	48530	197.070	0.379	1.075	536.682	2.179
1971-72	91339	33.267	101.94	49660	201.500	0.364	1.116	543.689	2.206
1972-73	91048	33.333	88.07	60500	198.570	0.366	0.967	664.485	2.181
1973-74	95192	36.411	91.27	62220	208.106	0.382	0.959	653.626	2.186
1974-75	96297	42.764	94.53	63260	221.936	0.444	0.982	656.926	2.305
1975-76	104968	46.550	98.69	65201	233.716	0.443	0.940	621.151	2.227
1976-77	106280	45.790	109.88	65930	244.495	0.431	1.034	620.342	2.300
1977-78	114219	46.423	120.02	69900	259.554	0.406	1.051	611.982	2.272
1978-79	120504	44.745	131.74	79800	278.657	0.371	1.093	662.219	2.312
1979-80	114236	45.625	138.98	82270	289.688	0.399	1.217	720.176	2.536
1980-81	122226	48.283	152.48	87400	312.305	0.395	1.248	715.069	2.555
1981-82	129776	51.930	171.85	89072	338.817	0.400	1.324	686.352	2.611
1982-83	133830	56.793	181.63	94248	361.068	0.424	1.357	704.237	2.698
1983-84	144817	59.627	195.65	100589	385.679	0.412	1.351	694.594	2.663
1984-85	150542	57.597	209.20	112561	408.156	0.383	1.390	747.705	2.711
1985-86	158176	61.777	223.57	121472	437.707	0.391	1.413	767.955	2.767
1986-87	164441	61.777	238.40	135738	466.803	0.376	1.450	825.451	2.839
1987-88	181071	64.600	256.65	164384	517.934	0.357	1.417	907.843	2.860
1988-89	197380	60.300	239.00	142159	471.609	0.306	1.211	720.230	2.389

1. GDP in Rs. crores at 1980-81 prices
2. MMT = Million Metric Tons
3. MTCR = Million Tons of Coal Replacement
4. MKWH = Million Kilowatt Hours

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□

Energy Consumption Trends in the Chloralkali Industry

NPC Energy Management Divisions

Chloralkali Industry, since its inception in early twenties, has established itself as one of the leading chemical industries in the country. With the growth in demand for caustic and chlorine, installed capacity has increased from 6.01 lakh tons in 1974 to 11.56 lakh tons of caustic in 1988. As a result, the chloralkali industry in India is heterogeneous, the units having been set up at different points of time with different technology sources and wide ranging inhouse modifications. Contribution of energy in the product cost being close to 50 per cent and with increasing cost and availability constraints, energy is a vital area for cost control. The industry consumes about 360 MW of power Caustic soda is manufactured in India by all the four process routes namely diaphragm process, amalgam process, chemical process and the latest, membrane technology. Till the fifties, diaphragm process was predominant. In this process, caustic soda produced, i.e., 11% lye, needed thermal energy for evaporation to concentrate but the presence of salt as impurity rendered the product unsuitable for Rayon manufacture, a major user. The amalgam process, developed in fifties, offered advantage of higher concentration i.e., 50% and better quality. Currently, this technology contributes about 90% of our country's production.

The chemical process, based on soda ash as feedstock has been adopted only by soda ash manufacturing units. The membrane process, developed abroad in recent decades, has entered the scene, of late. The process envisages production of caustic through the exchange across membranes and is attractive on account of many advantages such as lower energy needs, elimination of Mercury as a prospective pollutant, etc. However, the viabilitty of membrane technology, despite the advantages, is much debated in the industry on account of factors such as realisable energy saving margins, heavy investment needs site specific system modifications involved etc.

The Processwise installed capacities in India as in 1988 are as in Table I

Table 1: Processwise Installed Capacities in India

Process	No. of Units	TPY Capacity	% to Total
Mercury Amalgam Process	28	980500	84.7
Membrane Process	2	32350	2.7
Diaphragm Process	8	121450	10.4
Chemical Process	1	23300	2.0
	39	1157600	100.0

Based on industry estimates, the capacity installed is adequate for projected needs upto the year 1992.

For the reference year 1988, the contribution of caustic from different routes was 89.9% by Mercury Process, 3.0% by Membrane Process and 7.0% by diaphragm Process

The capacity utilisation varied from 63.5% in 1986 to 73.5% in 1988 which is influenced by the power availability from the grid.

Department of Power, Ministry of Energy, Government of India entrustred the National Productivity Council with the task of conducting energy audit studies.

According to these studies the estimated annual power and fuel consumption figures are 2837 million units and 5193 MT of fuel oil worth Rs. 283.7 crores and Rs. 37.57 crores respectively.

Power cut situation is one of the impediments to the sectoral energy productivity necessitating heavy investments and running costs towards captive diesel generation as an alternative to low capacity utilisation

In the prevalent scenario, an energy cost saving

Table 2: Sectoral Energy Consumption and Cost Per Annum

Sl. No.	Item Reference	Mercury Process	Membrane Process	Diaphragm Process
1.	Production level Tons/Year (1988)	765115	25964	59933
2.	Specific power consumption including auxliaries Kwh/MT	3381	2987	2900
3.	Specific Fuel Consumption (fuel) oil component Kg/MT	120	200	200
4.	Projected Annual Power Consumption in million Units	2586	77.55	173.8
5.	Projected Annual Fuel Oil Consumption in MT	91814	5193	10387
6.	Projected Power Cost at Re'1 per Unit(in crores Rs)	258.6	7.75	17.38
7.	Projected Fuel Cost at Rs. 3500/MT of fuel oil in Rs.crores	32.13	1.81	3.63.

potential of 6.43 per cent is considered realisable over the next 2 to 3 years with conservation measures

A number of improvement measures dependent upon imported technology affect the cost effectiveness of energy saving opportunities. Energy cost savings potential of 14.3 per cent exists under favourable conditions of import policy and incentives through adoption of membrane technology.

In diaphragm route, the membrane technology adoption is expected to yield a direct annual energy cost reduction of Rs. 7.94 crores which works out to 29.27% based on prevalent annual energy bill of Rs. 27.12 crores. The investment needs are estimated to be Rs. 40 crores.
In lieu of mercury process route, the membrane technology adoption is expected to yield a direct annual energy cost reduction worth Rs. 45.90 crores which works out to 15.7% based on prevalent annual energy bill of Rs. 290.73 crores. The investment needs for the conversion are estimated to be Rs. 750 crores.

The membrane technology viability is however to be realistically viewed, in the light of significant advantages of pollution abatement, reduction in costs of chemicals especially the elimination of mercury imports, maintenance, inventory and manpower, ease of operations and improved product quality, in addition to energy savings.

Compiled by
V. Raghuraman

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Technological progress has merely provided us with more efficient means for going backwards. *—Aldous Huxley*	No great man ever complained of lack of opportunity *—R.W. Emerson*

Pollution Audit in Fruits & Vegetables Processing Units

NPC Pollution Control Division

The Fruits & Vegetables processing sector is a major Agro processing industry. The units are licensed under the Fruit Product Order (FPO), Ministry of Food Processing. As on 1988, there were 2836 units with a total licensed capacity of 4.5 lakh tonnes per year. The 484 large/ organised units (with an installed production capacity of >100 TPA), account for 25 % of the total licenced capacity. The 2352 small, Cottage & Home scale units (with an installed capacity of 10 - 100 TPA), account for the remaining 75% of the total licensed capacity. However at 40% capacity utilisation, the actual annual production for 1988 was only 1.8 lakh tonnes.

On an average about 69 million tonnes of Fruits & Vegetables are harvested per year, out of which only about 0.5% is processed. Out of the 36 varieties harvested, Mango, Pineapple, Apple, Guava, Tomato, Potato, Cabbage and Greenpeas are the principal Fruits & Vegetables processed. They together account for more than 80% of the processed Fruits & Vegetables in the Country. With the changing life style, increased demand for export of processed foods and Governments's thrust on Agro/Food processing sector, the annual growth potential for Fruits & Vegetable processing industries has been estimated to be more than 10%.

Pollution Status

During various processing operations like, washing, peeling, boiling, blanching, pasteurisation and equipment cleaning etc., wastewater and solid wastes are generated. Till recently, no serious efforts have been made to assess the status of pollution generated by the Fruits & Vegetables processing industry. However during 1989-90, the National Productivity Council (NPC) carried out pollution audit studies in 19 units representing the principal Fruits & Vegetables processing sector. The studies were conducted as part of a project on "Comprehensive Industry Document for Fruits & Food processing Industries" sponsored by the Central Pollution Control Board. Based on the type of raw Fruits & Vegetables processed and the subsequent variations in the pollution load, the units surveyed have been divided into the following 4 categories:

Category A: Large Units (>250 TPA) - processing mainly one principal fruits/vegetables
Category B: Large Units (>250 TPA) - processing mixed type of fruits/vegetables.
Category C: Small Units (100-250 TPA) - processing single or mixed fruits/vegetables
Category D: Small Units (<100 TPA) - processing single or mixed fruits/vegetables.

In each of the units studied, wastewater flow measurements and composite wastewater sample collections were carried out for the daily complete production cycle. Based on these analytical results, specific waste generation factors for different principal fruits and vegetables processing units have been computed and given in table 1. The observed variations in specific wastewater volume and specific pollution loads are due to inherent characteristics of the raw fruits & vegetables processed and the subsequent variations in the production processes.

Pollution Abatement and Control Measures

It has been assessed that introduction of simple good house keeping measures, such as installation of coarse screens within the processing hall, spills control, avoidance of solid wastes carry over into effluent drain and segregation & continuous collection of fruit juices for recovery will reduce the total BOD load by about 10 to 20% and the Suspended solids (SS) load by about 30 to 40%.

Considering the typical characteristics of this industrial sector such as, seasonal variations in the types of fruits and vegetables processed, generation of low volume high organic strength wastewater by the small scale units, location of units within the city limits etc., appropriate wastewater treatment systems for each catagory of units were designed. For example, the units processing 100-250 TPA of raw fruits & vegetables (Category C) are mainly located in semi-urban or rural areas and for this category land intensive wastewater treatment system has been found to be the most effective. For units processing

less than 100 TPA of raw fruits & vegetables (Category D), it has been assessed that only the septic tank system is technically feasible. For the remaining categories (A & B) of Units, capital intensive compact wastewater treatment systems, with built-in operational flexibility to meet the seasonal variations in pollution load have been considered. The computed capital investment and the annual operating costs of these wastewater treatment systems, are shown in table-2.

Compiled by: N.K.Kuttiappan & L.Panneer Selvam.

Table 1 Computed specific waste generation factors for different principal fruits and vegetables processing units

	Type of fruits and vegeta-bles	Processi ng capac-ity in TPD and catagory	Raw wastewater characteristics* flow m^3/d	BOD kg/d	TSS kg/d	Specific pollution load (kg/ton. of raw fru & veg) flow m^3/t	BOD kg/t	TSS kg/t	Specific solid waste generated kg/t
			Fruits						
1.	Pine apple	6 Large	87	60	20.5	14.5	10.0	3.4	482
		1 Small	3.0	3.0	0.5	3.0	3.0	0.5	400
2.	Apple*	100 Large	689	584	31.0	6.9	5.8	0.31	300
		1 Small	0.85	0.85	0.2	0.85	0.85	0.2	225
3.	Mango	10 Large	54.0	42.1	8.7	5.4	4.2	0.9	450
		1 Small	5.4	4.2	0.87	5.4	4.2	0.9	400
4.	Guava	4.5 Large	19.5	19.0	9.9	4.3	4.2	2.2	200
			Vegetables						
5.	Tomato	15 Large	123	78.4	34.6	8.2	5.2	2.3	300
		1 Small	2.0	1.6	0.91	2.0	1.6	0.91	275
6.	Green peas	2 Large	50.4	86.1	9.7	25.2	43.0	4.9	200
		0.5 Small	12.6	21.5	2.4	25.2	43.0	4.9	200
7.	Cabb-age	2.5 Large	28.0	66.5	6.6	11.2	26.6	2.6	100
8.	Potato	6.5 Lar ge	109	262	56	16.5	40.3	8.6	160

*The large scale unit produces only the apple concentrate and the small scale unit produces apple juice/pulp.

