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Role of Women in Food Security in India

Shobha Supekar

Food is a basic human right and hence the concept of food security has a global importance, and being global, has assumed international importance. This paper deals with the role of women in food security.

Shobha Supekar is Assistant Secretary, Ghandi National Memorial Society; Principal Kasturba Mahila Khadi Gramodhyog Vidhyalaya; and Chief Coordinator, UNHCR Refugee Project, Pune.

During the new millennium the problem of food security has assumed great significance as a result of the alarming increase in population. Increases is food production are not keeping pace with the population growth, and related ecological problems, gender inequality and other issues that are discussed in detail in the succeeding paragraphs.

Food Security Definitions

Food security is a concept variously defined by the World Bank as "access by all peoples at all times to enough food for an active healthy life", and by the FAO as "the basic right of all people to an adequate diet and need for concerted action among all countries to achieve this goal in a sustainable manner". FAO adds that "food security exists when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life".

Former head of the International Rice Research Institute Dr. M.S. Swaminathan redefines food security as "livelihood security". He has further categorized food security at various levels of human organisations namely national level, regional level, household level and individual level. He states that public action for ending endemic hunger should keep in view the following:

a. Food security should be considered at the level of individual, rather than of the household, since women and girl children tend to suffer more from poverty induced under nutrition.

b. Non-food factors like income, environmental hygiene, primary health care, and literacy are equally important.

c. Poverty is the primary cause of under and malnutrition.

The above conditions prevail in all developing countries including India. Based on these consideration

therefore he adds that "sustainable food security involves strengthening the livelihood security of all members within a household by ensuring both, physical and economic access to balanced diet, including the needed micronutrients, safe drinking water, environmental sanitation, basic health care and primary education".

Issues Affecting Food Security

The core of the topic under discussion, namely the current issues affecting food security in India can be summarized as follows:

1. Heavy Population Pressure

India stands second in the world with its population exceeding one billion. The breakup of the 1,002,142,000 population as on 1 July 2000 is as follows:

Area	3,288,000 km² (1,269 miles²)
Urban	286,201,000 or 28.56 per cent
Rural	715,941,000 or 71.44 per cent

The female population in India is 960 per 1,000 males, but in rural areas it is 968 and in urban areas it is 936 per 1,000 males (Centre for Monitoring Indian Economy, *Basic Statistics: India*, 1993). The heavy population pressure is mainly due to poor utilization of contraceptives, early marriages and lack of awareness of population issues. The figures given below reflect the problem:

a. 51.8 per cent of women do not use any contraceptive methods.

b. 50 per cent girls are married below the age of 18 (27.9 per cent in urban area and 28.6 per cent in rural area).

c. The fast rates of growth of population necessitates a higher rate of economic growth including food production to maintain standard of living.

2. Poverty

Poverty can be defined as a social phenomenon in which a section of the society is unable to find any means of livelihood to meet even its basic necessities. In India there being mass poverty, the problem of food security is more acute. This can be seen from Tables 1 and 2, which are self-explanatory.

The following tables show that rural poverty is higher than urban poverty because larger numbers mean higher food insecurity in rural areas. The percentage of population Below the Poverty Line (BPL) in rural areas has come down over the years due to the impact of the poverty alleviation programs, but the absolute number has considerably increased due to the population explosion. In rural areas BPL people are mainly landless laborers and small and marginal farmers whose production is very low. Urban figures are mainly a spillover from rural poverty and urbanization. One result of being unorganised for both the rural and urban BPL is that people earn low wages, women being among the worst sufferers. In the global context the percentage of poor women among the total of all poor is about 70 per cent, which indicates gender discrimination.

Table 1: Population below the Poverty Line by Rural/Urban

(Unit: Million)

	1973-74	1977-78	1983-84	1987-88	1989-90
Rural	244.22	253.10	221.50	195.97	168.60
Urban	47.33	53.70	49.50	41.70	42.20
Total	291.55	306.80	271.00	237.67	210.80

Source: Centre for Monitoring Indian Economy (CMIE), *Basic Statistics: India*, 1993.

Table 2: Percentage of Population Below Poverty Line, by Rural/Urban

(Unit: Percent of total population)

	1973-74	1977-78	1983-84	1987-88	1989-90
Rural	54.1	51.2	40.4	33.4	28.2
Urban	41.2	38.2	28.1	20.1	19.3
Total	51.5	48.3	37.4	29.9	25.8

Source: CMIE, *Basic Statistics: India*, 1993.

It may be concluded that India's food insecurity is mainly due to mass poverty. It may be added that even though in India adequate food is available, due to poor purchasing power the same cannot be purchased by the masses.

3. Lack of Education and Awareness

India has suffered from mass illiteracy for decades. Gandhiji stated that "Mass illiteracy is India's sin and shame and must be liquidated". He believed that the salvation of India depended on the awakening of women.

Literacy is one of the most important indicators of the social, economic and political development of the society. Illiteracy leads to overpopulation, unemployment, poverty, gender inequality and low productivity. It also leads to food insecurity. The literacy percentage among

females in India is 39 per cent. In the age group of 15-49 the illiteracy percentage among married women is 58.4 per cent, and in urban areas it is 25.6 per cent. Those who cannot read lack of awareness of social and economic problems and this affects family planning adversely. In short, if women are better educated they will opt for smaller family size and will become more productive members of the society, thus reducing food insecurity.

4. Imbalance in Food Requirement and Food Availability

India is the third largest food producing country in the world. But still food availability does not mean food security. One should have the purchasing power to buy sufficient food whenever and wherever needed. At times there is a paradoxical situation where in spite of plenty of food being available, a number of children die of malnutrition. In the Melghat Tribal area of Maharashtra State for example, thousands of children die every year as a result of malnutrition. This finding is based on practical work experience by the NGO Gandhi National Memorial Society, covering 311 villages.

To overcome this chronic problem the NGO Gandhi National Memorial Society initiated a program of training for tribal women social workers in their institution. The curriculum covers *inter alia* health, hygiene, nutrition and skills development.

In India food grain production increased from 51 million mt in 1950-51, to 201 million mt in 1998-99. This was mainly due to the Green Revolution. While the population increased threefold during this period, food production increased fourfold. The overall growth of food production in all these years outpaced the rate of population growth. But that positive trend is expected to change in the new millennium. India's population of already passed one billion, and this year's food grain requirements will be around 220 million mt. It is estimated that for this increased population, additional food grain production has to be around 5-6 million mt per year. In short this means the increase in population will outstrip the increasing food production despite the Green Revolution, and the alternative of extensive cultivation is not an option because arable land area in India has reached its limit of 140 million ha. Compounding the problem, the use of Green Revolution technologies such as high yielding seed varieties, chemical fertilizers, pesticides and large-scale irrigation sometimes cause soil degradation, environmental pollution and loss of biodiversity.

5. Effects of Globalization

With globalization, developing countries are facing a dilemma! The problem is the need for the rapid industrialization *vis-à-vis* food security. The following problems have been identified:

- There is every possibility of agricultural land being shifted to industrialization or for cash crop. This will result in food insecurity.
- Land is also likely to be diverted to housing, road building, tourism, etc. as a consequent of increased population.
- Mega dams and other projects are likely to affect the eco-system and environment adversely.
- Increase in exports of food grain will cause shortage of food availability, unless only surplus food grains are exported.
- Due to diversion of water for industries, tourism, urban use, etc, there will be shortage of water for agriculture.

6. Other Factors

Other factors limiting food security are over crowding in agriculture, discouraging rural atmosphere, fragmentation of land, inadequate non-farm services, size of holding, poor techniques of production and processing, inadequate irrigation facilities, poor purchasing power, variations in food prices, sudden changes in incomes and prices, storage facilities and high storage cost and poor management of public food stock.

Women's Role in Ensuring Food Security

A sizeable proportion of Indian women is engaged in agriculture. To achieve the World Summit goal *"to halve the number of hungry people in the world by 2015"* women's full potential is crucial. It is a big task and requires a real "Cultural Revolution" in people's attitudes and behavior in a patriarchal society like India.

Globally women hold key positions in the diversified agriculture sector to produce food not only for their families but for millions of people worldwide. A woman farmer extends the food chain from the farm sector to the household, and takes responsibility for various food-related activities to ensure food security of her family. India practices traditional agriculture on small farms mostly of less than one ha. Operations like sowing, weeding, harvesting, picking of tea leaves and coffee beans, fruit and vegetable growing, etc, and particularly work related to rearing of animals is undertaken by women in the rural areas. This occurs in 7.5 million Indian villages.

In spite of the problems like lack of access to education or inadequate education, gender inequality, secondary status in a male dominated society, exclusion from participation in decision-making and lack of awareness, women in India do play a critical role in the progress of earning a livelihood. They participate in production and to some extent in the marketing of agricultural products. A very small proportion of women is directly involved in marketing. In production activities women play a role as a food producers and food providers, but their contribution is recognized only as that of laborers.

The vast majority of women are engaged in domestic and household production activities which contribute to the survival of the household, but go unrecognized and unrewarded. In India labor inputs per ha of women in agriculture was found to be higher in regions which higher rainfall and in agriculturally backward regions. Under Indian Himalayan conditions, a pair of bullocks is observed to work for 106 hours, a man for 1,212 hours and a woman for 3,485 hours in a year on a one-ha farm. A woman puts in greater number of hours than man and animal together.

As agricultural laborers, women play a key role in food production. When they head rural households they increasingly become farm managers especially in food production. Female-headed households are especially poor, and they have many young dependents. They struggle for food continuously. Due to price rises or food shortage food insecurity is always with them. At such times just to meet food needs, many families dispose of their assets, or they borrow money from moneylenders to meet their food needs.

Various studies showed that women have a major responsibility for feeding the household. As a result, when women's income is lacking the whole family suffers, and women have fewer opportunities to earn in rural areas. The 1991 census of India showed that 34.22 per cent of female workers are cultivators and 44.93 per cent of females are agricultural laborers. Data shows that women's contribution in food production and processing remains in the informal sector and for self-consumption. Because it is difficult to show their share in agricultural production or in household income, contribution by women is never counted and shown in formal statistics, which poses a handicap to their becoming equal partners in development.

Some practical examples of what Indian women are doing for ensuring food security are listed below:

- Women in Gujrat came together and started a cooperative milk industry known as *"Amul"*. A large number of women are members and managing the industry very efficiently. A major proportion of rural Gujrathi women benefited from this project.
- In Himachal Pradesh women changed the cropping pattern. Due to fragmentation of land it was not profitable to grow food crops, so women surveyed the market and started a floriculture enterprise.
- Tribal women from Himachal Pradesh offered a unique non-violent resistance and prevented deforestation. This movement is known as "Chipko" movement.
- Women in Kerala offered stiff resistance to encroachment by trawlers to safeguard the livelihood of small fishermen.
- Through the NGO Assisi Farm and Training Centre Society in Tamilnadu, 270 families are trained in kitchen-gardening activity, and about 50 per cent of their food requirement is being produced organically at little or no expense.

Important Measures Taken to Enhance Women's Access to Productive Resources

1. Government Efforts

The Indian Government has recognized women as productive workers and contributors to the country's economy, and has taken some steps towards upliftment of women. In the Ninth Plan a special emphasis has been given to women's empowerment. The following are some examples.

1. The *National Women's Commission* for women in self-employment has focused on the tremendous contribution made by women to the national economy. This leads to specific programs like: (a) Development of Women and Children in Rural Areas (DWCRA); (b) Support to Training for Employment Programmes (STEP); and (c) National Credit Fund for Women in 1993 (*Mahila Kosh*) aims to reach the poorest of the poor and assetless women who are in need of credit but cannot access the formal banking or credit but cannot access the formal banking or credit system.
2. *Women's development corporations* have been set up in various States. They are making concentrated efforts to improve women's conditions by upgrading their skills through training

programs and offering more employment opportunities to them in schemes like public distribution system, dairy development, food preservation, social forestry, rural marketing, etc. which are related to them in traditional occupation, agriculture and animal husbandry, etc.

3. *The Common Minimum Needs Programme* objectives give priority to agriculture and rural development, generating productive employment, and eradication of poverty ensuring food security for the vulnerable groups of the society.

4. For the eradication of poverty, *reservations have been made* for the women in poverty eradication program.

5. *Special Credit System* allows easy access to credit at low transaction costs to women in the formal sector.

6. *Mahila Sammriddhi Yojana* is a special saving scheme for rural women. A significantly large number of women have come forward to have their own saving accounts through which they can exercise better control over household resources.

7. *Indira Mahila Yojana* mobilizes women around and integrated delivery system which will cover a whole range of social, economic support services for women and children.

8. *National Social Assistance Scheme:* To provide old age pension to all persons below the poverty line and above 65 years age. Lump sum family benefits in the cause of the death of the principal bread earner and maternity benefits to women of poor households for the first two births.

9. *Integrated Child Development Services:* To cover 20 million children and women, National Creche Fund created to expand the network of day care centers. A massive mid-day meal scheme to cater to all primary school children in the country.

10. *National Literacy Mission:* To create awareness among the rural women.

11. *National Commission for Women:* Created through as act of Parliament. This acts as an ombudsman for women for reviewing the working of legal and constitutional safe-guards and intervening in cases of atrocities. Laws make it compulsory for the government to consult the commission on all major issues concerning women. Most of our States have also set up State commissions.

12. India has a policy today for encouraging *joint ownership of property* by women and men.

13. *Reservation for Women in Local Governments:* By law 33 per cent of places are reserved for women in local governments. This has created tremendous enthusiasm among women. Almost one million women have entered public offices and took control of their own lives and the destinies of themselves and their family.

14. *Women in Agriculture Scheme:* Considering lack of awareness of women's role and contribution in agriculture, Government of India formulated a scheme "Women in Agriculture". The objects of the scheme are to:

a. Create general awareness on the role played by women in agriculture;

b. Motivate and mobilize women farmers through a group approach;

c. Train groups to form effective network for channeling agricultural development programs and other support system such as income, technical and extension support.

d. Ensure and provide equal opportunity to make women farmers self-reliant.

e. Identify and organize women's groups which act as network for channelling the required agricultural support such as assessment of specific input needs and the training of women farmers, and the provision of organisational and financial support to self-help thrift groups.

f. Provide technical training in agriculture and various farming systems, training in management, organization, entrepreneurship development and decision-making schemes. One hundred per cent expenditure of this scheme is borne by the Government of India.

15. Reservations in Agricultural Universities: Thirty per cent of the seats are reserved in agricultural universities for women.

16. *Swarnajayanti Swayamrojgar Yojana:* This scheme is launched by Government of India to make rural people self-employed through entrepreneur-ship development programs. Forty per cent of reservations are made for women.

2. Limitations

Despite governments efforts towards the mainstreaming of women in national development, Indian

women still have a long way to go in terms of literacy, education, health and nutrition, etc. The problems of food, water, fuel and shelter facing the poor women of India are daunting. Following are some factors limiting women's role in food security.

1. *No Enforcement of the Law:* Although legal rights for joint properties including land are bestowed to women, gender discrimination, lack of awareness and education, and secondary status of male-dominated society mean that the laws are rarely implemented. As a result, women themselves have no security for their survival. Legal literacy is extremely important because it aims to educate women about the laws concerning their rights. This work has started is India but needs to reach the millions of our rural Indian sisters.

2. *Gender Discrimination:* In India gender discrimination exists in all walks of life especially in rural area. It is so alarming that girls and women are not even fully fed with adequate nutritious food and often sleep on a half empty stomach. Beside they are deprived of education, training and health care, etc.

3. Lack of Education and Training Opportunities, and Facilities: Lack of education and awareness means women know little of what is happening around them and in the world. In some cases if they want to learn, educational and training facilities are inadequate. Facilities for girls in rural areas are mostly restricted to primary level, as higher level facilities are available only in urban areas. Further due to inherent traditional conventions girls are not generally allowed to go to urban areas for higher education. This stunts their intellectual growth and socio-economic advancement and awareness. Further it is observed that while in India we have special colleges like management, engineering, pharmacy, medical, etc. for women, there are no agricultural colleges exclusively for women.

4. Lack of Education and Awareness: Women have no role to play in decision-making processes in the family, therefore have no self-confidence and are, in short, treated as secondary.

5. No Access to Credit: Women seldom have access to credit facilities, productive resources and other support, which results in physical and financial helplessness.

6. Traditional Culture: Traditional culture, including early marriages negatively affect the advancement of women in a male dominated society.

7. Discrimination in Wages: Rural women folk are mainly involved in agricultural operations. They work as causal laborers or daily workers. As with domestic work, much of women's agricultural labor is overlooked because it is unpaid. In India 30-40 per cent of landless laborers are women. Although minimum wages are fixed by law for farm laborers and the constitution stipulates no discrimination between men and women in wages, the laws are usually breached. Women get lower wages than men for the same work and as a result their contribution is not comparable to the wages they receive, but this is seldom recognized.

As regards work force participation, the women's contribution is not counted as workers because they work for less than the accepted measure of being employed i.e. working for full at least 183 days in year. In respect of small farmers, the women in the family work on the farms but they are not paid any wages nor their contribution is counted. Further they have to carry out all the domestic duties in the large families. Therefore they are overburdened with work.

8. Dependence: Last but not least there is a general limitation on the women's development because of heavy dependence on government funds and schemes i.e. price subsidy, feeding scheme rationing, employment programs, etc.

Prospects for Women in Sustainable Food Security

Despite the constraints for women, the prospects of attaining sustainable food security are bright. In this women can definitely play a major role and contribute substantially. To this end, some action at the government and local levels is in progress:

Population Control

In population control the participation of women and their decision-making capacities required to be strengthened. This work can be done especially by women's NGOs by creating better awareness and education. The Government of India has taken a decision in the right direction by reserving a 33-per cent quota for women in local government.

Sustainable Agriculture as the Key to Sustainable Food Security

Sustainable agriculture is possible if the following actions are taken:

1. *Security of land and ownership* has to be ensured. This can be done by enforcing the

property rights of women in joint property. At the time of marriage in India the bride's name is changed, and this name must also be incorporated in the property records.

2. Appropriate Modern Technology for Agriculture: As food producers and food providers women will adopt the most suitable technology that will not adversely affect the productivity of soil, the eco-system, the environment and human lives. As food providers to the entire family women have a full knowledge of the food requirements of the family with proper nutrition, and will therefore not go in for cash or commercial crops and will give first priority to food crops. This will ensure food security for the family.
3. Watershed Development: Water being the key factor in agricultural production particularly in rainfed areas, women's participation in watershed development is very crucial to ensure adequate production.
4. Access to Resources: Sustainable agriculture is possible if common property resources are made accessible to all. These resources should be owned and managed by local communities wherein women's equal representation as men.

Access to Credit for Augmenting Family Income

To ensure food security, increased purchasing power of the family is a must. A number of women are working in agriculture and in other production areas which require access to credit facilities. Irrespective of the source of income generation women workers have to be provided with credit facilities without gender or other discrimination. The Self-Help Groups (SHGs) credit scheme for women has shown excellent results not only in diversified income generation, but also in repayment of the credit.

Needs-based Training Programs

To enable women to undertake the agricultural or other income-generation programs, it is very essential that specific need based training courses are to be prepared and conducted. These training programs shall include *inter-alia* cropping management patterns, agro-processing and preservation, marketing, packaging, advertisement for entrepreneurship development, seed collection and selection, nursery activities, forestry, appropriate low-cost technology, organic farming etc. In short, in addition to adult literacy among women the "Agriculture Literacy" program has to be undertaken as a special campaign.

Entrepreneurship development programs undertaken by various NGOs in Maharashtra including the Gandhi National Memorial Society in Pune, India have shown excellent results. It is however necessary to expand these programs through mobile units so that it can be reached at the doorsteps of the individual rural women.

Gender Sensitization

With gender discrimination going down as a result of the gender sensitization programs undertaken by the various NGOs, and with increased awareness, the participation of women in all activities has increased substantially.

Alternative Public Distribution System of Food Grains

Alternative Public distribution systems for food grains and other necessities undertaken by government are in vogue for the last few decades, it has not achieved the desired result for the weaker section of the society. Therefore an alternative public distribution system has been adopted for the fair distribution with low cost for the benefit of weaker section. If this system is entrusted to women through local bodies the desired result can be achieved.

This has been proved by a model scheme adopted by an NGO namely Deccan Development Society in the underdeveloped and remote Medak district of Andhra Pradesh. This innovative alternative system covered 30 villages and is run by local women belonging to the most disadvantaged segments of the society. It has not only distributed food and other articles but also brought 3,000 acres of fallow land under cultivation. A community grain fund has also been created, through which food is locally produced, locally stored and locally distributed. This has eliminated the need for subsidy which the government had to bear.

The advantages of this system are increased production, which is sold locally, extending more jobs opportunities and leading to higher purchasing power. This model system has to be adopted all over India so that a strong local economy shall emerge. With this, local people will be less vulnerable and less dependent on out side factors. This is due to the management being in the hands of capable village women who understand the core of the problem.

SEWA Projects

The Self-Employed Women's Association (SEWA) is a cooperative which has brought together women from unorganized sectors and transformed their lives. SEWA

has shown the status that empowerment and organisation can bring the most poor and oppressed women in the work place. This model is exemplary and needs to be expanded all over India so that women's participation in sustainable food security through cooperative efforts will increase.

Rural Urban Linkages

To open up the channels for industrialization, marketing, rural urban linkages are very important, which would help towards upstream development of rural women.

NGOs and Women's Development Corporation

More and more participation of NGOs and women's development corporations are necessary for proper implementation of developmental schemes. In short, the conditions of Indian women are changing in a positive direction. Development of women is a central issue in our planing process. Since the 1980s, women have been organized as a special target group and government efforts have been directed towards the mainstreaming of women into national developmental processes. Nevertheless, Indian women have a long way to go in terms of literacy, education, health, nutrition and participation in work force.

Conclusion

- First, a country and its people are food secure when production, markets and social systems work in such a way that food consumption needs are always met.
- Second, food security requires economic development and large-scale public involvement, with a high level of commitment.
- Third, to ensure sustainable food security India must control its population and attend self-sufficiency with decentralized production and distribution with on dependence on imports.
- Finally, India strongly believes economic independence, positive political participation, easy access to health, education and means of production would enable women of our country to achieve sustainable food security.

For these to be achieved, women need to be united, motivated, trained and should be treated as main contributor to the country's economy. India will achieve full food security by motivating and empowering women and by setting up women's NGOs such as "American Agri Women" (AAW) and "Women Involved in Farm Economics" (WIFE).

The man of the millennium and the Father of the Indian Nation Gandhiji dreamed of self reliant villages. To fulfil his dream it is necessary to enhance the status of women, and confer on them the right to take decisions. In the words of an anonymous poet:

"I am a farmer, been one all my life.
So call me a farmer, not a farmer's wife.
The plough and the hoe left their patterns on my hand.
No one can tell me this is not my land.
I am farmer not a farmer's wife".

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[This paper is taken from "Role of Rural Women in Food Security in Asia and the Pacific", APO, 2002]

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Food Security in India: A Case Study of Tripura State

Nabanita Roy

This paper deals with the food security mechanism and government interventions in the State of Tripura.

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Tripura is in the extreme north-east of the country. The total area of the State is 10,491.61 sq. km. Bangladesh surrounds it on three sides. Backwardness of the State arises primarily due to its geographical isolation. Alongside its geographical limitations, another important feature of Tripura is its demographic pattern. According to the census figures of 1991, Tripura has a population of 2,757,000 of which female population is 1,339,000. Women constitute roughly 48 per cent of the State's population. A large part of the population is of indigenous people and those belonging to the weaker sections of the society. It is interesting to note that the ratio of females per 1,000 males is 945.

The State of Tripura does not have perennial rivers, and all rivers and streams are rainfed and drain into Bangladesh. Cultivable land is scarce (only 26 per cent of total surface area), and people depend on sectors other than the primary sector for survival. The State receives about 2,100 mm rainfall per year on average. High rainfall and good soil offer considerable scope for land-based economic activities. Productivity of rice in Tripura (1,813 kg/ha) is comparable with the all India figure of 1,879 kg/ha and is far above the north-eastern average of 1,396 kg/ha. In respect of the total yield of food grains, Tripura's productivity of 1,746 kg/ha is higher than the all India average of 1,487 kg/ha. However, the extent of the irrigated area in Tripura amounting to 19.6 per cent of the net sown area, is rather insignificant.

A significant area in the State is under fruits and plantation crops. The major crops grown in plantations are tea, cashew, orange and pineapple. Jackfruit, banana, lemon, coconut and arecanut are largely grown on the homestead. Fruits grow very well in Tripura and the quality of Tripura's jackfruit, orange and pineapple is widely recognized. Tripura grows large quantities of vegetables with potato as the major field crop. The yield of potato is Tripura is 6,795 kg/ha which is the highest in the north-

eastern region. It is higher than the all India average of 5,242 kg/ha and more than double the average for the north-eastern region 7,139 kg/ha.

Economic Scenario

1. Per capita State Domestic Product (SDP) of Tripura was estimated at Rs. 8,669 for 1998-99 at current prices, against the all India average of Rs. 14,682 in 1998-99. Per capita income by quick estimates at prices current in 1993-93 was Rs. 6,251.
2. The economy of the State is primarily agrarian with agriculture contributing 42 per cent of SDP and providing 64 per cent of employment. Ninety per cent of the farmers are small and classified as marginal. The net sown area constitutes about 25 per cent of the total area. Only 19.6 per cent of the area has access to assured irrigation. Due to high population density, the average size of operational holding is only 0.97 ha, which is much smaller than the all India figure of 1.68 ha. The secondary sector has its limitations in providing large-scale employment, and the present wages in the sector are low and unlikely to increase significantly.
3. Major field crop is rice with more than 50 per cent of the gross cropped area. But the area is decreasing. Simultaneously, area under other field crops is insignificant. The area under pulses and oilseeds is however increasing.
4. The State has no significant Central Government or private sector investment. The State is a net importer of capital through Central transfers such as grants and loans, but is unable to retain the transferred capital because of reverse transfers including payments for food and other essential imports, and because of the low credit-deposit (CD) ratio which is only 37:10. The present low CD ratio is a very serious constraint to the increase of labor productivity in the State.

Infrastructural Scenario

1. Basic physical infrastructure, such as a dependable transport system, power, etc. is a prerequisite for economic development. The present state of infrastructure, both in terms of quantity and quality continues to be abysmally poor as compared to the national level and even in comparison to other north-eastern states.
2. Tripura does not have facilities for inland water transport. Transport by road is therefore the only dependable means of transport. Extremely hostile, difficult hilly terrain and high rainfall makes construction and maintenance of roads and other transport network difficult and costly.
3. Per capita consumption of electricity in Tripura was 100 KWH during 1998-99, which was below the national average of 338 KWH. During the period from 1970-71 to 1998-99 per capita consumption of electricity has increased.
4. The overall backwardness of the State is evident from the composite infrastructural index evolved by the Centre Monitoring Indian Economy (CMIE), based on the availability of power, irrigation, road, railways, post-office services, education, health and banking. Tripura is the second most backward State in the entire country.
5. The State has only a token presence of the railways of about 45 km connecting to Assam. By road the State is connected with the rest of the country by National Highway (NH44) which passes through Assam and Meghalaya. This road is the State's lifeline.
6. The State has been continuously beleaguered by socio-economic problems since independence. Tripura was converted into an isolated territory with practically all normal communications with the rest of the country affected by the partition of India. A circuitous and landslide-prone rail or road route through some of the distantly located north-eastern States is the only transit now available, besides the hardly affordable air link.

Opportunities

On account of various geographical, social and historical reasons, Tripura has remained economically backward. As indicated above, the limited availability of infrastructure has made the process of economic development extremely difficult.

The State has, however strengths which can be exploited for ensuring sustained economic development. The north-eastern region is closed to the South-East Asian region, which has seen the fastest economic growth in the last decade. Development of infrastructure and the creation of conditions conducive for economic development however are essential for tapping this potential and bringing about economic development.

Some of the promising sectors of Tripura's economy are as follows:

1. Human Resources

Human resources are the most promising resource of the State. The overall literacy rate is 60.44 per cent with male rate at 70.58 per cent and female 49.65 per cent. These are higher than the national average. Literacy among the tribals is lower at 40.3 per cent (male, 52.88 per cent and female, 27.34 per cent) but also higher than corresponding national average.

The State has well-developed institutions of local self-government. These are integrated into all developmental activities and ensure the willing participation of the people in different programs. The Panchayat Raj, Nagar Panchayat and the Autonomous District Council are major strengths of the State.

2. Natural Rubber and Tea

After Kerala, Tripura is the second largest producer of natural rubber. Rubber produced is of superior quality. At present, about 23,000 ha is under natural rubber plantation and annual production is more than 7,000. In view of a good demand for and high price of natural rubber, this sector holds considerable promise for development in the State. Tripura, a traditional tea-growing area, also has tea gardens covering an area of 6,430 ha with a production of more than 5,500 mt per annum. Tea produced in the state has good blending qualities.

3. Natural Gas

As per the estimate, out of a prognosticated reserve of 400 billion m^3, approximately 16 billion m^3 natural gas is recoverable. This gas is available in non-associate form, with about 94 per cent methane. The availability of gas provides scope for setting up units for producing power, chemicals and fertilizer, which will lead to rapid economic development of the state.

Existing Food Security Mechanisms

In the background of the economic status of Tripura, the concept of community food security assumes greater importance. The physical environment of a hilly area has a generally beneficial effect on human health. However, a number of special features characterize this health scene. It is generally acknowledged that nutritional needs are higher, but little scientific work has been done to determine the precise levels; as a result, the importance of this factor is missed in such important fields as the Public Distribution System (PDS), determination of poverty levels, nutritional support programs for women and children, wage fixation, etc. It is high time now to hope that some scientific work is done on these basic matters.

Because of very limited purchasing power, a significant portion of the population especially in the rural areas cannot take full advantage of the assured food supply made through the universal PDS in the country. The government has a major role in the distribution of essential commodities like rice, wheat, edible oils and kerosene through the PDS at subsidized prices, but if it decides on a lesser role in production it will have to gear itself up to more of a role in distribution, to meet the needs of the poor. In more than 1,500 backward blocks such as in drought-prone areas, desert and tribal and hill areas, the PDS was revamped to include additional items such as soap, pulses and iodised salt. Here the price of food grains is less than in the normal PDS, but a stronger, more comprehensive and more efficient PDS needs to be put in place. But is there adequate effort put in to design and put in place such a system? This is an issue to ponder.

The PDS operates in Tripura, where there is a quite large network of PDS with 1,427 fair price shops (rural, 1,230 and urban, 197) which cater to 683,187 ration card holders. Of these, 632,769 card holders are in rural areas while the remaining 50,418 card holders reside in urban areas. Through the network of fair price shops, the following quantities of food grains and essential commodities are made available every month to the people:

- 13,740 mt if rice;
- 1,280 mt of wheat;
- 2,404 mt of sugar;
- 2,250 mt of iodized salt; and
- 3,509 kl of kerosene oil.

Because of poverty, a large section of the population can hardly take advantage of the benefits of existing PDS. Poverty is multidimensional and multi-sectoral in nature, having originated from a diverse range of conditions. The poor exist in both urban and rural areas of the country, though about 80 percent of them are found in rural areas, but they are not homogeneous. The rural poor consist of economically and socially heterogeneous groups. Rural poverty is in fact, directly related to land ownership and control over land. The poor have very little command over or access to resources, assets, income or credit. They depend heavily on their labor for survival, as there is little else they can derive income from. They have only their labor power to sell, but earn uncertain or low wages. There is also the gender dimension to poverty, since poor women have to shoulder the double burden of being dis-

advantaged by being female and doubly disadvantaged being poor.

The urban poor consist largely of overflow of the rural poor who migrate to towns, and are engaged mainly in casual and uncertain occupations such as street vending, construction, etc. There is little more than taken space in urban areas for the poor pushed out from villages by poverty and social degradation. Most of them live in unhygienic conditions in unending insecurity, never sure when they will be displaced by local authorities or other powerful groups.

Poor people are typically unorganized, hard to reach, inarticulate, often invisible. In particular, women and children, and even their residential locations in rural areas are on the periphery. They have very little access to education and are largely illiterate. In fact there is a close interrelationship between poverty and illiteracy; the number of poor and the number of illiterates are not very different. Self-reliance and creative self-engagement are not able to emerge.

The problem of poverty is aggravated by social deprivation and discrimination. The close intertwining of social oppression and economic exploitation can be seen in a major segment of the poor. Since a majority of the poor live in rural areas, the rural setting has a predominant impact on the poverty situation. The issue of land is of fundamental importance to the rural poor. The deep yearning for equality and land among the rural poor is not something new. They reflect the attitudes and values, which have grown in them in the course of their interaction with the material reality, which has deprived them of both equality and land. To them, ownership of land denotes one's social status and equality means equality in the ownership of land.

Poverty is closely related to employment or unemployment. The marginalized groups of poor in rural areas consist of landless laborers located precariously on the brink of subsistence, depending on uncertain employment and wages. The number of agricultural laborers is estimated at 110 million, about 75 per cent of the total rural labor force. They suffer from socio-economic deprivation and form the core of the laboring classes. It is also worth noting that the number of agricultural laborers is increasing in the last few decades at a rate faster than the population growth rate. For the large mass of agricultural and other laborers who have only their labor power to sell, wages and wage system have enormous relevance.

While land is perhaps the most obvious asset to redistribute, it has to be borne in mind that the economic opportunities in India depend on a much wider range of endowments. The distribution of employment, environmental resources, educational facilities, and affordable credit arrangements are examples of other influential factors. According to Dr. Amartya Sen, Harvard economist the opportunities for redistribution of these diverse endowments have to be considered along with the scope for land distribution, if the conditions of the poorer sections of the people are to significantly improve.

As Amartya Sen has pointed out, only enormous expansion of food production can make it possible to guarantee adequate food for all. For the more fortunate part of humanity, health problems connected with food consumption stem from having too much. While one part of humanity desperately searches for food to eat, another part counts calories and looks for ways of slimming! Persistence of hunger is related to extreme inequality within the society.

In simple terms, food security has two aspects: availability of food and accessibility to food stocks. A household can feel food secure if:

- food which is culturally acceptable with appropriate nutritional value is available in the system;
- households have the capacity to buy; and
- there is freedom to choose from the available food stocks, and at the same time there is no institutional barrier to access the available food.

People can feel secure within the household when all members especially the women and children have equitable access.

The critical role played by a well-organized PDS for essential food grains in a densely populated low income economy insulates the poor from the rise in food grain prices. This fact should be appreciated by policy-makers, and the State should make an explicit guarantee of the right of the poor to food security. Food security is an important component not only of survival, but also of basic dignity and well being of the poor. The running of the PDS is entirely in the hands of the administration. An efficient and responsive administrative machinery can ensure that the benefits reach the poor.

New considerations will include how to exclude the *"non-poor"* from the PDS, and how to reduce the big subsidy burden in making food grains available. The question of "targeting" the truly deserving sections poses major challenge to administration.

In overcoming this challenge, women can play a very significant role. Women have always been associated with the utilization of rice, wheat, sugar, kerosene, edible oils, etc. which are needed in cooking. They are acutely aware of problems such as lack of cash to buy their weekly supplies. Women could be utilized by the administration to form vigilance committees at local levels to ensure proper functioning of the PDS. Their representation at all levels of policy implementation in the distribution of essential commodities would promote scope for informed and empathetic decision-making it easier and more honest in its dealings at the retailing level.

There is criticism that the reforms have caused double-digit inflation and increased poverty and unemployment particularly in rural areas. A solution to it is sought in the curtailment in government expenditure. Cuts in expenditure sometimes result in the axe falling invariably on *"unproductive"* social welfare sectors.

One of the fears expressed by many people is that subsidies may have to be reduced all round, and that the poor and the poorest among the poor including women, would be affected. Some selectivity needs to be exercised after looking at short- and long-term implications and gauging the effect on different categories of people. Controlling inflation depends on containing the fiscal deficit, recovery of industrial production and better management of the supply of food grains and essential commodities. The delicate exercise of curtailing fiscal deficit in a democratic set-up will have major implications for public administration and the role of government.

Women have always had the habit of saving for a rainy day. They experience a daily dilemma of consuming versus saving. More than men, women are expected to keep the home fires burning. Women's perceptions arising from their experience may enable new approaches to curing fiscal without compromising on food security aspects, and this is well worth a trial.

Government Interventions

In a given scenario, a major intervention by the government is needed to strengthen existing food security mechanisms. Relatively more important and immediate steps may be:

- formulation of a comprehensive poverty policy;
- focused attention on strengthening the PDS to transform it in to a vibrant and efficient food assistance program;

educating the needy about their entitlement;

- recognizing the importance of a strong safety net that can provide families in need with the support to survive;
- encourage individuals, mainly women, to contribute in endeavors that will give them self-sufficiency in the long run;
- creating strategic alliances between public and private sectors for increased funding in food security-related activities;
- forging partnerships between voluntary organisations now engaged in diverse activities like anti-hunger campaigners, environmentalists, community development activists, literacy workers, etc.; and
- Launching initiatives to reduce hunger, improve food availability, nutrition and preservation.

[This paper is taken from "Role of Rural Women in Food Security in Asia and the Pacific", APO, 2002]

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Television has done much for psychiatry by spreading information about it, as well as contributing to the need for it.

– Alfred Hitchcock

Rice-Wheat Cropping System of India: A Total Factor Productivity Analysis and Implications

N.K. Taneja & Sanjeev Kumar

This paper estimates total factor productivity in wheat and rice crops in India at a disaggregated state level over the period 1983/84-2002/03 and compares the performance during these years by examining growth rates with respect to these two crops. The results show that there has taken place a significant deceleration in growth of TFP during the later period. An important implication of this decline in TFP growth is the likely shift in cropping pattern away from these crops to the other non-food commercial crops. It expresses serious concerns about India's food security in the 21st century arising from reduced rate of output growth of foodgrains. It is recommended that an increase in the rate of public investment in agricultural research combined with infrastructural development is essential to achieving a high rate of growth of foodgrain output through upwards shifts in production frontiers.