Table 2 Estimated capital investment and annual operating costs for the most appropriate wastewater treatment systems

Fruit & vegetable processed	Capital investment cost (Rs)	Annual operating cost (Rs)	As percentage of annual turnover (%) Capital	recurring
Category A:				
Pineapple (6 TPD)	5,67,000	1,06,000	0.98	0.18
Mango (10 TPD)	4,57,000	92,000	0.61	0.12
Tomato (15 TPD)	6,60,000	1,27,000	1.1	0.21
Greenpeas (2 TPD)	5,48,000	1,19,000	3.65	0.79
Category B :				
Mixed fruits &8,15,000 Vegetables (8.4 TPD)	1,08,000	1.27	0.17	
Category C :				
Mixed fruitsvegetable (1 TPD)	30,000	1,000	4.6	0.15
Category D :				
Small unit with less than 100 TPA capacity	Units require only septic tank system for wastewater treatment. Capital & recurring costs <0.1% of the annual turnover			

News & Notes

UNDER INVESTMENT IN INFRASTRUCTURE?

"Infrastructure has too often been given a low priority by both the public and private sectors. Our collective stock of public capital has failed to attract the research talent and investment" according to a recent Report (WORLD LINK July-Aug 1990). As a result. a large part of our infrastructure is obsolete. Among the developed countries, many of the large scale projects date from the Industrial Revolution. The Panama Canal, the North American and European Railways and the London and New York Sub-way systems were all completed around the turn of the century. In recent years, infrastructure investment has declined precipetuously. The US, for example, saw infrastructural investments decline from 2.3% of GNP in the sixties to a mere 0.4% by the early eighties. Europe too has under invested in infrastructure. In the Third World, accelerating population growth and limited budgets have prevailed governments from building infrastructure networks that reach no more than a fraction of the population. World Bank estimates that developing countries will require over $ 100 billion per year—a trillion dollars in the 1990s—just to build and operate electric power networks; according to the Report.

Just as a train cannot exceed the limits of its road bed, our economy cannot exceed the limits of its infrastructure, says the Report. Poor infrastructure translates directly in to lost productivity "US truck drivers can spend up to double the time needed on the road because of emergency maintainence work on roads and bridges. Half of all US communities cannot expand because they lack sufficient waste water treatment facilities. In London it takes longer to cross town by car today than it did by carriage 100 years ago, costing workers years of lost productivity as they wait in rush hour traffic", adds the Report. Inefficient water and sewage systems create a wasteful drain on natural resources and pose severe health hazards. Besides wasting travellers' time, inefficient transport systems increase toxic emissions in the air. Of course, a shoddy infrastructure exacts a social cost by lowering the quality of life. For the poorer citizens of many cities, low quality infrastructure can even increase health problems and mortality rates.

In order to finance the renewal of the world's infrastructure, many governments are augmenting tax based funding by turning to the private sector. "In the Third world, privatisation is unlocking financial resources trapped by years of central planning", according to the Report. While infrastructure has typically been considered a one time investment, a sophisticated investment approach would factor in life cycle costs, inventory stock levels and put all building assets in to a consolidated portfolio. However "with advances in transportation and communication allowing people to move out of cities, both North and South might be persuaded to spend on the decentralization process and ease the burden on city infrastructure", notes the Report optimistically.

STEEL : LOW PRODUCTIVITY

In steel production, India has lost substantially its position to other countries. This is best exemplified by the performance of the blast furnanees. Inspite of introducing several modern technologies since independence, the average blast furnance productivity achieved today has come down to 1 ton per cu.m perday while in other countries it has risen from 1.0 to 2.0 tons and even up to 2.5 tons per cu.m; reveals a recent Report by the Department of Scientific & Industrial Research (Govt. of India) (Technology Evaluation and Norms Study in Steel Sector).

The Report adds that China adopted Basic Oxygen Steel making soon after India. The first BOF plant in China consisted of 3 thirty ton conventers rated to produce 600,000 tonnes per annum. To day the same shop (with the same conventers) is producing about 1.88 million tons of steel per year, over 3 times the rated capacity. Compared to this, the initial LD shop at Rourkela with three 40 ton converters rated to produce 750,000 tons of steel per year) is today producing only 500,000 tons (Maximum achieved being 811,000 tons in 1965-66). "It is, thus, evident that somewhere on the road to capacity build up, India has missed out in certain strategic areas which has caused the prevailing stagnancy in the steel industry leading to loss of its competitiveness."

In the world steel making scenereo, the the shift to oxygen steel making process was the single most important event since its advent in early 1950s. The world capacity of oxygen steel making increased from a meagre 800,000 tons to over 80 million tons between 1955 and 1965. Though, bulk of our capacity was added during this period, India installed almost 6 million tons capacity with Open Health Process Compared to only 1.5 million tons of Oxygen Steel capacity, according to the Report.

A major step taken by the steel industry to improve production economics is increase in yield. This has been achieved by the adoption of continuous casting. About 50% of the world crude steel production is continuously cast. In selected countries such as Japan it is about 93%, France 90%, FRG 85%, Italy 85%, South Korea 71% and Brazil 46%. In India it is only 27%, says the Report.

Energy constituted the single largest item of expenditure in the steel plants. Therefore, to reduce the cost of energy, the steel industry has always resorted to cheaper energy sources. After the two oil crises in 1971-73 and in 1979, the energy sources altered in favour of coal and the use of oil and natural gas was discountinued in the steel industry, where it was possible. Additionally a large number of energy recovery systems were developed and introduced in the steel plants and else where to reduce the energy biil. Today the steel plants are introducing coal injection, developed much earlier, in the blast furnace in order to reduce the cost. In India, on the other hand, awareness towards reducing energy consumption has been manifest only since the recent past. Energy saving economy measures such as coal injection in the blast furness, developing energy recovery system etc are given priorities, adds the Report.

Anothor aspect which has not received adequate attention of Indian industry, is the quality of steel. The Indian steel producers, by virtue of the protection offered by a large sheltered market and the chronic shortages in steel supply, have not paid attention to improving the quality of steel products. Even qualities like deep drawing are not produced which were developed decades earlier. New verities of steel such as high tensile auto-body, electrolytic galvanising, colour/plastic coating and dual phased steels etc have also not received any attention by the steel producers. Some verieties of low alloy high strength steels have, however, been developed and are being produced in the Indian plants in small quantities. In the case of long products no genuine efforts have been made so for to produce speciality steels for tyre beads, high tensile bolts and nuts, wire ropes auto-forgings etc., according to the Report.

HRD IN JAPAN

According to the noted international HRD expert, Dr. Hideo Inohara, "Janpanese Companies are not mere economic entities, but more significantly social organisations. They highly value social considerations. Each company has its own corporate philosophy that always stresses sincerity and harmony, co-operation with suppliers and coustomers and contribution to the betterment of society. Employees, particularly regular employees, identify themselves with such an organisation, which is more a family than an industrial venture. Such a management philosophy and employee attitude shapes the foundation of employment relations.....For national survival and growth, co-operation among industries is promoted by economic and business organisations. On its part, each company, for its own survival and growth, seeks to have its own group of diversified enterprises and/or to affiliate with an industrial group of enterprises." Dr. Inohara has revealed this in his recent book 'Human Resource Development in Japanese companies' published by the Tokyo based Asian Productivity Organisation.

Dr. Inohara reveals that in Japan, the major factors affectiving the corporate image are legal status, marketshare, listing on the stock exchange, the management philosophy; these are much more significant than corporate stock price and profitability. Corporate image, in turn, affects accessibility to external funds and good potential human resources. This accessibility is reflected, for example, in credit rating of companies and annual corporate ranking by prospective university graduates.

Dr. Inohara continues that "In essence, management views the company as a family. The fate of a family affects, and is shared by, all the members; survival, growth and development are the concern of every one. The well being of individual members is considered according to the family's capacity and the invidual's needs. In times of financial difficulty, the children are fed and clothed at the sacrifice of the parents. In prosperous times, all enjoy a confortable life..... Applying the family norm, the Japanese company calls all employees *Shain* (members of the company), regular employees as *Seishain* (Formal members) and temporary employees either as *Junshain* (associate members) or *Rinji-Shain* (temporary members). It expects all members ..... to share the common fate and participate in pursuing corporate objectives..... Corporate directors themselves are also members of such a family; they are not seprate from the employees. Employees who join immediately after graduation from school and

remain with the company are called *Ko-gai* (true-born). Directors are also *Ko-gai*, few are outsiders".

"This Industrial familism" according to Dr. inohara, "is expressed particularly by monetary compensation in two ways; first, in the post-war years, pay differentials between top management and low level employees have narrowed. For example, the average annual compensation of company presidents has reduced to 7.5 times that of new university graduates. Second, in times of financial difficulty, companies first cut compansation at executive level. followed in more serious cases by voluntary pay cuts for middle managers, reductions of regular monthly pay of ordinary employees is almost unheard of. In many companies in the hard pressed coal, textile, steel and ship building industries, corporate directors have cut their compensation by 15-25% for periods of three months to one year;"

Working life requires information. It is provided and communicated through out the organisation on managerial, financial and personal matters as well. Communication flows in all directions, not only vertically but horizontally by various means such as company news, bulletin boards, and informal meetings.As a result, it is common that even floor sweepers are concerned about productivity and sales of the company. In order to strengthen family like ties among employees and between supervisors and subordinates, the company organises and subsidises cultural activities including cultural fastivals. Welfare facilities include company housing for married employees, dormitories for single employees, resort houses, library, gymnasium etc. These are shared by all regular employees, irrespective of positions. Often some of these facilities are open to the local community as well; adds Dr. Inohara.

Employment relations match the context of the work place. They are in accordance with the society's evaluation, corporate philosophy and worker attitudes towards the work place. Long term employment as the norm, "merit of years of service" as an important ceriterion for promotion and enterprise wide unionism are standard characterstics; according to Dr. Inohara.

AGRICULTURAL WASTES FOR FUEL

According to a SIDA-FAO Study, (The Briquetting Agricultural Wastes for Fuel, FAO Environment & Energy Paper, 11, 1990) worldwide, there certainly is huge volumes of residues which are associated with agriculture and with wood processing and, probably most of these are not fully utilised. In general, although there are crops with both higher and lower residue yields, it is reasonable to assume that about 25% of any dry agricultural feed stock is a residue. Commonly between 1 and 2 tonnes of residue will arise from every tonne of cereal crops. Other crops produce residue ratios which are both higher and lower.

The residue will have an average heat content of 12-20 GJ/tonne. This means that even in the least productive countries, it is possible to envisage household fuel needs being satisfied very largely from residues in some form or the other. As residues in rural areas arise close to the communities, the existence of such a resource base has aroused hopes that a fuller use of agro-residues could provide a partial solution to fuel wood shortages and increasing fuel costs; according to the Study.

The potential for utilisation of wood wastes is also, in principle, very great though there are no good data on the general arisings of such wastes. "One survey has suggested that in 1979, world wide, about 250 million tonnes of sawdust, close to 200 million tonnes of other wood residues were produced ..... about 60% of this material arose in developing countries and, where as in the USA upto 80% of this waste was utilised, in developing countries large quantities remained unutilised ..... factors which make the utilisation of residues in industrialised countries ..... include the presence of large combustors which can handle difficult fuels and a greater access to investment capital and technical know-how. Additionally, fuel costs are higher in many industrial countries than in many developing countries, so there may be greater immediate incentives towards conservation", adds the Study.

Any method of utilising residues has to follow the trends with in agriculture, it cannot hope to influence them in any significant way. New varieties of crops, new processing methods at new locations, new markets and routes to markets; all these things are likely to alter more or less significantly the volume and location of residues. However, in making the decision to use any new procedure, the effects on residues will be considered, if at all, as a very secondary matter. However attractive a residual conversion technology may seem in terms of its efficiency or cost effectiveness in producing fuel, it must conform to the existing local dynamics of agriculture or it will not be adopted; cautions the Study.

New techniques for residue use has been made attractive by the greater centralisation of processing to serve urban or export markets and the use of chemical fertilizers to raise yields and decreased dependance upon organic fertilizers etc. However, this may be offset by other changes like the use of high yielding varieties with a lower

ratio of residue to crop or changes in land holdings away from larger farms to smaller units; etc.

Wastes may, in practice, have various uses in the local community despite being given no monetary value. Attempts to utilise the residue without offering any compensation are unlikely to be successful. Even when compensation is made, it may be that if the payment is made to someone other than the person to whom the original benefit accrued, the result may be social disruption. "In general, it is probably unwise to assume that any waste has no alternative use without careful investigations" warns the Study.

INDIAN LABOUR: FEWER BENEFITS?

The Indian Labour should get reduced benefits and protection in order to facilitate an 'exit' for firms embroiled in losses; recommends a World Bank Report on India. Less benefits would also help reduce tariffs on imports and protection to Indian industry in order to make them produce goods that would be more competitive abroad. Agricultural prices and subsidy policies need to be reviewed not only to assess their impact on individual crops and income distribution, but also from the standpoint of over all efficiency and fiscal burdens. Lower protection would be desirable not only to ensure access to imported capital goods and inputs needed for productivity growth, but also to increase competition in sheltered domastic markets and to provide a better environment for exporters. The current defensive strategy of preserving and providing benefits to existing job holders and firms seems to have raised the explicit and implicit labour costs and there by worsned the over all environment for employment growth; according to the World Bank Report.

In larger firms individual job positions are protected against retrenchment by a regulatory and legal system. The smallscale secor is sheltred against competition from large firms in numerous" reserved" product lines. In the manufacturing sector, jobs are protected from foreign competition through a complex structure of tariff and quantitative restrictions. This overall approach has meant that attention has been focused on protecting particular individuals in their existing jobs and maintaining and raising their incomes; states the Report.

Paradoxically, given the general concern about employment, this has effected serious disincentives against rapid employment growth in the organised industrial sector, according to the Report. Protection from imports has seriously harmed the dynamism, efficiency, flexibility and competitiveness of Indian industry ultimately reducing its growth potential and employment generating capacity.

To prevent larger firms from "appropriating" SSI benefits, links between small and large firms are limited. This discourages the kind of auxillary relationships between small and large firms that have fostered industrial growth and employment growth in Japan and Korea. There are few incentives for SSI firms to expand production and employment, since by doing so they would loose the benefits associated with small size; according to the Report.

The legal framework and government apparatus regulating industrial labour and labour management relations have generated disincentives to employment growth in organised manufacturing. Though designed to further the interests of workers, these laws and regulations increase the direct as well as indirect and long term costs of hiring labour and thus, constitutes a potential disincentive to employment expansion. Regulations restricting retrenchment of workers and closure of factories are a disincentive to expansion of organised sector employment since firms are struck with the hired labour even when business declines or if workers do not perform. Moreover, legislation is ineffective in maintaining employment over the long run, since industrialists have found various means by which they can get around the regulations. The statutory payment of annual bonuses and other benefits has strengthened the disincentives to hire workers. The direct cost of labour to employers has increased sharply in recent years in part due to the overindexation of wages; adds the Report.

Under the present system, India has achieved rising real wages, job security and other protection and benefits for the existing organised sector workers, even in a labour abundant economy. However the present system appears to be costly in terms of slow growth of employment in the manufacturing sector as a whole; according to the Report.

BIO-TECHNOLOGY: FOOD & WORK FOR THE THIRD WORLD

"If the potential of advanced bio-technology is to be realised to the fullest advantage, it is important to examine the impact that it is likely to have, either directly or indirectly, on the labour market and employment; to question in which branches of activity jobs are created or labour displacements occur as a result of such a restructuring of the agricultural sector", reports a news in ILO Information (Vol. 26, No. 4, Oct. 1990). The News quotes an instance from Nigeria relating to the use of bio-technology in the production of animal feed which improved the nutritional

level, created jobs and enhanced incomes. "The so-called SCP technologies (Single Cell Protein Production) which use micro organisms in combination with natural gases that are abundantly available in the country, would produce animal feed, with a particularly high protein content. This could mean Nigeria would no longer need to import expensive feed, which is vital for its widespread poultry Production". Cheap production methods would make SCP technologies available to small family enterprises and would create many jobs in larger concerns. There would be an increase in production in the sub-ordinate animal husbandry sector, which would also create employment opportunities ranging from wage labour to self employment;" according to the News.

"The crucial importance of access can be seen in the Mexican case. The introduction of advanced bio-technologies (APB) is unable to break down easily existing economic and social structures in agriculture. An increase in yield would most probably benefit first and foremost the existing large enterprises. ..... There is even a doubt as to the positive benefits on the labour market in Mexico. Dispensing with the use of pesticides, which has now become possible, would even result in a drop in labour use". The Mexican example shows that the introduction of advanced plant bio-technologies can be successful only if preceded or accompanied by a more progressive labour and social policy. "As long as credit and market opportunities are restricted and un-equally distributed, there can be no guarentee that everyone will have access to the advantages of APB. Further more, since bio-technological research is dominated by universities in the United States, which in turn depends on the funds from the multinational enterprises, Mexico remains dependent upon foreign know-how and capital", according to the News.

"Access is the key. Provided it is guarenteed, bio-technologies present an opportunity to the Third World to break out of the viscious circle of rural poverty", adds the News.

PRODUCTIVITY, FLEXIBILITY AND INNOVATION

"The organisational characteristics belonging to efficiency, quality and flexibility in that order appear to be interlinked. Companies able to meet high quality requirements can be shown to naturally develop from organisations, striving for efficiency. Similarly, flexible organisations spring forth from quality organisations" states M/s P.T. Bolwijn and T. Kumpe in their recent study 'Manufacturing in the 1990s—Productivity, Flexibility and Innovation' (Long Range Planning, Vol. 23, No. 4, 1990). The study found "non-quality costs a lot of money and that quality improvement is ultimately the way to increased efficiency". Flexibility, the ability needed to produce wide ranges of up-to-date products, can be achieved only if processes are controlled, if co-ordinated actions are taken and if components and semi-finished goods are of excellant quality. Flexibility is thus an extention of efficiency and quality. Flexibility is profitable since it leads to dereased inventories, less space needed, and simpler logistics. Flexibility is all the more profitable as it enables companies to very quickly introduce new technologies leading to high quality products with improved price/performance ratios; according to the Study.

The requirement of the 1990s, that the products which clearly stand out from those of competitors will be called uniqueness. The corresponding internal characteristics, needed to fulfil that requirement will be called innovative ability or innovativeness. The ability for renewal under time pressure will give innovativeness a completely new character compared to the past; adds the Study.

It thus seems highly likely that innovative ability will be the new market requirement of the 1990s. This requirement is an extension from the previous ones i.e. efficiency, quality and flexibility. According to the study, flexibility should be mastered before innovative ability can be improved. "Concerning people, we believe that people form the key element in effectively exploiting the possibilities offered by new technologies. This more and more rules out force as a means of achieving the required improvement, change and renewal which are at the quality firm, the flexible firm and the innovative firm respectively..... The highly complex and uncertain environment leads to the search for competence over-riding heirarchy. But this must not lead to an approach in which organisations are seen as machines, where everything is programmable and decision making is completely rational"; warns the Study.

ENERGY CONSERVATION ACTIVITIES IN ASIA

Energy consumption as a percentage of GDP is four times higher in China than in developed countries. In many Chinese industries (agro, cement, glass, bricks) industrial energy consumption per unit of product output is 100 percent higher than in decentralised countries," reveals a Study by the International Institute for Energy Consenation (IIEC) with the title Energy Conservation Activities in Asia.' The study is a part of a project to identify options for multilateral development banks to increase investments in end use energy efficiency in developing countries.

Energy conservation is a high priority for the Chinese government. It has two state agencies that work on energy conservation—the Energy Conservation Company (ECC) and the Bureau of Resource Saving and Comprehensive Utilisation (BRSCU) and a network of energy conservation centres around the country", according to the Study. Although, there has been little foreign financial support for Chinese energy conservation programmes, the current leading policy of domestic banks in China is to charge the lowest interest rates for agricultural and energy conservation loans. The institutional framework for energy conservation in China also includes the Energy Research Institute (ERI) which assesses promising energy technologies for the federal government.

According to the study, the major institutions involved in Energy consveration in the Philippines are the federal government's Office of Energy Affairs (OEA), the Philippines National Oil Company (PNOC) and the Energy of Management Association of the Philippines (EMAP). In addition, the USAID runs an industrial energy conservation loan fund called the Technology Transfer for Energy Management (TTEM).The leading institutions in energy conservation in Indonesia are the Federal Govt's Directorate for New Energy Development and the Quasi-private Industrial Energy Conservation Corporation (KONEBA). With the exception of establishing KONEBA, the Indonesian government has not taken many steps to implement energy conservation; adds the Study.

The Major Thai institutions involved in energy conservation are the federal government's National Energy Administration; the quasi-public Energy Conservation Centre of Thailand (ECCT) and the state owned utilities, EGAT, the MEA and PEA. In addition, the prime-ministers' National Energy Policy Office is working with the support of the Canadian International Development Agency to advance the end use forecasting capabilities, to assess the impact of expanded time-of-use tariffs and to evaluate the benefits to utilities of demand side management programmes "In recognition of the need to encourage producers of energy efficient technologies to invest in Thailand, the Thai government now grants rebates on the import taxes levied on energy saving equipment, machinery and materials. These taxes now average 35 percent for industrial applications and can be higher for building applications. However when the industrial and user demonstrates that the equipment will save energy and will have a pay back period of 2 to 5 years, the government will rebate the import tax up to 50 percent", according to the Study.

The Study found that the major government institutions working on energy conversation in India are: the Department of Power and the Petroleum Conservation Research Association (PCRA), and the National Productivity Council (NPC). The major non governmental organisation are the Tata Energy Research Institute (TERI), Development Alternatives (DA), and the Central Institute for Road Transport (CIRT). The development banks; IDBI, IFCI and the ICICI also play key roles in energy of conservation. "The Government of India has set a national target to achieve 15 per cent energy savings across the board from 1987-88 base line year at the end of Eighth Five Year Plan (1994-95) and to achieve another 5 percent by the end of Ninth Five Year Plan. Energy conservation targets have been established for each industrial sub-sector and for the transport sector.....Officials believe a 10 per cent can be saved across the board just through house keeping measures, based up on the experiences of the steel industry which has already improved its efficiency by 10 per cent just through improvements in monitoring and operation with virtually no investment. Indian rail roads are also saving about 10 per cent through house keeping measures and small investments. In agriculture sector it is estimated that 50 per cent energy savings can be achieved through proper installation and sizing of irrigation system. Generally, replacing irrigation pumps will serve more energy than adding new generation. Efforts are now on to try to convert diesal irrigation pumps to electric pumps"; according to the study.