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Achieving food security has been and continues to be one of the prime concerns of the agriculture development policy of India. Introduction of high yielding varieties of rice and wheat in the late 1960s and early 1970s and the subsequent rapid spread has contributed to a sustained increase in output in foodgrains (Kumar and Rosegrant, 1995). Rice-wheat based cropping systems in India have significant contributed in enhancing the foodgrains production and achieving the food self-sufficiency and food security. Taken together these two crops accounted for nearly 94 per cent of the increase in the production of cereals over the period 1964-65 to 1996-97 (Acharya, 2000). Presently also these two constitute the major foodgrain crops in India as their combined shares in total foodgrain production and area are 79 per cent and 58 per cent respectively (Ministry of Agriculture, 2004).

This spectacular growth performance of the wheat and rice crops in India over the thirty year period from the 1960s to mid-1990s undoubtedly speaks of the successful implementation of new technology package in these crops. But over the past decade, particularly after the mid-1990s, doubts have been expressed about the sustainability of this growth performance (Kumar et. al, 1998). Take, for example, the case of wheat where production has almost stagnated over the past five years, staying in the range of 71 to 73 million tones per annum. These fears are further compounded in view of the overall poor growth performance of the agricultural sector as a whole after 1995. The agricultural growth has decelerated from 3.05 per cent per annum in the period 1983-84 to 1992-93 to 1.52 per cent per annum during 1993-94 to 2002-03. More recently, the mid-term appraisal of Tenth Five Year Plan (2002-2007) has also taken note of the deceleration in yield growth in these two crops and has expressed fears about a potentially serious exhaustion

of technological progress (Planning Commission, 2005). It raises serious doubts about the sustainability of the food security programme in the face of no significant reduction being achieved in the population growth during 1990s.

It is in this context that this paper examines the growth performance of wheat and rice crops in India at a disaggregated level over the period 1983/84 to 2002/03. In order to examine the change over time, the analysis has been carried out at two sub-periods, i.e. 1983-84 to 1992-93 and 1993-94 to 2002-03. The all-India macro aggregates of performance conceal regional imbalances that are very much a central feature of the Indian agriculture. This is because India is a vast country and the state level disparities in agro-climatic conditions and resource endowments are quite marked. Various states also differ in other factors affecting the agricultural production. Irrigation facilities, rural infrastructure and inputs used in crop production vary across different states. It would thus be very interesting to analyse the agricultural performance of India at the state level. One would first analyse the trend of growth rates of area, production and yield in each of these two crops at the state level and then estimate total factor productivity (TFP) indices with a view to examining whether the temporal variations in the former could be attributed to the changes in amounts of inputs or whether these were caused by shifts in the production frontiers.

Methodology and Data Sources

The increase in output could be brought about either by increasing the inputs or through an upward shift in the production function. The latter, of course, is the most sustainable and economic method of moving up the production space as it implies more output being attained worth the same package of inputs. This upward shift in production function implies an increase in total factor productivity (TFP).

It is in this context that the TFP measures the increase in total output which is not accounted for by increase in total inputs. The TFP index is computed as the ratio of an index of aggregated output to an index of aggregate inputs. Growth in TFP is, therefore, the growth rate in total output less the growth rate in total inputs (Rosegrant and Evenson, 1995). Defined in this manner, the TFP is quite a comprehensive concept capturing the effects of both the technical progress and technical efficiency.

There are three approaches to the measurement of TFP, namely, the parametric approach, accounting approach and non-parametric approach. Most studies on agricultural productivity of India have relied on the growth accounting approach. This approach is popular because computations involved are simpler and it does not require any econometric estimation. As such, the data requirements are minimal. It has also several useful properties (Diewert, 1976, Christensen, 1975, Capalbo and Vo, 1988). Thus, the Divisia-Tornquist index is used in the present paper for estimating the total output, total input and total factor productivity indices for the wheat and rice crops in the Indian states. The methodology used is as explained below:

Total Output Index (TOI):- Total output index is given by:

$$TOI_t/TOI_{t-1} = \Pi_j [Q_{jt} / Q_{jt-1}]^{(Rj\ t+Rj\ t-1)/2}$$

In present study, we estimate crop specific TFP indices and, therefore, $R_{jt} = R_{jt-1}=1$

Total Input Index (TII):- Total input indices are constructed as follows:

$$TII_t/TII_{t-1} = \Pi_i [X_{it} / X_{it-1}]^{(Si\ t+Si\ t-1)/2}$$

Total Factor Productivity Index (TFPI):- Total factor productivity index (TFPI) is computed as the ratio of total output index (TOI) to total input index (TII).

$$TFPI_t = \frac{TOI_t}{TII_t} * 100 \qquad \ldots (1)$$

Where, Q_{jt} = Output of j^{th} crop in t^{th} period

R_{jt} = Output share of the j^{th} crop in total revenue in t^{th} period.

X_{it} = Quantity of i^{th} input used in j^{th} crop in t^{th} period

S_{it} = Share of i^{th} input in total input costs of j^{th} crop in t^{th} period

The above equation (1) provides the total factor productivity index for the specified period 't'. In this study, TFP is measured for wheat and rice crops for major states of India for the period 1983/84 to 2002/03. For analytical convenience this period has been divided into two sub-periods, namely, 1983/84 to 1992/93 (first sub-period) and 1993/94 to 2002/03 (second sub-period). For analysis of performance of wheat crop, the study covers five Indian states, namely, Uttar Pradesh, Punjab, Haryana, Madhya Pradesh and Rajasthan. These states taken together account for 88 per cent of the total wheat produc-

tion in India. Similarly, the analysis of rice crop covers Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Andhra Pradesh, Assam, West Bengal and Orissa, which produce approximately 75 per cent of total rice output of India.

A widely accepted exponential model, $y = a\ b^t\ e^u$, has been fitted to the time series data for estimating growth rates. The logarithmic form of this function is given by;

$$\ln (y) = \ln(a) + t \ln(b) + u$$

where,

y is the dependent variable whose growth rate is to be estimated.

t is the independent variable (Time)

u is the disturbance or error term.

a and b are the parameters to be estimated from sample observations. The regression coefficient b is estimated by ordinary least squares (OLS) technique.

The Compound Average Growth Rate (CAGR) in % term is estimated as:

$$CAGR = \{\text{antilog } (b) - 1\}*100$$

The significance of difference between the growth rates of two different periods has been tested by applying the dummy variable technique. The model used is:-

$$Y_i = \alpha_1 + \alpha_2 D_i + \beta_1 X_i + \beta_2 (D_i X_i) + U_i$$

where,

Y_i is the variable whose growth rates over the two different periods are studied.

Di is dummy variable, taking value 0 for each observation in the first period, i. e., from 1983/84 - 1992/93 and 1 for each observation from 1993/94-2002/03.

X_i is the time, taking values from 1 to 20 respectively from 1983-84 to 2002-03.

Here β_1 gives the slope coefficient for the first sub-period and $\beta_1 + \beta_2$ gives the slope coefficient for the second sub-period.

Data Sources

For the estimation of TFP, we have included 10 inputs (seed, fertilizer manure, human labour, animal labour, machine labour, irrigation charges, depreciation of machine & implements, insecticides, and rental value of owned land). Human labour input is measured as the total number of male and female workers employed in the production of particular crop during the year. Land is measured as gross cropped area and animal labour is measured as the number of adult bullocks and male buffaloes in a particular crop. The data on these inputs are collected from "Comprehensive Scheme of Cost of Cultivation of Principal Crops in India", Department of Economics and Statistics (DES), Ministry of Agriculture, Government of India (GOI) and Commission on Agricultural Costs and Prices, Government of India (GOI). Data on some related variables have been obtained from the publications of the Centre for Monitoring Indian Economy (CMIE), Mumbai. Computation has been done by using the software packages, namely, SPSS, STATA and Excel.

Trends in Area, Output and Yield: All India and States

The results of estimation of compound average growth rates (CAGR) of output, area and yield in respect of rice, wheat, coarse cereals, pulses and foodgrains for the two sub-periods: 1983/84 - 1992/93 and 1993/94 - 2002/03 as also for the complete period are presented in Table 1.

Table 1: Growth Rates of Output, Yield and Area of Principal Crops in India: 1983-84 to 2002-03

Crops		Periods		
		1983/84 - 1992/93	1993/94 - 2002/03	1983/84 - 2002/03
Rice	Output	3.09***	0.44	2.13**
	Area	0.42*	0.24	0.46***
	Yield	2.65***	0.20	1.66***
Wheat	Output	3.08***	1.52*	2.94***
	Area	0.13	0.33	0.77***
	Yield	2.94***	1.19**	2.15***
Coarse Cereals	Output	0.90	-0.43	0.11
	Area	-2.02***	-1.66**	-2.07***
	Yield	2.97*	1.25*	2.21***
Pulses	Output	0.50	-1.52	0.10
	Area	-0.22	-1.00*	- 0.52**
	Yield	0.71	-0.52	0.62**
Foodgrain	Output	2.46***	0.55	1.89***
	Area	-0.48	-0.45	-0.35**
	Yield	2.95***	1.00*	2.24***

Notes: ***, ** and * denote significance at 1, 5 and 10 per cent levels of significance.

The sub-period level analysis shows that growth rates of output are significantly lower during the later period than the first period. The performance of rice, the main foodgrain crop, has been worse on this account, the deceleration in CAGR of output being recorded from 3.09 per cent per annum during 1983/84-1992/93 to 0.44 per cent during 1993/94-2002/03. The picture in the case of wheat is no different. But the decline in CAGR is certainly less than that of rice, the growth rates of output being 3.08 per cent and 1.52 per cent over the corresponding two periods. This sharp decline in growth rates of output of the two principal foodgrain crops has very serious implications for India's food security in the current century. The output performance of foodgrains as a whole is also quite disappointing as the growth rate has fallen from 2.46 per cent per annum in the former period to a low of 0.55 per cent per annum in the later period. It is feared that such a low growth rate of output of foodgrains shall not be able to meet the future challenges stemming from formidable increases in demand. It is likely to jeopardise the food security achieved so far.

It may also be observed from these results that the deceleration in foodgrain output growth is due to a fall in the contribution of both area and yield. But it is discernible that the yield growth has decelerated at a higher rate as compared to area growth. These results, particularly, the deceleration in yield growth, call for a through examination of the factors underlying this seemingly poor performance. We, therefore, present a state level analysis of the performance with a view to ascertaining which of the states fared well and which are lagging behind over the periods under consideration.

Rice

Analysis of growth rates of output, yield and area in respect of rice crop has been carried out at the state level and the results, presented in Table 2 show that the CAGR of output during the sub-period 1983/84-92/93 was highest of the order of 5.13 per cent per annum in West Bengal. The rise was between 4.25 to 4.50 per cent in Uttar Pradesh and Punjab. The other states which experienced a rise in CAGR greater than the all states average of 3.83 per cent per annum were Haryana and Assam. All other states, which include Orissa, Andhra Pradesh and Madhya Pradesh, recorded an output growth lower than the all states average during this period. In case of most of these states the observed CAGR was statistically insignificant. It may also be stressed here that in the case of the majority of the better performing states the relative contribution of yield vis-à-vis area has been much greater, the yield growth rate ranged between 0.85 per cent to 4.56 per cent per annum, while that of area between 0.07 per cent to 3.52 per cent.

Table 2: Growth Rates of Output, Yield and Area of Rice in Major States of India: 1983-84 to 2002-03

States		Periods		
		1983/84 - 1992/93	1993/94 - 2002/03	1983/84 - 2002/03
Andhra Pradesh	Output	3.00	0.59	1.71**
	Area	0.71	-0.54	0.03
	Yield	2.27**	1.13	1.72***
Assam	Output	3.33***	1.99**	2.52***
	Area	0.88	0.45	0.59***
	Yield	2.28***	1.57***	1.93***
Haryana	Output	3.85**	3.10**	4.24***
	Area	2.43**	3.47**	4.01***
	Yield	1.23	0.20	0.16
Madhya Pradesh	Output	2.32	-3.87	0.57
	Area	-0.51	-0.71	0.69
	Yield	1.00	-1.92	0.60*
Orissa	Output	3.07	-3.96	0.33
	Area	-0.38	-0.33	-0.02
	Yield	3.45**	-3.70	0.35*
Punjab	Output	4.38***	2.66***	3.40***
	Area	3.52***	2.15***	2.78***
	Yield	0.85	0.46	0.62**
Uttar Pradesh	Output	4.50***	1.12	3.02***
	Area	0.07	0.31	0.42
	Yield	4.56***	0.58	2.64***
West Bengal	Output	5.13***	2.19**	3.27***
	Area	1.21***	-0.12	0.07
	Yield	4.53***	2.59	3.32***
All States Combined	Output	3.83***	0.90	2.48***
	Area	0.82	0.57	0.76***
	Yield	1.84**	0.09	0.98***

Notes: ***, ** and * significant at 1, 5 and 10 per cent levels of significance.

The analysis of the second sub-period results shows that the relative ranking of the states in terms of output growth performance is more or less unchanged. But inter-period comparisons show that the growth rates of output in the second sub-period are much lower than the earlier sub period in almost all states. Again, this fall in CAGR is largely due to reduced contribution of yield. The fall in CAGR of yield for all the states taken together from a high of 1.84 per cent per annum in the first period to a low of 0.09 per cent per annum in the second period is a

matter of serious concern and points to a lower output growth of rice in future.

Wheat

The analysis of performance in respect of wheat crop, as presented in Table 3, reveals many interesting features pertaining to the state-level imbalances in India. Taking the entire period, the output has grown at a CAGR of 3.11 per cent per annum for all states taken together. During this period, the state of Rajasthan recorded the highest growth performance of the order of 4.30 per cent per annum followed by Haryana, MP, UP and Punjab in that order. The relatively poor performance of UP and Punjab, the two largest wheat producing states in India, as reflected through their growth rates being lower than the all India average, indicates that strains on output increases are severe.

Table 3: Growth Rates of Output, Yield and Area of Wheat in Major States of India: 1983-84 to 2002-03

States		Periods		
		1983/84 – 1992/93	1993/94 – 2002/03	1983/84 – 2002/03
Haryana	Output	5.35***	3.78***	4.23***
	Area	1.12**	2.15***	1.73***
	Yield	4.18***	1.58***	2.46***
Madhya Pradesh	Output	3.13**	-2.95	2.93***
	Area	-0.20	-2.21	0.71
	Yield	3.18***	-1.60	2.14***
Punjab	Output	3.05***	1.92*	2.46***
	Area	0.65**	0.44*	0.46***
	Yield	2.40***	1.44*	1.96***
Rajasthan	Output	4.95**	2.49***	4.30***
	Area	0.33	-0.37	1.88***
	Yield	4.33***	2.87*	2.32***
Uttar Pradesh	Output	2.85***	1.81**	2.77***
	Area	0.54**	0.34*	0.62***
	Yield	2.27***	1.32**	2.10***
All States	Output	3.44***	1.79**	3.11***
Combined	Area	0.46*	0.02	0.87***
	Yield	3.23***	1.33**	2.19***

Notes: ***, ** and * denote significance at 1, 5 and 10 per cent levels of significance.

The sub-period level analysis clearly shows that the output growth performance of almost all the states worsened during the later period, and consequently the CAGR for all states combined also declined to 1.79 per cent per annum. It is also observed that the fall in output growth is largely accounted for by the deceleration in yield growth. In almost all the states the fall in yield growth rate is much sharper than the corresponding reduction in area growth rate. In fact in Haryana, there is observed to be a distinct acceleration in area growth in the second period, which clearly establishes that poor yield performance is mainly responsible for the fall in output growth rate over the period 1993/94-2002/03.

The state-level disaggregated analysis shows that in almost all the states the growth rate of output and yield of wheat and rice are observed to be markedly lower in the second sub-period. There have also been observed widespread variations in the performance of different states in each sub-period, some of the states performing better and the others lagging behind. But the fall in yield growth rate is disturbing from the points of view of concerns for food security and economic sustainability of these two crops. It, therefore, needs to be examined whether the observed fall in yield is due to reduction in inputs or has been caused by downward shifts in production frontiers. In order to ascertain this, we have estimated total factor productivity in respect of these two crops, in terms of methodology, outlined earlier.

Total Factor Productivity Analysis: Rice and Wheat Crops

TFP Trends in Rice Crop

The movements in TFP indices of rice crop in major states over the period 1983/84 -2002/03 are presented in Figure (a). The level comparisons among these states over the period of study show that on an average TFP levels have been the highest in Andhra Pradesh followed by Uttar Pradesh and West Bengal in that order. Madhya Pradesh, Punjab, Assam and Haryana have experienced relatively lower TFP levels.

The trends in TFP in rice crop over the two sub-periods of the study as well as for the entire period have been estimated at the state level, and the results are presented in Table 4. It is observed from these results that all states, except Haryana, experienced a rise in TFP growth rate of rice over the period 1983-84 to 2002-03. But the CAGR of TFP varied across the states. It has been estimated between 1 to 2 per cent per annum for Andhra Pradesh, Orissa and Uttar Pradesh; while West Bengal, Punjab, Madhya Pradesh and Assam have experienced TFP growth between 0.2 to 0.9 per cent per annum over the entire period of study.

The comparison between TFP growth rates at state

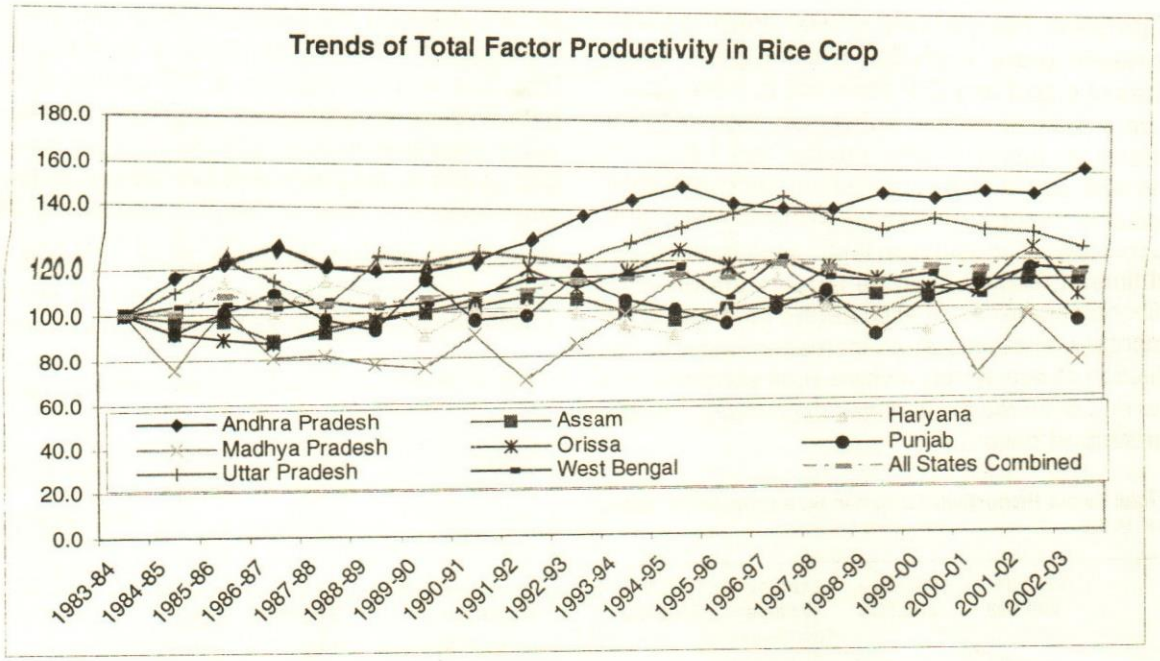

Fig. (a). Trends of Total Factor Productivity in Rice Crop

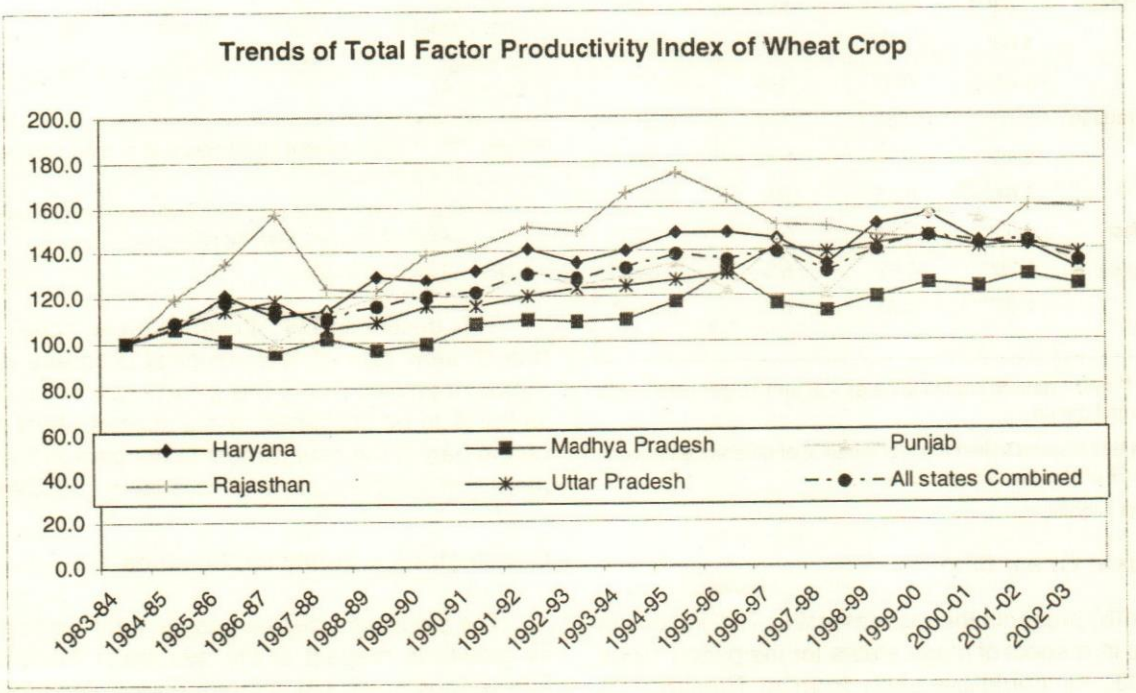

Fig. (b). Trends of Total Factor Productivity Index of Wheat Crop

level over the period 1983/84-1992/93 and 1993/94-2002/03 very clearly establishes that there has taken place a sharp deceleration from 1.07 per cent per annum in the first period to 0.31 per cent per annum at the aggregate level of all states taken together. The results obtained through application of dummy variable technique, which tests the significance of difference between the slop coefficients of two regressions, also show that the difference between CAGR of two periods is statistically significant at 6 per cent level of significance. The other states where the drop in CAGR is statistically significant are Orissa, Uttar Pradesh, West Bengal and Andhra Pradesh.

The foregoing discussion establishes that the rate of

technical progress has certainly slowed down in these states in recent years. It implies that the past higher growth rates of output and TFP observed in these states may not be sustained without substantial technological improvements in future. It also means that future increases in rice output in the immediate short run shall be realised only through an increase in inputs at a higher rate as technological upgradation takes a relatively longer period of time. It requires that the farmers are provided with additional incentives to allocate the land and other complementary resources at an increased rate towards the production of rice. It may involve input subsidies at a still higher rate or increases in output price through higher minimum support price.

Table 4: Total Factor Productivity Growth in Rice Crop: Major States of India

States	1983/84 - 1992/93	1993/94 - 2002/03	Dummy Variable Test Significance Level#	1983/84-2002/03
Andhra Pradesh	2.03***	0.79*	11 %	1.93***
Assam	1.03*	1.78***	NS	0.84***
Haryana	-0.67	0.07	NS	-0.57*
Madhya Pradesh	-1.76	-3.82**	NS	0.55
Orissa	2.44**	-0.73	1 %	1.28***
Punjab	1.01	0.55	NS	0.21
Uttar Pradesh	1.65**	-0.28	5%	1.35***
West Bengal	1.28***	-0.09	5%	0.69***
All States Combined	1.07***	0.31	6 %	0.91***

Notes: ***, ** and * denote significance at 1, 5 and 10 per cent levels of significance.

\# This test is used to test the significance of difference between CAGR of the two sub-periods.

NS – Not Significant

TFP Trends in Wheat Crop

Figure (b) presents the movements in TFP indices in wheat crop in respect of major states for the period 1983/84-2002/03. As could be seen from it, Punjab, UP, Rajasthan and Haryana show a rising trend in TFP with small fluctuations. On the other hand, the performance of MP is poor. After 1994/95 all states show the downward or stagnant trend in total factor productivity indices.

The compound average growth rates (CAGR) of TFP indices at the state level, as also for all states combined are presented in Table 5. It is observed that although technological progress has been able to boost the growth of TFP in wheat production in India over the period of study, its contribution has shown a declining trend over time. The temporal analysis of TFP growth, at the aggregate level of all states taken together, clearly shows a sharp deceleration from 2.26 per cent per annum in the first period to 0.57 per cent per annum in the second sub-period. The drop in CAGR is statistically significant also. Moreover the fall in CAGR of TFP has been uneven. It is more significant in case of Haryana and Rajasthan and less marked in Punjab and Uttar Pradesh.

Table 5: Total Factor Productivity Growth in Wheat Crop: Major States of India

States	1983/84 - 1992/93	1993/94 - 2002/03	Dummy Variable Test Significance Level#	1983/84-2002/03
Haryana	3.50***	-0.45	1 %	1.69***
Madhya Pradesh	0.82	1.05*	NS	1.49***
Punjab	2.46**	1.46	NS	1.85***
Rajasthan	3.16**	-1.16*	1 %	1.44***
Uttar Pradesh	1.69***	1.40**	NS	1.89***
All States Combined	2.26***	0.57	1%	1.67***

Notes: ***, ** and * denote significance at 1, 5 and 10 percent levels of significance.

\# This test is used to test the significance of difference between CAGR of the two sub-periods.

NS —Not Significant

This decline in TFP growth in these states is largely due to slow rate of technological progress during the 1990s. It implies that if the growth rate of production of wheat is to be sustained, more serious effort is needed on the part of the government to encourage the development and adoption of yield increasing technologies.

Conclusions & Policy Implications

The significant deceleration in total factor productivity growth in respect of the two major foodgrain crops has serious implications for food security of the country. It means that these two crops are now viewed as less profitable, and the farmers are likely to shift resources away from the production of these crops. As a matter of fact the trend has already set in, the CAGR of area under foodgrain crops being -0.45 per cent per annum over 1993/94-2002/03 (Table 1). Obviously, this shift in favour of non-food commercial crops, driven by falling TFP growth in wheat and rice, has already set in a trend of declining growth rates of output in these two crops, and

consequently the foodgrain. No wonder that the foodgrain output in India has grown at an insignificantly low compound annual average rate of 0.55 per cent per annum over the period 1993/94 - 2002/03. This, viewed against the growth rate of population of about 1.95 per cent per annum during 1991-2001, points to a significant reduction in per capita availability of foodgrains in the country. The resultant price rise will definitely hurt the poor, which may have serious social and political implications.

The obvious remedy is that the long-term sustainable increases in output could be attained only through a reversal in decline in TFP growth, which will lead to the massive supply–driven solution. It requires effective public policy interventions. Among others, government expenditure on agricultural research and education has been recognized as one of the most important factors favourably contributing to total factor productivity in agricultural sector. But the public investment in India in this area has remained at an abysmally low level of 0.5 per cent of agricultural GDP as against 0.7 per cent in other developing countries, and 2.0 to 3.0 per cent in the developed economies. Thus there is considerable scope for more public resources to be allocated to this high priority area. Further, improvements in rural infrastructure in the form of construction of new roads, creation of additional facilities for stepping up the rate of production of power and development of adequate irrigation network are crucially needed for boosting total factor productivity of the resources in the farm sector.

The huge investment requirements in these priority areas will obviously involve effective reductions in public expenditure on some other items. It is, therefore, recommended that the input subsidies on irrigation and fertilizers need to be scaled down as these are iniquitous and ill-targeted. The resources so released need to be invested in creating research and physical infrastructure much needed for bringing about a long-term sustainable increase in productivity.

Another important area of policy intervention stems from the realisation that various barriers on trade, both domestic as well as external, in agricultural commodities have discriminated against the farm sector by keeping the prices of the product at lower levels. The foodgrains are no exception. It is in this context that the private sector participation in foodgrain trade needs to be encouraged and barriers on inter-state trade in agricultural commodities removed. This would eventually lead to higher prices in free markets and serve as an incentive to the farmers to increase the resource allocation rate towards production of these crops.

In order to protect the poor from this situation of increased foodgrain prices, the public distribution system benefit should be limited to only the vulnerable sections of the population, and the lower middle class and not so poor should be excluded out of the safety net of the subsidized food. Further, the extent of benefit to these limited targeted groups should also be increased. This, along with reduction in input subsidies, would also enable the government to purchase foodgrains at a higher free market price if it is not able to buy the required quantity at the minimum support prices. This again would encourage more production of foodgrains.

Last but not least, the seed-fertiliser technology-driven tempo of growth, which began during the mid-1960s and ensured self-sufficiency in foodgrains production, has started slowing down since the mid-1990s. The barriers to fresh output growth could be broken only through utilisation of opportunities offered by emerging areas of research like biotechnology and genetic engineering. The distinguishing feature of these new technologies is the saving on chemical inputs and relatively more stable yield increases. Obviously, this will also lead to environmental protection and lesser extent of soil degradation. However, knowledge-intensity of these technologies will involve huge investments. Thus, it is high time that India reprioritiés its agriculture research system with a view to becoming competitive and cost effective in an open and globalised agricultural trade environment. This is the only way to achieving a long-term sustainable growth, which would also ensure poverty alleviation at an increased pace.

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Table I: Total Factor Productivity Indices of Rice Crop

Year	Andhra Pradesh	Assam	Haryana	Madhya Pradesh	Orissa	Punjab	Uttar Pradesh	West Bengal	All states Combined
1983-84	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1984-85	116.61	97.49	101.60	75.58	91.36	91.78	109.70	103.44	99.91
1985-86	121.37	97.10	113.96	102.77	88.92	100.69	122.97	104.34	107.45
1986-87	125.55	88.45	100.50	80.94	87.19	108.10	114.30	102.72	105.01
1987-88	120.07	92.00	114.52	82.21	93.79	97.37	102.52	104.99	103.73
1988-89	118.54	96.49	106.85	77.67	96.91	92.94	122.55	102.65	103.19
1989-90	118.48	99.97	90.42	75.76	100.73	114.79	120.59	103.82	106.13
1990-91	120.52	102.37	101.13	90.11	105.21	96.49	123.35	107.74	107.43
1991-92	127.95	106.27	101.63	69.62	117.83	98.08	121.76	113.76	109.14
1992-93	137.80	104.63	98.58	85.26	110.33	115.20	119.63	115.06	113.21
1993-94	144.76	99.53	92.47	98.34	116.74	103.75	127.32	115.28	113.58
1994-95	150.95	95.51	89.05	112.53	124.82	99.99	133.57	118.17	115.90
1995-96	143.77	99.74	98.45	117.61	118.03	93.18	139.61	104.71	114.17
1996-97	142.15	102.09	113.02	119.81	103.52	99.92	147.28	120.76	118.69
1997-98	142.32	105.22	100.44	103.66	117.06	107.95	137.25	113.70	117.43
1998-99	149.30	105.89	88.81	97.12	113.37	88.28	132.89	112.31	112.44
1999-00	147.49	107.83	89.70	106.55	108.74	103.87	138.22	114.59	117.41
2000-01	150.84	112.05	98.25	70.86	106.42	110.28	134.16	105.22	116.74
2001-02	149.61	111.95	97.68	96.18	127.04	116.69	132.85	117.29	122.53
2002-03	161.09	111.84	95.49	75.54	105.27	93.49	127.27	115.92	114.75

Sources: Author's calculation.

Table II: Total Factor Productivity Indices of Wheat Crop

Year	Haryana	Madhya Pradesh	Punjab	Rajasthan	Uttar Pradesh	All states Combined
1983-84	100.00	100.00	100.00	100.00	100.00	100.00
1984-85	106.41	106.16	109.19	119.33	106.62	108.65
1985-86	121.01	101.07	117.53	134.91	113.72	118.16
1986-87	111.07	95.82	99.94	156.59	118.06	114.31
1987-88	113.94	101.50	112.76	123.90	106.31	110.73
1988-89	128.89	96.31	119.94	122.88	108.66	115.50
1989-90	127.61	98.84	122.98	138.86	115.42	120.33
1990-91	131.70	107.84	118.24	142.24	115.66	121.92
1991-92	141.59	109.62	131.30	150.47	120.15	129.54
1992-93	135.18	108.81	124.96	149.54	123.47	128.05
1993-94	140.66	109.77	128.71	166.08	124.51	132.37
1994-95	148.66	117.66	135.01	174.72	127.38	138.79
1995-96	148.11	131.68	122.76	163.66	129.41	135.71
1996-97	145.22	117.00	143.58	151.39	142.28	139.44
1997-98	134.56	113.59	120.97	150.98	139.90	130.37
1998-99	151.43	119.38	142.60	146.23	142.57	140.05
1999-00	156.02	125.20	157.05	145.37	146.31	146.67
2000-01	143.57	123.29	154.56	142.44	141.11	142.82
2001-02	142.02	128.84	147.27	159.27	142.85	144.16
2002-03	131.65	124.87	131.58	158.46	138.44	135.50

□

Spatial and Temporal Trends of Rice Yield Response to Fertilizer in Andhra Pradesh: An Assessment from the Sustainability Perspective

M Narayana Reddy, N H Rao & K V Kumar

Sustainability of foodgrain productivity is crucial to meet the future food requirement of the growing population. Andhra Pradesh is one of the major rice producing states. There is an increasing concern about the negative environmental impact of greater quantities of mineral fertilizer. A detailed analysis of the trends in growth pattern of yield in relation to NPK mineral fertilizer use in all the districts of Andhra Pradesh (AP) and agro-ecological regions has been conducted, to assess the sustainability of rice productivity.

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Rice is the most important cereal crop of the developing world and is the staple food of over half of the world's population. In India, rice occupies about 34% of total foodgrain area with a contribution of 41 per cent towards total foodgrain production (Agricultural Statistics at a Glance, 2004, GOI). The average productivity of paddy in India is about 76 per cent of the world average productivity (3912 kg/ha) and the share of area under rice in India compared to the world is 29.4 per cent, whereas 22.3 per cent is the share of production.

Further, among Indian states, Andhra Pradesh (AP) accounts for about 7 per cent of the total rice area and about 10% of the total rice production (CMIE, 2006). The state ranks second in terms of productivity (3010 kg/ha) after Punjab (3696 kg/ha in 2004-05). About 28 per cent of the gross cropped area and 50 per cent of the area under food crops is under rice cultivation in this state. Most of the area under rice is irrigated, and rice is of key importance to the state's economy and the livelihoods of the people.

Foodgrain demand in India is estimated at about 300 Mt (Million tones) per annum by 2020 (NAAS-India, 2006). Since there is no likely prospect of any further increase in the area under cultivation over the present 142 M ha (Million hectares), much of the desired increase in foodgrain production has to be attained by enhancing the productivity per unit area. The productivity of rice in India has to be increased from the present average yield level of 2077 kg/ha to 2895 kg/ha by 2020 with an average increase of 5 per cent per annum (NAAS, 2006). Against their requirement, the productivity of most foodgrain crops, except wheat, has shown a negative

growth rate during the period 2000-01 to 2002-03. This is a formidable challenge for national food security.

Over the past few decades, the use of mineral fertilizers has been growing rapidly in developing countries, starting from a very low base. This is mainly because of the introduction of high yielding varieties and increasing share of irrigation. Mineral fertilizer has contributed much to the remarkable increase in foodgrain production (Smile, 2001). In countries, regions and locations where the potential of existing technology is being exploited fully, subject to agro-ecological constraints specific to each locality, further growth, or even maintenance, of current yield level will depend crucially on further progress in agricultural research. The fact that the fertilizer was the key input in augmenting foodgrain production after the availability of the seed of high yielding crop varieties, is evident from the significant increase in fertilizers ($N + P_2O_5 + K_2O$) consumption over the last three and half decades.

In this study the spatial and temporal trends in rice yield and fertilizer application in the state of Andhra Pradesh, are assessed by considering district as the spatial unit. The pattern of spatial and temporal trends at the state level are not representative of the pattern of trends in response to rice yield to fertilizer, say, at district, village or at field level. This is because, of the trends of spatial variations in agro-ecological conditions, crop varieties and input use. Homogeneous agro-ecological conditions can be characterized as agro-ecological regions. Agro-ecological regions in India are land unit on the earth's surface carved out of an agro-climatic region, when superimposed on different landform and soil conditions that act as modifiers of climate and length of growing period (Velayuthan *et al,* 1999). AP state comprises eight agro-ecological sub-regions (AESR) as per the classification proposed by Velayutham *et al,* (1999). For this reason, this study is proposed to assess the trends in rice yield in relation to NPK mineral fertilizer application with the district as the basic spatial unit, while grouping is based on agro-ecological regions. The specific objective of this study therefore is, 'to assess spatial and temporal trends in rice productivity in relation to inorganic fertilizer NPK application in the districts and agro-eco sub-regions of Andhra Pradesh from a sustainability perspective'.