Enercon is Pakistan's primary energy conservation government agency. In addition, the Ministry of Water and Power plays a small role in energy conservation. Other critial agencies include the Ministry of Industry which has jurisdiction over private industry and the Ministry of Production, which has authority over public industry. Enercon has found that the provision of audits alone will not prompt significant energy conservation implementation, even when a company has access to financing to implement the audit recommendations. In addition clients require information on the specific types of equipment needed, where to get them from and also how to install and maintain them. Enercon has developed a program of easily implemented quick return generic energy conservation measures such as cumbustion system improvements, steam system reprofits and electrical system improvements. The obstacles to energy conservation financing in Pakistan include high commercial interest rates (15 to 18 per cent) and unwillingness on the part of the commercial banks to lend for energy conservation; according to the study.

PORT PRODUCTIVITY INDEX

A recent study by the National Productivity Council attempted to develop a port productivity index (PPI) for the

port as a whole. This was done in the specific context of developing a productivity-linked bonus scheme for the port employees. Very briefly, the method used was to construct four different efficiency indicators, assign them weights and finally, aggregate them into a Port Productivity Index (PPI). Of the four indicators used, one, called the Operational Performance Indicator(OPI), is assigned a 60 per cent weightage in the calculation of PPI.

While arriving at the formula, the National Productivity Council Study reasons that the differences in the methods and efficiencies of handling of different types of cargo would not permit a simple aggregation of outputs and, secondly, that the complementarity of labour and other resources must be built into any method of assessing productivity. To overcome these problems, the Study suggests two conceptual devices, one called the, equivalent manpower, and the other, 'converted ship days'. Both these devices are used to arrive at OPI as explained below. Equivalent manpower is calculated by the formula Operating expenses divided by wages and salaries of actual manpower-equivalent manpower.

Converted ship days are arrived at by multiplying the actual number of ship days for each cargo type handled by a factor which takes into account the base (best) year performance. The formula used for calculating the OPI then is OPI is: equal to the number of converted ship days divided by equivalent manpower.

EXPORT POTENTIALS IN INDUSTRIAL MARKETS

An Exim study has identified 48 products which have potential for export to industrialised markets. The study findings have been summarised in an occasional paper brought out by the Bank. Copies are available on request; states the Exim News Magazine *Export Advantage (Sept, 1990)*.

Developed country markets offer attractive opportunities for exporting countries. Newly industrialising countries (NICs) have addressed product sectors which constitute major exports in developed countries. India has not diversified its export basket as rapidly. Products exported are in sectors which typically account for less than 1% of developed country exports. These now largely cover traditional exports.

Commodity exports are price sensitive, and can grow or decline in the short run. Diversification to manufactures requires a medium term strategy, since products will first need to be adapted, and tested to meet buyer preferences in target country, backed by careful market entry planning. Manufactures involving heavy capital outlay and long gestation periods have not been considered in the scope of the study. Focus is on the medium term, on products where modest outlays can yield rapid export expansion.

Thrust products have been determined based on the following criteria :

- Penetration by the four Asian NICs has been taken as a good indicator of potential for entry by India.
- Large investment outlays, with long gestation have not been considered, as also commodities which are primarily price sensitive.
- Demand factors evaluated included growth in world trade for various products, trade barriers, nature of industry viz, sunset industry where products are being phased out.
- Supply factors considered included level of technology, cost advantage, raw materials and skill advantages, capacity availability, quality levels attained.
- Products subjected to competition in the domestic market were considered as better placed to enter exports.

The Exim study is indicative and not exhaustive. As a next step following product level issues need to be addressed:

- alliance building for export growth.
- upgrade product, process, to meet buyer preferences and ensure compliance with product standards.
- dedicate capacity for exports, to ensure timely delivery.
- identify market segment where the firm has best competitive advantage.

ABOUT TECHNOLOGY MANAGEMENT IN INDIA

"The level of technology gravitates to the level of industrial structure and conversely when higher level of technology is brought into any community, the general structure of that economy improves. Technology acquisition has to begin with a problem identification followed by a search for suitable technologies and their evaluation in order to identifying the most appropriate one for adoptation and absorption in the recipient organisation"; reveals the

Proceedings of a National Seminar on Technology Management, organised by the National Productivity Council. Regarding the broad framework of technology transfer in India, it has been revealed that a National Register of Foreign Collaborations has been established with a view to assisting the further acquisition of technology in future. A Technology Information, Forecasting and Assessment Council (TIFAC) has been established in the Ministry of Science and Technology to deal with technology forecasting studies. A Technology Data Bank is also being established in the Directorate General of Technical Development (DGTD).

Technology in essense, is an embodiment of knowledge and a strategic resource for enterprise like any other resource. It also influences the entire gamut of business operations such as Human Resource Management, Financial Management, Engineering, Manufacturing, Marketing, Customer support etc., more intensely than any other single factor. Technology needs of any large organisation, operating in a high technology area, characterised by continuous product innovations, investment on R&D have necessarily to be planned. More than 10,000 collaboration agreements have been concluded by the Indian organisations since Independence. About 80% of the foreign collaborations in India have been renewed 2 to 5 times and 20% of them six times or more, according to the Report of the Seminar.

Contrasting the Korean experience with that of India, the Report points out that Korea has actively pursued policies aimed at encouraging local R&D and its utilisation by industry. The R&D expenditure has steadily increased over the years and was 1.82% of the GNP in 1986. It is planned to increase this ratio to 3% by 1991 and further to 5% by 2001. Foreign technology and foreign capital have played only a limited (though important) role in providing the Korean manufacturers with the advantages essential for them to compete in the international market. Of greater importance has been the numerous technology improvements arising from domestic sources. The relative importance of R&D is clearly showed by the fact that not only does industry spend a considerably large amount on R&D than on technology imports, but also greatly rely on domestic sources for many crucial innovations, according to the Report of the Seminar.

PRODUCTIVITY GAP AS THE LARGEST DEFICIT

The largest deficit barring the way to early success in Eastern European economies is the productivity gap; reveals Dr. Herbert Muller, Director of Rationlisicrungs-Kuratorium der Deutchen Wirtschaft (RKW) in RKW International No. 26, Jan. 1991. Earlier calculations were based on the assumption that, on an industry average, the productivity level of East Germany (the past GDR) was about 50 per cent below that of the West German standard. However, the German-German productivity gap is apparently much wider than was previously assumed. According to the calculation of the German Institute for Economical Research (Deutsches Institute fur Wirtschaftsforschung), East Germany needs about 1.5 million workers for an export volume of 50 billion Deuctschmarks. In the Federal Republic of Germany, however, the same value is achieved by as little as 500,000 workers. In the area of the exporting industry, the East German's productivity is only one third of that in the Federal Republic; according to Dr. Muller.

This explains the huge difference in incomes between East and West Germany. In real terms and per head,this is somewhere between 50 and 60 per cent. So as to overcome the difference in the per-head income within a period of ten years, and in order to double the income in East Germany, an annual productivity increase of seven per cent would be needed. Such a high rate has not been achieved even in the Federal Republic of Germany since the fifties; adds Dr. Muller.

In East German's economy, rationalization reserves are lying unexploited which can be utilized in the short term once the basic economic reforms have been carried out.

Anyone taking a look at East Germany's factories will, apart from in some privileged collective combines, see outdated machine and factory building structures at a glance. A similar look at the business statistics will drastically confirm this : The increasing superannuation of capital stocks in East German's businesses becomes apparent just by looking at the fact that the share of production facilities has doubled which, although completely written off, are being kept alive at great maintenance costs. At present, 21 per cent of East Germany's industrial plants are more than 20 years old. One or the other of these would be likely to arouse interest as collectors' items. On the other hand, only 27 per cent are less than five years old, a figure which does not necessarily say anything about the technical standard of performance of these production facilities; according to Dr. Muller.

In many cases, the situations in the companies can probably be improved. However, these will, of course not be sufficient for creating an "entrepreneurial climate". Production units being run on the principles of a planned economy cannot, in a matter of a few weeks or months, be turned into businesses geared to the principles of a market economy. And it will be even more impossible to make management act in keeping with entrepreneurial principles. □

Book Review

The Competitive Advantage of Nations, *by Michale Porter, The Mcmilan Press Limited, London, 1990. pp. 855 + xx*

"Michale porter reaches his conclusions the old fashioned way; he earns through solid research. The lessons of the book are sharp and deep" says Prof. R.M. Solow, Nobel Laureate in Economics about the book. True, this volume of about 875 pages is an outcome of four years of dedicated research by a team of 30 odd researchers spread into ten leading industrial nations namely; Denmark, Germany, Italy, Japan, Korea, Singapore, Sweden, Switzerland, United Kingdom and the United States. The effort is directed to exploring" what makes a nation's firms and industries competitive in global markets and propels a whole nation's economy to advance". In so doing, the book presents, according to the publisher, "a brilliant new paradigm which in addition, to its practical application, may well supplement the 200 years old concept of comparative advantage; a wholly unwarranted and exaggerated claim unlikely to be granted by economists world over. Porter interpreted the classical theory of comparative advantage within an over simplified framework and reached the conclusion that his paradigm is different. Despite the pains taking build-up of arguments by the author and the innumerably large number of 'nation-industry-firm' illustrated examples, the reader is left wondering how and where the present treatise differs from those of the classicals. Michale Porters' theme is an age old one; his methodology is old fashioned; yet he reached (apparently, atleast) new conclusions. For his purposes, Porter is not haunted by quantitative exactitudes, he is satisfied with the examination of the broad nature of the relationship among the crucial variables that decide competitive success.

The book "identifies the fundamental determinants of national competitive advantage in an industry, and how they work together in a system". It also explains the important phenomenon of `clustering' in which related groups of related firms and industries emerge in one nation to gain leading positions in the world market. Over 100 industries were examined including the German chemical and printing industries, Swiss textile equipment and pharmaceuticals, Swedish mining equipment and truck manufacturing, Italian fabric and home appliances and American computer software and movies. Building on his theory of national advantage in industries and clusters, Porter identifies the stages of competitive development through which entire national economies advance and decline.

The author tries to drive home in a forceful and convincing language the following three aspects:

(i) Competition is the 'driving force behind economic progress. A nations standard of living in the long term depends on its ability to attain high and rising levels of productivity in the industries in which its firm compete. (However, Porter gets into a definitional trap right at the beginning itself where he maintains "Productivity is the value of output produced by a unit of labour or capital". In reality neither labour nor capital alone can produce anything; the formulation needs to be replaced by 'labour and capital' which in turn opens a floodgate of assumptions, most of which are already known, in the empirical world of economists.)

(ii) Competitive advantage is created and sustained through a highly localised process. Differences in national economic structures, values, cultures, institutions and histories contribute profoundly to competitive success. While globalization of competition might appear to make the nation less important, the home nation takes on growing significance because it is the source of the skills and technology that underpin competitive advantage.

(iii) Unlike in the classical version of comparative advantage rooted mainly in factor endowments, competitive advantage can be created or even destroyed by national governments. To attain success, national governments must set appropriate goals; productivity. They must strive for its true determinants, such as incentive, effort and competition, not the tempting but usually counter productive choices such as subsidy, extensive collaboration, and 'temporary' protection. Government's proper role is to push and challenge its industry to advance not provide 'help' so industry can avoid it.

The four edged 'diamond' of national competitive advantage consisting of firm strategy, structure and rivalry; factor conditions' 'demand conditions' and finally' related and supporting industries' is surely open to serious questioning for its conceptual absurdities. While some of the so called edges are generic and abstract in character others are physical realities. Although analytically establishable links between them are matters of serious doubts, the author did achieve some amount of success in carrying the central theme home in a convincing style. The book made enormous contributions to economics (and management too), and deserves serious attention particularly in the context of the 'break down' of recent GATT negotiations. The analysis and conclusions of the book are extremely significant for developing nations particularly in the context of their plea for a 'new international economic order'.