Data and Analytical Framework

Data

This study is based on the secondary data for the period 1971-72 to 2003-04. Districtwise data on rice area, rice yield, gross sown area, gross irrigated area, NPK fertilized use in the districts of Andhra Pradesh were collected from the digital media compiled by CMIE (Centre for Monitoring Indian Economy Pvt. Limited) and from the published records of the Directorate of Economics and Statistics, AP. Data on Indian and world statistics were collected from "Agricultural Statistics at a Glance, 2004" published by Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. Digital maps of AP district boundaries and agro-eco sub-regions (NBSS & LUP, Publication No. 35, 1999) in AP are the spatial data used to link average rice area, yield, NPK use and estimates of spatial and temporal trends for preparing display of data through maps in ARCVIEW (ESRI) GIS.

NPK Data for Irrigated Crops

While data on total consumption are available at district level, data on fertilizer (NPK) applied to each crop at this level are usually not available. Rama Rao *et al,* (1998) conducted an extensive study on the use of fertilizer nutrients (N + P + K) for irrigated and dryland crops in seven agro-climatic zones of Andhra Pradesh. There was a wide variation in fertilizer use both within and across different agro-climatic zones. The average NPK use was 187.7 kg/ha for irrigated crops and 86.0 NPK kg/ha for dryland crops. The average intensity NPK application is in the ratio of 3:1 for irrigated and dryland crops, respectively. By assuming this ratio of 3:1 for irrigated and unirrigated crops, respectively NPK (kg/ha) for irrigated crops is estimated by the following equation:

$$NPK_t \text{ (kg/ha) for irrigated crops} = \frac{3Z_t}{3A_{1t} + A_{2t}} \quad ...(1)$$

When Z_t is total NPK applied in the year t, A_{1t} and A_{2t} are gross sown areas under irrigated and unirrigated crops, respectively in the same year t (see appendix).

Analytical Framework

Identification of independent time cycles for estimating productivity trends

The rice productivity (yield kg/ha) data for the period of three and half decades from 1971 (1971-1972) to 2003 (2003-2004) from all the 22 districts was analyzed for identifying independent trend periods using statistical cluster analysis methods. By implementing K-means cluster procedure in SPSS (Statistical Package for Social Scientists) software, a detailed analysis was carried out

by varying the number of clusters. By comparing results of this cluster analysis, and continuity in the time periods, two continuous time periods, 1971-72 to 1987-88 and 1988-89 to 2003-04 are identified as independent clusters. The period 1988-1989 to 2003-2004 is selected for detailed analysis as this represents the latest trends corresponding to the post-green revolution. The analysis is done for all the 22 districts of AP. The detailed trend analysis is carried out for the data on rice yield, NPK use, rice area and irrigated area etc., for this period (1988 to 2003). The intensity of fertilizer application in terms of NPK (kg/ha) for rice is assumed as similar to all irrigated crops.

Assessment spatial and time trends in districts and agro-eco sub-regions

As a first step, the differences in average rice productivity and NPK use among districts over time and AESRs was assessed through Analysis of Variance (ANOVA). In this analysis districts and AESRs were treated as dummy variables.

Time Trends

The following linear regression equations were fitted to various attribute data for estimating linear and compound growth rates as indicators of time trends.

$$y_t = a_1 + b_1 t + u_t \quad ...(2)$$

$$Ln(y_t) = a_2 + b_2 t + u_t \quad ...(3)$$

Where

y_t is the observed attribute value, say, yield/area/NPK at time t,

a_1, a_2, b_1, b_2 are unknown parameters to be estimated from data,

u_t stands for error in time t which quantifies unaccounted random variability

Ln (y_t) is the natural logarithm of y_t.

The value of b_1 in equation (1) is the estimate of linear growth and represents average increase in yield per year during the period under consideration. Equation (2) is commonly used to estimate annual compound rates on the consideration that the change in agricultural output in a given year would depend upon the output in the preceding year (Dandekar, 1980). A modification to this equation was suggested by Narayana Reddy *et al,* (1998) to identify homogeneous periods of trend and to estimate the corresponding growth rates. The estimate b_2 from equation (3) represent the average proportional growth $\left(\frac{dy}{dt}\cdot\frac{1}{y}\right)$ during the period 1988-89 to 2003-2004.

The per cent annual compound growth rate (ACGR%) can be estimated from b_2 by

$$CGR(\%) = \left(e^{b_2} - 1\right) \times 100$$

Assessment of Sustainability

Sustainability is a complex concept, which includes spatial and temporal aspects of productivity as well as biophysical, economic and social dimensions. Methods related measuring sustainability were discussed by Lynam and Herdt (1989), Monteith (1990), Barnett *et al,* (1995) and Rai *et al,* (2004). Lynam and Herdt proposed "a sustainable system is one with a non-negative trend in measured output". Monteith used growth rates of yield and per capita output as indicators of sustainability while assessing the sustainability aspects of cereal yield in Adilabad and Karimnagar districts of AP. But by the excessive use of inputs, it would be possible to achieve increase in output despite damage to the resource base. Based on this fact, Lynam and Herdt (1989) suggested that output should be defined as "total value of all output from the system over one cycle divided by the total value of all inputs". A non-negative trend in this ratio, referred to as "total factor productivity (TFP)" indicates the sustainability of the system. TFP indices have received greater attention as indicators of sustainability of agricultural systems (Hobbs and Morries, 1996). But the indices of partial factor productivity (PFP), the ratio of output value to specific input such as N, P and K fertilizes, can be more useful than TFP indices as indicator of sustainability, because they can provide useful information about the efficiency with which individual inputs are used. Yadav (2000) assessed the productivity efficiency of long-term N fertilizer use in rice-wheat cropping system.

In this study the non-negative trends in factor productivity of rice due to NPK input use are used to assess the sustainability of rice productivity in relation to NPK use. The estimates of the trends in factor productivity can be obtained by fitting the equation (3) to rice yield (kg/ha) and NPK (kg/ha) separately. The fitted equations are as follows:

$$Ln(Y) = a_2 + b_2 t \text{ and } Ln(F) = a_3 + b_3 t$$

Then $$Ln(Y/F) = a_2 - a_3 + (b_2 - b_3)t$$

Where F represents NPK (kg/ha), the ratio Y/F represent factor productivity of rice yield to NPK application

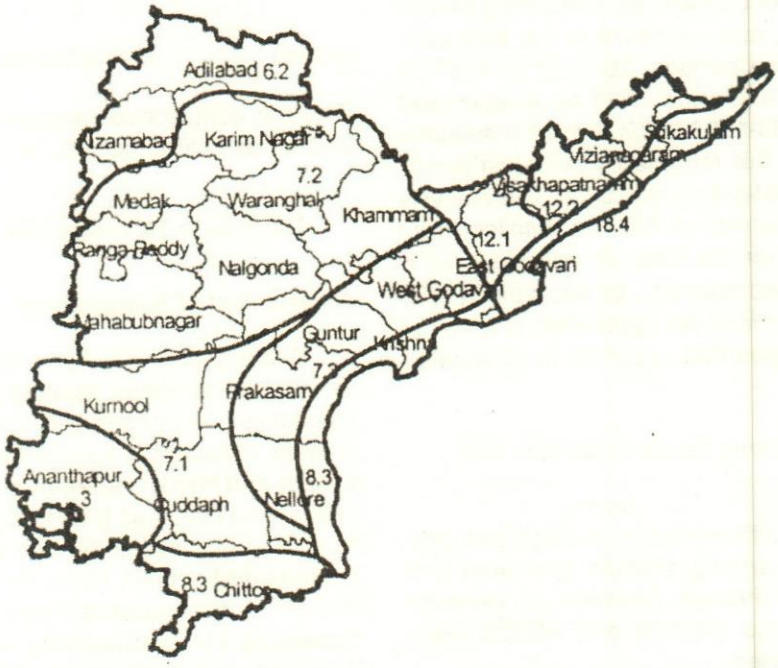

Fig. 1. Agro-Eco sub-regions and districts in Andhra Pradesh

Source: NBSS & LUP, Publication No. 35

viz. kg of yield per kg of NPK application. As compound growth rate values are very closely related to b_2 and b_3 estimates, sustainability of productivity in districts is assessed from the non-negative trends in the compound growth rates of yield and NPK use.

Results and Discussion

Spatial and Temporal Trends: Average Productivity and NPK use

Each district is identified with a AESR, based on the extent of the area that falls in an AESR. For example, the five coastal districts West Godavari, Krishna, Guntur, Prakasam and Nellore are identified with AESR 7.3, as a larger percentage of these districts belong to this sub-region. The map showing the overlay of districts with agro-eco sub-regions is shown in Fig. 1.

The average values of rice yield (kg/ha) and NPK (kg/ha) calculated as discussed above are presented in Table 1 for the period 1988-89 to 2003-2004 for all the districts of AP organized based on the information on agro-ecological properties.

Rice is completely irrigated in all the districts except in five districts, in Adilabad, Visakhapatnam, Khammam, Srikakulam and Vizayanagaram. Even in these districts the average percentage of area irrigated during the period 1988-2000 was 71, 75, 80, 86 and 90 per cent, respectively. These are also predominantly irrigated districts.

Out of 22 districts (in Table 1) seven districts belong to AESR 7.2, five districts belong to 7.3, three districts belongs to 12.2, two districts to 6.2 and two districts 10 7.1. One district each rice belongs to AESR 3, 8.3 and 12.1. There exists wide variation in the distribution of area among districts. The average percentage area of rice to gross sown area varied from 5.4 per cent in Anatapur to 66.4 per cent in West Godavari district. West Godavari, East Godavari, Krishna and Nellore are predominantly rice growing districts, with rice occupying more than 50 per cent of the gross sown in these districts. Productivity of rice is also higher in these districts. Area under rice is less than 20 per cent of gross sown area in seven districts, Adilabad, Anatapur, Chittor, Cuddapah, Kurnool, Mahabubnagar, Rangareddy. Average rice productivity is minimum (1499 kg/ha) in Visakhapatnam and intensity of NPK application in minimum (103 kg/ha) in Adilabad.

The yield and NPK indices in different districts are calculated by normalizing with these minimum values. Area is represented as dot density and each dot represents 10,000 hectares. The spatial distribution of average rice yield and NPK indices values and rice area are

Table 1: Average values of rice yield an NPK (kg/ha) for the period 1988-89 to 2003-2004 in the districts and different agro-eco sub regions of Andhra Pradesh

S.No.	Agro-eco sub-region (AESR)				Name of the	Yield	NPK
	Category	Eco-system	Soil	LGP in Days	district	(kg/ha)	(kg/ha)
1	3.0	Hot arid	Red & Black	60-90	Anatapur	2347	110
2	6.2	Hot semi-	Red & Black	120-150	Nizamabad	2355	270
3	6.2	arid			Adilabad	1831	103
4	7.2	Hot semi-	Red and Black	90-120	Karimnagar	2850	247
5	7.2	arid			Warangal	2465	261
6	7.2				Rangareddy	2266	454
7	7.2				Mahabubnagar	2036	162
8	7.2				Nalgonda	2716	225
9	7.2				Khammam	2415	229
10	7.2				Medak	2077	147
11	7.1	Hot semi-arid	Black and Red	90-120	Cuddapah	2595	210
12	7.1	arid			Kurnool	2593	216
13	7.3	Hot moist	Red and black	150-180	West Godavari	3024	333
14	7.3	semiarid			Krishna	2852	296
15	7.3				Guntur	3081	303
16	7.3				Prakasam	2676	223
17	7.3				Nellore	2704	233
18	8.3	Hot Semi-	Red loamy	120-150	Chittor	2278	136
		arid					
19	12.1	Hot moist	Red and lateritic	180-210	East Godavari	2815	226
		sub-humid					
20	12.2	Hot moist	Red and lateritic	180-210	Vishakapatnam,	1499	110
		sub-humid					
21	12.2				Vizayanagarm	1975	115
22	12.2				Srikakulam	1945	133
23					Andhra Pradesh	2427	216

shown in Fig. 2. These indices show the relative performance across the districts of rice productivity in relation to NPK application and rice area.

The factor productivity expressed as the ratio of yield to NPK application is lower at the higher level of NPK application. In six districts, the level of yield as well as NPK use is relatively low. Productivity and NPK use in the eight AESRs was analyzed by ANOVA, as discussed in the previous section. The differences among the average yields and NPK use are statistically significant over the years, and both in districts and in different AESRs. Yield is lowest in agro-eco sub-region (AESR) 12.2 and highest in AESR 7.3 and 12.1. There is no significant difference in NPK (kg/ha) use in AESRs 3, 12.2 and 8.3. The average values of yield and NPK use is shown in Fig. 3 for the eight AESRs in ascending order of yield. In general yield and NPK use show near similar trends among AESRs.

Estimates of linear growth rates and percentage annual compound rate (ACGR), along with t-values, are presented in Table 2 for all the districts. Trends in statistical significance of the estimates of compound growth rates and linear growth rates are similar. Even though the values of 't' given in table 3 corresponds to linear growth rates, they can also be useful in drawing inferences for compound growth rates. Total area under rice in the state showed a significantly decreasing trend during this period inspite of increasing trend in productivity. The rate of decrease is more than 3,000 ha per year in six districts. Crop diversification is taking place at a large scale in these districts. Nine districts showed non-increasing trend in area and 10 districts showed significantly

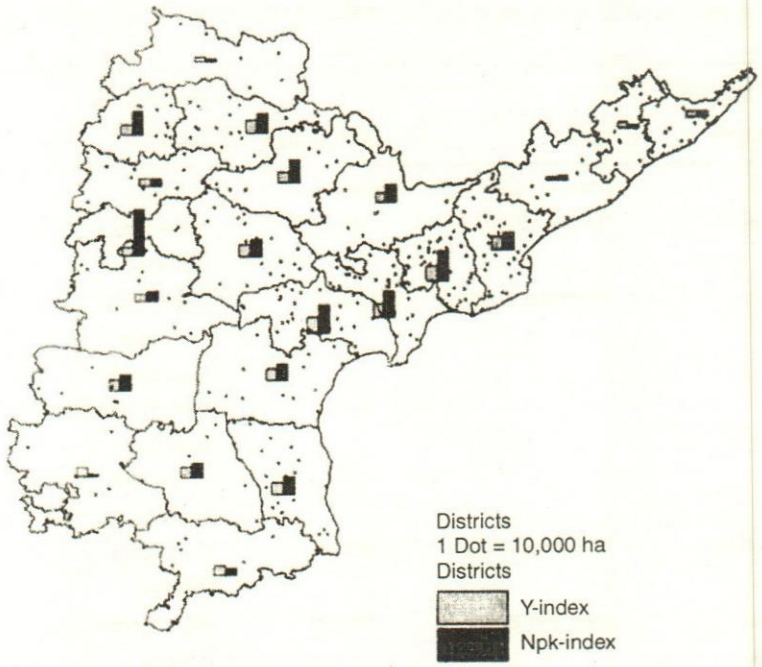

Fig. 2. Spatial distribution of average values of yield index and NPK index with respect to minimum values, and rice area as dot density in the districts of Andhra Pradesh, 1988-89 to 2003-2004

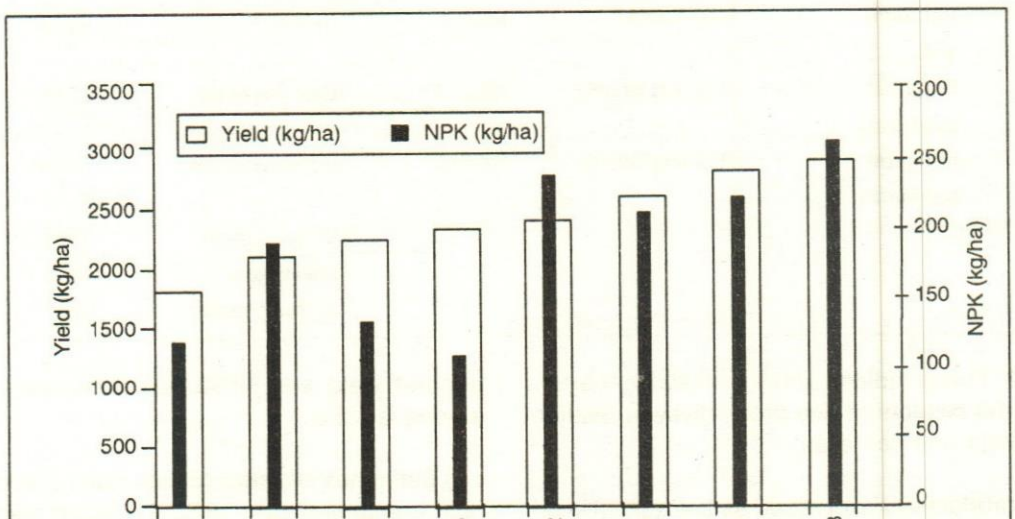

Fig. 3. Average Yield (kg/ha) and NPK (kg/ha) in different agro-eco sub-regions, 1988-2003

increasing trend in yield. Regarding the fertilizer input, majority of districts (16 districts) showed significantly increasing trend in NPK use. The average annual rate of increase in yield in districts East Godavari and West Godavari is maximum (88 kg/ha) compared to other districts, and is four times the state average rate of increase (22 kg/ha).

As compound growth rates are in terms of percentage and independent of units, the districts are classified into five categories based on the significant trends in Yield and NPK as estimated by their annual compound growth rate (ACGR) values. The categories, criteria of classification and the districts belonging to each category are presented in Table 3. Fertilizer use is considered efficient

Table 2: Values of linear growth rates and corresponding t-values. Figures in the parenthesis are percent annual compound growth (ACGR) values, 1988-2003

District	Area Linear growth	t-values	NPK Linear growth	t-values	Yield Linear growth	t-values
Adilabad	0.80 (1.04)	1.39	4.98 (4.85)	6.71	52.85 (2.98)	2.24
Anantapur	−1.23 (−2.29)	−1.49	2.71 (2.44)	3.70	26.58 (1.09)	1.94
Chittoor	−3.17 (−4.00)	−3.12	1.90 (1.44)	2.19	8.07 (0.32)	0.57
Cuddapah	−0.81 (−1.80)	−1.10	−1.21 (−0.39)	−0.57	−40.42 (−1.60)	−2.50
East Godavari	−1.97 (−0.55)	−1.12	4.88 (2.28)	2.38	89.22 (3.09)	4.63
Guntur	−4.66 (−1.92)	−2.33	−0.57 (−0.11)	−0.22	14.11 (0.44)	1.15
Karimnagar	0.22 (0.09)	0.10	10.17 (4.20)	5.20	42.10 (1.48)	3.69
Khammam	−1.18 (−0.94)	−0.93	7.46 (3.37)	7.54	17.41 (0.57)	0.99
Krishna	−7.68 (−2.37)	−3.18	7.86 (2.69)	3.59	26.46 (0.90)	1.96
Kurnool	−0.35 (−1.02)	−0.40	10.42 (5.33)	7.58	28.92 (1.09)	1.89
Mahbubnagar	−0.54 (−0.21)	−0.30	2.32 (1.55)	1.35	19.53 (0.92)	1.36
Medak	−1.74 (−1.65)	−1.77	4.64 (3.48)	2.70	44.07 (2.10)	2.99
Nalgonda	−5.95 (−3.11)	−2.46	11.11 (5.60)	4.43	−6.24 (−0.28)	−0.54
Nellore	−2.16 (−1.10)	−2.20	2.73 (1.17)	2.46	47.79 (1.81)	3.49
Nizamabad	−0.73 (−0.75)	−0.46	5.47 (2.12)	2.02	18.27 (0.57	0.92
Prakasam	−3.09 (−3.54)	−2.14	6.85 (3.24	3.02	28.97 (1.02)	1.44
Rangareddi	−0.68 (−1.58)	−1.33	31.95 (8.80)	7.36	8.96 (0.36)	0.87
Srikakulam	−2.49 (−1.29)	−3.47	3.01 (2.57)	2.12	−3.34 (−0.18)	−0.26
Visakhapatnam	−1.44 (−1.60)	−1.91	1.38 (1.25)	2.09	−22.43 (−1.52)	−1.34
Vizianagaram	−1.46 (−1.24)	−2.54	−0.64 (−0.53)	−0.88	−30.31 (−1.70)	−1.85
Warangal	0.77 (0.41)	0.35	0.29 (1.29)	0.12	33.24 (1.29)	2.19
West Godavari	−3.82 (−0.91)	−1.89	1.80 (2.95)	0.19	87.57 (2.95)	485
State	−1.97 (−1.26)	−2.00	5.43 (0.89)	4.28	22.34 (0.89)	2.53

Table 3: Category of districts classified based on Annual Compound Growth rates (ACGR) of Yield and NPK fertilizer use

Category	Criteria of Classification	Name of the district
1	Significant positive ACGR in Yield & non-significant ACGR in NPK application	West Godavari (7.3), Warangal (7.2)
2	ACGR of Yield greater than ACGR of NPK application (both are significant)	East Godavari (12.1), Nellore (7.3)
3	Non-significant ACGR of yield and ACGR of NPK	Guntur (7.3), Mahabubnagar (7.2) and Vizayagaram (12.2)
4	ACGR of Yield less than ACGR of NPK application	Adilabad (6.2), Karimnagar (7.2), Anatapur (3.0) Krishna (7.3), Kurnool (7.1), Medak (7.2)
5	Non-significant ACGR of yield and significant ACGR of NPK application	Chittor (8.3), Cudapah (7.1), Khammam(7.2) Nalgonda (7.2), Nizamabad (6.2), Prakasam (7.3) Rangareddi (7.2), Srikakulam (12.2), Visakhapatnam (12.2)

Note: Figures in the brackets represent agro-eco sub-regions.

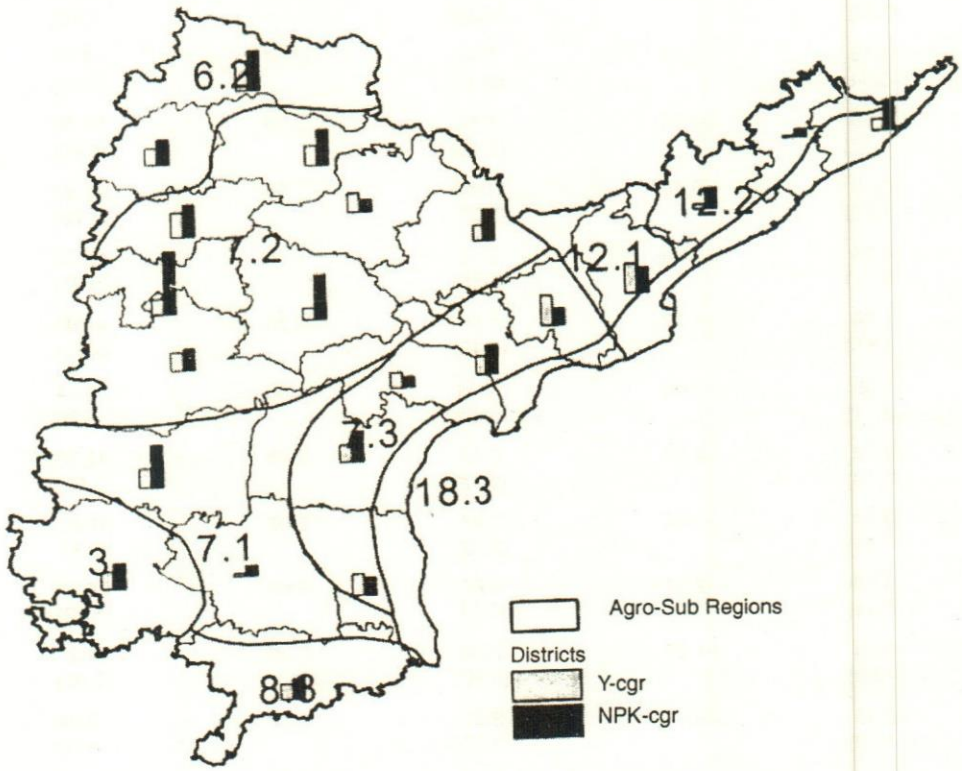

Fig. 4. Compound growth rates (CGR) of yield and NPK use in the districts of Andhra Pradesh during 1988-89 to 2003-04.

and the production system is sustainable in the time cycle under study, when the percentage annual growth in yield in more than the percentage annual growth in NPK use. Districts under category 1 and category 2 are efficient and productivity is sustainable as output growth (yield) is more compared to input growth (NPK). Clearly, fertilizer use in the districts under category 5 is inefficient as there is no response to increasing levels of NPK fertilizer, and productivity is unsustainable. The growth in output is negative when input growth is subtracted from output growth in the district. Yield response to fertilizer in the districts under category 4 is significant, but not efficient as the per cent growth in yield is less than the per cent growth in NPK use. Category 1 and category 2 represent relatively sustainable rice production system, whereas category 4 and category 5 belong to unsustain-

able rice production system. Category 3 represents a situation that is presently sustainable but needs to be continuously monitored to ensure sustainability. Both efficient and inefficient districts with respect to productivity in relation to input use belong to agro-eco sub-regions 7.2 and 7.3. This proves the role of management practices adapted in a districts influence efficient use of fertilizer apart from agro-eco characteristics. Water management is the most important determinant of fertilizer, use efficiency. The values of compound growth rates are shown in Fig. 4, for all the districts in AP.

Table 4: Average consumption of N, P and K during 2001-2004 in the districts of Andhra Pradesh

District	Thousand tonnes			Ratio-2001-2004		
	N	P	K	N	P	K
Andhra Pradesh	1179.76	514.83	219.74	5.37	2.34	1.00
Adilabad	24.20	8.25	2.28	10.64	3.62	1.00
Anantapur	30.85	19.91	11.13	2.77	1.79	1.00
Chittoor	27.14	9.87	5.96	4.56	1.66	1.00
Cuddapah	28.65	16.76	5.20	5.51	3.22	1.00
East Godavari	83.71	33.40	23.73	3.53	1.41	1.00
Guntur	96.53	46.75	16.00	6.03	2.92	1.00
Karimnagar	93.85	29.74	8.70	10.78	3.42	1.00
Khammam	45.77	19.35	5.93	7.72	3.26	1.00
Krishna	90.71	42.83	32.64	2.78	1.31	1.00
Kurnool	66.28	43.31	14.60	4.54	2.97	1.00
Mahbub-nagar	39.80	21.80	4.94	8.06	4.42	1.00
Medak	35.04	11.09	2.43	14.45	4.57	1.00
Nalgonda	62.88	27.73	6.76	9.30	4.10	1.00
Nellore	48.27	19.41	7.06	6.83	2.75	1.00
Nizamabad	61.26	16.31	3.92	15.63	4.16	1.00
Prakasam	48.89	23.60	6.71	7.29	3.52	1.00
Rangareddi	49.41	31.17	18.63	2.65	1.67	1.00
Srikakulam	27.32	8.33	3.39	8.05	2.45	1.00
Visakha-patnam	19.76	3.30	3.62	5.46	0.91	1.00
Vizia-nagaram	18.63	5.64	2.24	8.31	2.51	1.00
Warangal	75.49	23.16	7.93	9.53	2.92	1.00
West Godavari	108.69	55.54	25.98	4.18	2.14	1.00

Balanced fertilizer use is the other major management activity that influences fertilizer use efficiency. An ideal N : P_2O_5 : K_2O ratio is 4:2:1 for grain-based production systems (Tandon, 1997). Average ration of N:P:K consumption ratio during the latest available 4 years (2001-2004) is given in Table 4. There exists significant fertilizer use imbalance in most of the districts. N use is five times greater than K in 16 districts. P use is greater than three times of K in 9 districts. The degree of imbalance is more with respect to N use compared to P use. Productivity efficiency to NPK is maximum in West Godavari district which is in category 1 with perfectly balanced fertilizer use. Further the ratio is within the limits of balanced fertilizer use. Further the ratio is within the limits of balanced fertilizer use in East Godavari and Krishna, the districts belonging to sustainable productivity category.

When N, P and K applications are imbalanced, large quantities of the nutrients not applied in adequate amounts are mined from the soil until they become critically deficient. Balanced fertilizer use for high yields goes beyond N, P and K application. Balanced fertilizer use is a profit maximizing approach not only in intensive irrigated farming, but also in rainfed-dryland farming where higher productivity and yield stability are required.

To achieve future rice production targets, balanced and adequate use of P and K fertilizers as well as N, S and Zn is essential. Low fertilizer use efficiency in a country like India is of serious concern (Shortriya, www.iffico.nic.in), both economically and environmentally. High expenditure by farmer and Government is not fully utilized due to low nutrient use efficiency and this is harmful to soil health and is harming the environment. Thus, ensuring the sustainability of rice-based production system (particularly category 4 & 5) require significant increase in nutrient use efficiency, that is rice production per unit of added NPK and water.

Conclusions

Sustainable rice production in the districts of Andhra depends both on agro-ecological characteristics and management factors such as irrigation and water use. Maximum and sustainable productivity benefits are derived from the balanced use of N, P and K fertilizer application and efficient water management. There is a danger of environmental pollution in the districts of category 5 with inefficient use of fertilizer, as greater portion of applied nitrogen and a smaller portion of applied phosphorous may be lost from the rice fields. An integrated approach to plant nutrient needs to be adopted to ensure a sustainable supply of plant nutrient so that future yields can be increased without harming soil productivity and environment. Stagnant yield potential is one of the chief impediments to sustainable agriculture and con-

certed efforts are needed to increase the yield potential of the major staple food crops based on agro-ecological and irrigation capabilities and constraints. Unless water-use efficiency is increased, greater agricultural production will require increased irrigation. Many areas in India and AP in particular either currently or will soon fail to have adequate water to maintain per capita food production from irrigated land.

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Appendix

Let Z_{1t} and Z_{2t} be the total NPK applied to irrigated and unirrigated crops in the year t, such that $Z_{1t} + Z_{2t} = Z_t$, where Z_t is the total NPK applied in year t.

Let A_{1t} and A_{2t} be the total irrigated area and unirrigated area in the year t, such that $A_{1t} + A_{2t} = A_t$, where A_t is the total gross sown area.

Let F_{1t} and F_{2t} be the intensity of fertilizer application in terms of NPK (kg/ha) for irrigated unirrigated crops, respectively.

We have

$$F_{1t} \cdot A_{1t} + F_{2t} \cdot A_{2t} = Z_{1t} + Z_{2t} = Z_t \quad \ldots(I)$$

But $F_{2t} = F_{1t}/3 \quad \ldots(II)$

$$F_{1t} \cdot [A_{1t} + (F_{1t}/3) \cdot (A_{2t})] = Z_t$$

$$F_{1t} = (3\ Z_t)/(3 \cdot A_{1t} + A_{2t})$$

□

Wholesome food and drink are cheaper than doctors and hospitals.

– Dr. Carl C. Wahl

Resource Utilization through Integrated Aqua-cultural Activities

P.P. Ambalkar

The available surface and sub-surface runoff water needs to be harvested in systematically planned and properly designed storage structures, such as single or multiple farm ponds or on-farm reservoirs. This papers analyses how aqua-culture, with a crop and livestock combination, leads to maximum utilization of the available resources of water, land, manpower and material input.

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India occupies 2.4% of the world area and has more than 16% of the world's population. Our scarce natural land resource is experiencing about eight times more production pressure than the legitimate yielding capacity. Further, food demand, under sustainable agriculture, will put even more production load on an already grim situation.

The normal rainfall availability for water storage in India in general seems to be adequate. However, complementary to land, the potential of water needs to be explored for meeting the additional food demand, so that timely decisions may be made to encounter any serious menace that may arise due to futuristic food shortage problems.

The easiest definition of aqua-culture is the culture of aquatic organism, say, fish, prawns, lobsters and crabs etc. and for aqua-culture the availability of water is the basic requirement. To drain water in vertisols/or from other soil strata means the availability of some good quality water is ensured. This available surface and sub-surface runoff water needs to be harvested in systematically planned and properly designed storage structures i.e. single/multiple farm ponds or on-farm reservoirs. Here utilization of this available water, based on its quality parameters, is suitable for supplement irrigation as per crop water requirement and/or also for some integrated aqua-cultural activities to be performed. It needs to be ascertained just how judiciously we may allocate and utilize this stored water.

Why aqua-culture/pisciculture?

There is special significance in eating fish and prawn for the following reasons:-

- Meeting the demand of additional food requirement through aqua-culture. So far agricultural

production in terms of cereals, pulses, meat and poultry products appear to have met up the food shortage problem in India. However, owing to population increase and change in lifestyle, the demand for clean, safe, hygienic, nutritious, properly packed, labeled and presentable food items at an affordable rate by adoption of state of the art technology, is very much required.

- Fish is an attractive means to supplement the supply of animal protein and fight malnutrition. Fish protein comprises all the essential amino acids for human consumption. These are present in good proportion and fish is easily digestible, helps in growth, body formation and in keeping the reproductive system of human beings healthy. The essential minerals, micronutrients and fatty acids are very much required for the normal functioning of the vascular system and for the formation of the brain and nervous system.
- As far as the medicinal role of fish is concerned, fish carries an abundant source of long chain n-3 poly unsaturated fatty acids (PUFA) which comes under density protein and that ultimately leads to checking the possibility of a heart attack. It also reduces serum cholesterol levels and helps to prevent excessive plateless aggregation which leads to thickening of the blood. It helps in wound healing, as fast cell build-up becomes possible. Furthermore, the fish body part is used in surgery, dentistry and as artificial skin.

Construction of water storage structures

Fish is to be cultured either in farm ponds or in reservoirs. If the site does not facilitate any provision of natural drainage grid and surface runoff along with subsurface drainage flow to average/scanty rains, then the construction of a number of farm ponds in a catchment area will have a retarding effect on the downstream flow. However, in low lying areas on the farm reservoir (without a bund) come into production effect by establishing carp hatchery/seed complex and cage culture under reservoir fishery, if excess volume of drainage water is to be conserved.

Preference for Adoption under Integrated Aqua-culture as System Approach

Here, whatever quantity or quality of water stored in these structures needs balance water allocation and management policy for its prudent use. Since more than 200 aquatic species are available for culture and adoptability to acclimatize and grow in poor quality/sewage water, hence aqua-culture is to be practiced for sustainable development and value addition of resources. For this preference is to be given to integrated aqua-culture under a systems approach. However, under multicultural system techniques the criteria for site selection is to be followed by considering site parameters with their respective weightage factors (see Table 1), which may help the decision maker evaluate the potential of the site.

Table 1: Criteria for potential site selection

S. No.	Site Parameters	Relative Weightage
01	Accessibility	10
02	Socio-economic impact	30
03	Water supply system	20
04	Available area	20
05	Water quality	30
06	Soil quality	30
07	Type of vegetation	5
08	Density of Vegetation	5
09	Elevation	30
10	Possibility of Mechanization	10
11	Protection from wind, water, waves and climatic conditions	10
	Total Weightage	200

For evaluation of the potential site selection the following percentage marks may be allocated and accordingly remarks may be attributed as per the score attained by the site (Table 2).

Table 2: Evaluation of the potential site (marks allocation)

Percentage marks out of 200	Remarks
80-100%	Excellent
60-79%	Very good
40-59%	Good
Below40%	Fail not worth consideration

A computer programme in C++ may be incorporated for the evaluation of potential of the site as follows-

```
#include<iostream.h>
#include<stdio.h>
#include<conio.h>
void main()
{
clrscr();
```

```
float a,b,c,d,e,f,g,h,i,j,k,sum=0.0;

cout<<"Enter predicted relative weightage of exogenous parameters for site evaluation"<<endl;

cout<<"Enter value of a Accessibility= ";cin>>a;

cout<<"Enter value of b Socio- economic impact = ";cin>>b;

cout<<"Enter value of c Water supply system = ";cin>>c;

cout<<"Enter value of d Available area = ";cin>>d;

cout<<"Enter value of e Water quality = ";cin>>e;

cout<<"Enter value of f Soil quality = ";cin>>f;

cout<<"Enter value of g Type of vegetation = ";cin>>g;

cout<<"Enter value of h Density of Vegetation = ";cin>>h;

cout<<"Enter value of i Elevation = ";cin>>i;

cout<<"Enter value of j Possibility of Mechanization = ";cin>>j;

cout<<"Enter value of k Protection from climatic factors etc. & conditions = ";cin>>k;

sum=a+b+c+d+e+f+g+h+e+f+g+h+i+j+k;

cout<<"sum is="<<sum<<endl;

if(sum>=160)

cout<<"Site is excellent, higher production capacity plant may be suggested for installation\n";

else

if(sum>=120)

cout<<"Site is very good, scope for capacity expansion of existing plant may be recommended\n";

else

if(sum>=80)

cout<<"Site is good, calculated risk of capacity expansion of present plant may be planned\n";

else

cout<<"Site does not worth consideration, Site improvement measures are to be executed for increase in weightage of exogenous parameters value\n";

getch();

}
```

Based on above selection criteria, micro/ macro economic activities may be planned and executed (Table 3 and 4).

Table 3: Micro activities

Sites - Good to very good

Issues - Mainly alternative use of resources by adopting live-stock-crop-fish

Type of culture - Mainly subsistence and/or semi-intensive

Characteristics/goal of system approach	Fish-crop-Livestock combination
Minimal to more input, small in number to herd expansion, naturally available/processed feed, by-products availability to use and their better management of short duration, strategy adoption for targeted market, income generation through secondary or primary source of income.	Paddy, other field crops, commercial crops, horticulture crops, forage crops and grasses, agro-forestry, seri-culture and animal husbandry-bovine, ovine, piggery/poultry.

Table 4: Macro activities

Sites - Very good to excellent

Issues - World trade, national development, social characteristics such as positive cultural attitudes

Type of culture - Intensive culture

Characteristics/goal of system approach	Fish-crop-Livestock combination
High and assured input, labour-intensive, large herd, availability and good quality roughage, nutritionally balanced concentrated feed, by-products optimal use and their skillful management, best resource utilization (land, water resources, industry and sanitation). Well-structured and organized market, major source of income, employment generation.	Paddy, other field crops, commercial crops, horti-culture crops, forage crops and grasses, medicinal/ aromatic plants, agro-forestry, sericulture and animal husbandry-dairy, piggery, poultry. Vertical integration for agri-business is also adopted as industrial development.

Advantages of Multiculture System

- Mutually sustainable culture units will be more productive and profitable than the mono-cropping system.
- It stimulates production activity and thus generates scope for developing/reviving the agri-business activities because the system functions as all-weather industry.
- The socio-economic condition is upgraded due to generation of income throughout the year to provide self employment opportunities in rural areas especially for women.

- Diverting the rainwater to the collection ponds prevents flooding and erosion of soil, maintain soil fertility and also sustenance of integrated pest management.
- Integrated fish farming systems exhibit excellent synergetic effects wherein plant and animal products significantly increased animal manure and vegetable/ food wastage are fully utilized.
- Bio-waste from one unit becomes the input for the other unit. Such waste is fully recycled and supplies nutrients to both pond water and farmland.
- Environment-friendly culture can be developed by adopting, mutually compatible culture system, or formation of artificial eco-system conducive for sustainable development.
- Potential for utilization of wasteland, scope for organic farming and conservation of energy through generation of alternate bio-energy source.
- Low input of supplementary feed not only saves the feed cost but also reduces the bottom load of the pond and prevents degradation of the aquatic environment and biological oxygen demand in the impoundment of the water body.
- Increase in market accessibility due to multiplication of agro-products and establish linkages with markets; inter-alia through product development and innovation.
- Increase in the number of mutually compatible systems inhibits rural influx to the urban mega cities in search of livelihood.

Some Models of Mutually Beneficial Multicultural Practices

Paddy-Fish-Vegetable Integration

These culture units fit very well for farmers with small land holdings in rural areas. Trenches of 1.5 m depth can be made in the paddy field on either side with water depth of 1.2 m. Advanced fry stocked in July can be grown to fingerlings and can be marketed in the month of September, and farmers can start getting their income within three months. Till the harvesting of paddy, income is also generated by selling vegetables. Fish and vegetables along with bread serves as a complete diet for human consumption as this contains protein, carbohydrate, minerals, vitamins and also fat as complete nourishment.

Paddy-Prawn-Mushroom

Here paddy straw is used for mushroom culture, and spent straw from mushroom is used in prawn trenches for the production of natural food. Prawns can be grown on the natural feed sources in the paddy fields. However, agro byproducts such as rice bran and broken rice can be used as concentrated feed ingredients. In the paddy prawn culture system the canal area that is used for prawn culture covers 15 to 20 per cent of the total area of the paddy field. Canals or trenches are made on either side of the paddy field and water level maintained at 1 to 1.2 m in these trenches in the paddy field, where 0.2 to 0.3 m water depth is maintained. The width of the trenches is kept at 2 to 3 m wide. Here freshwater prawn juveniles stocked are 5-10gm at a stocking density of 2 to 3 individuals/m^2.

The culture period in the paddy-prawn system varies from 4 to 8 months depending upon the farming practices. The production of prawn in this system is about 200-250kg/ha and farmers can obtain income from mushroom and prawn. In the fish culture practice, about 60 per cent of the total expenditure of this integration is utilized as fish feed. Thus, fish-mushroom integration drastically reduces fish production cost, because the spent straw, after harvesting the crop, is full of nutrients. This nutrient-loaded straw could be used for pond productivity.

Fish-cum-dairy

Fish-cum-dairy farming is considered an excellent innovation for the use of organic waste. Use of cow/buffalo manure in fish farming is a commonly prevailing practice. On an average, one cow/buffalo excretes 12,000 kg of dung and 8000-litres of urine per year. The cattle faeces and urine are beneficial to the filter-feeding and omnivorous fish. The edible part of the dung is consumed by many species of fish. On an average, 3-4 cows/buffaloes can provide sufficient manure to fertilize a one-hectare pond.

In this system, the farmer gets milk, fish and a calf as well, which increases revenue and reduces input costs. The system gives a net profit of Rs1,14,000 per year from one hectare land (All Profit estimation source - Official website of fisheries department, Haryana). An adult cow consumes about 10,000 kg of grass per year and the remaining quantity of grass can be used as fish feed. Each cow can provide manure for a pond area of 0.13 ha of fish culture that subsists on wasted cow feed and manure having a net production target of about 250 kg of fish.

Fish-cum-Poultry

The droppings of birds in this system are utilized to

fertilize the pond. Poultry litter recycled in a fishpond produces 4500 to 5000 kg fish per hectare per year. Broiler production provides good and immediate return to the farmers. Success in production depends mainly on the efficiency of the farmer, experience, aptitude and ability, in the management of the flock. This involves procurement of better brood stock, housing, brooding equipment, feeders, water trays and management practices, which also includes prevention and control of diseases. The poultry litter is applied to the pond in daily doses at a rate of 40-50 kg per hectare. The application of litter may be deferred during the days when algae blooms appear in the ponds. One adult chicken produces about 25 kg of compost poultry manure in one year. 500 to 600 birds would provide sufficient manure for fertilization of one hectare of fishpond. A farmer can get a net income of Rs I,37,157 from one hectare of pond in one year. The Government provides financial assistance to farmers for promoting this system.

Fish-cum-Piggery

Pig dung as organic manure for fish culture has certain advantages over cattle manure. The waste produced by 20 to 30 pigs is equivalent to one ton of Ammonium Sulphate applied to the soil. The pigs are fed largely on kitchen waste, aquatic plants and crop byproducts. At present, fish-pig integration is practiced in all the developing countries. Several exotic breeds of pigs have been introduced in the country to augment pork production. The popular races are the White Yorkshire, Berkshire and Landrace. The pigsties should provide adequate protection from adverse weather conditions. A run or courtyard adjacent to the pig house is essential. The size of the pig house depends on the number of pigs to be reared. Floor space is provided at the rate of 3-4 m^2 for every pig weighing 70 to 90 kg. The excreta voided by 35 to 40 pigs are found adequate to fertilize one hectare of water. The net income in this integration from one hectare of pond is Rs I,39,000.

Fish-cum-Duck farming

Fish-cum-duck integration is most common in the developing countries. This type of integration is not popular in northern states of India. Ducks are of several types and Khaki Campbell is recommended for fish-cum-duck integration. A fishpond being a semi-closed biological system with several aquatic animals and plants, provides an excellent disease-free environment for the ducks. In turn, ducks consume juvenile frogs, tadpoles and dragonfly etc. thereby providing a safe environment for fish. Duck droppings go directly into the pond, which in turn provide essential nutrients such as carbon, nitrogen and phosphorus that stimulate growth of natural food organisms. Ducks also help in aerating the pond water, along with bottom racking. About 300 ducks are enough to fertilize a pond of one hectare. The system results in a net income of Rs 77500 per year per hectare. However, due to difficulty in marketing of eggs and duck meat, the system is not very common in some places.

Fish-cum-Horticulture

Integration of fish-cum-flowers, fruit plants, vegetables and mushroom can be taken up. The pond humus is used as manure for plantation. Pond water can be used for plants hat are rich in nutrients, thereby decreasing the cost of inorganic fertilizers. The pond dykes are used for the plantation. The culture practice can be taken up as per suitability to the location. The economics also varies and depends on the type of plantation. However the bunds of the pond can be utilized for horticulture plantation such as pappai, banana, guava and pomegranate, and the outer slope of the bund can be utilized for plantation of vegetables such as bitter guard, brinjal, tomatoes and coriander leaf etc. Fish horticulture fetches at least 20 per cent higher return compared to fish culture alone.

Fish-Sugarcane Cultivation

For fish-sugarcane farming in addition to sugar from the sugar factory the molasses as waste of industry can be utilized as one of the essential binding ingredients for production of aqua/avian/bovine feed.

Fish-Prawn-Sericulture

It is the most profitable multicultural system to be developed in rural areas. Mulberry silkworm culture is labour intensive and produces six to eight crops of cocoons in a year. It is an all-weather industry similar to fisheries. Hence sericulture very well fits in the fish-prawn farming system. Irrigation of mulberry plantation can be carried out from the water exchange needed for prawn-fish polyculture. Pupae of silkworm are a protein rich food for prawn and fish; silkworm rearing tray waste can be used as manure for prawn culture. In such a mutually sustainable culture unit input costs are very much reduced and one can even do away with artificial feed. A mulberry plantation gets manure rich prawn pond water for irrigation.

Sericulture generates much higher returns in comparison to many cash crops. Sericulture has been identified as the best suited project for generating employment and socio-economic upliftment of rural and tribal areas. Silkworm cocoons already have a ready market.

Furthermore, the silk reeling industry employs about 12 to 14 for every acre of mulberry plantation.

Participation and Involvement of Local Masses

The techno-economic viability of the culture units has to be ascertained before introducing any new cultural practices. For this interaction with the local people, especially women/local entrepreneurs, is necessary for identifying the feasibility of the culture units. Rural farmers, women and entrepreneurs should be convinced of the marketing avenues of the new product.

Greater involvement of these active rural folks in planning and their participation in decision-making should be encouraged for the development of location-specific multicultural projects. To encourage the adoption of a new culture system apart from incentives, there is a need for motivational campaigns, demonstrations, training and extension work. Moreover, such income generating activities would empower women and would give them an enhanced status in their family and community.

Success rate of the multicultural system

The success rate of the multicultural system depends on technological upgradation, improving the efficiency of the infrastructure facility and enhancing the skills of labour. It is necessary to enhance the farm income through change in cropping pattern for conservation of water, keeping in view the changing consumer preference and promoting marketed-oriented products.

Conclusion

Sustainable development through integrated aqua-culture requires that the traditional reductionist approach of science be complemented by a well-planned and meticulously designed system approach. In this production technology, socio-economic and environmental aspects need to be taken care of. The means to promote integrated aqua-culture through education, research and development should be given proper attention, provided precious resources like water and land, and equipment and facilities are supplied on time and their incorporation into the system is ensured. Site suitability evaluation work for adoption of multicultural practices may be undertaken as well. This is easily, efficiently and effectively possible with the application of computer programmes.

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□

Better utilization of women in labour force itself would improve productivity significantly.

– Yuwa Hedrick Wong

Feature

Correlates of Productivity of Milch Animals in Urban, Peri-Urban and Rural Dairy Production System

C. Manivannan & Hema Tripathi

The study was carried out in Thanjavur district of Tamil Nadu state in three localities namely, urban, peri-urban and rural areas. A sample of 50 families was selected from each area leading to a total sample size of 150 families. Knowledge level about improved dairy husbandry practices, economic motivation, scientific orientation, achievement motivation, self confidence and innovation proneness were the psychological characteristics that had positive and significant association with productivity of milch animals in the overall sample as well as among respondents of each of the three localities.

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Dairying is an occupation that supports the livelihood of many people especially of the rural poor in India. It is considered to be one of the subsidiary occupations of the rural people that plays a crucial role in the national economy by generating income and employment. Dairying is an important sub sector of livestock development accounting for nearly 65 per cent of the total livestock contribution to GDP with an encouraging growth rate of five per cent (Balaraman, 2003). India continues to be the largest producer of milk in the world with the estimated 91 million metric tonnes of milk production in the year 2004-05 (Misra, 2005). This achievement has been made possible through the implementation of various dairy development programmes/schemes etc., launched by the Government of India. Improvement in the productivity of milch animals through cross breeding with exotic germplasm, development of technology for transportation of milk and its products over long distance, development of technology for increasing the shelf life of milk and its products and development of organized marketing facility etc; have altered the dairy farming scenario tremendously and helped the dairy entrepreneurs to obtain higher profits.

In India, rapid population growth, urbanization, increase in per capita income, increase in awareness about the nutritive value of milk, change in preference and consumer behaviour etc., are some of the factors that are expected to increase the demand for milk and its products in the coming decades. Such a growing demand can be achieved only through augmenting the productivity of milch animals. Sustainability of dairy enterprise as a viable self-supporting unit depends on higher productivity of the milch animals, which in turn depends on several factors. It is a common picture in India that the small-scale dairy entrepreneurs are located in urban, peri-urban and rural areas and it is possible that this may have

Table 1: Variables and their measurement

Variables		Measurements
Independent variables		
X_1	Family education status	Index of Ray (1967)
X_2	Herd size	Schedule developed for the study
X_3	Experience in dairy farming	Schedule developed for the study
X_4	Input availability	Schedule developed for the study
X_5	Market facilities	Schedule developed for the study
X_6	Proximity to veterinary support system	Schedule developed for the study
X_7	Level of knowledge about improved dairy husbandry practices	Test of Subramanian (1992)
X_8	Economic motivation	Scale of supe (1969) modified by Manivannan (1997)
X_9	Achievement motivation	Scale of Singh (1974)
X_{11}	Self confidence	Scale of Basavanna (1971) modified by Nagaraja (1989)
X_{12}	Innovation proneness	Scale of Moulik (1965)
Dependent variable		
Y	Productivity of milch animals	Milk yield index of Yang (1980)

an influence on the productivity of milch animals as a whole due to varied availability of inputs, marketing facility and existence of veterinary support systems etc. Besides these, several situational and personal factors like size of the farm, educational status, experience, economic motivation, scientific orientation, innovation proneness and various other psychological characteristics of the individuals may also have an influence on the productivity of milch animals. A clear understanding of all those factors influencing productivity of milch animals is therefore of paramount importance in augmenting the productivity of milch animals.

Considering this scenario a study was conducted to know the correlates of productivity of milch animals in urban, peri-urban and rural dairy production systems with the following specific objectives:-

1. To know the productivity of milch animals amongst dairy farmers in urban, peri-urban and rural areas.
2. To study the relationship of selected situational and personal factors with productivity of milch animals.

Methodology

The study was carried out in Thanjavur district of Tamil Nadu state in three localities namely, urban, peri-urban and rural areas. Thanjavur town, which is the district headquarter and which is the largest in terms of geographical area (36 sq. km.), was selected as an urban area for the study. The villages located within 10 km radius from the boundary of the Thanjavur town were considered as peri-urban area and villages located beyond 10 km from the boundary of the urban area were considered as rural area for the study. Five clusters of villages each from the peri-urban and rural areas; each comprising three villages, were listed on the basis of higher milch animal population. From this, one cluster each from the peri-urban and rural area was selected randomly. From each of the selected urban, peri-urban and rural areas, 50 dairy-owing households classified into small (1-4 milch animals) and large (more than 4 milch animals) herd-owning categories, were selected through proportionate random sampling method. The numbers of small herd-owning households selected from each of the urban, peri-urban and rural areas were 29, 32 and 34 and under large herd-owing households were 21, 18 and 16, respectively. Thus a total of 150 dairy-owning households constituted the sample for the study.

Keeping in view the specific objectives of the study, 12 independent variables related to productivity of milch animals were identified through judges rating method. The list of variables selected along with their measurement is given in Table 1. The dependent variable of the study, productivity of milch animals was conceptualized as a manifestation of obtaining total fluic milk per unit of dairy animal through the adoption of scientific dairy farming practices, available manpower and financial resources. Productivity of milch animals (cattle and buffaloes) was measured with the help of milk yield index of Yang (1980).

According to him, milk yield index represents the average milk yield of all the milch animals in a dairy farm compared with the average milk yield of the region. The data were collected from the selected respondents through a structured interview schedule and the data were compiled, tabulated and analyzed using percentage analysis, zero order correlation and multiple regression analysis, keeping in view the objectives set forth for the study.

Results and Discussion

Distribution of respondents according to levels of productivity of milch animals

Table 2 revealed that the average milk yield index of the milch animals of the urban, peri-urban and rural respondents was 115.49, 97.73 and 86.03 respectively. Regardless of the herd-size categories, majority of the respondents in urban area (78.00%) achieved higher productivity of their milch animals, followed by those in peri-urban (44.00%) and rural areas (30.00%). Large herd-owning respondents (LHOR) from urban (85.71%) and peri-urban (55.56%) areas had better productivity of their milch animals as compared to rural respondents (25.00%), where majority of the respondents had low-level productivity, irrespective of the herd size.

Table 2: Distribution of respondents according to levels of productivity of milch animals

Locale	Mean index	Level	
		Low (< 99.82) f	High (≥ 99.82) f
Urban			
SHOR (n = 29)	113.36	8 (27.59)	21 (72.41)
LHOR (n = 21)	118.44	3 (14.29)	18 (85.71)
Total (n = 50)	115.49	11 (22.00)	39 (78.00)
Per-urban			
SHOR (n = 32)	97.54	20 (62.50)	12 (37.50)
LHOR (n = 18)	98.63	8 (44.44)	10 (55.56)
Total (n = 50)	97.73	28 (56.00)	22 (44.00)
Rural			
SHOR (n = 34)	85.56	23 (67.65)	11 (32.35)
LHOR (n = 16)	87.03	12 (75.00)	4 (25.00)
Total (n = 50)	86.03	35 (70.00)	15 (30.00)
Overall			
SHOR (n = 95)	98.08	51 (53.68)	44 (46.32)
LHOR (n = 21)	102.82	23 (41.82)	32 (58.18)
Total (N = 150)	99.82	74 (49.33)	76 (50.67)

Figures in Parentheses indicate percentages

Better management efficiency, maintenance of good stock of high yielding animals and high rate of adoption of concentrate feeding might be the reasons for achieving higher productivity of milch animals by the urban respondents. Table 2 further reveals that the majority of the large herd-owning respondents (58.18%) achieved higher productivity of their milch animals and about 54 per cent of small herd-owning respondents (SHOR) fell in the low-level category, irrespective of the localities studied.

Zero-order correlation analysis between independent variables and productivity of milch animals

Table 3 shows that out of 12 selected independent variables, 10 variables viz. family education status, herd size, input availability, market facilities, level of knowledge about improved dairy husbandry practices, economic motivation, scientific orientation, achievement motivation, self confidence and innovation proneness, had positive and significant ($P < 0.01$) relationship with productivity of milch animals among overall sample of respondents. Proximity to veterinary support systems, however, was found to be negatively but significantly ($P < 0.01$) correlated, whereas experience in dairy farming showed a non-significant relationship with productivity of milch animals among overall sample of respondents.

The positive and highly significant relationship of family education status with productivity of milch animals indicates that the higher the family education status of the dairy owning households, the better would be the productivity of their milch animals. John (1974) and Tripathi (1991) also reported similar results. Sagar (1996), however, reported a non-significant relationship. Table 3 further reveals positive and significant ($P < 0.05$) correlation of family education status with productivity of milch animals only among peri-urban respondents, whereas it showed a non-significant relationship among urban and rural respondents. This indicates that the animal productivity achieved by the urban and rural respondents was not affected by their family education status. The size of the herd was found to have a positive and significant ($P < 0.01$) association with productivity of milch animals only among overall sample of the respondents. This indicates that the productivity increases with the increase in number of milch animals. Similar findings were reported by Hundal, (1976); Chauhan, (1979) and Tripathi, (1991). However, Sagar (1996) stated decline in productivity with increase in number of dairy animals and Shree Shailaja (2000) reported a non-significant relationship of herd size with productivity of milch animals. Areawise, the present study also revealed a non-significant relationship between herd size and productivity of milch animals among urban, peri-urban and rural respondents. The availability of

Table 3: Zero order correlation analysis between independent variables and productivity of milch animals

Sl. No.	Locale / Independent variables	Correlation co-efficients (r)			
		Urban (n = 50)	Peri-urban (n = 50)	Rural (n = 50)	Overall N = 150)
X_1	Family education status	0.005^{NS}	0.295**	0.011^{NS}	0.242**
X_2	Herd size	0.231^{NS}	0.039^{NS}	0.057^{NS}	0.228**
X_3	Experience in dairy farming	–0.094^{NS}	0.060^{NS}	–0.215^{NS}	0.132^{NS}
X_4	Input availability	0.278^{NS}	0.223^{NS}	–0.089^{NS}	0.435**
X_5	Market facilities	0.000	0.245^{NS}	0.000	0.326**
X_6	Proximity to veterinary support systems	0.044^{NS}	0.109^{NS}	0.101	–0.214**
X_7	Level of knowledge about improved dairy husbandry practices	0.569**	0.632**	0.556**	0.634**
X_8	Economic motivation	0.498**	0.565**	0.829**	0.682**
X_9	Scientific orientation	0.304*	0.635**	0.617**	0.454**
X_{10}	Achievement motivation	0.304*	0.648**	0.695**	0.640**
X_{11}	Self confidence	0.430**	0.602**	0.813**	0.669**
X_{12}	Innovation proneness	0.419**	0.614**	0.679**	0.637**

** - Significant at 0.01 level of probability, *Significant at 0.05 level of probability, ^{NS}Significant at 0.05 level of probability, ^{NS} - Non-significant

inputs for running a dairy enterprise had positive and significant (P < 0.01) relationship with productivity of milch animals among overall sample of respondents irrespective of the three areas. Better availability of technical inputs in terms of breeding, feeding and health care practices of dairy husbandry are required to enhance the productivity of milch animals. The present study showed no significant relationship between input availability and productivity of milch animals among urban, peri-urban and rural respondents due to less variability in the selected sample.

The sustained growth of any enterprise in terms of productivity depends on continuous flow of money through regular sale of its products for which availability of better marketing facility is a necessary pre-requisite. This is true for the dairy enterprise too, hence, positive and significant (P < 0.01) correlation between market facilities and productivity of milch animals was observed among overall sample of respondents. Market facilities had no correlation with productivity of milch animals among urban as well as rural respondents, whereas it had a non-significant relationship among peri-urban respondents. It may be due to the fact that the market facilities available to individual respondents in urban areas as well as in rural areas did not differ; hence, no correlation was found. Table 3 further reveals that socio-psychological characteristics such as level of knowledge about improved dairy husbandry practices, economic motivation, scientific orientation, achievement motivation, self confidence and innovation proneness were found to have positive and significant (P < 0.01) correlation with productivity of milch animals among overall sample of respondents, irrespective of the localities. Localewise also, similar observations were made indicating that respondents higher level of knowledge about improved dairy husbandry practices led to augmented productivity of their milch animals. This finding is in line with the findings of Sidhu (1980) and Shree Shailaja (2000). Tripathi (1991), however, reported non-significant relationship between knowledge and productivity of milch animals. Respondents with high economic motivation tried to achieve higher returns from their dairy enterprise by enhancing the productivity of their milch animals. A similar finding was also reported by Shree Shailaja (2000). She also found positive and significant association of scientific orientation and achievement motivation with productivity of milch animals. Tripathi (1991) reported better productivity of milch animals owned by rural women who were highly prone to adopt dairy innovations.

The present study also showed a positive and significant (P < 0.01) relationship between the self confidence among respondents and productivity of their milch animals. It revealed that the respondents, who were more confident of themselves in running a dairy enterprise, were quicker in making and implementing the right decisions concerning various operations of their dairy enterprise to achieve higher productivity of milch animals. The variable proximity to various veterinary support systems was found to be negatively but significantly (P < 0.01) associated with productivity of milch animals among over-

Table 4: Multiple regression analysis for productivity of milch animals on selected independent variables

(N = 150)

S. No.	Independent variables	Urban			Peri-urban			Rural			Overall		
		'b'	S.E. (b)	't'	'b'	S.E. (b)	't' value	'b'	S.E. (b)	't' value	'b'	S.E. (b)	't' value
X_1	Family education status	–	–	–	0.25	2.536	0.10^{NS}	–	–	–	–1.37	1.274	-1.08^{NS}
X_2	Herd size	–	–	–	–	–	–	–	–	–	–0.80	0.690	-1.16^{NS}
X_4	Input availability	–	–	–	–	–	–	–	–	–	–0.11	0.611	-0.18^{NS}
X_5	Market facilities	–	–	–	–	–	–	–	–	–	2.26	1.022	2.21*
X_6	Proximity of veterinary support systems–	–	–	–	–	–	–	–	–	–	–2.20	1.445	-1.53^{NS}
X_7	Level of knowledge about improved dairy husbandry practices	5.56	2.064	2.70**	5.19	1.781	2.92**	–0.27	1.159	-0.23^{NS}	3.36	1.008	3.34**
X_8	Economic motivation	1.68	1.331	1.26^{NS}	–0.79	1.111	-0.71^{NS}	2.87	0.857	3.35**	1.88	0.623	3.02**
X_9	Scientific orientation	–1.22	1.341	-0.91^{NS}	0.81	1.324	0.61^{NS}	–0.65	0.668	-0.98^{NS}	–0.75	0.591	-1.27^{NS}
X_{10}	Achievement motivation	–0.83	1.594	-0.52^{NS}	0.61	1.307	0.47^{NS}	–0.02	1.144	-0.02^{NS}	–0.26	0.759	-0.35^{NS}
X_{11}	Self confidence	5.15	4.089	1.26^{NS}	4.04	3.252	1.24^{NS}	7.23	2.181	3.32^{NS}	6.03	1.776	3.40**
X_{12}	Innovation proneness	1.25	2.975	0.42^{NS}	2.58	2.447	1.05^{NS}	2.06	1.916	1.07^{NS}	2.51	1.427	1.76^{NS}
	R^2		0.399			0.595			0.773			0.629	
	'F'		4.77**			8.83**			24.39**			21.29**	

** - Significant at 0.01 level of probability; * - Significant at 0.05 level of probability; ^{NS} - Non-significant.

all sample of respondents, irrespective of their locality. Localewise, the same was found non-significant in all the three areas. The productivity of milch animals was found high among the urban respondents, who had less proximity to veterinary support systems as compared to those that hailed from peri-urban and rural areas.

Multiple regression analysis for productivity of milch animals on selected independent variables

The contribution of situational and personal factors towards productivity of milch animals among each of the urban, peri-urban and rural respondents and also among overall sample of the three areas were analyzed and presented in Table 4. In the multiple regression analysis model, only those situational and personal factors which showed positive and significant correlation with productivity of milch animals were included as the independent variables.

1. Urban area

It could be observed from Table 4 that 39.90 per cent of variation (R^2) in the productivity of milch animals was due to the combined influence of the six independent variables in urban area. The model further reveals that the contribution towards variability in the productivity of milch animals was found significant ($P < 0.01$) only for level of knowledge about improved dairy husbandry practices. Thus, it could be stated that higher knowledge level of urban respondents helped them in achieving higher productivity of milch animals.

2. Peri-urban area

Table 4 reveals that the seven independent variables accounted for 59.50 per cent of variation (R^2) in the productivity of milch animals among peri-urban respondents. Likewise in the urban area, level of knowledge about improved dairy husbandry practices among peri-urban respondents was found to contribute positively and significantly ($P < 0.01$), while the other variables were not contributing at statistically significant level in explaining the variability of the dependent variable. This indicates that the peri-urban respondents who had more productive milch animals, had a higher level of knowledge regarding improved dairy husbandry practices.

3. Rural area

It could be observed from the table 4 that the six independent variables together explained 77.30 per cent of variation (R^2) in the productivity of milch animals among rural respondents. Out of six, only two variables namely, economic motivation and self confidence, exhibited positive and significant ($P < 0.01$) contribution and the rest of the variables showed non-significant contribution in explaining the variability of productivity of milch animals.

Thus, it could be concluded that the rural respondents, who were highly confident and economically motivated had achieved higher productivity of their milch animals.

Overall sample

The significance of coefficient of multiple determination at 0.01 level of probability ($R^2 = 0.629$) indicated that 62.90 per cent of variation in the productivity of milch animals was due to the combined effect of the eleven independent variables among overall sample of respondents (Table 4). The 't' test concluded that the level of knowledge about improved dairy husbandry practices, economic motivation and self confidence showed positive and significant contribution at ($P < 0.01$), while market facilities showed positive and significant contribution at ($P < 0.05$). Thus, it could be concluded that high self confidence, more knowledge about improved dairy husbandry practices, high level of economic motivation of the respondents and existence of better market facilities motivated the dairy farmers to achieve higher productivity through their milch animals.

Conclusion

The findings revealed that productivity of milch animals was found to be positively and significantly correlated to family education status, herd size, input availability and market facilities among overall sample of respondents, irrespective of their localities. Hence improving the input availability and market facilities for dairying shall be given due importance in the formulation of programmes for augmenting the productivity of milch animals. Localewise, family education status showed positive and significant relationship in the peri-urban area only. Knowledge level about improved dairy husbandry practices, economic motivation, scientific orientation, achievement motivation, self confidence and innovation proneness were the psychological characteristics that had positive and significant association with productivity of milch animals in the overall sample as well as among respondents of each of the urban, peri-urban and rural localities. Hence, due consideration of these factors is essential in the formulation and implementation of suitable extension and training strategies for improving the productivity of milch animals in all three different localities of milk production.

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Feature

Employment Generation in Asia: The Emerging Challenge in the 21st Century

Badar Alam Iqbal

The emergence of huge potential and opportunities of growth in China, India and other economies of the East and Southeast, have been responsible for the shift of the growth center from Europe to Asia. But this growth has not been commensurate with the generation of employment opportunities for the labor force. Hence, employment creation has emerged as the most strategic issue and challenge for the Asian region to face in the 21st century. This paper looks at the employment situation in Asia in general, and in India in particular, and examines the issue of sustainable job creation being the key to both decent jobs and a better livelihood.

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Today, development economists and growth strategists call the 21st century a century belonging to Asia. Four billion people live in this region. Since 1995, the growth has been more than double of the global growth average. As a result, the productivity in the region has registered a massive rise of more than 41 per cent, which has towered over the rest of the world. But the most pertinent fact has been that this dynamic growth is not of much meaning and purpose, as the growth in the region has not been matched with an equal growth in employment generation, which is the sine-quo-non for better lives and livelihoods of the people living in Asian region. The resultant effect has been that there has not been a desired improvement in the working environment and the wages of the labor force of the region, that stood at 1.9 billion.

The cumulative effect has been that unemployment, underemployment, insecurity, inadequate working environment, shortage of marketable skills and expertise have been persisting in the region, resulting into underutilization of potential and opportunities already in existence in the Asian region. Due to such trends and such a situation persisting in the Asian region, still nearly 1 billion people are working in such a situation. Added to this, inadequate social development and protection, particularly among rural masses and the urban informal sector, have been adding fuel to the fire and also making the challenge of meeting the employment needs more difficult and formidable.

Recently, the president of the Asian Development Bank (ADB) has rightly pointed out "policy agenda of region's economy is not geared to meeting the objectives of full productive and decent employment. It is easy to conceive a region, say 25 years from now, which despite growth, will still harbor most of the world's poor".

Serious and Alarming Trends

The following trends have to be looked at on a war footing to meeting the challenges of full, productive and decent employment.

(a) In the year 2005, nearly 84 per cent of the labor force of South Asia (SAARC), 58 per cent of workers from Southeast Asia region (ASEAN), 47 per cent of East Asia and 36 per cent from the Arab world have not been able to earn enough to improve themselves and their families from the US $ 2 per day level of poverty and hence, the entire Asian region has been trying hard to transform the dream of 'decent work' into a reality.

(b) Informal employment has been the biggest segment of employment in the Asian region. The relative share of informal employment in comparison to non-agricultural employment has been on the very high side in major economies of Asian region. The figure for India is 83 percent. Indonesia constitutes nearly 78 per cent followed by 72 per cent in the Philippines, followed by 51 per cent in Thailand and 42 per cent in Syria.

(c) The Asian region accounted for nearly 48 percent, or in absolute terms, 41.6 million eligible workers without jobs. Similarly, eligible workers are at least three times likely than adults to be unemployed. Added to this, eligible workers underemployment is also a contributory factor towards the unemployment scenario.

(d) The most depressing trend in the Asian region employment trend has been that about 1 million workers die per year because of work-related accidents or accidents on the job and critical diseases.

(e) Even after observing the major international labor standards, the Asian region has been at the bottom with regard to ratifications of the two International Labor Organization (ILO) Conventions with respect to freedom of association and the right to collectively bargain with any other region of the globe.

(f) The annual growth rate of migration of labor force in Asian region is 6 per cent for the last more than 20 years. The astonishing trend has been that the rise of 6 per cent in migration is the twice the growth rate of the labor force of the sending or migrating countries.

From the above emerging trends, it is very clear that there has been an alarming deficit in terms of 'decent work environment'. Hence, what is needed is to make concerted efforts with regard to poverty reduction or eradication of poverty on a massive scale. The massive reduction or eradication in poverty would result into enormous boost to the quality of living (still distant dream) and security of people, families, and communities.

Youth Unemployment: A Major Issue

Youth are a natural resource, which every nation has. But they are not utilizing them properly. Youth unemployment has become one of the most serious issues for the global world in general and the Asian region in particular. The major offshoots of this situation are poverty, drug abuse, crime, poor health care, terrorism and the simple tragedy of untapped human potential.

The immediate need is how to combat youth unemployment. In this regard, the role and contribution of Youth Employment Summit (YES) has been of vital and strategic nature. So far more expertise has been extended to more than 12 nations right from Afghanistan to Paraguay. Today 84 YES networks have been under operation worldwide. These networks have been extending education and job training.

The major thrust is on self-sufficiency, on equipping young people with entrepreneurial skills that enables the youth to build up their own business. What is immediately required is to focus on the issue of shortage of employment opportunities for the youth. But sometimes, this major issue gets short shrift in nations that struggle to cope with persisting crisis, war, AIDS and famine. Therefore, the need of the hour is to encourage and accelerate ways and means of promoting entrepreneurship, attracting foreign investment, strengthen trade and develop markets for goods and services that can employ the youth.

Two Welcome Developments

To tackle the burning problem of youth unemployment at the global level, two very positive and encouraging developments have come up. First, the United Nations has intensified its efforts with regard to youth employment, and hence, declared a statement in August 2006 that 'the center of youth poverty is the need to address widespread youth unemployment'. Second the World Bank recently enacted a loan program to help poor youth break into labor market. These efforts may go a long way to providing employment opportunities to the youth the world over.

South Asian Region Scenario

The South Asian region has been lagging far behind in respect to job creation and better wages to the labor force. These trends have been persisting due to lack of adequate economic growth rate and needed improvement in productivity. These trends have been resulting in a growing discontent in terms of socio-economic facets.

According to the latest report of ILO, 'solid economic growth since 2000 in India, Bangladesh, Maldives, nowhere in the South Asian region has employment creation been strong enough to fully absorb new labor force entrants'. Unemployment in South Asian region averages 5 per cent, as compared to 4.6 per cent in case of the Asia-Pacific region. Unemployment has been most common in men and women of the 15 to 24 age group. Therefore, this segment is bearing the burnt as the said age group accounts for 11.3 per cent of the unemployment.

In South Asian region, the major effect has been on Bangladesh and Sri Lanka where young workers are four times more likely to be unemployed as older workers, in case of India three times more, and in the rest of the region at least twice more. Young women labor force has higher unemployment rates as compared to male. Today, the South Asian region has as much as 202 million working poor and hence, this is the biggest challenge for the economies of South Asia to face and tackle the serious problem on a war footing.

Unemployment trends are likely to become more alarming in the next decade. This is because the South Asian labor force is expected to increase by about 2.1 per cent per year, hence adding more than 14 million new labor market entrants between 2006 and 2015. The most accelerated rise would be in economies with the greatest number of working poor and the largest informal economies namely - Bangladesh, Pakistan, Nepal and lowest in case of Sri Lanka. It is a true to say that unemployment and the working poor have overshadowed the South Asian region's strong economic performance.

Indian Employment Scene

The initiation of required economic reforms has transformed the economy into a rising and accelerated economy in Asia in general and the South Asian region in particular. The economic reforms have brought an improvement in the lives of millions of people in the country. But these trends can not be relished without creating an adequate number of better jobs.

It is pertinent to point out here that despite a per capita GDP of nearly 5 per cent during the last decade i.e. in the nineties, a growing number of employed Indians are working on daily or periodic contracts, constituting the largest segment of informal sector of Indian economy.

Employment growth in the organized sector where good jobs or decent work have been created, has been excruciatingly slow, if not negative, over the three to four years. While average wages have gone up, it is large pay packets for the small sliver at the top end of the income scale that have been the major driving force. The recent industrial growth surge has contributed little to employment generation. Between 1995-96 and 2004-05, nearly 1 million jobs were lost in the organized manufacturing sector. According to the Central Statistical Organization in the next three years, despite accelerated industrial growth, employment did not increase. Instead there is a marginal fall in employment by nearly one per cent.

Silver Lining

There is a true saying that the more you study the better you are. Grandpa's classical wisdom may finally be coming true as there are indications that unemployment rates among educated youth are either declining or stabilizing after ballooning frighteningly during the initial years of liberalization in the mid-90s.

According to the latest NSSO survey on unemployment, 59 out of 1000 rural males in the labor force were unemployed during 2004-05, a substantial fall from 68 in 1999-2000 and 88 during 1993-94. For urban males, the same was 60 during 2004-05 as compared to 66 in 1999-2000 and 69 during 1993-94.

Gender disparity and rural divide, however, underline the trend of unemployment. The fair sex is on the whole, on the wrong side of the fence. While men grab a bigger chunk of the seemingly expanding job market, women are not so fortunate. In rural areas, 201 out of 1000 women were without work in 2004-05 as against figures of 204 during 1999-2000 ands 269 in 1993-94. Those in the cities were only marginally better placed with 194 jobless in 2004-05 as compared to 163 in 1999-2000 and 206 during 1993-94.

The most noteworthy feature is that the lesser-educated have smaller unemployment rates while the higher educated have higher unemployment rates. The meticulous study makes a mockery of the stress middle class India puts on education. Among youth between the age of 15-29 years, graduates are above 252 jobless among

1000 in the labor markets, in sharp contrast to a mere 14 out of 1000 among illiterates. For secondary and above, the unemployed rate stands at 175 out of 1000.