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Population Explosion : A Contemporary Concern *by Arti Laroia : Agricole Publishing Academy, 1990, pp. 122, Rs. 150.*

The world's population reached the one billion mark in 1850. It is said that it took two million years to reach this first one billion population. But the next one billion was added in just 80 years. The third, fourth and fifth one billion additions took 30 years, 15 years and 12 years respectively. If you have a pond with one lily in which it doubles its size every day and which will completely cover the pond in 30 days, on what day will the lily cover half the pond? The riddle is simple to answer. The answer is 29th day, you have only one day left. The stick of the dangerous population bomb is already lit as in the case of the long fuse of a bomb, once lit it may sputter along for a while and suddenly one day it may explode. Either to postpone or to prevent this explosion, one needs population education and that too from the school level onwards. The UNESCO has stated: "Population education, in essence, is an educational response to contemporary economic, social and political issues." Arti Laroia's research study "Population Explosion—A Contemporary Concern" is an attempt to highlight the importance of creating awareness about the population explosion through population education and to bring to the reader the content of population education in the USA.

Arti Laroia surveys the U.S. curriculum in order to obtain activities for children between the ages of twelve and eighteen and makes a recommendation for adapting some of these materials to the needs of India. The essence of population education is to make it a problem-solving exercise which teaches analytical skills, concepts and rational attitudes to school children who are the future parents of the country. Chapter 4 of the book gives a fair idea about the numerous teaching methods developed for population education. India has already tried to organise Nature Club, Conservation Club etc. in schools to make the student aware of population explosion. Arti Laroia strongly argues for personalised teaching at all levels and integrating population education content into the existing curricula of science, social studies, mathematics and languages. Teaching techniques like role play, simulation and open-ended case study can appropriately be adopted in Indian Schools. Those who are interested in this population education curriculum in the context of India will find chapter 4 of the book useful.

The book has only 53 pages spread over five chapters and also contains a dozen photographs and a select bibliography. However, the book is in the high price bracket and a little more careful editing would have made it attractive to readers particularly to those who are associated with education curriculum.

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Managing people at work *by Mahfooz A. Ansari,: Sage Publications, New Delhi, 1990.*

The book under review is a research report based on the study of 440 managers (Top, Middle and Low level) from 7 organizations selected by the researcher, four belong to public sector and 3 to private sector. 3 organizations are in manufacturing, 2 in service and 1 in semi-manufacturing, (out of seven, five are profit making whereas two have been making losses) 5 are regarded as efficient while one is labelled as inefficient. (Criteria for these judgements have not been spelt out in clear terms.)

Some 440 managers were chosen from a population of about 2100 managers. From table no. 2.2 it appears that definite proportions were not maintained. Who are to be regarded as top managers and who are middle managers has not been clearly explained. For example, in organization no. 2, there were 50 doctors, 42 nurses, staff & ward boys and 373 paramedical staff (p. 63) out of these 40 managers were selected in the sample. (12 are regarded a top mangers; 6 as middle managers and 22 as low level managers. Nothing is mentioned about how many top managers were in this organization, how many were in middle level and so on. The reader is confused by vague

categorizations. The percentages of sample also show variability from 6.36% to 22.50. One wonders, why? In data analysis all these managers are clubbed together. What is the rationale for considering these different managers (Public sector, private sector; top, middle and low levels belonging to profit making organizations and loss making organizations) as belonging to a single large group. Problems of top managers differ from those of middle level managers). Situations of managers in public sector are different from those in private organizations. Organizations which continue to make profits also differ substantially from loss making organizations. This decision of the researcher to club these divergent managers in one single group is an unsound one. Chapters on data analysis have regarded these 440 managers as belonging to one group. Probably the researcher believes that these 440 managers represent the 'Indian' managers.

Chapters on analysis and interpretation of data are well written. The researcher has indicated the prevalent styles of these managers in dealing with their superiors, their subordinates or their understanding of their organization climates.

The researcher suggests that task-oriented and participative style is more predominant in India compared to bureaucratic and authoritarian styles. Our psychologists have discovered that when one asks an individual to describe his own characteristics and behaviour in specific situations, the individuals are more likely to give socially desirable responses which may not be the real responses at all.

The terms 'authoritarian' and 'bureaucratic' are highly value loaded concepts. An individual would not like to describe himself as authoritarian or bureaucratic. He would like to believe that he is result-oriented and participative. The cherished dream of an authoritarian leader is that people should accept him as one who cherishes democratic values. Even Hitler believed that he was a democratic leader. Such findings should be taken with a pinch of salt. His description of one's own behaviour should be compared with one's subordinate's description of his behaviour. What stance we take in public and what we really are can be contradictory.

When one looks at business organizations or political organizations or trade unions one observes that participative styles are not practised at all. Democratic-participative values are fast disappearing from our institutions. Casual observations indicate that by and large our behaviour is authoritarian. Persons in authority want to prove to others that they have authority and that they would like to use this authority to control others around them. The mentality of our leaders is still feudal. They expect that the followers should behave like serfs.

While interpreting self-descriptive statements one has to be cautious. One may say that this is what the respondents say about themselves but this may not be the reality.

A practising manager expects that the researcher would be able to tell him what he should be doing in order to be effective. He also expects evidence in support of the advice given by the researcher. Management thinkers recommend a contingency approach. A better way of getting answers to these questions would be to study the behaviour of managers in successful organizations and contrast them with the behaviour of others in unsuccessful organizations. There is not much relevance in combining different types of organizations and different levels of managers and interpret the results as group responses. Generalisations from such an approach are quite unrealistic. And one would not like to recommend these to the practising managers.

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Agricultural Growth and Non-Agricultural Growth : Dynamics of National Development; *by T.K. Meti, Gian Publishing House, 1990; pp. 161; Price Rs. 160.*

For a developing country like India growth of agricultural as well as non-agricultural sectors assumed great importance in the entire process of development. Without proper and effective inter-action between the two sectors, the country cannot achieve any appreciable degree of growth and development.

The book under review deals with micro and macro concepts relating to growth and development so that the process of development in the agricultural and non-agricultural sectors of the economy could be accelerated. It consists of 8 wellwritten chapters, 5 appendices, a detailed bibliography and an index. It also includes a foreword by one of the India's most distinguished economists Prof. V.K.R.V. Rao. In his illuminating foreword Prof. Rao has rightly written that the author 'has put in a considerable amount of thinking and hard work and this effort may prove worthwhile if other researches could also be undertaken on this pattern.

The study brings to light some of the vital issues relating to the relative role and contribution of the three very important sectors namely—agriculture, industrial and

service sector in the promotion of foreign trade. It also studies some of the vital facets affecting the relationship between the different sectors of the economy. Much emphasis has been given to the role and growing importance of service sector in foreign trade.

The study also discusses the inter-relationship and interaction between different sectors of the economy both on individual as well as aggregate basis with the application of inter-sectoral linkages, inter-industry dependence, foreign trade and environmental sustenance and balance.

The book lays down much emphasis on the quality of life rather than merely with material goods and needs. It advocates that growth and development must outgrow the short-term perspective and personal and group selfish interest to cover the broader field and harmonize the personal and social interest. The author goes ahead by saying that balance between agriculture and industry has to be global in nature and equitable in practice so that economic gains should bring more equitable distribution of income and wealth among the masses and regional disparties must be reduced to a greater extent. Efforts must be combined with spirituality so that a work culture could be created which is the need of the day.

The study is interesting and thought provoking. However, such a vast topic has been incorporated in a small volume which has resulted in an inadequate treatment of different facets of agricultural and non-agricultural growth and development. On the other hand, such a vast topic in a small volume is a commendable effort on the part of the author.

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Management of Business Enterprises *by N. Dey, Anmol Publications. New Delhi, 1990, pp. 326, Rs. 350.*

The book deals with various aspects of management accounting and its applications in business. It is a blend of technical aspects of management accounting with profit planning and budgeting and demonstrates the application of the same for cotton textile industry. It attempts to supplement conceptual aspects with practical aspects of management. It adopts a methodology of survey, based on a questionnaire followed by discussions with executives.

The book has two parts. Part-I focuses on management of cost, while Part-II emphasises on management of profit and control.

Three chapters of Part-I discuss cost accounting system, cost structure and the cost accounting in cotton textile industry. Cost accounting has been stated to be concerned with three basic objectives viz. : (i) unit cost determination; (ii) cost control; and (iii) cost analysis.

Part-II, in its five chapters attempts to discuss concept of modern management, profitability, cost, profit planning, management control and management information system. Management as discussed is concerned with profit management of business enterprise.

The book is planned to cover three streams of thought: how does a manager manage an enterprise? What does he need for this purpose? And how does he get the results? It contains exhaustive references and would be useful to a researcher and a manager.

This book, while describing the role and functions of a manager, lays down that top manager has to perform a task delegated by the board and has to determine the objectives of the company. How far those who are delegated would determine the objectives of the company is intriguing? The book refers to lack of uniformity in the terminology of profit and profitability and states that the Institute of Chartered Accountants of India and the Institute of cost and Works Accountants of India use 'academic terminology' without defining the word 'academic' and without referring to the terminology laid down by such institutes.

Statements like 'we feel flexible budget with standard cost can appropriately be applied as a management tool for profit planning' are generic ones and appear to be the views of the author and not based on the results of the survey. Discussion of the methodology and analysis of the questionnaire and questionnaire presentation in the book would have made the book a valuable reference for a researcher.

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The Role of Scientific Research and its Management in Accelerating Socio-Economic Transformation, *Edited by K.V. Raman, R. Choudhary, A. Bandyopadhyaya and S. Maiti, Agricole Publishing Academy, New Delhi, 1988, pp. 211 + XX, Rs. 200.00.*

This book under review was the outcome of a National Symposium on the same title organized by Agricultural Research Service Scientists' Forum (ARSSF) at Indian

Agricultural Research Institute (IARI), in 1987. The book contains sixteen papers divided into six chapters in accordance with the sequence of the sessions of the Symposium. Presentations are current and lively as they reflect Indian experiences since fifties. As contents are derived by historical analysis and investigative methods by the experts, they present over all strengths and weaknesses inherent in Indian agriculture.

Modernization of agriculture (Chapter I), highlights the role played by agricultural research scientists and their research efforts in modernizing Indian agriculture. The age old concept, that agriculture is a way of life in the subsistence stage of economies, is now modernised as agri-business to suit the market oriented commodity mode of production. This concept of agri-business has four interrelated sub-systems : agri-supply; agri-production; agri-processing; and agri-distribution. This model enables agri-business system to contribute more to the national economy as it is subjected to the push and pull mechanisms of markets.

Organization of Indian agriculture on the lines of agri-business concept certainly enabled a closer interface among several sub-systems. This can be seen in the degree of modernization and the associated accomplishments made in food grain production and productivity. Besides, it is complemented by a network of research and development (R & D) institutions under the umbrella of ICAR and Agricultural Universities who employ more than 7200 research workers.

How can S&T and agricultural potential be fully exploited in the country? What are the additional impediments to the growth of the system? These are lucidly brought out by the experts in the Chapters II-IV.

More than 52 per cent of people, comprising 26 million rural house holds in India, live below the poverty line. About 72 per cent of the farming community are small and marginal farmers whose resources and skills are meagre. Nearly 75 per cent of the rural folk are illiterates. Further, land under cultivation also lacks requisite nutrients as 75 per cent of soil in the country is phosphorous-deficit and 25 per cent potash-deficit. These factors collectively make it difficult for S & T knowledge to spread in time and get diffused. Initiatives of the farmers are further blocked by reinforcing effects of non-availability of funds, seeds, fertilizers, pesticides, agro-processing, packaging, transporting, storing and marketing support sub-systems.

However, R&D efforts by Indian agricultural scientists, as demonstrated by high yields achieved by experimental stations, have established the potential capability for future growth. According to the experts, by proper use of currently available S & T knowledge, India can enhance production of wheat by 2.5X; rice by 3X; maize by 3.5X; jowar by 5X; bajra by 3.5X; and pulses and oil seeds by 3.5X. Same is the case with the capabilities for production of fruits and vegetables, milk and milk products, fish, egg and meat and meat products. Slow, but steady growth in urbanization and per capita income provides opportunities for manufacture of ready-to-eat and easy-to-transport food packages.