Educated women fail to buck the trend of higher joblessness in their gender bracket as compared to men. In the secondary and above educational bracket, 237 out of 1000 women were without work, almost double of 112 out of 1000 jobless men.

There is a great concern that the National Rural Employment Scheme (NRES) has failed in generating adequate employment opportunities for the rural poor. This has been due to inadequate allocation of resources to the scheme. According to the data available, at 200 Natural Rural Employment Guarantee Act (NREGA) districts, the budget allocation for 2006-07 is only Rs 10,000 or so, less than half of the NAC's (National Advisory Council) estimates of the amount required for efficient and effective implementations. Added to this, the modest allocated amount is grossly under-utilized.

Imagine what exciting times we would live in if this level of commitment to such districts was to spread across the nation. A whole range of creative activities can be linked with this, namely - planning productive works, launching innovative social security schemes, creating and promoting workers' associations, designing effective crèches, arranging work for persons with disabilities, conducting social audits, organizing literacy programs. This will call for sustained building Natural Rural Employment Guarantee Act as a national endeavor, instead of treating it as a feather in one's cap.

The most dangerous form of 'inaction' on the NREGA relates to the most strategic requirement namely - transparency safeguards i.e. the mandatory access to muster rolls at the working site.

Strategy for Meeting Challenges

In order to meet the challenges of decent working, an effective and meaningful as well as purposeful strategy or action plan is required at regional (Asia), subregional (South Asia), and country (India) levels. The strategy or action does depend on the following guideposts:

1. Promotion of sustained economic growth, which should concentrate on the creation of decent jobs. This could be possible by making investment and encouraging entrepreneurship, skill development, appropriate labor standards and sustainable livelihoods on the key areas the region.
2. Inculcate a sense of respect, promote, and realize the most fundamental principles and rights at the work. These include freedom of association and the effective recognition of the right to organize and bargain collectively.
3. Promotion of gender equality is sine qua non. The best example is that one of the four most powerful global CEOs appointed by Pepsi, is an Indian woman.
4. Extension of needed social protection which enhances its effectiveness in the informal sector wherein labor laws are not applicable.
5. Effective and efficient governance of the Asian labor market. This could be possible by the creation of an institutional framework, which may result in a 'decent work agenda'.
6. Creation of flexible labor laws for expansion of decent jobs in the organized or formal sector.
7. Increased public investment especially in the creation jobs in the rural areas.
8. Creation of decent jobs in the higher productivity non-farm sector.
9. Proactive role of Governments in enabling producers to restructure and diversify into new economic operations. This is very strategic for job creation.
10. Effective and efficient collaboration between public and private sectors.
11. Immediate attention to the woeful state of power and transportation needs.
12. The red tape that slows business in Asian economies must be minimized.

The coming ten years would be crucial for Asia in general and the South Asian region in particular. If the increased growth rates the region has been enjoying continue and remain consistent in a stable social framework, the gains need to be felt by all through improvement to lives and livelihood, resulting in 'decent work'.

Conclusion

Job creation is critical to Asian region development. A structured region wide approach to meet the challenge of decent work is the best option or alternative for an equitable, sustained economic growth. Asia has shown it can change. The Governments of the Asian region must focus on improving the lives of the poor. This would ensure

that the entire people benefit from strong growth and that growth would be fully sustainable. The Youth Employment Summit (YES) is an important and strategic effort in the right direction and may go a long way in solving the problem of youth unemployment.

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Try as hard as we may for perfection, the net result of our labors is an amazing variety of imperfectness. We are surprised at our own versatility in being able to fail in so many different ways.

– Samuel McChord Crothers

Feature

Deregulation and HRM: The Case of the Indian Electricity Sector

Asha Prasad

In post-independent India, the entire gamut of power supply including generation, transmission and distribution of electricity, was brought under government control. However, the State Electricity Boards were established as public utilities with a social objective rather than as commercial organisations. Excessive political interference and bureaucratisation led to inefficiency in operation and unabated financial losses. This paper studies the impact of the reforms process in the electricity sector on human resources in the early nineties.

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Development of the Electricity Sector in India

Prior to 1947 private companies or local authorities accounted for more than four-fifths of the total power generation capacity in the country, which came to 1362 MWs. The Central and the Provincial governments were concerned only with the regulatory aspects. In the post-independence era, massive infrastructure building exercises were taken up. Top priority was given to electricity as this is one of the most critical inputs for the development of the economy and for the improvement of the quality of life.

The Indian Electricity Act, 1910, which dealt with the functioning and regulation of private licensees only, was replaced by the more comprehensive The Electricity (Supply) Act, which came into force in 1948. It provided for the creation of the state-owned State Electricity Boards (SEBs) charged with the responsibility of promoting coordinated development of generation, transmission and distribution of electricity. The Industrial Policy Resolution of 1956 reserved the generation and distribution of electricity almost exclusively for the state sector and this led to the gradual nationalization of the power sector industry. Till 1991 SEBs controlled more than 70 per cent of power generation and virtually all distribution.

Tight state control over SEBs rendered them public utilities with social objectives rather than commercial organisations which bred inefficiency and frustration among employees. Structural inefficiency resulting from political interference resulting from political interference in the working of SEBs combined with arbitrary subsidy to the agricultural consumers without government compensation and a forced irrational tariff structure, led to an acute financial crisis in the SEBs. The losses of SEBs in India were up to the extent of about $ 3 billion per year or about 1 per cent of the country's GDP. The reasons

behind the poor performance of the SEBs can be summed up as follows:

- Low plant load factor due to poor maintenance.
- Disparity in tariff structure and free supply of electricity to the agriculture sector without government compensation.
- High transmission and distribution losses mostly attributable to pilferage and theft of energy.
- Low revenue collection efficiency.
- High outstanding debts.
- High manpower costs.
- Increasing fuel costs
- Lack of competition and attention to consumer satisfaction.

Need for Reforms

Reforms in the electricity sector started in 1991 with the introduction of the policy of liberalisation and reforms in macro-economy. The poor performance of SEBs, many of which have been recording very low performance levels, brought in its wake the need for reforms for the targeted rapid growth of national economy. The power sector reforms are aimed at achieving the following minimum performance:

(i) Electricity generation at an economically affordable cost.

(ii) Reliable and quality service to the consumers.

(iii) Financial viability of the sector.

(iv) Creation of an attractive environment for private investments in the power sector.

The reform in the electricity sector started with various notifications of the Ministry of Power, Government of India. These can be succinctly summarised as:

(i) Enactment of legislation in 1991 by the Government of India with the basic objective of encouraging the private sector to set up and operate power generation plants of any size and to enter into long-term power purchase agreement.

(ii) Enactment of Electricity Regulatory Commission Act, 1998 with the objective of rationalization of electricity tariff and transparent policies regarding subsidies.

(iii) Introduction of Electricity Laws (Amendment) Act, 1998 to facilitate private investment in transmission.

(iv) Introduction of Electricity Regulatory Commission (Amendment) Bill, 1999 aimed at empowering two or more states or union territories to form joint Electricity Regulatory Commission.

(v) Announcement of Mega Projects Policy.

(vi) Setting up Power Trading Corporation.

(vii) Initiation of new hydel policies to provide impetus to hydel power capacity addition.

(viii) Launching of the Accelerated Power Development Programme with the objective of financing renovation and maintenance projects.

(ix) Upgradation of district networks including sub-transmission.

(x) Installation of meters to regulate supply of electricity and to check T&D losses.

(xi) Enactment of the Electricity Act, 2003 to replace the Indian Electricity Act, 1910, Electricity (Supply) Act, 1948 and the Electricity Regulatory Commission Act, 1998 with the following objectives:

- To make generation free from licensing.
- To make setting up of the Electricity Regulatory Commission mandatory.
- To ensure the granting of licenses for the supply of electricity.
- To set tariffs.
- To promote competition and efficiency.
- To set up a machinery for dispute resolution.
- To reduce the role of Central Electricity Authority.
- To meter all supplies.
- To establish bulk electricity spot market.
- To attain a progressive reduction of cross-subsidies.
- To initiate transitional arrangements with respect to reorganization of SEBs.

World Bank and other lending agencies have been playing active roles in implementing power sector reforms in developing countries including India. According to a new policy framework implemented by the World Bank in 1993, it decided to extend loans only to those utilities which functioned on a commercial line, or which were committed to bring in improvement in functioning of utilities through reforms. Statewise restructuring of State

Electricity Boards started with the following objectives:

- To render the SEBs commercially viable.
- To improve operational efficiency of the SEBs.
- To reduce dependence of electricity utilities on budgetary support from government.
- To delink electricity tariff fixation from the politicians.
- To provide quality services to the consumers.

Reform Highlights

Encouragement of Private Sector Participation

The growing demand for electricity could not be fulfilled as the Central and State Governments were financially constrained to revitalize the ailing SEBs. The private investment in the electricity sector was urgently needed. Under its new economic reform policy adopted in 1991, the Government of India took the initiative of involving the private sector in power generation in a big way. In October 1998, the Government notification provided generous incentives to a few mega projects of Independent Power Producers (IPPs) with a capacity of 1000 MW or more. These incentives interalia included a guaranteed minimum 16 per cent return on equity, a five-year tax holiday and selective counter guarantee from the Central Government to cover payment default by SEBs.

Transmission and distribution also required complete overhauling as part of the total restructuring of SEBs, as rightly emphasized by the World Bank and Asia Development Bank. Accordingly the Parliament passed the Transmission Bill permitting private sector participation in this area.

Initially the response from the private sector was very encouraging with both foreign and Indian investors reacting positively to the offer. By the end of September 1996, private companies proposed to set up 265 projects totaling 63,238 MW of generating capacity and investment worth Rs 229,411 crores. Yet by September 1998, only 4 power plants, 2 in Gujarat and 2 in Andhra Pradesh were in operation with a total capacity of 1346 MWs.

The major cause for failure to augment capacity in the area was the weak financial positions of the SEBs, as a result of which IPPs found it difficult to settle financial agreement due to the lack of credit worthiness of SEBs, the sole purchaser of power.

State Electricity Board Reforms

SEB reforms were initiated to enhance energy supply, mobilize resources and increase efficiency through competition. Two sets of reforms in the existing state power sector identified for immediate implementation were structural reforms and regulatory reforms. A committee constituted by National Development Council to identify measures needed to make SEBs viable, worked under the guidance of the World Bank and the Asian Development Bank and submitted a policy report with the following recommendations in 1995:

- Unbundling of SEBs into generation, transmission and distribution companies.
- Creation of independent regulatory boards at the central and regional levels for regulation of tariff.
- Phasing out of subsidies to agriculture consumers.
- Rationalization of tariff structure.
- Legislation to
  (a) Change the institutional structure and
  (b) Divide rural and urban electricity sectors.
- Reduction in T & D losses with metering of all consumers followed by an energy audit at all levels.
- Introduction of the element of competition and efficiency through participation of private sector.

Independent Regulatory Mechanism

With increasing private sector involvement and foreign competition, it became necessary to deregulate the existing regulatory regime of the government to insulate the power industry from special interest groups and to protect consumers' interest. Towards this end, the Electricity Regulatory Commission Act, 1998 was enacted by the Central Government which enabled the establishment of the Central Electricity Regulatory Commission and the establishment of an independent State Electricity Regulatory Commission.

The main areas of jurisdiction of these two commissions relate to rationalization of electricity tariff, regulation of inter-state power exchange and transparent policies regarding subsidies and licensing. A strong and independent regulator is needed to instill greater confidence in investors and to hasten the pace of reforms.

Employees' Response to Reforms

With the initiation of reform processes in many states, employees' unions have expressed grave misgivings and apprehensions about the reforms and its adverse impact on employees. Most of the employees were reluctant to work for the private sector as they were apprehensive that this was more demanding than working in companies under government control. The author conducted opinion survey of a large section of employees in SEBs of several states and concluded that some of the fears and misgivings of the employees about the reforms are set out on the following grounds:

(i) Employees feel their jobs are secure in government-controlled companies, while working for the private sector entails some degree of risk. Their salaries and other benefits are far better in government-controlled companies when compared with those in the private sector. Employees fear that the private management may adopt a hire-and-fire policy, making their jobs insecure.

(ii) Employees fear that because of the pursuit of profit maximization on the part of private management, their social security benefits are at stake. They are also irked by the lack of well-defined and proper provident fund and pension policies.

(iii) Employees are concerned about uncertainty of working conditions in the post-reform era. They apprehend that working hours would be extended under the private sector management.

The feeling of insecurity and aforesaid apprehensions about remuneration and working conditions led to protest and strike by employees of several SEBs.

Human Aspect of Reforms

Distrust of employees of the power sector in general towards reforms can be attributed to the following factors:

(i) Human resource management is a new concept for the electricity industry. Technocrats who were neither qualified nor possessed necessary expertise in human resource management, used to handle personnel-related matter in the SEBs. According to Mikkelsan, Nybo, Grenahaug (2002) the industry used to be known as the 'world of engineers'. On account of lack of expertise and proper knowledge of human psychology and group behaviour, personnel management by technocrats was not professional in approach.

(ii) While extensive analysis was carried out by experts of concerned fields on technical, commercial and financial aspects of the reform proposals, not much attention was paid to human aspect of reforms in the power industry. Any change in status quo and that too to the extent of shift in ownership to private hands, is bound to have a major impact on employees' psychology *(Pasmore et al, 1982).*

(iii) Employees of the power sector who have given their lifetime to the industry, were not considered worthy of constructive consultancy in bringing about reforms to the ailing industry. No meaningful discussions were ever held between the Government, The World Bank, the prime mover of the reforms process and the National Trade Unions (Prayas, Ratnam C.S.V. 2003)

(iv) In order to bring about any change successfully in an organisation, dissemination of information related to the proposed change is of vital importance (Jackson C. Peter, 1987). Information should percolate from the higher to the lower level of management. Sadly, it was found hopelessly lacking in the matter of reforms in the power sector. In a survey conducted by the author, higher and middle level managers in SEBs were not found fully informed with regard to the content and direction of reforms proposed in the industry.

(v) Issues like job security, retirement benefits, working conditions, terms of employment, etc. which are so vital for employees, were not spelt out clearly. Employees were kept in the dark with vague assurances, leading to increasing apprehension in the minds of the employees. There was a general perception among employees that instead of creating new job opportunities, the reform process would lead to a shrinking of employment opportunities.

(vi) Employees apprehended that the upgradation of technology to be ushered in through the reforms process would make their present level of skills obsolete and that this would threaten their position in the organization.

Role of Human Resource Management in Sector Reforms

People make an organisation. People are the key factor behind the successful management of change. Perception, attitude and beliefs of employees need be

reoriented to bring about the change in an organisation. Successful implementation of reforms in the power sector is dependent upon the willing and effective cooperation of staff, managers and trade unions. Management must instill trust in employees through the following human resource policy measures for their obtaining their partnership in bringing about changes:

(i) *Dissemination of Information:* There should be widespread dissemination of information at all levels of employees and civic society regarding the need for reforms in the sector under the present state of its health and global economic milieu. An information campaign should effectively highlight how reforms are inevitable for the very survival of the organization, how they are in the ultimate interest of the employees and for society in general. During periods of dramatic change in the electric power industry it is important to communicate with employees up and down the line about specific changes that are taking place in the industry (Luthans, Kyle; 1998).

(ii) *Involvement of Employees:* Employees through trade unions and associations should be formally involved in formulating measures of reforms which would instill among employees a sense of belonging to the reforms process.

(iii) *Transparent Terms and Conditions of the Service:* Terms and conditions of services following implementation of reforms in the following aspects of vital concern to the employees, should be clearly spelt out keeping in consideration the existing provisions:

- Continuity in service, job security and the designation of employees.
- Wages and other benefits vis-à-vis those presently enjoyed by the employees.
- Retirement benefits like provident fund, gratuity and pension.
- Organisation structure of entities after reforms.
- Work-hours and working conditions.
- Productivity improvement and incentive bonus scheme.
- Accountability.
- Performance appraisal system.
- Scope of career development and promotions.
- Disciplinary proceedings and grievance redress mechanism.
- Management of surplus employees.
- Early voluntary retirement scheme.
- Employees' welfare measures like group insurance, death-on-duty compensation, etc.

(iv) Training and Development: Human resource management should formulate a comprehensive policy on human resource development through training and continuing education. The new regulatory environment and fast changing technology scenario demand new skills and expertise. A planned training and education programme would ensure that employees are not redundant in the changing environment.

(v) *Public Awareness:* Forceful and effective publicity campaign should be taken up to educate public in general that the electricity industry is not a charitable organisation but one that has to operate on sound commercial considerations for its sustenance. Hike in power tariff is inevitable on account of the prevailing price environment. However, hike in tariff should be reasonable and convincing.

Reforms, including privatization in the power sector or for that matter in any industry in India, cannot be and should not be simply copied from industrially developed countries like Europe or America, or from an autocratic country like China. Cultural ethos, working conditions and social security systems in India are very different from those prevailing in other countries. No change or industrial reforms which are in conflict with work ethos and social norms of the country can be successfully implemented unless appropriate changes are brought in society through sustained education of the people. On the other hand, employees of the power sector must have a clear understanding of the forces of change as this will enable them to become a part of the solution rather than the problem.

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Weather means more when you have a garden. There's nothing like listening to a shower and thinking how it is soaking in around your green beans.

– Marcelene Cox

Feature

Total Factor Productivity: A Sectoral Analysis of Indian Industry

Hina Sidhu

Many studies at the aggregated level in India have shown dismal performance of the Indian industry during the 1970s and also during the post liberalization period. While this study has broad agreements in results at the aggregated level, there exist considerable differences in drawing the conclusions. Analysis at the disaggregated level reveals that some strategic sub-sectors of the Indian industry recorded high growth in TFP during the 1973-2003 period and also during the post liberalization period.

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Since the publication of Solow's paper on the theory of economic growth in 1956, there has been considerable refinement of the productivity models. Development of neoclassical endogenous growth models has opened up new avenues of research. Important studies, conducted in India and abroad to examine productivity growth, are reviewed in Ahluwalia (1985 & 1991), Balakrishnan and Pushpangadan (2002), Cororaton and Caparas (1999), Felipe (1997), Goldar (2002), Goldar and Kumari (2003), Islam (1999), Lipsey and Carlaw (2001), Pillikara (2001) Pradhan and Barik (1999) and Unel (2003).

Literature related to productivity states that the estimated growth of the total factor productivity (TFP) has varied widely across studies. These differences can be related, in part, to the differences in methodology, type and sources of data and the time period considered. The conflicting results of different methodologies have initiated debates among researchers about the usefulness of each method.

In this study the total factor productivity (TFP) is estimated through the application of the growth accounting method and the econometric approach. TFP relates the input factors like capital and labour to gross value added (GVA) and measures the growth in GVA that can not be explained by the growth of the weighted combination of the inputs. This study examines the TFP for each subsector of the registered manufacturing units during different periods of time. The results show that for the aggregated manufacturing sector:-

(a) the growth in TFP was negative during the 1973-83 period

(b) there was a swell in TFP during the 1983-93 period and

(c) there was a slow down in TFP growth during the 1993-03 period.

However, the estimates at the disaggregated level reveal that the performance of some strategic sub-sector, which are the key governors of the Indian industry, was appreciable. During the 1973-83 period, the growth in TFP was positive in most of the sub-sectors. Moreover, during the 1993-03 period the growth of TGP in some of the sub-sectors was relatively higher than in the pre-liberalisation period.

Concept and Measurement of Total Factor Productivity

Total factor productivity (TFP) is a neoclassical concept which links the factor efficiency with the aggregate production function. In classical economics the concept of the productivity of single inputs like labour productivity or capital productivity, did not pose a measurement problem. However, the consideration of more than one inputs (e.g., labour as well as capital) by the neo-classical economists gave rise to the problem of weight assignment to each input. This problem has been overcome through the application of the aggregate production function. A simple form of the production function is:

$$Q_t = F (L_t , K_t, t)$$

where Q is the output, L is employment, K is capital stock, and t is time. The time factor proxies the effects of technical progress as well as productivity. The subscript 't' also represents time. With the assumption that the effect of technology is separable from other factor inputs ie. labour and capital, the production function would take the form:

$$Q_t = \lambda_t F (L_t , K_t)$$

and

$$\lambda_t = Q_t / F(L_t, K_t)$$

where λ_t represents the disembodied, exogenous, and Hicks-neutral technical progress and it measures the changes in output over the period of time holding other inputs constant. At this stage it is important to explain the concepts like disembodied, exogenous and Hicks-neutral. Disembodied technological change means the change is not embodied in factor inputs. In other words it indicates better methods of production and organisational efficiency, which improve the efficiency of both the old as well as new factor inputs. This discloses that every technological change embodied in the factor inputs is assumed to be properly specified and accounted for in the production function. Exogenous technical change means the change brought by external factors like the diffusion of technology, training of workers, impact of information technology, expenditure on research and development, etc. Hicks-neutral technological change means that the impact of technology is equally spread, which improves the efficiency of both capital as well as labour. Thus the concept of TFP represents an index of all the factors, other than labour and capital, which have contributed to the production process. Such factors may be managerial efficiency, organizational competency, diffusion of technology, etc.

Although there are various methods to estimate TFP, this study has used the growth accounting method and the econometric estimation of the production function.

Growth Accounting Method

The growth accounting method is widely used to measure TFP. In this method the output growth is decomposed to calculate the contribution of each factor of production. To decompose the GVA growth, the coefficients of Cobb Douglas production function are used as weights for the estimated growth rates of the factor inputs. The World Bank team used the Cobb-Douglas production function and the differential calculus estimating the growth rates of output and TFP in the developed countries (Cororaton and Caparas 1999). The growth accounting equation used for the present study is as follows:

$$r_G = \alpha r_L + \beta r_K + \lambda_T$$

where r_G is the growth rate of gross value added, r_L is the growth rate of employment, r_K is the growth rate of capital stock, λ_T is the technical progress, and α, β and λ are the coefficients for labour, capital and time (representing technology) in the Cobb Douglas production function. It is important to note that this study has considered the gross value added (GVA) instead of the value of gross output because the use of GVA avoids the effects of variations in the quality of raw materials. The use of gross output would require the inclusion of raw materials which may obscure the role of labour and capital in the estimation of TFP growth.

The growth accounting method implicitly assumes a well behaved neoclassical production function that facilitates the decomposition of the sources of growth. The TFP in the growth accounting method is the residual between the growth in GVA and the weighted sum of the growth of the primary factors of production ie. labour and capital. Thus the TFP corresponds to the growth in GVA due to technological change and exogenous factors. In the equation form this can be written as:

$$\lambda_T = r_G - \alpha r_L - \beta r_K$$

In this equation the λ_T is the TFP. The interpretation of TFP is subject to assumptions like constant returns to scale and technical and allocation efficiency of the primary factors of production ie. capital and labour. Since the factor accumulation ie. the growth in labour and capital, is subject to the diminishing marginal productivity, as per the law of diminishing returns, the growth in value added due to factor accumulation will finally stop and the growth process will become unsustainable in the long run. However, the TFP has the characteristics of increasing returns, which indicates that there is no end to the growth process. Thus TFP growth is the contribution of technical efficiency as well as technological progress. Technical efficiency means the existing strengths of the organization, whereas the technological progress means the shift in the productivity brought about through the induction of improved technology, training of employees, investment in the research and development activities, etc.

Econometric Approach

The econometric estimation of the aggregate production function is an alternative to the growth accounting approach. Due to its simplicity, the most widely used form of econometric approach has been the Cobb-Douglas production function (Felipe 1997). In the Cobb-Douglas production function, the technical change is viewed as a shift in the production function over the elapse of time. The coefficient of the time trend ie. It measures the average rate of TFP growth. Thus, the econometric equation to measure TFP can be written as:

$$\text{Ln } G_t = c + \alpha \text{ Ln}L_t + \beta \text{ Ln}K_t + \lambda t + u_t$$

where G is the gross value added, L is employment, K is capital stock, t is time, c is the intercept and u is the disturbance term. Ln represents the logarithmic values of the variable. From the time series data the input coefficients a and b and the technology coefficient λ are estimated. Coefficient λ is the TFP which measures the average growth rate of GVA holding inputs constant. Depending upon its value, λ has different interpretations. Small λ may mean inefficiency in the implementation or adoption of technological change while a large λ could be due to the impact of economies of scale, efficiency of resource allocation and some external factors.

As per the equation the growth in GVA comprises of two folds – one is due to the increased use of inputs and the second is the change (gain or loss) in productivity. This implies that the growth in GVA may be accompanied by:-

(a) the increase in both factor inputs as well as productivity

(b) or the decrease in factor inputs and increase in productivity

(c) or the increase in factor inputs and decrease in productivity.

Jesus Felipe, while comparing the growth accounting method with the Cobb Douglas Production function, stated that the growth accounting method makes it easy to calculate the changes in total factor productivity growth from year to year, while the econometric estimation provides an average growth rate for the period under consideration (Felipe 1997).

Source of Data

This study is based on the statistics of the Annual Survey of Industries (ASI) for the period of 1973-74 to 2002-03. The ASI is an important survey of the Central Statistical Organisation under the Ministry of Statistics and Programme Implementation, Government of India. ASI statistics pertaining to individual sub-sectors are the aggregates of all the establishments in the respective sub-sector. In the ASI statistics, the manufacturing units are broadly classified as:-

(a) unincorporated enterprises

(b) corporate sector

(c) cooperative societies

(d) khadi and village industries

(e) handloom industries and

(f) others (including N.R.) activities.

Unincorporated enterprises include:-

(i) individual proprietorship

(ii) joint family (HUF) establishments

(iii) and partnership firms.

The corporate sector includes:-

(i) public limited companies

(ii) private limited companies

(iii) government department enterprises and

(iv) public corporations.

Since the khadi and village industries, handloom in-

Table 1: Representation of Different Sub-sectors of Industries in the ASI Statistics (Fig. in %)

Sl. No.	Sub-sector	1973-74	1980-81	1985-86	1990-91	1995-96	2000-01	2001-02	2002-03
1	Individual Proprietorship	18.11	17.89	17.55	18.38	20.15	24.41	24.75	25.59
2	Joint Family HUF	NA	NA	NA	7.36	4.67	2.29	2.41	2.45
3	Partnership	49.85	46.33	53.95	41.33	37.44	36.44	35.38	34.59
4	Un-incorporate Enterprises (1+2+3)	67.95	64.23	71.50	67.07	62.26	63.15	62.54	62.64
5	Public Limited Company	7.58	7.42	7.82	10.44	10.66	11.00	10.77	11.01
6	Private Limited Company	10.84	9.56	14.81	16.28	18.82	22.44	23.52	23.66
7	Govt. Dept. Enterprises	NA	NA	NA	2.12	2.31	0.43	0.33	0.34
8	Public Corporation	1.66	1.87	2.10	1.55	3.87	0.52	0.53	0.44
9	Corporate Sector (5+6+7+8)	20.08	18.85	24.73	30.39	35.66	34.40	35.15	35.45
10	Co-operative Societies	2.18	1.88	1.95	2.12	1.65	1.57	1.59	1.41
11	Khadi & Village, Handloom and Others	9.78	15.04	1.83	0.41	0.43	0.66	0.72	0.50
	Total (All Sectors)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

NA : ASI data prior to 1988-89 is not available.

Source : (a) Annual Survey of Industries, Ministry of Statistics & Programme Implementation, Government of India.
(b) Economic and Political Weekly Research Foundation, Mumbai.

dustries and others (including N.R) activities have relatively low representation in the ASI, they are clubbed together under a common sub-sector ie. khadi & village, handloom and others in this study.

Over the 1973-03 period, the growth of the industrial sector has brought sizeable shifts in the share of different sub-sectors in the ASI coverage. The representation of corporate sector units has increased by 15 per cent from 20 per cent in 1973-74 to 35 per cent in 2002-03, due to which the share of some other sub-sectors has declined considerably (see Table 1). Decline in the representation was highest in case of khadi & village, handloom and others ie. from 10 per cent to less than one per cent, followed by un-incorporated enterprises from 68 per cent to 63 per cent and cooperative societies from 2 per cent to 1 per cent. The un-incorporated sector represents small scale sector in the Indian industry. High representation of the un-incorporated sector in the ASI states that the performance of this sector is critical for the overall growth of the industrial sector in India.

ASI data considered for the present study are the sub-sectorwise number of employees, value of fixed capital and gross value added. Yearly data on capital stock and GVA are available at the current prices and to make the time series data comparable, the nominal the value of fixed capital was deflated by the wholesale price index of machinery and transport equipment and the GVA was deflated by the wholesale price index of manufactured products. Both these variables are measured at the 1993-94 prices.

For analytical purposes the grouping of ASI data from 1973-74 to 2002-03 is done into three sub-periods viz. 1973-83, 1983-93 and 1993-03 so that each sub-period covers the time-span of 10 years. The 1973-83 period may be considered as the pre-liberalisation process period, 1983-93 period as the liberalisation process period and the 1993-03 period as the post-liberalisation period.

Empirical Analysis

The empirical results are discussed in three parts viz:-

Growth of Gross Value Added

Table 2 presents the growth of GVA during different time spans in different sub-sectors. For the aggregated manufacturing sector the GVA increased at an average rate of 7.8 per cent per annum during 1973-83, at 6.8 per cent during 1983-93 and at 2.1 per cent during 1993-03. Apparently during the post-liberalization period, the growth in GVA has recorded a steep fall.

Sub-sector level estimates state that during 1973-83 the average growth in GVA was highest in the public corporations (14.8 per cent) followed by khadi and village, handlooms and others (11.7 per cent), cooperative societies (11.2 per cent), individual proprietorship (7.7 per cent), public limited companies (7.3 per cent), partnership firms (5.0 per cent) and private limited companies (4.9 per cent). For the joint family HUF and

Table 2: Sectorwise Growth Rates of Gross Value Added (% per annum)

Sl. No.	Sector/ Sub-Sector	1973-83	1983-93	1993-03	1983-03	1973-03
1	Individual Proprietorship	7.68	8.14	1.56	9.83	8.95
2	Joint Family HUF	NA	NA	–8.21	NA	NA
3	Partnership	4.98	1.78	2.90	4.54	4.98
4	Unincorporated Enterprises (1+2+3)	6.32	4.47	1.98	5.60	5.98
5	Public Limited Company	7.34	7.92	5.33	7.59	7.08
6	Private Limited Company	4.85	4.46	10.04	6.59	7.18
7	Govt. Dept. Enterprises	NA	NA	–33.21	NA	NA
8	Public Corporation	14.83	7.39	–11.20	2.50	7.15
9	Corporate Sector (5+6+7+8)	7.68	8.56	2.17	6.91	7.40
10	Cooperative Societies	11.17	8.45	0.93	5.55	7.82
11	Khadi &Village, Handloom & others	11.75	–48.78	–1.07	–11.26	–8.70
12	Total (All sectors)	7.80	6.76	2.11	6.22	6.78

NA: ASI data prior to 1988-89 is not available

the government department enterprises the GVA growth for the 1973-83 period could not be estimated due to non-availability of ASI statistics.

Estimates for the 1983-93 period state that the growth in GVA was highest in the cooperative societies (8.5 per cent), followed by individual proprietorship (8.1 per cent), public limited companies (7.9 per cent), public corporations (7.4 per cent), private limited companies (4.5 per cent), partnership firms (1.9 per cent), while it was negative in the khadi & village, handlooms and others (-48.8 per cent). For the joint family, HUF and the government department enterprises, ASI data is not available prior to 1988-89. Therefore, for the 1983-93 period also, the GVA growth could not be calculated for these two sub-sectors.

During the 1993-03 period the growth in the GVA was highest in the private limited companies (10.0 per cent), followed by public limited companies (5.3 per cent), partnership firms (2.9 per cent), individual proprietorship units (1.6 per cent), cooperative societies (0.9 per cent), while the growth was negative in the government department enterprises (-33.2 per cent), public corporations (-11.2 per cent), joint family HUF (-8.2 per cent), and khadi and village, handlooms and others sub sectors (-1.1 per cent). Negative growth in the four out of nine sub- sectors has adversely affected the overall GVA growth in the manufacturing sector during the 1993-03 period.

For the longer duration of time ie. 1973-03 as well as 1983-03, the average growth in GVA was highest in the individual proprietorship units and lowest (negative) in the khadi & village, handlooms and others. Apparently the growth of GVA over the longer period of time was adversely affected by the poor performance of khadi and village, handlooms and others sub-sectors. For the aggregated manufacturing sector the annual growth in GVA was 6.8 per cent during 1973-03 and 6.2 per cent during 1983-03.

An overview of Table 2 reveals that during all the three phases of time, the public limited companies and the private limited companies recorded appreciable growth in the GVA. On the other hand there was steep fall in the growth of GVA in public corporations, cooperative societies and individual proprietorship units.

Sources of GVA Growth

An insightful technique to evaluate the GVA growth is the decomposition of growth rate. Decomposition breaks up the contribution of factor inputs and technical progress. Decomposition of the GVA growth estimated for different sub-sectors and for different periods of time is presented in Tables 3a to 3e. Estimates at the aggregated level show that during the 1973-83 period (Table 3a) the growth in employment contributed 91 per cent to the GVA growth, followed by the contribution of capital stock at 27 per cent, while the contribution of technical progress was negative at – 18 per cent. During the 1983-93 period (Table 3b) the technical progress contributed highest at 66 per cent to the GVA growth, followed by accumulation of capital at 19 per cent and increase in employment at 15 per cent. During the 1993-03 period also the technical progress contributed highest at 133 per cent, followed by the accumulation of capital at 49

Table 3a: Decomposition of the Sources of Gross Value Added Growth During the 1973-83 Period

Sl. No.	Sector / Sub-sector	GVA Growth (% per annum)	Decomposition of the Sources of GVA Growth (% per year)			Contribution to GVA Growth (%)		
			Labour	Capital	Technical Progress	Labour	Capital	Technical Progress
1	Individual Proprietorship	7.68	10.37	1.73	-4.41	134.98	22.51	-57.49
2	Joint Family HUF	NA	NA	NA	NA	NA	NA	NA
3	Partnership	4.98	0.15	1.90	2.94	2.91	38.15	58.94
4	Unincorporated Enterprises (1+2+3)	6.32	8.02	5.29	-6.99	126.97	83.74	-110.70
5	Public Limited Company	7.34	5.11	4.08	-1.86	69.65	55.68	-25.33
6	Private Limited Company	4.85	-0.11	2.48	2.48	-2.19	51.09	51.09
7	Govt. Dept. Enterprises	NA	NA	NA	NA	NA	NA	NA
8	Public Corporation	14.83	1.35	-1.28	14.77	9.09	-8.64	99.55
9	Corporate Sector (5+6+7+8)	7.68	-0.44	4.83	3.29	-5.75	62.96	42.79
10	Co-operative Societies	11.17	-6.15	13.90	3.42	-55.10	124.51	30.59
11	Khadi & Village, Handloom and Others	11.75	8.31	-4.05	7.48	70.77	-34.46	63.69
12	Total (All Sectors)	7.80	7.09	2.11	-1.40	90.95	27.04	-17.99

NA: ASI data prior to 1988-89 is not available.

Table 3b: Decomposition of the Sources of Gross Value Added Growth During the 1983-93 Period

Sl. No.	Sector / Sub-sector	GVA Growth (% per annum)	Decomposition of the Sources of GVA Growth (% per year)			Contribution to GVA Growth (%)		
			Labour	Capital	Technical Progress	Labour	Capital	Technical Progress
1	Individual Proprietorship	8.14	0.84	2.78	4.52	10.32	34.16	55.52
2	Joint Family HUF	NA	NA	NA	NA	NA	NA	NA
3	Partnership	1.78	0.51	-0.87	2.14	28.68	-48.94	120.27
4	Unincorporated Enterprises (1+2+3)	4.47	0.11	0.64	3.72	2.51	14.37	83.12
5	Public Limited Company	7.92	1.80	-2.10	8.22	22.68	-26.54	103.86
6	Private Limited Company	4.46	1.35	1.55	1.56	30.21	34.86	34.94
7	Govt. Dept. Enterprises	NA	NA	NA	NA	NA	NA	NA
8	Public Corporation	7.39	1.13	3.42	2.84	15.32	46.29	38.39
9	Corporate Sector (5+6+7+8)	8.56	1.28	6.97	0.31	14.91	81.48	3.61
10	Co-operative Societies	8.45	8.21	0.77	-0.53	97.19	9.10	-6.29
11	Khadi & Village, Handloom and Others	-48.78	-24.88	-27.69	3.79	-51.01	-56.76	7.77
12	Total (All Sectors)	6.76	1.02	1.27	4.47	15.05	18.79	66.16

NA: ASI data prior to 1988-89 is not available.

per cent while the contribution of employment was negative at -82 per cent (Table 3c).