Organised agricultural research in India began with the establishment of Imperial Agricultural Research Institute (IARI) at Pusa in 1905 with many specialised sections including cattle breeding, bacteriology, botany, chemistry, entemology and mycology. A decade earlier, the Imperial Institute of Veterinary Research (IIVR) was already established at Mukteswar. Later on a network of colleges of Agriculture were also set up in the country. Administrative measures taken by the British India Government such as the Famine Enquiry Commission 1880 and 1901 and Indian Central Cotton Committee in 1924. The Royal Commission on Agriculture, 1928 to tackle the problems of recurring famines, droughts and crop failures have paved the way for introducing S & T inputs in Indian agriculture. The two Joint Indo-American Teams on Agricultural Research Education and Extension, in 1954 and 1959 recommended the establishment of cross commodity research projects that led to the setting up of a number of PIRYCOM (The Project for Investigation of Regional Research on Cotton, Oilseeds and Millets) centres adjacent to other research institutions. The year 1962 was another land mark in Indian Agricultural Research when a beginning was made to establish a series of State Agricultural Universities with mission orientation to integrate teaching, research, consultancy and extension education.

Green Revolution, that led to the introduction of modern agri-management techniques like use of irrigation, HYV seeds, chemical fertilizers, farm mechanization and integrated pest control systems, bioengineering, biotechnology and tissue culture, is the latest land mark in Indian Agriculture. But all these attempts to super impose modern S & T on the tradition-bound Indian society, without restructuring the socio-economic relationship, have resulted in the uneven developments. Hence the need for correcting this distortion so that S & T is made to play a catalytic role in accelerating socio-economic transformation.

The appeal for corrective measure is glaringly brought out by the experts whose papers are devoted to the management aspects of Indian Agricultura Research (Chapter-VI). For, India to emerge as a techno-cultural industrial

society it should wither its obsolete and hurdle some traditions and practices which it inherited from feudal and colonial rules. To this end, India should acquire modern S & T knowledge from all parts of the world and apply them judiciously. People should be involved in this process to inculcate a sense of social responsibility and democratic norms. A practice, contrary to this, as seen today, will further deteriorate the conditions by wasteful deployment of scarce resources.

Wasteful deployment of resources reflect in the acts of matching of skills of S & T manpower with inappropriate tasks and projects; funds allocation below critical level and keeping facilities idle while many critical projects starve of them. A survey presented in this book reveals that responsibility and accountability in Indian agricultural research institutions are marginal. For example 73 percent of scientists got no responsibility formally assigned to them by the management. Some 63 percent were neither given orientation to research activities nor indoctrinated in to the aims and objectives of the institutions they joined. On the other hand it was left to the interests of some 77 percent of S & T personnel to choose their own areas of work. And in case of 23 percent of S & T personnel, the bosses have come on their way to deny freedom of choice. It is revealing to notice here that 79 percent of S & T personal who initiated R & D programmes did not get necessary facilities in time. It was mostly due to the bureaucracy and non-responsiveness of administration. And 79 percent of those who did get the facilities were able to get them by cultivating personal relationship with their bosses. In all probability, it is not a democratic process as none is held responsible or accountable to any definite objective. Such trends should be reversed by undertaking time-bound mission mode projects.

The National Symposium (and the this Book under review) has certain limitations. Firstly is the non-inclusion of satellite-based remote sensing, weather forecasting and computer simultation and modelling and their application's to agriculture. Secondly, comes the non-coverage of use of audio-visuals, radio and TV programmes for extension education. Third is the non inclusion of impact assessment of Indian Agricultural Policies like pricing, new seed import policy, bank financing, fertilizer policy and large scale irrigation projects in promoting agriculture and human habitats in harmony with nature. Finally, it fails to cover the role played by Food Corporation of India (FCI) in promoting Indian agriculture. One should try to understand the cumulative effects of all these factors in promoting S & T, agriculture, industry, trade and economy. Thus it demands a fresh dialogue on these aspects.

It will be more fitting on the part of AGRICOLE to upgrade this book by way of another national (or international) symposium. Experts may be requested to share their data-based research experiences to crystallize the strengths and weaknesses of Indian Agriculture and its research. Such a work will be useful guide for formulating future plans. It, will help in consolidating the strengths by overcoming weaknesses. It will also help in transforming the threats into opportunities. Thus Indian Agriculture will be made more relevant, responsive and competitive in the world markets.

ICAR, IARI and ARSSF in association with other national agencies like NPC (National Productivity Council) can take initiatives in this direction. Focus should be given to the identification of feasible models and systems that convert S & T knowledge into viable investment projects by the farming house holds, agri-cooperatives and agri-corporate companies.

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Documentation

Productivity Abstracts

NPC Documentation Section

Administrative theology: Dharma of public officials, Dwivedi O.P., *The Indian Journal of Public Administration, Vol. 36(3), July-Sept 1990, p. 406-419.*

This article is drawn from the author's various writings on the subject. The article discusses five aspects of Dharma of public officials (both elected and appointed) as follows:

1. Emerging administrative culture and morality,
2. religious foundations of administrative culture,
3. role of administrative theology,
4. emerging challenges and
5. need to build a moral government.

Chemostat studies of a mixed culture growing on phenolics; Hobson J. Michael and Millis F. Nancy; *Research Journal of The Water pollution Control Federation Vol. 62(5), July/August 1990, p. 684-691.*

The authors studied the growth of a mixed culture in a two-stage chemostat with growth limited by phenolics. The first stage provided a fully viable, adapted population that was fed at a constant rate to the second stage, where the concentration of phenolics could be varied. The authors found that, the population exhibited inhibition kinetics at high concentrations of phenolics. The viability of the culture decreased with increasing dilution rate, or with increasing phenolic concentration. The nonviable population did not utilise significant amounts of substrate, but ignoring viability can lead to a significant underestimate of the growth rate. The maintenance requirements were insignificant at inhibitory levels of phenolics, but rose to 0.15 g/g.h at inhibitory levels, possibly due to the need to repair damaged cell membranes.

Concepts and measures of productivity, *Mital K.M., Udyog Pragati, Vol. 13 (1&2), Jan-June 1989, p. 4-16.*

In this paper the author gives an account of concepts and measures of productivity. It includes viewpoints of eminent personalities on productivity expressed at different forums such as conferences, seminars and shareholders meetings. The author has also attempted to make a detailed review of productivity measures which have been evolved by productivity scientists from time to time. The paper also discusses the role of human resources in productivity enhancement.

Correlations among water quality parameters of a textile mill effluent, Patnaik L.N., Mohapatra P.K., Misra G, *Indian Journal of Environmental Protection, Vol. 10(6), June 1990, p. 418-423.*

The authors carried out correlation studies among all possible pairs of 14 physico-chemical water quality parameters of the effluent of a textile mill along a channel, using the average values of the monthly observations made over a period of one year, as well as those for four seasons. With the exception of temperature, all the correlations were found to be good to excellent, indicating that for a particular part of an ecosystem under identical or near identical natural conditions, different parameters are strongly interrelated.

The authors found that the correlations provide an excellent tool for the prediction of parameter values within reasonable degree of accuracy.

Could a machine think? Churchland Paul M & Churchland Patricia Smith, *Vigyan Scientific American, Vol. 1 (3), January 1990, p. 32-37.*

Machines that manipulate symbols according to rules may well never achieve intelligence, but the authors argue, the proposition does not have absolute force. New kinds of systems (such as artificial neural networks) whose physical organisation mimics that of the brain might well succeed.

Dimensions of materials research, Rao CNR, *Urja, Vol. 28(5), Nov. 1990, p. 41-46.*

In this article the varied dimensions of materials research are examined in relation to India in the context of the world scenario. The way materials science works today is illustrated by chosen real-life example. The problems and challenges posed by the new super conducting cuprates are presented as a case study. The author's interests in the area of oxide materials, specially superconductors, are also briefly indicated. It is pointed out how in this highly competitive area, it is essential to develop the right strategies in order to find a meaningful role for ourselves.

Disparity in income and levels of living among teachers in Delhi, Kansal S.M., *Economic and Political Weekly, Vol. 25(46) Nov. 17, 1990 p. 2547-2558.*

Income levels are generally expected to relate directly to levels of academic qualifications and skills. But quite often this is not the case. There is considerable income inequality for instance among teachers with the same level of education and experience. Such inequality primarily originates due to arbitrary factors like job opportunities and the resources which vary from person to person. One of the main objectives of this study according to the author is the pinpoint the income inequality due to these arbitrary factors among teachers with the same level of education and educational institutions in metropolitan Delhi area. Secondly, identifying these factors may help in the formulation of a rational income policy.

Estimation of thermal environment on a longwall face, Kumar Vijya G & Rao Krishna G.V., *Journal of Mines Metals and Fuels. Vol. 38(7&8), Aug. 1990, p. 146-150.*

The paper identifies the main sources of heat in a mechanised underground coal mine and reviews the basic modes of heat flow into mine air. Mathematical equations are given to estimate the heat flux in different modes of transfer. Heat flow measurements made on a longwall face are presented graphically and the salient points are discussed.

Feminism and class consolidation, Ehrenreich Barbara, *The American Review, Vol. 34(4), 4/1990, p. 52-56.*

American feminists of the 1960s and '70s quickly came to realise that before they could achieve true political and social equality with men, women must first win economic independence. Their campaign for access to male-dominated occupations and for equal pay for equal work has met with success in many areas. To cite one example, the representation of women at professional schools of law, business, and medicine has more than tripled since the late 60s. Yet, from the point of view of longtime feminist Barbara Ehrenreich, the economic triumphs of the women's movement have brought some unforeseen and ironic consequences. Through the income that working women contribute to their families, "the originally radical and egalitarian ideology of feminism" has helped preserve the American middle class, and the rise of the professional couple—where both husband and wife earn high salaries in skilled careers—has widened the gap between the best-off Americans and those less fortunate. Ehrenreich goes on to trace current developments and rise of new issues among feminists.

Hot strip coilers with hydraulically actuated wrapper rolls, Rohde Wolfgang, Rosenthal Dieter & Sudau Peter, *Metallurgical Plant and Technology International, Vol. 13(4), 1990, p. 48-60.*

Coilers are one of the most highly loaded mechanical units in hot strip mills. This article presents a new coiling technology which, by the use of hydraulically actuated wrapper rolls, has enabled distinct reduction of dynamic loads and noise emissions. The overall system consists of mechanical, electrical, hydraulic and electronic components and during the design stage its behavior was checked and optimized on a hybrid simulation facility by the authors. Simultion results were confirmed through measurements in the production works.

Indian agriculture and its vast potential, Kaul Ikbal, *Yojna, Vol. 34(20), Nov. 1-15, 1990, p. 19-21.*

Training the rapid growth of Indian agriculture and its significant contribution to the national economy, the author feels that Indian agriculture has vast potential and can feed even larger population provided, irrigation targets are met and lands managed judiciously.

Inference in life tests based on a Weibull model when an outlier is present, Lingappaiah G.S., *Journal of The Indian Association for Productivity, Quality & Reliability, Vol. 15(1), 1990, p. 1-10.*

This paper deals with two concepts—prediction and outliers. First, a sample is drawn from a Weibull population, where an outlier of type θg is present. Then the predictive distribution of the r-th order statistic is obtained in the future sample based on the estimate in the original sample. Next, two sample case is considered where prediction can be made on the r_2-th order statistic in the second sample based on r_1-th order statistic on the first sample where outliers of type θg_1 and θg_2 are present in each sample. Finally, extension to K-sample case is made for a particular case of predicting minimum in the K-th sample based on minima in earlier samples, where outliers of type θg_i, $i = 1.....$, are present at each stage. An illustration is provided with simulated samples where minimum is actually predicted in one and two sample cases. A table gives the tail probability for various values of g_1 and g_2.