Disaggregated level results indicated that in the unincorporated sector, the individual proprietorship units experienced employment as the major source of GVA growth during 1973-83 and 1993-03 periods, while the contribution of technology was negative during both the time spans. Further, during the 1983-93 period, the contribution of technology was maximum while the contribution of employment was very low in this sub-sector. For the joint family HUF, the estimates for the 1993-03 period reveal that negative growth in GVA was accompanied by the fall in factor inputs as well as TFP. In the partnership firms the contribution of employment to the growth in GVA was very low. TFP was the major contributor to the GVA growth during the 1973-83 and 1983-93 periods, while capital accumulation contributed

Table 3c: Decomposition of the Sources of Gross Value Added Growth During the 1993-03 Period

Sl. No.	Sector / Sub-sector	GVA Growth (% per annum)	Decomposition of the Sources of GVA Growth (% per year)			Contribution to GVA Growth (%)		
			Labour	Capital	Technical Progress	Labour	Capital	Technical Progress
1	Individual Proprietorship	1.56	5.41	1.34	-5.18	345.77	85.79	-331.56
2	Joint Family HUF	-8.21	-4.40	-2.47	-1.34	-53.61	-30.13	-16.26
3	Partnership	2.90	0.06	5.31	-2.47	2.04	183.26	-85.30
4	Unincorporated Enterprises (1+2+3)	1.98	0.04	2.62	-0.67	1.77	132.14	-33.91
5	Public Limited Company	5.33	-0.77	-0.84	6.93	-14.38	-15.82	130.20
6	Private Limited Company	10.04	-0.38	4.82	5.60	-3.79	48.00	55.79
7	Govt. Dept. Enterprises	-33.21	-18.65	-11.95	-2.61	-56.16	-35.98	-7.86
8	Public Corporation	-11.20	-18.00	-0.29	7.08	-160.68	-2.57	63.25
9	Corporate Sector (5+6+7+8)	2.17	-2.22	1.09	3.30	-102.30	50.33	151.97
10	Co-operative Societies	0.93	-0.33	-1.37	2.63	-35.56	-146.60	282.15
11	Khadi & Village, Handloom and Others	-1.07	-0.77	-0.75	0.44	-71.44	-69.56	41.00
12	Total (All Sectors)	2.11	-1.73	1.04	2.80	-82.16	49.37	132.79

Table 3d: Decomposition of the Sources of Gross Value Added Growth During the 1983-03 Period

Sl. No.	Sector / Sub-sector	GVA Growth (% per annum)	Decomposition of the Sources of GVA Growth (% per year)			Contribution to GVA Growth (%)		
			Labour	Capital	Technical Progress	Labour	Capital	Technical Progress
1	Individual Proprietorship	9.83	4.30	2.52	3.01	43.71	25.68	30.61
2	Joint Family HUF	NA	NA	NA	NA	NA	NA	NA
3	Partnership	4.54	-0.02	2.58	1.98	-0.43	56.77	43.66
4	Unincorporated Enterprises (1+2+3)	5.60	1.48	1.86	2.26	26.45	33.25	40.30
5	Public Limited Company	7.59	1.39	0.22	5.99	18.32	2.87	78.82
6	Private Limited Company	6.59	1.64	4.06	0.89	24.87	61.58	13.55
7	Govt. Dept. Enterprises	NA	NA	NA	NA	NA	NA	NA
8	Public Corporation	2.50	-5.47	0.05	7.92	-219.20	1.87	317.33
9	Corporate Sector (5+6+7+8)	6.91	0.56	4.09	2.26	8.15	59.15	32.70
10	Co-operative Societies	5.55	0.84	0.81	3.90	15.11	14.59	70.30
11	Khadi & Village, Handloom and Others	-11.26	-8.28	-5.12	2.14	-73.56	-45.49	19.05
12	Total (All Sectors)	6.22	0.61	1.69	3.92	9.88	27.12	63.00

NA: ASI data prior to 1988-89 is not available.

maximum during the 1993-03 period. Negative contribution to the GVA growth was attributed by capital accumulation during 1983-93 and by TFP during the 1993-03 period. Overall results for the unincorporated enterprises state that during 1973-03 the growth in GVA was mainly attributed to the increase in employment while technical progress contributed relatively more during the 1983-93 period, and the contribution of capital accumulation was maximum during the 1993-03 period. The contribution of TFP was negative during the 1973-83 and 1993-03 periods in the unincorporated enterprises.

With regard to the corporate sector, the results pertaining to public limited companies tell that during the 1973-83 period, the GVA growth was mainly contributed by the increase in factor inputs while the contribution of TFP was negative, whereas during the 1983-93 and 1993-03 periods the contribution of TFP was maximum. In private limited companies the contribution of employment was negative during the 1973-83 and 1993-03 periods. Although both the capital stock and TFP had highly contributed to the growth of TFP during the 1973-83, 1983-93 and 1993-03 periods, the share of TFP was relatively

Table 3e: Decomposition of the Sources of Gross Value Added Growth during the 1973-03 Period

Sl. No.	Sector / Sub-sector	GVA Growth (% per annum)	Decomposition of the Sources of GVA Growth (% per year)			Contribution to GVA Growth (%)		
			Labour	Capital	Technical Progress	Labour	Capital	Technical Progress
1	Individual Proprietorship	8.95	1.17	2.84	4.94	13.07	31.69	55.24
2	Joint Family HUF	NA	NA	NA	NA	NA	NA	NA
3	Partnership	4.98	0.15	1.90	2.94	2.91	38.15	58.94
4	Unincorporated Enterprises (1+2+3)	5.98	0.64	2.27	3.08	10.72	37.86	51.42
5	Public Limited Company	7.08	0.80	1.78	4.50	11.35	25.07	63.57
6	Private Limited Company	7.18	0.35	4.95	1.88	4.81	68.97	26.22
7	Govt. Dept. Enterprises	NA	NA	NA	NA	NA	NA	NA
8	Public Corporation	7.15	-0.83	-0.67	8.65	-11.60	-9.40	121.01
9	Corporate Sector (5+6+7+8)	7.40	1.21	2.34	3.85	16.31	31.62	52.07
10	Co-operative Societies	7.82	0.82	2.91	4.10	10.42	37.15	52.43
11	Khadi & Village, Handloom and Others	-8.70	-8.68	-3.24	3.22	-99.73	-37.29	37.02
12	Total (All Sectors)	6.78	0.76	3.32	2.71	11.15	48.96	39.89

NA: ASI data prior to 1988-89 is not available.

high during the last two decades. For the government department enterprises, the estimates reveal that during the 1993-03 period the GVA recorded a negative growth and nearly 92 per cent fall in the GVA was brought by the decline in factor inputs ie. labour and capital stock. In the public corporations, the contribution TFP to the GVA growth was maximum during the 1973-83, and 1993-03 periods while in 1983-93 the accumulation of capital stock had relatively higher contribution. During 1993-03 the negative growth in GVA was accompanied by the negative growth in factor inputs while TFP contributed positively in the generation of GVA. Overall results for the aggregated corporate sector show that the accumulation of capital was the major source of GVA growth during the 1973-83 and 1983-93 periods while TFP was the major contributor during the 1993-03 period. Contribution of employment to the GVA growth was negative during the post-liberalization period.

In the cooperative sector the growth in GVA was mainly attributed to accumulation of capital during the 1973-83 period, employment was the major contributor during the 1983-93 period and the rise in TFP contributed maximum during the 1993-03 period. As regards khadi and village and handlooms and others, the growth in GVA during the 1973-83 period was mainly contributed by employment and TFP while the contribution of capital stock was negative. For this sector the estimates reveal that during the 1983-93, 1993-03 periods and also over the longer duration of time ie. 1973-03 and 1983-03, the negative growth in GVA was accompanied by negative contributions of employment and capital stock while TFP contributed positively towards the generation of GVA.

For the aggregated industrial sector the estimates for the 1983-03 period (Table 3d) tell that the contribution of technical progress to the GVA growth was highest at 63 per cent, followed by the accumulation of capital at 27 per cent, while the increase in employment contributed lowest at 10 per cent. Furthermore, the estimates for the entire period under consideration ie. 1973-03 (Table 3e) show that the contribution of capital accumulation to the GVA growth was highest at 49 per cent, followed by technical progress at 40 per cent and increase in employment at 11 per cent. An overview of the estimates reveals that the contribution of each source of growth changes with the change in time span. Overall results show that among the three sources of GVA growth, labour was the major contributor during the 1973-83 period, while technology contributed maximum during the 1983-93 and 1993-03 periods. Thus the industry was employment-driven during the 1973-83 period and technology-driven during the last two decades.

Growth of Total Factor Productivity

TFP measures the effects of technological change and increases in efficiency over the longer period of time. Sub sectorwise estimates of TFP for different time periods are presented in Table 4. In the unincorporated sector, the individual proprietorship units recorded positive

Table 4: Sectorwise Estimates of TFP (Fig. in % per annum)

Sl. No.	Sector /Sub-Sector	1973-83	1983-93	1993-03	1983-03	1973-03
1	Individual Proprietorship	–4.41	4.52	–5.18	3.01	4.94
2	Joint Family HUF	NA	NA	–1.34	NA	NA
3	Partnership	2.94	2.14	–2.47	1.98	2.94
4	Unincorporated Enterprises (1+2+3)	–6.99	3.72	–0.67	2.26	3.08
5	Public Limited Company	–1.86	8.22	6.93	5.99	4.50
6	Private Limited Company	2.48	1.56	5.60	0.89	1.88
7	Govt. Dept. Enterprises	NA	NA	–2.61	NA	NA
8	Public Corporation	14.77	2.84	7.08	7.92	8.65
9	Corporate Sector (5+6+7+8)	3.29	0.31	3.30	2.26	3.85
10	Co–operative Societies	3.42	–0.53	2.63	3.90	4.10
11	Khadi & Village, Handloom and Others	7.48	3.79	0.44	2.14	3.22
12	Total (All sectors)	–1.40	4.47	2.80	3.92	2.71

NA : ASI data prior to 1988-89 is not available

growth in TFP during 1983-93 and negative growth during the 1973-83 and 1993-03 periods. For the joint family HUF sub-sector, the data prior to 1988-89 is not available. Therefore, for this sub sector the growth in TFP was computed for the 1993-03 period, which is negative. In the partnership firms the TFP growth was positive during the 1973-83 and 1983-93 periods and negative during 1993-03. Estimates for the aggregated unincorporated sector state that the growth of TFP was positive during 1983-93 (3.7 per cent) and negative during the 1973-83 (–6.99 per cent) as well as 1993-03 periods (–0.67 per cent).

In the corporate sector, the public limited companies recorded a positive growth in TFP during the 1983-93 and 1993-03 periods and negative growth during the 1973-83 period. Both the private limited companies and the public corporations experienced positive growth in TFP during each of the 1973-83, 1983-93 and 1993-03 periods. For the government department enterprises the data prior to 1988-89 is not available. Therefore, for this sector the growth in TFP was computed for the 1993-03 period, which is negative. The computation of TFP growth for the aggregated corporate sector show positive growth in TFP during each of the 1973-83, 1983-93 and 1993-03 time spans. Moreover, the estimates reveal an increase in the TFP in the corporate sector during the 1993-03 period.

Estimates for the cooperative societies show that this sector has experienced positive growth in TFP during the 1973-83 and 1993-03 periods and negative growth during the 1983-03 period. Cooperative societies is the only sector which recorded negative growth in TFP during the 1983-03 period. As regards the khadi and village, handlooms and others industries, although the growth of TFP was positive during each of the 1973-83, 1983-93 and 1993-03 periods, the rate of growth has declined steeply in the successive phases.

For the overall industrial sector the growth in TFP was negative during the 1973-83 period (-1.4 per cent), while it was positive during the 1983-93 and 1993-03 periods. However, the growth of TFP was relatively higher during 1983-93 (4.5 per cent) compared to the 1993-03 period (2.8 per cent). Thus the study at the aggregated level showed a dismal performance of Indian industry during the 1973-83 and 1993-03 periods. However, the investigation at the disaggregated level clearly states that the performance of the Indian industry was not so gloomy. In fact, the key drivers of the Indian industry viz. public limited companies, private limited companies and public corporations recorded appreciable growth in TFP during the post-liberalization period.

Conclusion

The study reveals that during the post-liberalization period the growth in gross value added slowed down in most of the sub-sectors. For the overall industrial sector the decomposition of long term GVA growth states that after accounting for the contributions of capital and TFP, the contribution of employment to the growth of GVA was insignificant.

Refuting the claims of many studies about the miserable performance of Indian industry during the pre-liberalization process period (1973-83), this study reveals

that negative growth in TFP was recorded only in two sub-sectors viz. individual proprietorship units and the public limited companies. During the post-liberalization period (1993-03), the growth in TFP was negative only in the unincorporated sector and the government department enterprises. In cases of public limited companies, although the growth of TFP was appreciable during both the 1983-93 and 1993-03 periods, there was marginal fall in the TFP during the last post-liberalization period. However, the private limited companies and the public corporations recorded a relatively higher growth in the TFP during the post-liberalization period. Inter-sectoral comparison states that during the post-liberalization period the TFP recorded significant increase in the corporate sector and cooperative societies while in the unincorporated enterprises and khadi and village and handlooms and others, there was a fall in the TFP. The estimates also reveal that the key governors of the Indian industry viz. public limited companies, private limited companies and public corporations recorded significant growth in productivity during the post-liberalization period. These three sub-sectors have a larger share in the capital investment, employment and value added in the Indian industry. Thus it is concluded that the performance of the Indian industry was not as gloomy as projected in many studies.

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Mathematical rigor is like clothing; it its style it ought to suit the occasion and it diminishes comfort and restrain freedom of movement if it is either too loose or too tight.

– G.F. Simmons

Feature

An Evaluation of Technical Efficiency of Indian Capital Goods Industries: A Non-parametric Frontier Approach

Sunil Kumar & Nitin Arora

This paper has endeavored to evaluate the performance of Indian capital goods industries using a non-parametric frontier approach named Data Envelopment Analysis (DEA). The efficiency analysis for 31 capital goods industries in the year 2003-04 disclosed that the extent of technical inefficiency in these industries is to the tune of 29.51 per cent. Only 4 industries with efficiency score equal to unity defined the efficiency frontier, while the remaining 27 industries were found to be operating much below this frontier. A logistic regression analysis shows that efficiency is positively related to the extent of capital deepening, profitability and labour skills.

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In India, the development of capital goods industries has been assigned a prominent place in the strategy for industrialization. The documents of Five Year Plans and Industrial Policy Resolutions/statements extolled the backward and forward linkages of these industries with the rest of the branches of the industrial sector. The second Five Year Plan explicitly emphasized the development of capital goods industries as a catalyst for achieving higher growth in other rivulets of Indian manufacturing sector and achieving self-sufficiency in the production of capital goods. The subsequent Five Year plans, too, envisaged the development of capital goods industries for building a strong industrial base.

It is highly acknowledged in the literature on industrialization and industrial development that the sustainability of the growth of an industry hinges critically on how efficiently the firms in that industry utilize their inputs to achieve a given level of output(s). Though industrial growth always remained high on the agenda of the Indian planners, yet negligible attention has been paid to the measures for improving the efficiency of the industrial sector to achieve gains in productivity and competitiveness. The awareness towards efficient use of existing resources through appropriate adjustment of policy variables is sadly lacking in India [Neogi and Ghosh, 1993]. In this context, Patel (1992) remarked, "*...to increase the supply of factors of production and reduce the constraints on growth and out of excessive zeal for distributional justice, we have often overlooked the importance of efficient use of existing resources*".

The empirical literature on the efficiency of Indian industries is not voluminous. Existing studies on the efficiency of the Indian industrial sector can be broadly classified into two groups. The first group includes those studies that applied the non-parametric frontier technique

named Data Envelopment Analysis (DEA) for computing technical efficiency scores. The studies of Majumdar (1998), Ray (2004), Mukherjee and Ray (2005), Singh (2006), and Kumar (2006) belong to this category. The second group contains those studies in which the parametric frontier technique, named Stochastic Frontier Analysis (SFA), has been applied for obtaining the measures of technical efficiency. Some of the notable contributions to this group are Neogi and Ghosh (1993), Ferrantino and Ferrier (1995), Aggarwal (2001), Kumar (2001), Parmeswarn (2002), and Goldar, Renganathan, and Banga (2004). The existing studies concentrate either on evaluating the efficiency of a single industry or different industrial groups. To the best of our knowledge, no attempt has been made till date to evaluate the relative efficiency of Indian capital goods industries. The present study is an endeavor in this direction.

The main objective of the present study is to analyze the extent of technical (in)efficiency in 31 capital goods industries by using the technique of Data Envelopment Analysis (DEA). The choice of DEA in the present context is primarily governed by the fact that DEA does not need any stringent data requirement, which suits a small sample study like this. In addition, it doesn't require any *a priori* specification of the production function. Besides providing technical efficiency scores, DEA provides targets for input and output variables that can be utilized to work out potential savings in inputs and addition in output(s).

Concept of Technical Efficiency: A Theoretical Exposition

The theoretical consideration of technical efficiency has existed in economic literature since Koopmans (1951) who defined technical efficiency as a feasible input/output vector where it is technologically impossible to increase any output (and/or reduce any input) without simultaneously reducing another output (and/or increasing any other input). Debreu (1951) and later Farrell (1957) developed input-based indices of technical efficiency measured as the maximum equiproportional reduction in all inputs consistent with equivalent production of the observed output. According to Farrell (1957), the economic (cost) efficiency of a firm consists of two components: *technical efficiency*, which reflects the ability of a firm to obtain the maximal output from a given set of inputs and *allocative efficiency*, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices.

To be precise, the concept of technical efficiency refers to the producer's ability to avoid the waste of the resources by producing as much output as input usage allows, or by using as little input as output production allows. Simply, technical efficiency is a measure of how well the inputs are converted into output(s) by the production process (Avkiran, 2006). Sherman (1988) defines technical efficiency as 'the ability to produce the outputs or services with a minimum level of resources required'.

In order to measure technical efficiency as defined above it is first necessary to define the production frontier. A production frontier is defined in terms of the maximum output that can be achieved from a set of inputs and given the technology available to the firm. Underlying the frontier approach is the assumption that if a firm is operating at the point inside the frontier then it is technologically inefficient (Coelli *et al.*, 1998). Once the frontier has been defined the position of any firm relative to the frontier can be gauged and interpreted as a measure of relative (in)efficiency. A starting point for examining the basic notion of measurement of technical efficiency is shown in Figure 1, which illustrates the case for just one input and one output. The line *OC* indicates the simplest of all technologies: no fixed costs and constant returns to scale. A technically efficient firm would then produce somewhere on this line, which can be thought of as the production possibility frontier. Any element of inefficiency would result in a firm lying strictly below the line *OC*. If a firm, say firm *B*, produces at output level Y_0 with a given level of input X_0 then the firm is said to be technically inefficient due to inefficient use of resources with given technology, resulting in the loss of output given by $OY_0^* - OY_0$ where Y_0 is the observed (actual) output of the firm and Y_0^* is the potential output given by the maximum output attainable if the firm operates efficiently. Technical efficiency is, therefore, measured by the ratio of actual output to the potential output:

Technical Efficiency(TE) =

Actual Output / Potential Output = OY_0 / OY_0^*

The value of TE measure lies between zero and one. A value of TE equal to one would mean that the firm is technically efficient and is operating on the production frontier. Many other technologies are possible, e.g. the curve *OV* indicates a frontier with variable returns to scale. Up to the point *A*, the ratio of output to input decreases (increasing returns to scale) and thereafter it increases (decreasing returns to scale).

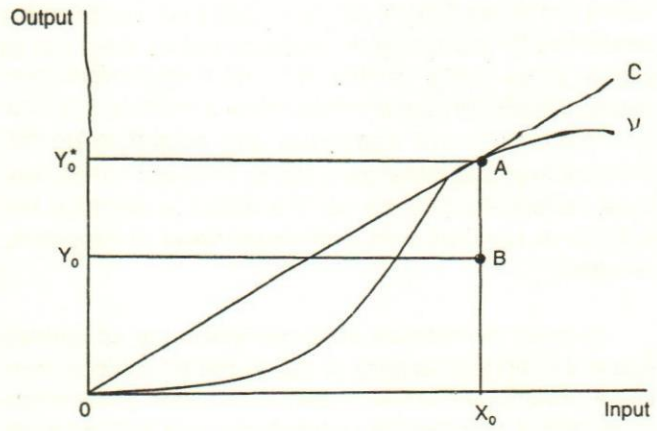

Fig. 1. Efficiency measurement under constant returns to scale

Approaches to Measure Technical Efficiency

The contemporary literature on technical efficiency measurement spells out into two major categories of methodologies: Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA). The stochastic production frontier models were introduced by Aigner, Lovell, and Schimidt (1977) and Meeusen and Van den Broeck (1977) simultaneously, motivated by the idea that deviation from the production frontier may not be completely under the control of producers. They account for technical inefficiency, measurement error and random shocks outside the control of producers to affect output such as weather, as well as the combined effects of unspecified input variables in the production function.

The former uses statistical methods and the latter mathematical programming to estimate the *efficiency frontier* and to obtain efficiency scores. The SFA requires the specification of a functional form for the production frontier. It also requires assumptions about the probability distribution describing the error term of the model. In this approach, inefficiency is assumed to have asymmetrical distribution, usually a half normal distribution and random error is expected to have standard symmetrical distribution. The primary advantage of the SFA is that the firms are allowed to deviate from the production frontier due to the random error (noise) as well as inefficiency, whereas DEA measures all departures from the production frontier as inefficiency. Thus, SFA deals with the problem that not all deviations from criteria are due to a lack of efficiency. They may also occur as a result of misfortune (fortune) or measurement errors.

The idea of technical efficiency measurement in SFA and DEA can be well illustrated with the help of Figure 2 in which the dots represent observed input and output combinations for six firms. The two sets of lines (the solid curved line and the dotted line made up of lots of straight segments) are *efficiency frontiers* and show the maximum output that could be produced for each level of input. SFA utilizes statistical methods to fit an *efficiency frontier* like the solid curve in Figure 2. The idea is to identify the relationship between output and input(s) whilst allowing for two types of deviation from this relationship. One is statistical 'noise'- in other words, random variations in the data caused by inaccuracy in the measurement of output and by other errors. This first type of deviation is assumed to be zero on average, so that, on average, output is measured accurately. The second type of deviation is a measure of inefficiency. It is one-sided: if a firm is fully efficient, it would be zero, and the more inefficient the firm is, the more negative the deviation. These two types of deviation from the *efficiency frontier* are shown in the figure by the curly brackets for firms D and E. In this case, firms B and E are classed as efficient as they lie above the frontier and firms A, C, D and F are inefficient to some degree. The extent to which a firm's total deviation from the frontier is designated to be noise versus inefficiency depends on the choices made about the joint distributions of the two components.

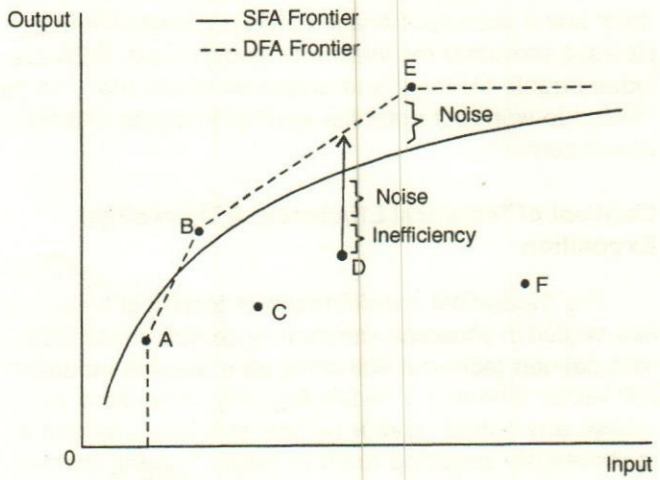

Fig. 2. Measurement of Technical Efficiency in DEA and SFA

Data envelopment analysis is a non-statistical approach to the problem of efficiency measurement. DEA floats a piecewise linear surface to the rest *on top* of the observations (Seiford and Thrall, 1990). Put simply, it takes data on firms' outputs and inputs, and measures the efficiency of a particular firm by its distance from the 'outer envelope' of the data. This outer envelope is shown in Figure 2 by the dashed line. With this technique, all deviations from the *efficiency frontier* are classed entirely as inefficiency. In the figure, the solid arrow represents a measure of firm D's inefficiency. Firms A, B and E are

measured as efficient and firms C, D, and F as inefficient. It is worth noting that this procedure can designate a firm as completely efficient simply because it produces more of a particular output than other firms.

Both SFA and DEA have their distinct advantages and disadvantages. The SFA has the advantage that it is a statistical approach and formal hypothesis tests can, therefore, be performed. However, SFA requires a functional form and needs assumptions about the distribution of the 'random' errors and the efficiencies. The disadvantage of the SFA approach is that efficiency estimates can be confounded by specification error if the wrong assumptions are made about the functional form and error term distribution (Lovell *et al.*, 1993; Bauer, 1990). Infact, SFA requires a great deal of knowledge, both about the shape of the frontier and the distributions of the two types of deviation, if it is to yield a useful answer. The choice that is made about the shape of the frontier and the distributions of the deviation components can have significant effects on the efficiency rankings and absolute efficiency measures generated. These choices can be pretty much arbitrary: Economic theory often provides little information about the shape of the frontier, and the data can be uninformative about the distributions of the two types of deviation. Failing to measure the inputs accurately can further complicate the task of correctly identifying firms' relative efficiency. In contrast to SFA, DEA places no restrictions on the functional form of the frontier and it does not impose any (explicit) distributional assumption on the firm specific efficiency. DEA can accommodate multiple outputs and inputs but is extremely sensitive to variable selection and errors. In DEA, the efficiency of a firm is measured relative to all other firms with the simple restriction that all firms lie on or below the *efficiency frontier*. DEA has excellent asymptotic statistical properties. DEA is equivalent to the maximum likelihood estimation, with the specification of the production frontier in DEA as a nonparametric monotone and concave function instead of a parametric form linear in parameters (Banker, 1993). DEA estimators also are consistent and converge faster than the estimators from other frontier methods (Grosskopf, 1996).

Methodological Framework: The CCR Model

In their seminal paper, Charnes, Cooper and Rhodes(1978) developed a 'data oriented' method based on linear programming technique and coined it as Data Envelopment Analysis (DEA) for estimating the relative technical efficiency of a set of peer entities called decision making units (DMUs) Throughout this paper and consistent with DEA terminology, the term 'decision making unit' or 'DMU' will refer to the individuals in the evaluation group. In the context of present application, it will refer specifically to capital goods industries.

DEA floats a piecewise linear surface to the rest *on top* of the observations (Seiford and Thrall, 1990). The DMUs that lie on the frontier are the best practice institutions and retain a value of one. Those DMUs enveloped by the extremal surface are scaled against a convex combination of the DMUs on the frontier facet closest to it and have values somewhere between 0 and 1. Several different mathematical programming DEA models have been proposed in the literature (see Charnes *et al.*, 1994). Essentially, these DEA models seek to establish which of *n* DMUs determine the envelopment surface, or *efficiency frontier*. The geometry of this surface is prescribed by the specific DEA model employed. In the present study we use the input-oriented CCR model named after Charnes, Cooper and Rhodes (1978), to get a scalar measure of technical efficiency[1].

To illustrate input-oriented CCR model, consider a set of decision making units (DMUs), $j = 1,2,..., n$, utilizing quantities of inputs $X \in R_+^m$ to produce quantities of outputs $Y \in R_+^s$. We can denote x_{ij} the amount of the ith input used by the jth DMU and y_{rj} the amount of the rth output produced by the jth DMU. Assuming constant returns to scale (CRS), strong disposability of inputs and outputs and convexity of the production possibility set, the technical efficiency score of the DMU k (h_k) can be obtained by solving following model (Charnes *et al.*, 1978):

$$\left.\begin{aligned} &\max \quad h_k = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}} \\ &\text{subject to:} \\ &\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1 \qquad j = 1,2,...,n \\ &u_r,\ v_i \ge \varepsilon \qquad r = 1,2,...,s;\ \ i = 1,2,...,m \end{aligned}\right\} \quad (1)$$

1 Given the small sample size in the present study, CCR model provides better discrimination than any other DEA model especially BCC model, named after Banker, Charnes and Cooper (1984). In the CCR-model, it is assumed that constant returns to scale (CRS) prevails in the industry.

where: y_{rk} = the amount of the *rth* output produced by the DMU *k*;

x_{ik} = the amount of the ith input used by the DMU *k*;

u_r = the weight given to output r;

v_i = the weight given to input i;

n = the number of DMUs;

s = the number of outputs;

m = the number of inputs;

ε = a non-Archimedean (infinitesimal) constant.

In the above model, the objective function defined by the h_k aims to maximize the ratio of weighted outputs to weighted inputs of the DMU *k* subject to the constraints that i) the efficiency ratios for all DMUs cannot exceed one by using the same weights, and ii)the weights are positive and unknown. The justification for ε is twofold: first, to ensure that the denominator is never zero and second to ensure that each input (output) is considered. It is important to note that the output and input weights (i.e.,u_r and v_i) are obtained through optimization (i.e., linear programming solution). Such optimization is performed separately for each DMU in order to compute the weights and technical efficiency scores.

The DEA model (1) is a fractional program but may be converted into linear program (LP) by restricting the denominator of the objective function h_k to unity, and adding this as a constraint to the problem. The linear programming version of fractional setting is shown in Model (2):

$$\left.\begin{aligned} &\max\ h_k = \sum_{r=1}^{s} u_r y_{rk} \\ &\text{subject to:} \\ &\sum_{i=1}^{m} v_i x_{ik} = 1, \\ &\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0 \quad j = 1,2,\ldots,n \\ &u_r,\ v_i \ge \varepsilon \qquad\qquad r = 1,2,\ldots,s; \\ &\qquad\qquad\qquad\qquad i = 1,2,\ldots,m \end{aligned}\right\} \quad (2)$$

One possible solution to the linear programming (the primal) in Model (2) is to formulate a dual companion. By denoting the input weights of DMU *k* by θ_k and the input and output weights of other DMUs in the sample by λj, the dual form of the maximizing problem is formalized as follows:

$$\left.\begin{aligned} &\min\ \theta_k - \varepsilon\left(\sum_{r=1}^{s} s_r^+ + \sum_{i=1}^{m} s_i^-\right) \\ &\text{subject to:} \\ &\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta_k\, x_{ik} \qquad i = 1,2,\ldots,m; \\ &\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{rk} \qquad r = 1,2,\ldots,s; \\ &\theta_k \text{ free},\ \lambda_j \ge 0, \qquad j = 1,2,\ldots,n. \\ &s_r^+, s_i^- \ge 0 \\ &0 < \varepsilon \le 1 \end{aligned}\right\} \quad (3)$$

The primal model has $n + s + m + 1$ constraints while the dual has $m + s$ constraints. The number of DMUs(n) should usually be considered larger than the number of inputs and outputs ($s + m$) in order to provide a fair degree of discrimination of results. In view of this, it is clear that dual model [Model (3)] will be simpler to solve as it has $n + 1$ fewer constraints than the primal [Model (2)]. It should be noted that both the primal (popularly known as *Weights'* or *Multiplier* form) and dual (popularly known as *Envelopment* form) problems have the same solutions. The presence of the non-Archimedean ε in the objective function of Model (3) effectively allows the minimization over θ_k to preempt the optimization involving the slacks, s_i^- and s_r^+. In the present study, we solved Model (3) to obtain technical efficiency scores for 31 capital goods industries.

Database and Specification of Inputs and Outputs

The required data have been culled out from the 'Summary Results of Annual Survey of Industries (ASI)' for the year 2003-04. Till date, this is the most recent year for which data are available with Central Statistical Organization (CSO), New Delhi. Our analysis is confined to 31 major capital goods industries classified on the basis of National Industries Classification (NIC) at 4 digit level of disaggregation. In the present study, one output (gross value added) and three inputs (gross fixed capital; production workers; and non-production workers) have been

considered for evaluating the performance of 31 capital goods industries. The data for gross value added and gross fixed capital have been obtained from the table entitled 'Capitals Employed, Input, Output and GVA at Industry (NIC-4 Digit) by All India'. To obtain gross value added figures, we added the figures of depreciation to net value added. As per the practice of CSO, the figure of net value added is arrived by deducting total input and depreciation from total output. However, the figures of fixed capital as given in ASI represent the depreciated value of fixed assets owned by the factory as on the closing day of the accounting year. Fixed assets are those that have a normal productive life of more than one year. Fixed capital includes land including lease-hold land, buildings, plant and machinery, furniture and fixtures, transport equipment, water system and roadways and other fixed assets such as hospitals, schools etc. used for the benefit of factory personnel. To obtain gross fixed capital the depreciation charges are added to net fixed capital. The depreciation is defined by ASI as the consumption of fixed capital due to wear and tear and obsolescence during the accounting year and is taken as provided by the factory owner or is estimated on the basis of cost of installation and working life of the fixed asset. Following Goldar (1986) and Jayadevan (1995), we preferred the use of gross value added over net value added because depreciation charges in Indian industries are known to be highly arbitrary fixed by income tax authorities and seldom represent true/actual capital consumption. However, the data for production workers and non-production workers have been obtained from the table entitled 'Employment and Emoluments at Industry (NIC-4 Digit) by All India'. As per the definition provided by ASI, the production workers relates to all persons employed directly or through only agency whether for wages or not and engaged in any manufacturing process or in cleaning any part of the machinery or premises used for manufacturing process are lying under the production workers. However, persons holding the positions of supervisor, or management or employed in administrative office, store keeping section and welfare section, engaged in the purchase of raw material, etc. are included in the non-production workers. To reduce the variations among the different industrial groups, the figures of input and output variables have been divided by the number of factories in each industrial group. Thus, our analysis provides the efficiency of a representative firm in the capital goods industry. This treatment of inputs and output variables is in the lines suggested by Mukherjee and Ray (2005) and Kumar (2006).

Results and Discussion

It is significant to note that an input oriented DEA model provides the answer to the question: "*How much input quantities can be proportionally reduced without changing the output quantities produced*?" Table 1 presents the technical efficiency scores for 31 capital goods industries, using DEA model (3). Table 2 provides descriptive statistics of efficiency scores. The results indicate a presence of marked deviations of the industries from the *efficiency frontier*. The average of technical efficiency scores turned out to be 0.705 for 31 capital goods industries included in the sample which means that the overall level of technical inefficiency in capital goods industrial sector is to the tune of 29.5 percent. This suggest that by adopting the best practices, capital goods industries can, on an average, reduce their inputs of gross fixed capital, production and non-production workers by at least 29.5 percent. However, the potential reduction in inputs by adopting the best practices varies from industry to industry. Alternatively, capital goods industries have the scope of producing 1.418 times (i.e. 1/0.705) as much outputs from the same inputs.

Of the 31 capital goods industries, four industries have been identified as 'relatively efficient' with technical efficiency score equal to one and thus, defined 'efficiency' or 'best practice' frontier. These industries are 'Manufacturing of steam generators, except control heating hot water boilers (NIC code 2813)', 'Manufacturing of office accounting and computing machinery (NIC code 3000)', 'Manufacturing of electric motors, generators and transformer (NIC code 3110)', and 'Manufacturing of industrial process control equipments (NIC code 3313)'. For these industries, the resource utilization process is functioning well. These industries can set an example of good operating practices for inefficient industries to emulate. The remaining 27 industries have found to be 'relatively inefficient' with efficiency score less than unity. The inefficient industries can improve their efficiency either by decreasing inputs or increasing output. For example, the efficiency score of 'Manufacturing of structural metal products (NIC code 2811)' is 0.577. It can be inferred that this industry has attained 57.7 percent level of the operating efficiency. That is to say, this industry reaches only 57.7 percent of the level of output of the efficient industries with the same level of inputs. Technical efficiency score among the inefficient industries ranges from 0.372 for 'Manufacturing of weapons and ammunitions (NIC code 2927)' to 0.989 for 'Manufacturing of lifting and handling equipments (NIC code 2915)'. Thus, inefficiency levels range from 1.10 percent to 62.80 percent among capital goods industries. On the whole, the results provide that only 13 percent of capital goods industries are forming best practice frontier and thus, are globally technically efficient. Alternatively, 87 percent of capital goods industries are operating away from the *best practice fron-*

Table 1: Technical Efficiency Scores, Super Efficiency Scores and Ranks of the Indian Capital Goods Industries.

(1)	(2)	(3)	(4)	(5)	(6)
NIC 4-Digit Code	Industry Description	Technical Efficiency Scores	Technical Inefficiency (Percentage)*	Super-Efficiency Scores	Ranks
2811	Manufacturing of structural metal products	0.577	42.30	0.577	22
2812	Manufacturing of tanks and reservoirs and containers of metal	0.390	61.00	0.390	30
2813	Manufacturing of steam generators, except control heating hot water boilers	1.000	00.00	1.465	02
2891	Forging, pressing, stamping and rolling of metal	0.791	20.90	0.791	11
2892	Treatment of coating of metal	0.583	41.70	0.583	20
2893	Manufacturing of cutlery, hand tools and general hardware	0.568	43.20	0.568	23
2899	Manufacturing of other fabricated metal products	0.513	48.70	0.513	27
2911	Manufacturing of engines and turbines, except aircraft, vehicles and cycles	0.965	03.50	0.965	06
2912	Manufacturing of pumps, taps, compressors and valves	0.711	28.90	0.711	15
2914	Manufacturing of ovens, furnaces and furnaces burners	0.802	19.80	0.802	10
2915	Manufacturing of lifting and handling equipments	0.989	01.10	0.989	5
2919	Manufacturing of general purpose machinery	0.555	44.50	0.555	25
2921	Manufacturing of agriculture and forestry machinery	0.639	36.10	0.639	17
2922	Manufacturing of machine tools	0.537	46.30	0.537	26
2923	Manufacturing of machinery for metallurgy	0.615	38.50	0.615	18
2924	Manufacturing of machinery for mining quarrying and construction	0.837	16.30	0.837	9
2925	Manufacturing of machinery for food, beverages and tobacco processing	0.562	43.80	0.562	24
2926	Manufacturing of machinery for textile, apparel and leather products	0.582	41.80	0.582	21
2927	Manufacturing of weapons and ammunitions	0.372	62.80	0.372	31
2929	Manufacturing of other special purpose machinery	0.723	27.70	0.723	14
3000	Manufacturing of office accounting and computing machinery	1.000	00.00	1.819	1
3110	Manufacturing of electric motors, generators and transformers	1.000	00.00	1.101	3
3120	Manufacturing of electric distribution and control apparatus	0.784	21.60	0.784	12
3130	Manufacturing of insulated wires and cables	0.419	58.10	0.419	29
3140	Manufacturing of accumulators, primary cells and primary batteries	0.749	25.10	0.749	13
3311	Manufacturing of medical and surgical equipments	0.890	11.00	0.890	8
3312	Manufacturing of instruments and appliances for measuring, checking, testing, navigating some other purpose except industrial process	0.614	38.60	0.614	19
3313	Manufacturing of industrial process control equipments	1.000	00.00	1.026	4
3511	Building and repairing of ships	0.496	50.40	0.496	28
3520	Manufacturing of railway and tramway	0.690	31.00	0.690	16
3530	Manufacturing of aircraft and spacecraft	0.899	10.10	0.899	7
Average		0.705	29.51	0.750	

Notes: * Technical Inefficiency= (1-Efficiency Score) × 100

Source: Authors' Calculations

tier and thus, are technically inefficient in the process of input utilization.