Life in the postmodern world, Gitlin Todd, *The American Review, Vol. 34(4), 4/1990, p. 12-18.*

For sociologist and media critic Todd Gitlin, postmodernism is an international phenomenon with particular relevance for American life. He defines its characteristic method as repetition and juxtaposition, a mixture of high and low culture—and its characteristic attitude as irony. While fascinated by postmodernism, Gitlin is clearly no enthusiast, and in the end he indicts the movement for devaluing the political passions of the 1960s.

Measures for traffic calming in residential areas, Jamanaka Hideo & Odani Michiyasu. *The Wheel Extended, No. 73, 1990, p. 24-32.*

The concept of traffic calming in residential areas, which may be defined as fostering the harmonious coexistence of automobiles and people by restraining vehicle speed and traffic volume, was first put into practice in Woonerf projects in the Netherlands. The Dutch approach was later developed and implemented elsewhere, mainly in West Germany, Denmark, and other West European Countries. A variety of techniques grew out of this work.

In Japan, traffic calming has been widely adopted in "community streets" and in new residential areas. The techniques of traffic calming have drawn considerable attention as a means of physically reinforcing the conventional, statutory traffic control measures.

In this article the authors have discussed some of the specific techniques used for traffic calming.

Mould compaction by air impulse—Results obtained in actual foundry applications, Karlsruhe, Muller Gunter, *CP+T International, Vol. 6., 3/90, p. 8-11.*

This report first describes application characteristics of air impulse moulding and then goes into some detail on vario—impulse compaction evolved from it. Representative moulds from actual production runs and test runs by foundries using the vario-impulse technology are shown to illustrate the wide range of possibilities offered by this advanced technology.

Natural disasters—The vital role of infotech, Singh Ranjit, *Telematics India, Vol. 4(3), Dec. 1990, p. 38-40.*

Telecommunication has been the life blood of meteorology since the last century. Each killer cyclone that raises its monstrous head over Indian seas is continuously tracked by two powerful coastal radars. Satellite based disaster warning systems enable AIR to broadcast warnings to vulnerable areas while hams provide yeoman's service in calamities. IETE's recent convention focussed on the role information technology plays in prediction and mitigation of effects of natural disasters.

Nehru and the Planning process, Panda N.M., *Yojna Vol. 34(20), Nov. 1-15 1990, p. 17-18.*

On the occasion of the 101st birth anniversary of Pandit Nehru, the architect of modern India, the author recalls the services rendered by him in laying the foundation of planning. The author says that all the sectors of the Indian economy had the stamp of Nehru's scientific ideas, who strove for strengthening the country's socio-economic fabric.

Occupational heat illnesses—A review, Rastogi K. Subodh, Gupta N. Brahma & Husain Tanveer. *Indian Journal of Occupational Health, Vol. 33(3), July-Sept. 90, p. 83-100.*

According to the authors the thermal conditions prevailing in some industries in India and the physiological response of the exposed workers is well documented. However, there is a dearth of information on the clinical aspects of heat illnesses. In this paper a review is presented of the recent literature on acute occupational heat illnesses. Also reviewed is the information on chronic heat illnesses. Most of this latter data comes from studies performed in Europe and South America. However, a recent mortality study among steel workers in U.S.A., contributed significantly to the knowledge of this problem. The study found that primary targets of chronic heat illnesses are the cardio-vascular and the gastrointestinal systems. A discussion on how to prevent acute and chronic heat illnesses is presented in the paper.

Patterns of availability of information technology in Nigerian special libraries: A study of present status, Nweke Ken MC, *IASLIC Bulletin, Vol. 35(1), March 1990, p. 25-34.*

In this article the results of a survey of types and quantity of available information technology in Nigerian special libraries is reported. Patterns of availability according to the subject groups of the special libraries, groups of special library sizes, groups of Nigerian special libraries providing high, moderate and low quality services, and according to the groups of degrees of use of information technology in the special library services are discussed.

Planned OJT is productive OJT, Rothwell J. William & Kazanas H.C., *Training and Development Journal, Vol. 44(10), October 1990, p. 53-56.*

On-the job training is one of the most important components of learning in the workplace—yet it's often unplanned and ineffective. In this paper a new study looks at OJT and suggests some practical ways to improve it.

Productivity of the expanding services employment, Ramona D.V. & Kumari Krishna D.B., *The Indian Journal of Labour Economics, Vol. 33(2), April-June 1990, p. 133-144.*

Shift of workforce from agricultural to secondary and tertiary activities involving a change in the employment structure is a concomitant of economic growth. But, during last four decades, this process has assumed a new dimension whereby the majority of the workforce are employed not in the secondary, but in the tertiary sector. This tertiary

revolution had started in the United States economy during the mid-fifties, after the introduction of computers and the accompanying information revolution. The paper discusses the extent, nature and some of the important economic implications of the phenomenon in the United States.

Regionalisation of health care for army—A concept, Lt. col. Singh Vir, *Defence Management, Vol. 17(2), Oct. 1990, p. 33-35.*

According to the author a concept of total regional health cover in army could be brought by integrating hospital and field ambulance into one whole system, keeping flexibility of war and peace in mind. This systems approach will provide comprehensive regional medical care in peace and field areas which will be effective, efficient and optimum.

Studies on the effect of row space and nitrogen on yield and quality of early maturing sugarcane varieties, Devi Chitkala, Rao K.L. & Raju D.V.M., *Indian Sugar, vol. XL(7), October 1990, p. 541-544.*

The authors conducted a field experiment at the Regional Agricultural Research Station, Anakapalle for two seasons in 1987 and 1988 to study the individual and integrated effect of row spacings and nitrogen levels on short duration sugarcane varieties in relation to their cane and sugar yields. The results indicate that the crops planted at 60 cm row space produced significantly higher cane and sugar yields then the crops planted in 80 cm rows. Increasing the level of nitrogen from 112 to 168 kg/ha or additional dose of 28kg nitrogen per hectare supplied through soil of foliar spray does not seem to have had any beneficial effects on growth and development of cane crops.

Co 6907 proved superior to the other varieties (Co 8338, Co 8339 and Co 8341) in respect of both cane and sugar yields.

Tables and charts on price rise of books and periodicals—Columns and juxtaposition : Observations and reforms, Subba Rao C.V., *ILA Bulletin, Vol. 25(4), Jan-March 1990, p. 179-198.*

The author feeling the need, whether the tables and graphs had achieved their purpose with clarity, while examining the price-rise of books and periodicals, has a second look at them.

The author observes that:

1. Publisher—price relationship has not been studied.
2. Country—quotient/weightage could have been taken by every year's budget, instead of the latest year.
3. Mean price table needs to be separated from country—quotient/weightage,
4. Derived table to come after General/Mother Table, i, e D and E to change appellations.
5. Readjustment is suggested in columns 7 and 8 of table D.
6. Selects Index Method as it is clearer in showing effects.
7. Need of giving Table H1 and H2 on the same page, side by side, with the sequence of years being same in both.
8. Advantage of giving graph and table together on the same page.
9. In table J, the author suggests last column to be 11: (10-5) and not 11:(10-3).

Towards effective functioning of internal audit, Khanna A.K. & Chopra N., *The Chartered Accountant, Vol. 39(6), Dec. 1990, p. 469-471.*

The authors present an audit approach to ensure more active involvement and participation of auditees and thereby to enlist their willing cooperation in implementing the audit recommendations. The salient feature of the approach is encouraging auditees themselves to come out with the recommendations. If auditees do not come forward, auditor himself/herself can formulate the recommendations. If the auditee's recommendations are not sound, auditor is still free to give his/her independent views to the management, alongwith the auditee's recommendations and hammer out a consensus.

Towards finding the right wage system, Wee Aleth & Foo Yoon Lim, *Productivity Digest, October 1990, p. 2-5.*

According to the authors any formula designed to establish a formalist link between wage and any one of several wage criteria such as productivity and profitability can only be a PARTIAL MECHANISM for guiding wage decisions. A major part in the wage determination process has to be determined based on qualitative judgements pertaining to the economic and business environment as well as equity considerations.

The right wage formula varies depending on objectives pursued by decision-makers as well as the theories they choose to support.

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Books in Brief

NPC Documentation Section

An Introduction to Team-Approach Problem Solving: *Louis N. Jones and Ronald C. McBride. Milwaukee, American Society for Quality Control Press, 1990, 85 p, $19.95.*

Presents a six-step method for team building and increasing team dynamics. Developed over may years of trial and error, the system combines creative, judgemental, and logical approaches to move a team from problem identification to a long-lasting solution.

Appropriate remuneration in Developing Countries : *Rama Murthy Kuppachi. New Delhi, Sage Publications, 1990, 262 p, Rs. 195.*

This book makes an excellent text in any program dealing with problems of understanding and interacting with industrial and business communities of all developing countries whose political and economic structures have been influenced primarily by socialistic philosophy in these matters. The author presents four cases which highlight the salient aspects of the preparatory, application and implementation phases of the materials in varied organizational, national and international settings.

Bound to Lead : The Changing Nature of American Power: *Joseph S. Nye. Jr. New York, Basic Books, 1990, 307 p, $19.95.*

Examines America's status as a dominant world power. Changes in the nature of power and the global increase in transnational interdependence affecting America's position are analyzed.

Building Industrial Competitiveness in Developing Countries: *Sangaya Lall. Paris, OECD Publications, 1990, 100p, $19.00*

The capacity of developing countries to build modern industry and compete in world markets depends on their ability to apply new technologies. This study examines how ten developing countries have promoted technology-oriented industrial development by policy choices affecting trade, competition and intellectual property rights, capital and labour markets, science and technology programmes and, most importantly, human capital development. It also shows how successful technological and industrial development strategies in developing nations have direct consequences for industrial restructuring in OECD countries. The countries covered are Brazil, Hong-Kong, India, Kenya, Malaysia, Mexico, Singapore, South Korea, Thailand and Taiwan.

Canal Irrigation Management-Problem of Time and Use Relationship : *Lakshmi Shukla and Ram Kumar Gurjor. New Delhi, Agricole Publishing Academy, 1990, 118p, Rs. 125.*

In this study an attempt has been made to study and analyse the problems of the irrigated areas and their evil effects on society so as to be able to find solutions to the problems. The conclusions derived from the study are based on frequent visits to the area and meeting the farmers during a full crop calender year.

Conflict Management : The Courage to Confront: *Richard J. Mayer. Columbus, Battelle Press, 1990, 155p, $24.50.*

Describes the attitudes and simple skills that enable the positive confrontation of conflict. Besides discussing example setting and the coaching of subordinates in the expression of differences with others, the book provides an outline for identifying conflict at an early stage.

Corporate Success and Transformational Leadership: *P. Singh and Asha Bhandarkar. New Delhi, Wilay Eastern 1990, 385p.*

This publication highlights (a) the profile and role of transformational leaders, and (b) the process of culture building and corporate transformation in five Indian organisations—three belonging to public sector, one to the corporate and one to the private sector. The cases have been built around the themes : Building a new church; from solo to folk; Quest for excellence; From Pandemonium to peace, and; Man at the centre.

Economic Theory and Polity : Essays in Honour of Dipak Banerjee : *Edited by Bhaskar Datta and others, Calcutta, Oxford University Press, 1990, 276p, Rs. 1990.*

This collection of papers on economic theory is brought out as a tribute to Prof. Dipak Banerjee of Presidency College, Calcutta, by his former students. As is usually the case with collections of papers in honour of an academician, the volume does not have a single theme. The contributions, coming from former students of Prof. Banerjee, who are engaged in research in various different areas of economics, have nevertheless been grouped under five broad areas. The group of essays in the areas of macro economics contains papers by Amitava Bose, Dipankar Dasgupta and Rajat Deb.

Fitness Inc: A Guide to Corporate Health & Wellness Programs: *Robert E. Pritchard and Geogory C. Potter. Homewood, III, Dow Jones-Irwin, 1990, 350p, $24.95.*

Describes fifty-three of the best fitness/wellness programs in corporate America to help companies embarking on such projects make the right decisions. The impact of wellness on employee performance and corporate profits is also discussed.

How To Listen Better : *Promila Ahuja and G.C. Ahuja. New Delhi, Sterling Publishers, 1990, 96p, Rs. 90.*

This book will help the reader to develop skills and techniques of listening. The what, why and how of listening are its themes. The suggestions given in the book are easy to follow. With a little effort, the reader should find a great change in his listening behaviour, enchaning his image in all spares of life.

Human Resource Development in Japanese Companies : *Hideo Inohara. Tokyo, Asian Productivity Organisation, 1990, 294p.*

This publication provides a through explanation of the external and internal factors of work organisation in Japan. Also convered in detail is a review of all aspects of personnel management in Japan. The author clarifies and reveals the realities of Japanese personnel management and labour relations. This text serves as a basic and comprehensive reference for managers and students who would like to learn positive as well as negative lessons from Japanese development of human resources.

The Indian Economy - Resources Planning Development and Problems, *Ishwar C. Dhingra, New Delhi, Sultan Chand & Sons, 1991, 712p, Rs. 85.*

This publication is a textbook that systematically analyses different aspects of India's economic scene. With the help of the data, derived the published and unpublished sources, it surveys the scenario as it has emerged during the decades of economic planning of India.

Indian New Dimensions of Industrial Growth : *England, Basil Backwell, published for United Nations Industrial Development Organisation, 1990, 253p. £20.*

The UNIDO study characterises recent industrial growth strategy as an "import-led export growth strategy" and believes that it will yield results only if there is a continuity of defined policies and if inputs are supplied at competitive prices. Across five chapters, it offers a detailed analysis of industrial development in India looking closely at such important industries as food processing, textiles, steel, chemicals, automobiles and so on.

Integrated Packing Systems for Transportation and Distribution: *Charles W. Ebelling. New York, Marcel Dekker, 1990, 280p, $107.50.*

This book identifies the cost sensitive areas for each activity in the logistical system. It illustrates how packaging in addition to providing protection and preservation of its contents—can affect the total system cost efficiency if designed to adopt well to unitized shipping methods and equipment.

Management of Information Technology : *J. Burn and E. Cladwell. Alfred Walker, 1990, £20.*

The major emphasis of this book is the identification and development of the most effective type of information system for a particular organisation. Starting with a discussion of the nature of information and the role of computers in different types of organisations, it also reviews available information technology.

Management of R & D Organizations : *R.K. Jain and H.C. Triandis. New York, John Wiley, 1990. 268p, $44.95.*

Provides a technique for increasing research productivity and boosting financial support for any organization that markets its research. Among the topics addressed are innovation, hierarchical streamlining, attitude change, managing conflict, and technology transfer.

Management of Technology II : *Tarek M. Khalid and Bulent A. Bayraktar (Eds). Georgia, Institute of Industrial Engineers, 1990, 1337p. $120.*

This book features the papers presented at the International Conference on Management of Technology held in February, 1990. It is an area which will determine the future of a business and entire country's economic competitiveness. Addressing issues and problems at all levels

of techno-economic environments, these proceedings provide the latest research and innovations in the exploding field of technology management.

Managing People at Work: *Mahfooz A. Ansari. New Delhi, Sage Publications, 1990, 219p, Rs. 185.*

This absorbing book is the systematic effort to integrate two of the most recalcitrant problems in human work-behaviour, leadership and power. Dr. Ansari conceptualizes leadership as a 'reciprocal influence process' and power as 'potential influence', the link between the two being influence. Based on the findings of his survey of 440 executives, the author concludes that the influence strategies which a Manager uses cannot be universally fixed. Instead, to be effective the Manager must learn about the climate of the organization of which he is a part.

The Paper Industry in India—Status and Prospects : *Y.A. Rao, New Delhi, Oxfords IBH Publishing Co, 1989, 224p, Rs. 225.*

This publication is the presentation of various aspects of paper, paperboard and newsprint industry. The contents of the book are mainly divided into five parts with each part sub-divided into well defined chapters. It traces growth and structural changes, the industry has undergone during Plan era. Newsprint industry has also given due consideration. Aspects like raw material, process technology, government policies, fiscal as well as regulatory, are dealt at length. The future prospects of the industry are also nicely presented.

Planning and Measurement in Your Organization of the Future: *D. Scott Sink and Thomas C. Tuttle. Norcross, Georgia, Industrial Engineering and Management Press, 1989, 331p, $46.25.*

Presents planning and measurement as the two critical faces of the quality and productivity effort. The book explains the development of improved planning for performance improvement systems and how effective measurement systems can improve performance, and offers a technique to help managers to move their organizations from where they are to where they ought to be.

Productivity in Transition : *Chan Choon Hian and Foo Check Teck. Singapore, McGraw Hill, 1990, 267p, $9.50.*

This book deals into the dynamics of the productivity movement as well as its salient features and developments. It is a collection of articles which offer important practical insights on managing productivity in the Asian context. It deals with three main aspects—managing productivity at both the macro and micro levels, developing and optimising manpower and practices and experiences of local companies and trade unions.

Research Methods and Measurements in Behavioural and Social Sciences : *O.P. Bhatnagar, New Delhi, Agricole Publishing Academy, 1990, 272p, Rs. 250.*

This publication provides the concepts, principles, philosophy and practical approaches in study of the behavioural components of the individuals, society and/or community with special reference to development and use of methods and measurements.

Role of Trade Unions in Productivity Improvement: *G.K. Suri and Ajit Singh. New Delhi, National Productivity Council, 1990, 152p, Rs. 150.*

The people are the most important assets of an organisation and play a key role in improving productivity. In developing countries, and particularly in India, the trade unions have strong attitudinal and motivational impact on the employees. Keeping in view the important role trade unions play in productivity improvement, NPC organised a three day National Conference on the "Role of Trade Unions in Productivity Improvement" in collaboration with ILO and Ministry of Labour. The Conference brought together the representatives of national level trade union organisations and unit level trade unions. This book contains the theme papers, proceedings, conclusions and recommendations of the Conference. Reflecting the diverse range of views and experiences, the book provides an insight into the emerging cossensus of trade unions on productivity.

Strategic Approach to Human Resource Management: *Y.R.K. Reddy, New Delhi, Wiley Eastern, 1990, 120p.*

This book is an attempt to understand Human Resource Management from the practice point of view in the strategic environment encompassing various subsystems of manpower management. While recapitulating the development in approaches, techniques and tools, there is an attempt to raise new issues and propositions as feed for further debate, research and practice. It is addressed to the non-competitive and service sectors as well as to competitive and manufacturing sectors.

The Ecology and Politics of Survival : Conflicts over Natural Resources in India : *Vandana Shiva and others. New Delhi, Sage Publications, 1991.*

This book analyses ecology movements in contemporary human society and the conflicts generated over vital natural resources. While it is relevant for societies all over the world, the study analyses in particular the intense and

emerging social contradictions in India related to conflicts over natural resources. A path-breaking study, it examines the way ecology movements in the Third World have questioned the validity of the dominant concepts and indicators of economic development.

Total Quality : An Executive's Guide for the 1990s : *Ernst & Yound Quality Improvement Group. Homewood, Ill : Dow Jones - Irwin, 1990. 248 p, $34.95.*

A comprehensive guide for top managers to help them affect the cultural transformation necessary to improve equality. Leadership commitment, Policy deployment, total productive maintenance, and technology implementation are among the topics discussed from the perspective of quality improvement.

Training for Development : *Rolf P. Lynton and Udai Pareek. New Delhi, Sage Publications, 1990, 364p, Rs. 95.*

This publication focuses on training not primarily as a source of new information, but rather as a means for changing behaviour for lasting improvement on the job. Training is most effective when viewed as a system of interactions between trainers and trainees, and between work organizations and institutions providing training.

Work Culture in the Indian Context : *Jai B.P. Sinha. New Delhi, Sage Publications, 1990, 236p., Rs. 190.*

It is based on a empirical analysis of six large organisational for their apparent differences in terms of history and leadership styles, each organizational confirms to one of two work culture patterns. The author terms these patterns "soft" and "Synergetic" respectively. A "soft" organizational is characterized by pliant management and an emphasis on non-work activities and influences. "Synergetic" management, on the other hand, is assertive, awards hardwork and provides ample welfare measures.

Wood Energy Systems: *O.P. Vimal and M.S. Bhatt. New Delhi, K.L. Publications, 1989, 251p, Rs. 360.*

There is serious concern in India about the demand and supply of fuelwood. Scarcity of fuel wood results in burning considerable quantities of animal dung and agricultural residues, which otherwise would have been used for restoring soil fertility and increasing food production. Very low combustion efficiencies have been achieved. The book reviews the wood situation in India, and the lack of a systems approach to the supply problem. The authors have identified systems for generating, converting and utilizing wood in a better way. Simple conservation measures can lead to significant savings in fuel; replacement of clay pots with aluminium, pressure cooking, and control of air have potential for energy saving.

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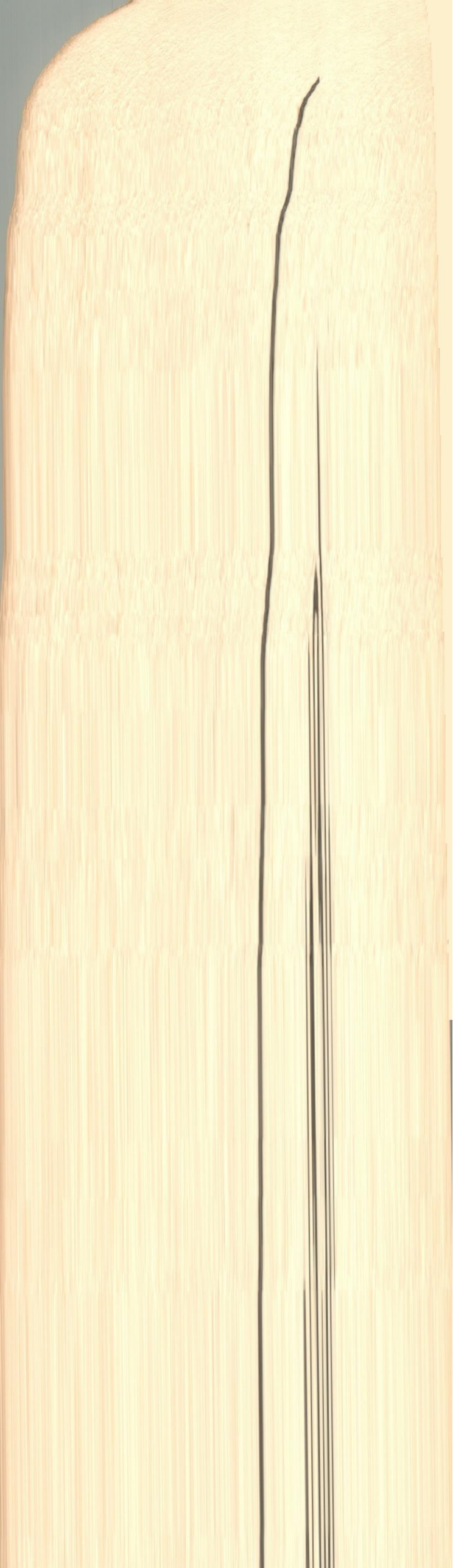
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