In CCR model, it is only possible to provide strict ranking to the inefficient DMUs by means of their efficiency scores because it does not allow ranking of the efficient units themselves. The efficient DMUs have the same efficiency scores equal to one in the CCR model. Thus, it is impossible to rank and differentiate the efficient DMUs with efficiency scores obtained from the CCR model. However, the ability to rank and differentiate the efficient DMUs is of both theoretical and practical importance. To overcome this weakness, Andersen and Petersen (1993) developed the Superefficiency DEA model. In the present study, we also utilized Andersen and Petersen's Superefficiency model to differentiate and rank efficient capital goods industries. The model proposed by Andersen and Petersen (1993) is identical to the CCR model, except that the unit under evaluation is not included in the reference set. Specifically, rather than evaluating each DMU in turn with a linear combination of all units in the sample (including the DMU in question), the DMU is evaluated against a linear combination of all other units, i.e., the DMU itself is excluded from the reference set. As Andersen and Petersen (1993) argue in respect of input oriented DEA: "*It is conceivable that an efficient DMU may increase its input vector proportionally while preserving efficiency. The unit obtains in that case an efficiency score above one. The score reflects the radial distance from the DMU under evaluation to the production frontier estimated with that DMU excluded from the sample, i.e., the maximum proportional increase in inputs preserving efficiency*". The Andersen and Petersen superefficiency DEA model can be outlined as below:

$$\min \quad \theta_k - \varepsilon\left(\sum_{r=1}^{s} s_r^+ + \sum_{i=1}^{m} s_i^-\right)$$

subject to:

$$\left.\begin{aligned}
&\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta_k\, x_{ik} \qquad i = 1,2,\ldots,m;\\
&\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{rk} \qquad r = 1,2,\ldots,s;\\
&\theta_k \text{ free}, \ \lambda_j \geq 0, \qquad j = 1,2,\ldots,n.\\
&s_r^+, s_i^- \geq 0\\
&0 < \varepsilon \leq 1
\end{aligned}\right\} \quad (3)$$

The results of Andersen and Petersen's *super efficiency* scores provide that the 'Manufacturing of office accounting and computing machinery industry (NIC code 3000)' with super efficiency score equal to 1.819 is the most efficient capital goods industry which scored over the other 30 industries (see column 5 of Table 1). The industry 'Manufacturing of steam generators except the central heating hot water boilers (NIC code 2813)' attained the second place in terms of technical efficiency with super efficiency score of 1.465. The industries 'Manufacturing of electric motors, generators and transformers (NIC code 3110)' and 'Manufacturing of industrial process control equipments (NIC code 3313)' ranked at the third and fourth place in the list of the capital goods industries with the super efficiency scores equal to 1.101 and 1.026, respectively.

Besides discriminating the efficient industries, we also made an attempt to separate out the 27 inefficient industries. For this, we utilized the values of first quartile, median and third quartile of technical efficiency scores (as given in Table 2) as three cut-off points to segregate the inefficient industries into four distinct categories as given below.

Table 2: Descriptive Statistics for Technical Efficiency Scores

Statistics	All Industries	Efficient Industries	Inefficient Industries
Number of Industries	31	4	27
Mean	0.705	1.000	0.661
Standard deviation	0.195	0	0.169
Q_1	0.562	1.000	0.555
Median	0.690	1.000	0.615
Q_3	0.890	1.000	0.791
Minimum Value	0.372	1.000	0.372
Maximum Value	1.000	1.000	0.989

Source: Authors' Calculations

Category I (Below First Quartile)

In this category, those industries have been included which attained the efficiency score below the first quartile value. The candidates of this group are the worst performer in the sample. The industries in this category are (i) 'Manufacturing of weapons and ammunitions (NIC code 2927)', (ii) 'Manufacturing of tanks and reservoirs and containers of metal (NIC code 2812)', (iii) 'Manufacturing of insulated wires and cables (NIC code 3130)', (iv) 'Building and repairing of ships (NIC code 3511)', (v) 'Manufacturing of other fabricated metal products (NIC code 2899)', (vi) 'Manufacturing of machine tools (NIC code 2922)', and (vii) 'Manufacturing of other general purpose

machinery (NIC code 2919)'. These industries lack vitality in terms of the efficiency of resource utilization and are distinctly inefficient.

Category II (Below Median)

This category includes those industries which have attained a technical efficiency score less than median score but greater than first quartile value. The members of this category are (i) 'Manufacturing of machinery for food, beverages, and tobacco processing (NIC code 2925)', (ii) 'Manufacturing of cutlery, hand tools, and general hardware (NIC code 2893)', (iii) 'Manufacturing of structural metal products (NIC code 2811)', (iv) 'Manufacturing of machinery for textile, apparel, and leather production (NIC code 2926)', (v) 'Treatment and coating of metal (NIC code 2892)', (vi) 'Manufacturing of instruments and appliances for measuring, checking, testing, navigating some other purpose except industrial process (NIC code 3312)', (vii) 'Manufacturing of machinery for metallurgy (NIC code 2923)', and (viii) 'Manufacturing of agriculture and forestry machinery (NIC code 2921)'.

Category III (Above Median)

The industries in this category obtained a technical efficiency score above the median score but lesser than the third quartile value. In most of the cases, the performance of the industries included in this category has been observed to be above average. The affiliates of this category are (i) 'Manufacturing of railway and tramway, (NIC code 3520)', (ii) 'Manufacturing of pumps, taps, compressors and valves (NIC code 2912)', (iii) 'Manufacturing of other special purpose machinery (NIC code 2929)', (iv) 'Manufacturing of accumulators, primary cells, and primary batteries (NIC code 3140)', (v) 'Manufacturing of electricity distribution and control apparatus (NIC code 3120)', (vi) 'Forging, pressing, stamping and rolling of metal (NIC code 2891)', (vii) 'Manufacturing of ovens, furnaces, and furnaces burners (NIC code 2914)', and (viii) 'Manufacturing of machinery for mining quarrying and construction (NIC code 2924)'.

Category IV (Above Third Quartile)

Those industries that have achieved the efficiency score above the value of third quartile are included in this category. It is worth mentioning here that these industries are operating at a high level of operating efficiency and are marginally inefficient. These industries can attain the status of efficient industries by bringing little improvement in the resource utilization process. Although these industries are not fully technically efficient yet these industries are the prospective candidates for the status of global leaders in the capital goods industry because of their vitality in the terms of efficiency of inputs utilization. The constituent of this category are (i) 'Manufacturing of medical and surgical equipments (NIC code 3311)', (ii) 'Manufacturing of aircraft and space craft (NIC code 3530)', (iii) 'Manufacturing of engine and turbines, except aircraft, vehicles and cycles (NIC code 2911)', and (iv) 'Manufacturing of lifting and handling equipments (NIC code 2915)'.

Target Setting for Inefficient Industries

Each of the 27 inefficient industries can become overall efficient by adjusting their operations to the associated target point determined by the efficient industries that define their *reference frontier*. The DEA produces diagnostic information about the sources of inefficiency for each industry with respect to the variables included in the calculations. The efficiency scores and the optimal slack values provide the target points on the *efficiency frontier* that the inefficient industries can reach by adjusting its input and output levels. The target point (x^*, y^*) is defined by the following formulae:

$$x_{ik}^* = \theta_k^* x_{ik} - s_i^{-*} \qquad i = 1,2,...,m$$

$$y_{rk}^* = y_{rk} + s_r^{+*} \qquad r = 12,,...,s$$

Where x_{ik}^* = the target input i for industry k, y_{rk}^* = target output r for industry k; x_{ik} = actual input i for industry k; y_{rk} = actual output r for industry k; θ_k^* = efficiency score of industry k; s_i^{-*} = optimal input slacks; and s_r^{+*} =optimal output slacks. Input slack(s) indicates the need for further reductions in corresponding input(s). Output slack(s) signals any additional output(s), which could be produced by the efficient levels of inputs. The difference between the observed value and target value of inputs $(x_{ik} - x_{ik}^*)$ represents the quantity of inputs to be reduced, while the difference between the target values and observed values of outputs $(y_{rk}^* - y_{rk})$ represents the amount of outputs to be increased, to move the inefficient industry on to the *efficiency frontier*.

Tables 3 and 4 present the target values of input and output variables for inefficient industries along with percentage addition in output and saving in inputs. This shows those areas of improvement in input-output activity needed to put them on the *efficiency frontier*. It can be observed that on average, approximately 29.10 percent of gross fixed capital, 46.96 percent of production workers and 30.40 percent of non-production workers could be

Table 3: Targets of Input Variables and their Potential Savings

NIC 4-Digit Code	Industry Description	Targets of Input variables*			Potential Input Savings (Percentage)		
		X_1	X_2	X_3	X_1	X_2	X_3
2811	Manufacturing of structural metal products	46.9	10.2	5.8	42.29	63.18	42.29
2812	Manufacturing of tanks and reservoirs and containers of metal	36.9	5.0	2.8	60.96	77.95	60.96
2891	Forging, pressing, stamping and rolling of metal	289.3	18.0	11.6	20.94	59.42	20.94
2892	Treatment of coating of metal	22.9	5.0	2.8	41.68	64.32	41.68
2893	Manufacturing of cutlery, hand tools and general hardware	39.6	7.6	4.0	43.21	65.15	43.21
2899	Manufacturing of other fabricated metal products	43.4	7.0	3.8	48.72	75.23	48.72
2911	Manufacturing of engines and turbines, except aircraft, vehicles and cycles	262.0	34.7	23.0	3.51	3.51	3.51
2912	Manufacturing of pumps, taps, compressors and valves	100.2	21.7	12.2	28.93	36.56	28.93
2914	Manufacturing of ovens, furnaces and furnaces burners	82.0	15.3	10.8	19.75	19.75	28.28
2915	Manufacturing of lifting and handling equipments	155.4	30.4	18.2	1.06	1.06	1.06
2919	Manufacturing of general purpose machinery	71.3	14.2	9.6	44.47	44.47	44.47
2921	Manufacturing of agriculture and forestry machinery	167.6	14.1	8.5	36.06	56.87	36.06
2922	Manufacturing of machine tools	46.8	10.5	6.2	46.28	46.28	46.28
2923	Manufacturing of machinery for metallurgy	102.0	13.4	7.5	38.55	38.71	38.55
2924	Manufacturing of machinery for mining quarrying and construction	249.5	30.5	17.2	16.29	28.80	16.29
2925	Manufacturing of machinery for food, beverages and tobacco processing	53.0	12.1	6.9	43.80	54.92	43.80
2926	Manufacturing of machinery for textile, apparel and leather products	77.7	11.0	6.1	41.80	54.12	41.80
2927	Manufacturing of weapons and ammunitions	25.5	8.0	5.1	62.79	74.07	66.26
2929	Manufacturing of other special purpose machinery	94.1	16.4	10.1	27.75	27.75	27.75
3120	Manufacturing of electric distribution and control apparatus	103.8	24.7	14.4	21.55	35.33	21.55
3130	Manufacturing of insulated wires and cables	199.6	8.8	6.3	58.13	76.48	58.13
3140	Manufacturing of accumulators, primary cells and primary batteries	401.5	31.6	19.3	25.07	43.59	25.07
3311	Manufacturing of medical and surgical equipments	295.4	38.1	21.3	11.03	11.03	11.03
3312	Manufacturing of instruments and appliances for measuring, checking, testing, navigating some other purpose except industrial process	87.3	20.6	12.0	38.64	43.68	38.64
3511	Building and repairing of ships	164.2	31.3	16.6	50.42	76.04	50.42
3520	Manufacturing of railway and tramway	113.2	26.4	15.3	30.96	53.68	30.96
3530	Manufacturing of aircraft and spacecraft	642.7	57.3	36.9	10.09	10.09	10.09
Total		5604.5	987.3	451.0	29.10	46.96	30.40

Notes: X_1 = gross fixed capital per factory; X_2 = production workers per factory; and X_3 = non-production workers per factory.

Source: Authors' Calculations

theoretically reduced if all the inefficient industries operate at the same level as the best practice industries (i.e., efficient industries).

It can also be observed that no increase in gross value added is possible by inefficient industries with these reductions in inputs. However, there are considerable variations in saving in inputs and addition in output among inefficient industries. For example, the worst inefficient industry 'Manufacturing of weapons and ammunitions (NIC code 2927)' should reduce its gross fixed capital input by 62.79 percent, cut production workers input by

Table 4: Targets for Output Variable and Potential Output Improvement

NIC 4-Digit Code	Industry Description	Targets of Output Variable	Potential Output Improvement
2811	Manufacturing of structural metal products	73.78	0
2812	Manufacturing of tanks and reservoirs and containers of metal	41.43	0
2891	Forging, pressing, stamping and rolling of metal	208.34	0
2892	Treatment of coating of metal	35.85	0
2893	Manufacturing of cutlery, hand tools and general hardware	56.51	0
2899	Manufacturing of other fabricated metal products	54.38	0
2911	Manufacturing of engines and turbines, except aircraft, vehicles and cycles	293.15	0
2912	Manufacturing of pumps, taps, compressors and valves	156.72	0
2914	Manufacturing of ovens, furnaces and furnaces burners	116.99	0
2915	Manufacturing of lifting and handling equipments	226.53	0
2919	Manufacturing of general purpose machinery	106.37	0
2921	Manufacturing of agriculture and forestry machinery	140.86	0
2922	Manufacturing of machine tools	75.22	0
2923	Manufacturing of machinery for metallurgy	111.88	0
2924	Manufacturing of machinery for mining quarrying and construction	261.27	0
2925	Manufacturing of machinery for food, beverages and tobacco processing	86.26	0
2926	Manufacturing of machinery for textile, apparel and leather products	89.60	0
2927	Manufacturing of weapons and ammunitions	53.96	0
2929	Manufacturing of other special purpose machinery	126.30	0
3120	Manufacturing of electric distribution and control apparatus	174.77	0
3130	Manufacturing of insulated wires and cables	124.01	0
3140	Manufacturing of accumulators, primary cells and primary batteries	325.52	0
3311	Manufacturing of medical and surgical equipments	320.06	0
3312	Manufacturing of instruments and appliances for measuring, checking, testing, navigating some other purpose except industrial process	146.14	0
3511	Building and repairing of ships	232.69	0
3520	Manufacturing of railway and tramway	187.66	0
3530	Manufacturing of aircraft and spacecraft	560.83	0
Total		4387.081	0

Source: Authors' Calculations

74.07 percent and use 66.26 percent less of non-production workers. Even with these reductions, this industry cannot add to the level of gross value added. A similar conclusion can be drawn for other inefficient industries.

Nature of Returns to Scale

As microeconomics theory indicates, one objective of firms is to operate at most productive scale size i.e. with constant returns to scale (CRS) in order to minimize costs and maximize revenues. In the short run, firms might operate with increasing returns to scale (IRS) or decreasing returns to scale (DRS). However, in the long run, they will move toward constant returns to scale by becoming larger or smaller to survive in the competitive market. The process might involve changes of a firm's operating strategy in terms of scaling up or scaling down of the size. The regulators may use information on this parameter to determine whether the size of representative firm in the particular industry is appropriate or not. To determine the nature of returns to scale in capital goods industries, we followed the method suggested by Zhu (2003). Let λ_j^* be the optimum value of intensity variable (λ_j) in the CCR model. The following three distinct cases have been enumerated by Zhu (2003):

Table 5: Returns to Scale in Indian Capital Goods Industries

NIC-4 Digit Code	Industry Description	$\sum\lambda^*$	Returns to Scale
2811	Manufacturing of structural metal products	0.236	Increasing
2812	Manufacturing of tanks and reservoirs and containers of metal	0.119	Increasing
2813	Manufacturing of steam generators, except control heating hot water boilers	1.000	Constant
2891	Forging, pressing, stamping and rolling of metal	0.358	Increasing
2892	Treatment of coating of metal	0.115	Increasing
2893	Manufacturing of cutlery, hand tools and general hardware	0.188	Increasing
2899	Manufacturing of other fabricated metal products	0.168	Increasing
2911	Manufacturing of engines and turbines, except aircraft, vehicles and cycles	0.847	Increasing
2912	Manufacturing of pumps, taps, compressors and valves	0.502	Increasing
2914	Manufacturing of ovens, furnaces and furnaces burners	0.338	Increasing
2915	Manufacturing of lifting and handling equipments	0.711	Increasing
2919	Manufacturing of general purpose machinery	0.313	Increasing
2921	Manufacturing of agriculture and forestry machinery	0.307	Increasing
2922	Manufacturing of machine tools	0.234	Increasing
2923	Manufacturing of machinery for metallurgy	0.317	Increasing
2924	Manufacturing of machinery for mining quarrying and construction	0.713	Increasing
2925	Manufacturing of machinery for food, beverages and tobacco processing	0.272	Increasing
2926	Manufacturing of machinery for textile, apparel and leather products	0.263	Increasing
2927	Manufacturing of weapons and ammunitions	0.157	Increasing
2929	Manufacturing of other special purpose machinery	0.396	Increasing
3000	Manufacturing of office accounting and computing machinery	1.000	Constant
3110	Manufacturing of electric motors, generators and transformers	1.000	Constant
3120	Manufacturing of electric distribution and control apparatus	0.546	Increasing
3130	Manufacturing of insulated wires and cables	0.149	Increasing
3140	Manufacturing of accumulators, primary cells and primary batteries	0.677	Increasing
3311	Manufacturing of medical and surgical equipments	0.898	Increasing
3312	Manufacturing of instruments and appliances for measuring, checking, testing, navigating some other purpose except industrial process	0.457	Increasing
3313	Manufacturing of industrial process control equipments	1.000	Constant
3511	Building and repairing of ships	0.771	Increasing
3520	Manufacturing of railway and tramway	0.589	Increasing
3530	Manufacturing of aircraft and spacecraft	1.285	Decreasing

Source: Authors' Calculations

(i) If $\sum_{j=1}^{n}\lambda_j^* = 1$ then constant returns to scale prevails in industry *k*.

(ii) If $\sum_{j=1}^{n}\lambda_j^* < 1$ then increasing returns to scale prevails in industry *k*.

(iii) If $\sum_{j=1}^{n}\lambda_j^* > 1$ then diminishing returns to scale prevails in industry *k*.

Table 5 provides the values of $\sum_{j=1}^{n}\lambda_j^*$ and observed returns to scale in the Indian capital goods industries. It has been found that the four 'best practice' industries with technical efficiency score of one operate at the most productive scale size (i.e. constant returns to scale). The industrial group of 'Manufacturing of aircraft and space craft (NIC code 3530)' has been found to be the only industrial group that follows the decreasing returns to scale. This sector needs to downsize the average firm size for experiencing a gain in the technical efficiency. In

Table 6: Results of Sensitivity Analysis

NIC 4-Digit Code	Industry Removed from the Analysis	Mean of Technical Efficiency Scores in Remaining Industries
3000	Manufacturing of office accounting and computing machinery	0.719
2813	Manufacturing of steam generators, except control heating hot water boilers	0.701
3110	Manufacturing of electric motors, generators and transformers	0.697
3313	Manufacturing of industrial process control equipments	0.696

Source: Authors' Calculations.

the rest of 26 industrial groups, we observed increasing returns to scale. This signifies that there is enough room to increase the average size of the firm in these industrial groups for achieving a high level of technical efficiency. A drive towards modernization may really help these industrial groups in gaining efficiency in the resource utilization process.

Sensitivity Analysis

With the purpose to check the robustness of the efficiency scores obtained and the presence of extreme observations (outliers) in the sample, a sensitivity analysis has been conducted. The purpose of our DEA analysis is twofold, first to compute the efficiency scores for individual industries so as to quantify the potential for efficiency improvement and secondly, to identify those industries that define *efficiency frontier*. For this double purpose, the simplest and probably most reasonable sensitivity analysis is to remove all the frontier industries one by one and study the effect of their removal on the average efficiency of the remaining 30 capital goods industries. Table 6 presents the results of sensitivity analysis.

Recall that four industries defined the *efficiency frontier* and the average of technical efficiency scores for 31 capital goods industries turned out to be 0.705 (see Table 1). We performed the sensitivity analysis by removing these efficient industries from the best practice frontier one by one and analyzed the impact of their removal on the average efficiency of remaining 30 capital goods industries. In fact, we have four distinct cases which came into existence by removing efficient industries one by one from the sample. An efficient industry may be considered as an outlier if its removal from the *efficiency frontier* drastically changes the average efficiency of capital goods industrial sector.

By adopting this procedure to identify an outlier, we observed that none of the industry on the *efficiency frontier* is extreme in the sense that its exclusion from the analysis did not bring any significant and drastic change in the average technical efficiency of capital goods industrial group. This is evident from the fact that average efficiency scores obtained by removing efficient industries one by one from the sample ranged from 0.696 to 0.719. The average efficiency scores in all the four cases of sensitivity analysis are very close to average efficiency score of 0.705 that has been obtained in our DEA analysis. Thus, we can safely infer that the results of the present study are quite robust to discriminate between efficient and inefficient industries belonging to Indian capital goods industrial sector.

Explaining Technical Efficiency

To explain the observed variation in industry's performance by the characteristics of the each industry, we followed Worthington (1998) and applied logistic regression. To facilitate this, we defined the dependent variable P_i as follows

$$P_i = \begin{cases} 1 : \text{if } \theta = 1 \\ 0 : \text{if } \theta < 1 \end{cases}$$

That is, P_i =0 if ith industry is inefficient on the basis of the DEA measure of overall technical efficiency and P_i =1 if ith industry is efficient. We estimated the following set of logistic regression equations to ascertain the relationship between dependent and independent variables.

$$P_i = f_1\{(K/L)_i\}$$

$$P_i = f_2\{(RETURN)_i\}$$

$$P_i = f_3\{(SKILL)_i\}$$

$$P_i = f_4\{(K/L)_i, (RETURN)_i\}$$

$$P_i = f_5\{(RETURN)_i, (SKILL)_i\}$$

Table 7: The Results of Logistic Regression Analysis

Dependent variable	Constant	K/L	Return	Skill
P_i	-3.047 (1.004)	0.242 (0.162)	*n.i.*	*n.i.*
P_i	-5.910 (2.161)	*n.i.*	5.746 (2.699)	*n.i.*
P_i	-13.443 (6.065)	*n.i.*	*n.i.*	31.469 (15.470)
P_i	-16.026 (9.673)	1.098 (1.139)	12.621 (6.615)	*n.i.*
P_i	-19.251 (9.018)	*n.i.*	5.55 (3.224)	35.718 (20.148)
P_i	-12.834 (5.866)	0.132 (0.208)	*n.i.*	28.258 (15.387)
P_i	-39.605 (32.605)	2.029 (2.481)	18.232 (14.145)	39.237 (35.967)

Notes: i) Figures in parenthesis of type ( ) are standard errors; and ii) *n.i.* refers the variable has not been included in the model.
Source: Authors' Calculations

$$P_i = f_6\left\{(K/L)_i, (SKILL)_i\right\}$$

$$P_i = f_7\left\{(K/L)_i, (RETURN)_i, (SKILL)_i\right\}$$

To estimate the parameters of the logistic model, the statistical software package Minitab Version 14 has been utilized. In the aforementioned models, the explanatory variables used to explain technical efficiency in capital goods industries are i) *K/L*, ii) *RETURN* and iii) *SKILL*. The variable *K/L* represents the capital intensity and is defined as gross fixed capital per employee. It is used as a measure of relative degree of mechanization of production process. Higher capital intensity {i.e. (*K/L*)} signifies a greater degree of mechanization and expected to facilitate larger operating efficiency. Therefore, it has been hypothesized that capital intensity variable has a positive influence on technical efficiency. The variable *RETURN* is defined as the ratio of 'contribution of capital' (gross value added minus emoluments) to gross fixed capital. The variable *RETURN* is used as a proxy for the level of profitability in an industry. It is hypothesized that profitability has a positive relationship with the technical efficiency i.e. higher profitability leads to higher efficiency and *vice-versa*. The variable *SKILL* represents the availability of human skills, and highlights the availability of the trained manpower including supervisory, administrative and managerial staff. Following Ghosh and Neogi (1993) and Bala (2006), it has been measured as the ratio of skilled persons (all employees minus production workers) to all employees. This variable has also been hypothesized to affect technical efficiency positively. The estimated results of logistic regression models given above are presented in the Table 7. It has been observed that in the all the regression equations, the signs of the estimated coefficients are in consonance of *a priori* expectation.

The explanatory variable *K/L* has a positive sign in all the logistic regression equations in which it has been included. Thus, we can infer that the industries with higher degree of mechanization have higher technical efficiency. In all the regression equations, the explanatory variable *RETURN* has a positive sign indicating that the profitability of the industry has a significant positive effect on the technical efficiency of Indian capital goods manufacturing industry. The proposition that higher managerial skills maintain higher technical efficiency appear to hold in capital goods industrial group since the sign of the variable *SKILL* turned out to be positive in all the logistic regression equations.

Conclusions

In this study, an attempt has been made to analyze the extent of technical efficiency in the capital goods industries using the Annual Survey of Industries data for the year 2003-04. The average technical efficiency score for 31 capital goods industries has turned to be 0.705. It indicates that the level of technical inefficiency in these industries is to the tune of 29.5 percent. The results suggest that by adopting the best practices, capital goods industrial sector, on an average, can reduce their inputs of gross fixed capital, production and non-production workers by at least 29.5 percent. On the contrary, the sector has the scope of producing 1.418 times more output from the same resources. Out of the 31 capital goods industries, four industries have been identified as 'relatively efficient' with technical efficiency score equal to 1 and thus, defined the *efficiency frontier*. The target setting exercise for inefficient industries provides that on an average approximately 29.10 percent of gross fixed capital, 46.96 percent of production workers and 30.40 percent of non-production workers could be theoretically reduced if all the inefficient industries operate at the same

level as the best practice industries (i.e., efficient industries). It has also been observed that no addition in gross value added is possible by inefficient industries with these reductions in inputs.

The analysis of returns to scale reveals that all the efficient industries operate at the optimum scale (i.e. constant returns to scale). Of the remaining 27 industries, only one industry was found operating in the zone of DRS and the remaining 26 industries were found operating in the zone of IRS. The production theory suggests that for a firm experiencing IRS, an increase in input would bring larger than proportionate increase in the output. The direct connotation of this suggestion in the context of our study is that the firms in the industrial groups that are experiencing IRS should scale up the scale of operations to enhance the efficiency level. This calls to adopt a comprehensive programme of technology upgradation and modernization. It is expected that the adoption of such programme would improve the efficiency level of the firms in these industrial groups. With the higher level of efficiency, the firms would be able to reduce the inputs by the extent suggested by the aforesaid target setting exercise. To investigate the robustness of the results, a sensitivity analysis has also been carried out. The results indicate that none of the industries on the *efficiency frontier* is extreme, i.e. its exclusion from the analysis did not bring any significant and drastic change in the average technical efficiency of the remaining capital goods industries. To determine the factors influencing technical efficiency in Indian capital goods industries, a logistic regression analysis has been applied. The explanatory variable *K/L* indicating the extent of capital deepening has observed a positive sign in all the logistic regression equations in which it has been included. This implies that the capital goods industries with higher degree of mechanization have higher level of technical efficiency. In all the regression equations, a positive sign for explanatory variable *RETURN* has also been noted. This implies that the profitability of the industry has a significant positive effect on the technical efficiency of Indian capital goods industries. The proposition that higher managerial skills lead to higher levels of technical efficiency appears to hold in capital goods industries since the sign of the variable *SKILL* turned out to be positive in all the regression equations.

The following policy recommendations emerge immediately from the aforementioned findings of the present study. For reducing the extent of technical inefficiency in Indian capital goods industrial sector, there is an urgent need to scale up the scale of operations of the firms in this sector. This would help to achieve a move towards most productive scale size. In this direction, a comprehensive programme of technology upgradation and modernization may provide fruitful results. Further, better manpower planning is needed to augment the efficiency level of the firms belonging to Indian capital goods industrial sector.

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Throughout history, it took centuries for the habits of one culture to materially affect another. Now, that which becomes popular in one country can sweep through others within months.

– Dee Hock

Feature

Manufacturing Planning and Control Practices in Batch Manufacturing: A Case Study

B.S. Chetty, B.V. Chowdary, K.N. Krishnaswamy & A.S. Ramasastry

This paper presents the details of manufacturing planning and control (MPC) practices followed in an Indian batch manufacturing firm in order to extract some indicative variables. The selected manufacturing firm produces refrigerators to cater to the needs of the local as well as global markets. The analysis of the case revealed the importance of organizational and managerial variables like top management involvement, role of MPC function, reliability of suppliers, and importance of manufacturing strategy in the process of MPC. The case results provide valuable information for researchers and practitioners who are seeking ways of helping the economy in India.

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Batch manufacturing is a typical mode of manufacturing in many countries and aims at producing a large variety of products and models using a common resource base. As the manufacturing sector starts integrating with the global economy, the manufacturing lot sizes will be reduced, the product variety will increase and the efforts to increase the manufacturing flexibility will be given a lot of importance. With this the complexity of manufacturing planning and control (MPC) increases and thus will deserve a greater attention by manufacturing practitioners and the academia.

The emphasis in the prior studies on MPC (Barber and Hollier, 1986; Rho and Whybark, 1990) was either on MPC practices or factors influencing the manufacturing control especially in the developed nations. Though the batch manufacturing represents a major segment across manufacturing sectors in India, research studies focusing on this were not attempted. This paper aims to present the details of MPC practices followed in one of the batch manufacturing firms of India. The selected firm manufactures air conditioners. The case study was analyzed with the purpose of extracting some indicative variables in MPC.

Conceptualizing MPC practices could prove beneficial to both researchers and practitioners seeking to model or to develop a theory of MPC. The literature in the field of MPC is not so rich in conceptual development and it is still in the evolution phase. Descriptive surveys are still being carried out in order to compare MPC practices across countries and industries (Kim et al., 1990). Adam and Swamidass (1989) assessed operations management from a strategic perspective to identify the missing themes and notice that manufacturing structural and infrastructure decisions such as MPC, plant location, and total quality control (TQC) have strategic implications and

further that these topics failed to receive direct attention in literature.

Anderson et al. (1989) identified that literature in the area of strategic implications of MPC dealt mostly with the conceptual vein, and therefore, that the empirical examination of the relationships was dealt with only parochially. Handfield (1994) analyzed a resource dependence perspective of just-in-time purchasing, which plays a critical role in the MPC system. Further, Lane and Szwejczewski (2000) studied the relative importance of planning and control systems in achieving delivery performance. The role of the MPC system in a manufacturing strategy was carried in the past (Olhager and Rudberg, 2002) specifically to link market requirements, product characteristics and the process choice to the MPC system.

The literature pertaining to MPC appears to be inadequately understood with regard to factors influencing MPC especially at the lower levels that deal with procedures, formats and control parameters (Rho and Whybark, 1990). Dierdonck and Miller (1981) developed a contingency model to explain aggregate differences in the specifications for MPC systems across firms using two dimensions only - one technical and the other organizational, and only with two contingent factors, uncertainty and complexity. Several researchers (Finch and Cox (1988); Rho and Whybark (1990); Lane and Szwejczewski (2000) identified the characteristics of MPC system under various environments. Taylor et al. (1981) presented an extensive list of factors influencing the design of MPC system in process industries. Finch and Cox (1988) modeled the relationship graphically between the influencing factors and MPC system. The empirical research work conducted by Swamidass and Newell (1987), Kotha and Orne (1989), and Kotha and Swamidass (2000); case histories (Kwasi and Samuel, 1998), and conjectural writings (Kwasi and Samuel (1998); Swamidass et al. (2001) have played the central role in the development of the discipline.

The current literature in MPC is largely expository in nature and is primarily empirical oriented research. The challenge of researchers now is to move on to case methodologies that would augment the development of theories. This motivated the authors to study and present the details of MPC practices employed in a batch manufacturing firm in India along with the environmental scenarios for manufacturing through a case study.

Case study at a glance: XY LIMITED

XY Limited (XYL) was started in 1942 primarily to manufacture products required for the local market. It became the first company in India to contemplate production of refrigerators and finally introduced its first refrigerator to the Indian market in 1958, introduced three more new models by 1984, all for the first time in India. It was the market leader in the late seventies with a 40% market share. Other manufacturers increased their production capacity and captured a major share, relegating XYL to the fourth position by 1988, due to which XYL's expansion project got delayed. Around the same time two more manufacturers entered the refrigerator market with the technical collaboration of Japan and captured a sizable upper crust market.

The 165-litre, single-door (165SD) refrigerator model of the company is the reigning model in the Indian market, constituting as it does, close to 50% of the total sales. XYL's manufacturing and sales functions are primarily organized to meet the demand of 165SD. The market is highly competitive, and manufacturers are trying to restructure strategies not only to capture the burgeoning Indian market but also to enter into export markets, following the liberalization policies. The case is narrated below, which describes the situation without losing the peculiarities.

Organization and Manpower

As the majority shareholding is under the control of the state government, XYL thus follows all the rules and regulations framed by the state government from time to time. The corporate office looks after functions such as research and development, contracts planning and exports, industrial engineering, plant engineering, personnel and industrial relations, finance, marketing, materials management and corporate planning. The plants are given the responsibility for production, quality control, maintenance, production scheduling and control. XYL has two plants and the main plant has 475 technical personnel and the workers plus the supporting staff together comes to 3,761.

Aggregate Production Planning

The marketing department provides the demand for refrigerators based on the past sales, governmental policies, competitors' capabilities, and the general economic environment. It helps to work out a business plan at the beginning of every year, based on which the top management sets the annual sales targets. Before the end of the first quarter of year, the company finalizes the yearly targets, which are specified in the sale value of production. Then the aggregate production plan (APP) is finalized by the contracts planning department in consulta-

tion with the marketing and production division, keeping in view the plant manufacturing capacities, the off-loading possibilities and the working environment.

Some of the plant working conditions considered in this study are union-management relations, major equipment overhauls and modifications, and major capacity bottlenecks or input constraints in the manufacturing system. Other important decision factors, such as closure of contracts, introduction of new products, finalization of subcontracts, and adjustment of manpower among divisions are also considered.

PPC Section

A manager heads the PPC section of the refrigerators unit. The major activities of the section are preparation of production schedules, shortage lists and follow-up with other departments and also corporate office, material accounting, and assisting the head of the division in production reviews.

A four-month production schedule is prepared by the PPC section for the purposes of material procurement, manpower allocation and manufacturing. The production schedule has four parts. The first part provides firm production plan for the first month and the second part deals with the tentative production for the balance three months. The third part provides the details of the available manpower, anticipated workers' absenteeism, and productivity rate, and computation of manpower required per day to facilitate the transfer of manpower from surplus to deficit shops. The fourth part gives the details of assumptions including the decisions taken in the previous meetings.

Production System

The first stage in production is the shearing and presswork of plates. After these operations, the pressed plates are passed on to the cabinet assembly section for operations such as heat treatment, plastic dip coating, plastic forming, electro-plating and liner formation. The cabinet assembly has two lines of production - single door and double door models, respectively. The first assembly line produces 165SD and the second line produces double door models of three different capacities. The paint shop is common for both models.

The compressor is manufactured in eight sections, namely, die casting, component manufacturing, stator winding, projection welding, foundry, rework, block assembly and final assembly include painting, dehydration and MIG welding. XYL manufactures two models of compressors, one for 165SD and the other for double door models. All divisions in the assembly section work on a two-shift basis. The designed capacity of the refrigerator plant is 150,000 units per year. Over the past three years the plant has produced around 100,000 units per annum.

Materials Planning and Management

The APP forms the basis for the purchase plan in the materials department. The time-phased material requirements are worked out with the help of the bills of materials. The likely stock-on-hand at the end of the period is used for preparing purchase indents. The purchase section initiates procurement after ascertaining the outstation orders, orders-in-transit, and also materials-under-inspection, and after deducting them the net material requirement is calculated.

Nearly 300 components go into the production of one refrigerator. ABC classification of components has been done on the basis of the annual consumption value, and is used for arriving at stocking policies. A two-month stock is recommended for the 'B' and 'C' class items, and a one-month stock for the 'A' class items. The order quantities of all items are generally based on one-month needs.

XYL maintains three sources of supply for every raw material, component and sub-assembly. Further, there are 90 sub-contractors who process materials supplied by XYL to specifications on the basis of agreed conversion charges, from time to time. The purchase section sends the tender documents to all the approved suppliers with yearly estimates, and after due evaluation of their offers, orders are placed to meet the four-monthly production schedule. In XYL, no annual tendering is done and the company does not like to be tagged onto suppliers for a long period.

Production scheduling, batch sizes and lead times

The PPC section in consultation with others, works out the four-monthly production schedule and the major inputs considered are: (a) changes in customer preferences and the likely orders (b) receipt of materials (c) the availability of critical equipment (d) economic volumes of production and (e) the likely interruptions due to local issues and others. The normal batch size is 5000 units.

PPC issues job orders to production department. A five-digit code is used for job order issue. Production inside the factory from shearing of plates to final assembly takes between 23 and 38 working days, depending upon the model, batch quantity, and working conditions in the plant. The time standards for a batch of 5000 units of

165SD model are: 15 days in shearing and press shop, 4 days in block assembly, and 4 days in final assembly. However, the divisional PPC usually plans for 18 days in shearing and press shop, and six days each in block and final assembly areas to provide for unforeseen conditions in the shops. Similarly it is done for other models.

Production Control

The material allotment programme forms the basis for the shearing shop to prepare the materials indent for ten 'A' class items. It is sent to the stores, and the follow-up is done by PPC to push the material from place to place before the start of production. Once the plates are sheared and pressed, the quality control department does the inspection and the accepted pieces are sent to the stores.

A shortage list is prepared and handed over to the press shop. Generally, a lead time of four days is required by the press shop to meet any shortage requirement as the set up times are very high and the press shop prefers production in large batches. This is the procedure with other assemblies too. The research and development department carries out modifications to the existing models and forwards the revised material schedules to PPC section.

Material shortages and production uncertainties occur due to various reasons, some of which (in the order of decreasing frequency) are: workers' absenteeism, short supply of materials and components, process rejections above the normal level, sudden changes in the production schedules or in the priorities and market preferences.

Scrap tickets are raised by production shops weekly once and passed to the material control through PPC section. If the scrap tickets are in order and are approved by the material control, then fresh material is drawn from the stores against scrap ticket by the PPC department and issued to the production department. A monthly comparative statement of the actual material consumption versus the goods transferred is also prepared.

PPC Coordination

The PPC section takes care of data collection on actual production, expedites the procurement of shortage items, records the progress with quality control and production shops, and analyses the shortfalls in production to prepare weekly reports. The industrial engineering department prepares weekly reports on standard man-hours versus actual man-hours spent. The material department prepares weekly reports on purchase, stores, material control and issue and also on scrap disposal. The quality control department prepares weekly reports on rejections at various stages of production, material receipts, finished goods dispatches, laboratory testing and new vendor evaluation.

Maintenance Management

The maintenance function which is decentralized involves routine breakdowns and preventive maintenance. Activities such as overhaul, replacement of old machines and maintenance audit are carried out by the corporate level plant engineering department. Various breakdown reports on the availability of machines for production are prepared and submitted to the refrigerator division.

Quality Management

The quality control (QC) function is also decentralized, which looks after the inspection of the in-coming materials, work-in-process, service components and finished goods. The corporate QC looks after the inspection of output of common press shop, standards laboratory, new vendor evaluation, quality audit and quality circles. Various reports on rejection and rework are prepared and the issues are discussed in PPC meetings. Quality circle activities cover 16% of the employees in the refrigerator division. About 25 instances on problem-solving are presented every year by the quality circles, and QC teams have won the national level awards over three consecutive years.

Performance of the Division

The refrigerator division is making profits. No change has been observed by PPC with regard to production lead time, production batch sizes, machine set-up times, and material turnover ratio, in the last five years. The production of 165SD refrigerator is between 240 and 250 per day, and no indication is available regarding the increase in the production. Investments have been made to recondition the machinery and to introduce computers for data analysis.

Discussion

The process as laid out in the case study reveals the environment of MPC in XYL. In particular, the case offers the following insights:

- The market for refrigerators is spread all over the country and XYL's strategy has been to concentrate in the lower price range of 165SD re-

frigerator market where volumes decide the profitability. Customer service has been the focus of XYL's strategy to market its products, but of late, customers have been showing interest more towards highly reliable refrigerators.

- There are some common facilities shared by various products manufactured by the company and others are product specific. Most of the machines are general-purpose type with some special purpose machines for component manufacturing, and no automation has been attempted. The data on the availability of critical common equipment in the formulation of the four-month production schedule showed the importance attached to the bottleneck equipment in scheduling. The sharing of common facilities does create problems of coordination for PPC.
- The PPC activity is truncated in XYL. For instance, the contract planning and export department looks after the preparation of the yearly APP while the material purchase, issue and scrap control come under the materials department. The PPC takes care of production scheduling and control by coordinating with other departments in the division. Material shortages seem to be a major problem, followed by unexpected process rejections, equipment breakdown and increased workers' absenteeism.
- One of the special features of PPC responsibilities in XYL is the transfer of manpower from deficit to surplus shops to take care of demand changes, absenteeism, and productivity differences.
- The run-out time concept is used in XYL to prepare the purchase indents by the material control group in order to facilitate the smooth flow of production through adequate stocks-on-hand.
- The PPC division creates a slack in production scheduling to take care of any unforeseen developments in the shops.
- The emphasis of production control seems to be on the individual product rather than on the division as a whole. These deviations from the standards are addressed in the scheduled meetings, and there are also interventions by the PPC function to achieve mid-course correction.
- Though the supplier base is very large, the firm splits orders among at least three suppliers. Variations in supply lead time are more due to problems faced by the suppliers. Frequently the supply schedules are revised as the company finds it difficult to make alternative arrangements.
- XYL, being a state Government undertaking, had to follow its rules. The chairman and managing directors are changed frequently, thereby disrupting the continuity of leadership. In view of this, the firm developed a target culture wherein the only objective is to achieve the annual APP.
- XYL introduced quality circles to solve some of the work-related problems. No substantial benefits have been accrued, but the top management likes to continue because this gives visibility to the firm outside.

Analysis of the Case Study

In this section, to arrive at a comprehensive understanding of the MPC practices, findings from the case study are discussed, under the following headings.

- Firm's position
- Manufacturing
- Markets and supplies
- Manufacturing planning and control
- General aspects

The above characteristics have been chosen for the comprehensive representation of the selected firm, and these represent the system oriented, managerial and environmental manifestations of the MPC practices in the Indian batch manufacturing scenario.

Firm's Position

The primary method of manufacturing in the selected case is production of a range of similar components in each division, and then integrating them into final assembly with bought-out items. The firm operates make-to-order and also make-to-stock to meet off-the-shelf sales. XYL operates in high volume in one model and in medium volume in the other models. The firm competes in the market with multiple products. Table 1 provides some of the variables on firm's positioning elicited through case analysis.

The strategy of XYL was to provide a quick response to the peak season demand with back-order production during the lean season. Price seems to be one of the important factors for major customers of all the companies. Variety of products seems to be a dominant factor in the case of refrigerator market. Though XYL was the

first company to introduce refrigerators, and features in them, it could not commission new projects to produce the new models or increase outputs from the existing piant to cash in on the market acceptance. Others who followed a little later could blend their business strategies well, complete new expansion projects and capture the market so that XYL has been relegated into the fourth position.

Table 1: Variables on firm's positioning elicited by the case analysis

Sl. No.	Variable	Influence
1.	Product Variety	Low
2.	Customized Products	
3.	Multiple Markets	Low
4.	Product Pricing	Medium
5.	Delivery Performance	Low
6.	Quick Response to Market	Medium
7.	Product Quality	
8.	Reliability of Delivery	Medium

Manufacturing

The production facilities were created in the 1980s before the Indian government initiated liberalization. Some of the facilities have been replaced with new equipment in the same layout. The component manufacturing facilities were generally of the process type and common for all products, and the assembly facilities were exclusively for a single product or a range of similar products. The number of components that go into production of one unit ranges from 50 to 800 in the case unit. Production facilities are divided into work centres with 6-10 machines under each centre. Wherever NC/CNC machines or exclusive lines in a work centre are installed, approximately 20 operations are done per piece. Table 2 provides some of the variables on manufacturing elicited through the case analysis.

The opinion of managers of the selected firm was that batch sizes as well as lead times had to be high for internal manufacturing. One major reason mentioned for this was that there is a need for amortization of set-up times which are quite high. Current batch sizes and lead times for manufacturing are very much comparable with those three or five years ago as no significant efforts were made to reduce them. The amount of rework has come down in some shops, while it has gone up in some other shops bringing no change in the overall rework. XYL seem to have labour flexibility as the technology employed is labour intensive.

Table 2: Variables on manufacturing elicited by the analysis of case

Sl. No.	Variable	Influence
1.	Common Facilities Sharing	Low
2.	Product Complexity	Low
3.	Rework	Low
4.	Design Changes	
5.	Labour Inflexibility	
6.	Machine Breakdowns	Low
7.	Workers' Absenteeism	
8.	Layout and Flow Issues	Low
9.	Production Inflexibility	

Production loss due to various uncertainties is found in the firm. It is not the output of a particular machine which is affected when a worker is absent, but a multiplier effect is felt throughout downstream operations. Though work-in-process is expected to take care of this problem, it does not happen in a sequence as is required. The cumulative effect of production loss due to machine breakdown, non-availability of materials and workers' absenteeism is three to four times of the direct loss of production time and this leads to an increase in manufacturing lead time. Machine breakdowns seem to affect production in XYL as the machinery is over 20 years old.

Markets and Supplies

These represent the front and back ends of a firm and both are external to the organization. However, both influence the outcome as well as the MPC effectiveness of batch manufacturing firms. It is possible to have slack resources such as inventory buffers, extra manpower, back ordering, and extra machines to cope with the turbulence in the external environment since XYL seems to have slack resources in machine capacities and manpower respectively. As these methods put a burden on the profitability, efforts are generally made by the planning and control function to reduce them. Table 3 shows variables identified by the case analysis.

XYL has to compete with a large number of manufacturers and take orders from a large number of customers. The level of competition used to be low, but now with the opening up of economy the severity of competition is rising, leading to demand fluctuations. Many are contemplating introducing programmes to improve their performance. XYL is under intense competitive pressure due to the sudden change in the business environment. The firm has good distribution network and sales offices throughout the country.

Table 3: Variables on market and supplies elicited by the analysis of case

Sl. No.	Variable	Influence
1.	Slack Resources	Low
2.	Level of Competition	High
3.	Small Orders and Large Customer Base	High
4.	Demand Fluctuation	Medium
5.	Dependence on Suppliers	Low
6.	Large Supply Base	Medium
7.	Ancillary Development	
8.	Reliability of Suppliers	Low
9.	Distribution Network	Medium
10.	Long lead Times for Procurement	Medium

The company depends upon outside sources of supply for materials anywhere between 10 and 30 per cent by value of production. Though XYL has a very large number of suppliers, it restricts the buying to a limited number. The firm believes in the development of new sources of supply to enlarge the supply base.

Manufacturing Planning and Control

The firm translates its long-term goals into yearly sales and finally into the production units per unit time. In the selected case, long-term and short-term plans of manufacturing are made explicit, clear up to the lower levels of management. Table 4 shows details of variables on MPC elicited from the case study on MPC. It was found that the MPC plays a substantial role in not only assisting top management in the preparation of APP but also in exercising control over production schedules so that they reflect the changes in the environment.

The firm has a detailed work order system to facilitate production scheduling and shop loading. Unscheduled meetings are conducted in XYL very often during the peak season to match the production schedules with market requirements. XYL exhibits a high degree of intervention during peak seasons of demand.

Table 4: Variables on MPC elicited by the analysis of case

Sl. No.	Variable	Influence
1.	Role of MPC	High
2.	Degree of Top Management Intervention	Low
3.	Aggregate Production Planning	Low
4.	Detailed Production Scheduling	Medium
5.	Unscheduled Meetings and Coordination	High
6.	Availability of Precise and Timely Information	Low

General Aspects

This section deals with aspects such as leadership, training, incentive scheme, performance and usage of computers. The top leadership is being changed frequently leading to the lack of continuity of direction at the top. XYL shows extreme concern for achieving aggregate targets somehow by the end of the financial year. Incentive plans have been introduced in all firms to get the production out of the system and they are, by and large, the driving force in the achieving aggregate targets. No appreciable reduction in man-hours per unit of production is noticed in the selected firm in the last five years. And also no change has been noticed in manufacturing batch sizes, lead times and inventory levels. New equipment has been introduced to replace old and troublesome equipment, but these have increased the machine productivity rather than the overall productivity of the plant. Computers are being used for trend analysis and report preparations, but not for modeling to improve the performance of systems or to capture information at the action floor.

Table 5: Variables on general aspects elicited by the analysis of case

Sl. No.	Variable	Influence
1.	Frequent Top Management Changes	Medium
2.	Great Concern for Production Targets	Low
3.	Incentive Plans	Low
4.	Level of Computer Usage	Low
5.	Formal Training for Supervisors and Workers	Low
6.	Manpower Planning and Career Development	

No formal training centres have been established to impart technical and other skills continuously to the employees. XYL introduced quality circles at the shop floor level to bring in the participation of employees in problem solving. The concept of learning beyond the job has not been consciously pursued. Many executives feel that no formal manpower planning and career development are being carried out by companies. Table 5 provides the details of variables identified by the case analysis.

Conclusion

In the selected batch manufacturing firm, the manufacturing planning aspects appear to be the major concern of the practitioners and very little thought is given to the manufacturing control aspects. The present study is an attempt at identifying the influence of organizational, managerial and external variables on MPC practices, and

it also provides a new perspective to understanding its various aspects.

The analysis of the case revealed the importance of organizational and managerial variables like top management involvement, role of MPC function, reliability of suppliers, and importance of manufacturing strategy in the process of MPC. The analysis further indicated that the financial performance of the company can be good even when the role played by MPC is rudimentary if the firm is active in monopoly situation. But, when the firm is operating in a competitive market with multiple products, the MPC has to play a significant role and its role is much more pronounced in achieving the manufacturing control effectiveness which seems to be one of the prerequisites for higher levels of financial performance.

One of the important insights offered by the case was about the reliability of suppliers and their importance in the present day context of liberalization. The case further revealed that the firm did not put in efforts to introduce automation or flexible manufacturing systems on a large scale or come up with a total change in their thinking vis-à-vis manufacturing. Even computerization has been done to carry out the analysis of historical trends, and for the preparation of reports, but not for modeling, as the methods used for sales forecasting and production simulation are still manual and qualitative. The role of integration among various functions seemed to be achieved by MPC using scheduled and unscheduled meetings in the firm. Further, the insights from the case study may also help scholars develop a more general theory of manufacturing excellence that can be of use in any manufacturing sector.

At the firm level, the roles of external factors such as suppliers' base and market conditions; as well as the internal mechanism affecting MPC have not been investigated yet. It is necessary to validate these measures systematically as it leads to a strong linkage between concepts and their measures, and enhances theory development, and also sprouts new hypotheses for investigation.

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Feature

A Productivity Measurement Model for Technical Educational Institutes

Jagtar Singh, Anil Singla & Sanjeev Bansal

The objective of this paper is to critically examine the structure and work fronts of a technical institution viz the objectives, facilities, delivery of services, user satisfaction and allied aspects, to assess productivity of a technical educational institution, by considering the technical institution as a service organization. A gap identification between facilities available and level of services rendered is highlighted and relevant remedial measures have been suggested to improve performance. A factor-based model to measure productivity in a technical educational institute has been proposed.

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The conventional production-oriented society is transforming at a rapid pace into a service-oriented society. A large number of service professions have come up to occupy a significant place in day-to-day life. These include banks, telephone departments, electricity boards, roadways, hospitals, nursing homes, R&D centers, educational institutes, post offices, aviations, retail chains etc. Collectively the domain is referred to as the service sector. The measurement of productivity of the service sector is beset with problems related to subjectivity in output and evaluation of the whole work, diverse inputs such as dedicated information, technical knowledge, energy, physical effort, mental aptitude, individual preferences etc. In this model an attempt has been made to measure the productivity index of a technical institute. A factor-based model has been proposed, which consists of several inputs and out puts. A typical technical educational institute deploys the following main inputs for its operation:

- **Students**: Their caliber, aptitude and background.
- **Teachers:** Their qualifications, experience, training and qualitative attribute.
- **Infrastructure**: Includes buildings, laboratories, workshops facilities, library and computer center.
- **Materials**: For workshop, laboratories, estate, sports, offices and maintenance.

The outputs of this factor-based model can be measured in several dimensions:

- Successful completion of course work i.e. a consistent high success rate and high rank.
- Performance acceptance of students in the market i.e. placement, jobs in reputed company.
- Acceptability in subsequent higher education institutes.

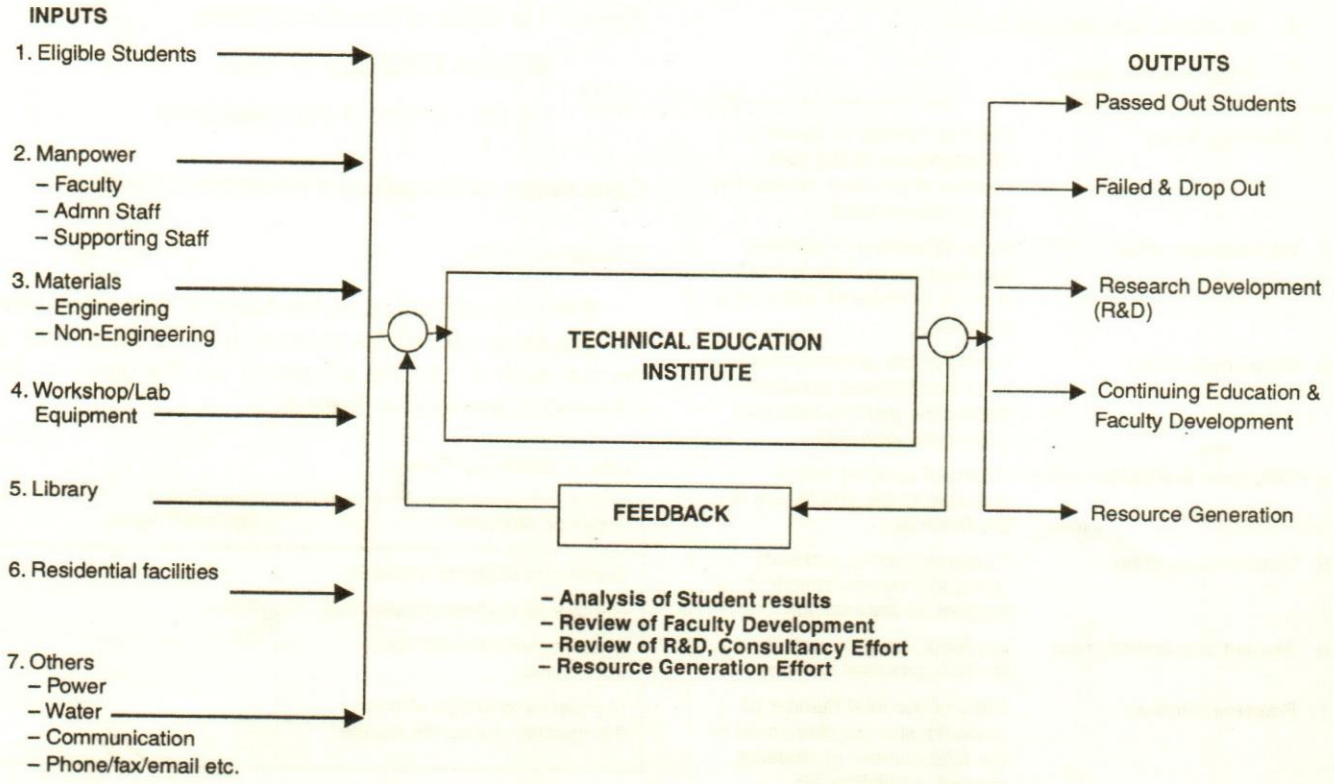

Fig. 1. Input-output Model of Technical Education Institute

- Conduct as a balanced disciplined citizen.
- Emotional Stability Quotient and IQ etc.
- R & D output of the faculty.
  - o Publications by faculty.
  - o Consultancy services to Industry and resource generation.

Based on the above-mentioned inputs and outputs an Input-Output model of the technical institute has been devised in Fig. 1.

Need of Productivity Measurement

Measurement of productivity of an Educational Institution aims at assessing and improving its performance, laying emphasis on effectiveness of services rendered and efficient use of resources. The objectives of measuring the productivity in such cases can be categorized as follows:

- To monitor the performance
- Optimal use of resources.
- To formulate both long-term and short-term goals.
- To analyze and re-establish the objectives of the system taking into account the available resources, changing needs and values of the society.
- To integrate inputs and outputs so as to achieve a holistic performance.

Productivity Index of Educational Institution

In order to calculate the productivity of an educational institute (Productivity Index) one has to take into consideration many factors, which directly or indirectly affect its functioning and efficiency. These factors are converted into indices and after assigning appropriate weightage to each factor, the total productivity index can be calculated. Total productivity index is an integration of various indices, which are identified on the basis of opinion of the experts. The details of these indices is as follows:

1. Efficiency Index
2. Effectiveness Index
3. Cleanliness and Hygiene Index
4. Employee Satisfaction Index
5. Infrastructure Index

6. Student Satisfaction Index
7. Placement Index

1. Efficiency Index	Ratio of number of students declared pass to the total number of students admitted in the particular batch.
2. Effectiveness Index	Ratio of number of students securing above 70% to total number of students admitted in a batch.
3. Cleanliness Index	Rating of the general cleanliness and hygienic conditions both in the institute premises and hostel premises.
4. Employee Satisfaction Index	Rating of facilities made available to the employees of the Institute.
5. Infrastructure Index	Students, faculty and staff rating the various infrastructure facilities in the institute.
6. Student satisfaction Index	Students rating of various facilities provided to them.
7. Placement Index	Ratio of the total number of students who got placement to the total number of students passed out/eligible for placement

Sources of Data

These are the various sources of data collection:

- Academic Cell
- Training and Placement Cell
- Faculty and Staff
- Students
- Administrative and Accounts Cell
  - Estate office

Total Productivity Index (TPI)

The Total Productivity Index can be calculated on the basis of weighted average method. Weightages are given to various constituent indices mentioned above. Total productivity model for a Technical Educational Institute is shown in Fig. 2. Opinion of the users/experts in the profession is taken into consideration and a rationale for weightage is developed. By assigning suitable weightage to these indices, a mathematical index is developed as below:

$$\text{Total Productivity Index (TPI)} = \frac{\sum I_j W_j}{\sum W_j} \times 100 \qquad ...(1)$$

Where: I is Value of Constituent Index

W is the Weightage of Index

j is the number of individual Index

Calculation of Constituent Productivity Indices

Efficiency Index

It can be calculated on the basis of data taken from the academic cell of the institute. It could be overall or course wise. It can be calculated on the basis of the information provided in Table 1.

Table 1: Efficiency Index

Types of Students	Diploma/Degree
Number of students admitted	
Number of students passed out	
Students who scored above 70% marks	
Number of students who left the Institute during his course	

$$\text{Efficiency Index} = \frac{\text{No. of students passed out}}{\text{Total No. of students Admitted} - \text{Students left}}$$

Effectiveness Index

It signifies the quality of system output.

$$\text{Effectiveness Index} = \frac{\text{No. of students who scored above 70\% marks}}{\text{Total No. of students admitted in a batch}}$$

Cleanliness Index

For estimating this index, a questionnaire regarding the various elements influencing housekeeping/cleanliness may be designed, where Likert's five-point scale can be used to rate the information regarding the status of cleanliness. This questionnaire may be distributed to a sample of employees and students (sample size depends upon the total strength of employees and students, say between 50 to 100). The cleanliness index is the sum of the responses of students and employees. The weightage given to the cleanliness index of student's response and employee's response is based on the opinions of the experts in the teaching profession. The information obtained is processed in the form of Table 2.

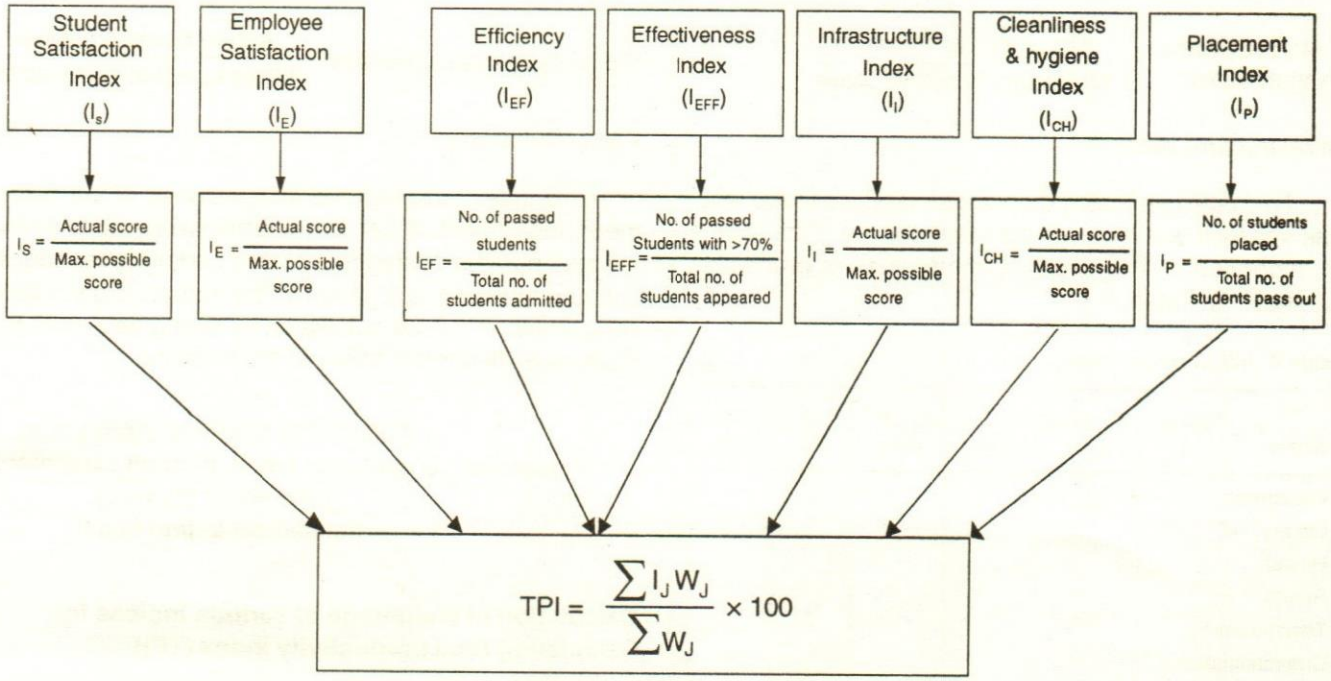

Fig. 2. Model for TPI for a Technical Educational Institute

$$\text{Cleanliness Index} = \frac{\text{Sum of the Actual Scores}}{\text{Sum of Maximum Possible score}}$$

$$CI = 0.6(CI)_s + 0.4(CI)_E$$

Where: CI is the cleanliness Index

$(CI)_S$ is the cleanliness Index of students

$(CI)_E$ is the cleanliness Index of employees

Maximum Possible Score = Total number of responses × Maximum score (10)

Table 2: Cleanliness Index

Activity \ Facility	Excellent (10)	V.Good (08)	Good (06)	Fair (04	Poor (02)
Response of Students (Institute premises)					
Response of Students (Hostel premises)					
Response of Employees (Institute premises)					
Response of Employees (Campus premises)					

	Sample Size	Max. Possible Score	Actual Score
Students Employees			
Total			

Employee Satisfaction Index

A suitable questionnaire may be designed and used to find the level of satisfaction among the employees. The information obtained is processed in Table 3.

Table 3: Employee Satisfaction Index

Activity \ Facility	Excellent (10)	V.Good (08)	Good (06)	Fair (04	Poor (02)
Response of Employees: 1. Service Conditions 2. Campus Amenities 3. Future prospects and development					

$$\text{Employee Satisfaction Index} = \frac{\text{Actual Score Possible}}{\text{Maximum Possible score}}$$

Infrastructure Index

This index indicates the various facilities in the institute and their quality. Again the questionnaire is the source of information. The information obtained is processed as shown in Table 4:

Table 4: Infrastructure Index

Activity \ Facility	Excellent (10)	V.Good (08)	Good (06)	Fair (04	Poor (02)
Classroom					
Library					
Hostel					
Sports					
Transportation					
Communication					
Computational Facility					
General Facilities					

$$\text{Infrastructure Index} = \frac{\text{Sum of the Actual Score}}{\text{Maximum Score Possible}}$$

Student Satisfaction Index

For calculation of this index, Likert's five-point scale may be adopted to find the level of satisfaction among the students. On the basis of the data collected already through the questionnaire, the following calculations can be made. Here in this index the weightage also given to various factors based on the suggestions of experts in the teaching profession is shown in Table 5.

Table 5: Student Satisfaction Index

Activity \ Facility	Excellent (10)	V.Good (08)	Good (06)	Fair (04	Poor (02)
Response of students: *Classroom Teaching/Delivery system (0.5) *Infrastructure Adequacy (0.2) *Faculty Interaction (0.1) *Placement (0.1) *Staff Behaviour (.1)					

*Numerical value mentioned in brackets of first column indicates factor weightage.

$$\text{Students Satisfaction Index} = \frac{\text{Actual Score Possible}}{\text{Maximum Score Possible}}$$

Placement Index

This index indicates the effectiveness of the placement department. It can be determined by considering the total number of students placed under higher education and offered employment in the various organization companies. It can be calculated by taking data from the Training & Placement office of the institute.

$$\text{Placement Index} = \frac{\text{Total no. of students placed from a particular batch, through placement}}{\text{Total no. of students passed out in that batch.}}$$

Calculation of Weightage of various Indices for Calculating total productivity index (TPI)

For calculating the weightage to be given to different indices, experts from the teaching profession were consulted. The experts were explained the concept of each index and requested to give a rating to each of the various constituent indices of TPI. Weightage given by the experts can be seen in Table 6.

Table 6: Weightage to the various Indices

	Index	Weightage out of 100 Points
1	Efficiency	09
2	Effectiveness	17
3	Cleanliness	06
4	Employee satisfaction	11
5	Infrastructure	14
6	Students satisfaction	24
7	Placement	19

Source: [9]

Total Productivity Index

The Total Productivity Index is proposed to be calculated on the basis of weighted average method. Weightages are given to various indices as indicated earlier. Opinion of the experts of the teaching profession is taken into consideration and a rationale is developed while assigning the weightage to the indices. The following Table 7 is proposed for use in calculation of the TPI. It can be calculated by using equation no. 1.

Table 7: Calculation of Total Productivity Index

Sl. No.	Type of Index	Weightage(W)	Index Value(I)	Weighted Index (I.W)
1	Efficiency	09		
2	Effectiveness	17		
3	Cleanliness	06		
4	Employee satisfaction	11		
5	Infrastructure	14		
6	Student satisfaction	24		
7	Placement	19		
	Total	100		

Case Study

A project was given to the final year degree students by the authors, on the basis of this model. This model has been applied to determine the productivity of a national level technical institute established by the Govt of India (SLIET, Longowal, Punjab). Data has been collected from various sources as proposed in the model. After this, the efficiency and effectiveness indices have been calculated by considering the whole batch of students of all the engineering trades and all other indices by considering the opinions of a sample size of staff members of 125 and a student sample size of 250 (see Annexure-I). It may be worthwhile to mention that the study is in no way is conclusive. It may just be treated as the basis for more exploratory research. Moreover, by using different parameters the productivity might vary significantly.

Conclusion

With the growing economy, services are becoming a major contribution towards the GDP of our country. Hence, the productivity measurement in the service sector is very useful for assessing the proper utilization of the resources deployed and for ensuring service quality. Meaningful results of productivity measurement can be achieved only if a fairly elaborate system of management of input resources, operations and performance monitoring is evolved and established with specific measurable goals. Equally important is the existence of an appropriate information system and defined measurement indices in the system.

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Annexure -I

S.No.	Type of Index	Value of the Index (%age)
1	Efficiency	82.00
2	Effectiveness	48.00
3	Cleanliness	59.86
4	Employee satisfaction	46.88
5	Infrastructure	60.62
6	Student satisfaction	43.88
7	Placement	58.69
	TPI	54.44

□

Traditionalists are pessimists about the future and optimists about the past.

– Lewis Mumford

Feature

Developing a Conceptual Model of NGO Effectiveness in the Indian Context

M.S.A. Mahalinga Shiva & Santanu Roy

The enhanced role of non-governmental organizations (NGOs) in the public and private sectors has created a need to study what goes into making NGOs effective. Transformational leadership is a crucial component for the effective functioning of NGOs. But the interplay between transformational leadership and NGO effectiveness is not well understood and very little research has been conducted in this area. This paper proposes a conceptual model that portrays the relationship between transformational leadership and NGO effectiveness in India.

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Effectiveness is not a stable construct; it is real but changeable (Herman and Renz, 2004). Organizational effectiveness (OE) has been one of the most extensively researched issues since the early development of organizational theory (Rojas, 2000). Despite some consensus, there is still a significant lack of agreement on the definition and operationalization of this concept for different kinds of organizations (Cameron, 1986). The subject of organizational effectiveness in non-profit organizations, although controversial, remains important to both practitioners and researchers. In spite of this, the empirical research on the subject has never been comprehensively reviewed (Forbes, 1998).

Given the widespread interest for accountability in the public arena (Glisson, 1975), surprisingly very little attention has been given to the development and testing of models that explain variation in performance of non-profit organizations in general and human service organizations in particular (Glisson and Martin, 1980).

Non-governmental organizations (NGOs) have been around for more than 150 years. Over the last decade, however, there has been a subtle but steady shift in the nature of their influence over business (Nalinakumar and Maclean, 2005). There has been tremendous growth in the number of NGOs participating in international negotiations (Gulbrandsen and Andersen, 2004) in the last two decades. The Report of the Thirtieth United Nations Issues Conference (1999) has clearly stated that non-governmental organizations are more involved than ever before in global policy making.

This report has also predicted that the numbers of NGOs, and nature of their involvement, would broaden and would be evolved in terms of substance. Nalinakumar and Maclean (2005) have observed the exponential growth in the numbers of NGOs. They have reported that from around 12,500 during the year 1980, the number of

international NGOs that is working in different parts of the world has increased to 45,000 in the year 2000.

The non-governmental sector in the United States of America today accounts for a significant portion of overall economy (*www.independentSector.org*). As per the study made by Mandato (2003), 70% of American households contribute more than U.S. $ 700 billion each year to the NGO sector.

Poverty is one of the major problems in all the developing countries. The developing world has increasingly come to look at NGOs as a conduit for financial aid and assistance. The timely availability of credit to the rural masses and to the primary sector is crucial for the economic development of these countries. This remains a challenging task for most governments to meet the credit needs of this hinterland. Bangladesh has shown the way to the rest of the world with regard to the power of the NGO sector in alleviating the poverty that is prevalent among the rural masses. The emergence of the micro-finance industry in Bangladesh has presented a tremendous opportunity to extend financial services to the vast majority of the poor people. The micro-finance industry in Bangladesh consists of NGOs, cooperatives, public sector programmes and the Gramin Bank. In this winning trio, the Gramin Bank and the NGOs have played the major role in alleviation of poverty that is so prevalent in the hitherto neglected hinterland of Bangladesh. The country is now teeming with more than 1000 micro-finance NGOs (*http://www.gdrc.org/icm/country/bangla-001.html).*

The non-profit sector in India employs about 20 million people and attracts to the tune of INR 18000 crores of funding annually (*http://timesfoundation.indiatimes.co).*

The effectiveness of NGOs continues to remain an elusive concept (Herman and Renz, 2004). Making generalizations about management in the NGO sector is difficult, because the sector contains so many different types of organizations. But it has been found by many researchers that NGOs ultimately measure their success by the impact they have on their beneficiaries, their families, and the communities in which they live (Woller and Parsons, 2002). However, other researchers have considered different dimensions such as values, extent of control and flexibility, extent of stability and innovation etc (Campbell, 1977; Cameron, 1986; Quinn and Rohrbaugh, 1983; Herman and Renz, 1997, 1998). In this connection it may be pertinent to mention Bradshaw's (1998) contribution in this area, who has felt a need to develop a model for NGOs especially one that takes care of the governance aspects.

In line with the above arguments, the present study attempts to develop a conceptual model that tries to link the transformational leadership with NGO effectiveness in terms of different dimensions of performance measures for NGOs.

Studies of leadership have gone through several stages. Earlier no-one can deny the importance of leadership to the success of a corporation, and the chief executive officer (CEO) bears the responsibility of establishing effective leadership. Consequently, given present organizational realities, leadership skills have never been more important (Hagen and Morsheda, 1998). In periods of increasing disorder, leadership is the catalyst that enables one organization to differentiate itself from another and not only endure, but thrive. The concept of leadership has drawn great attention from scholars in various fields for several decades (Weiner, 1988; Yukl, 1989; Wang and Satow, 1994).

In this connection Yukl (1989) has noted the fact that 'the study of leadership has been an important and central part of the literature of management and organization behaviour for several decades'. Although much effort has been made to investigate leadership, there is no clear agreement on its conceptualization. Leadership has been defined as the 'ability to influence a group toward the achievement of goals' (Robbins, 2001, p. 446) and in today's dynamic world, we need leaders to challenge the status quo, to create visions of the future, and to inspire organizational members to convert the visions into a reality.

Earlier studies on leadership had probed into aspects of leadership such as traits of leaders, leadership behaviour, and situational variables within organizations. Later, the concept of transformational leadership was put forth by Burns (1978) and was further developed by Bass (1990). Bass had noted that 'there are almost as many different definitions of leadership as there are persons who have attempted to define the concept.'

Transactional and transformational leadership

Transactional Leadership involves an exchange between leaders and followers (Bass and Avolio, 1990b). These leaders 'give followers something they want in exchange for something the leaders want' (Kuhnert and Lewis, 1987, p. 649). Transformational Leadership exists when the employees are motivated to work for transcendental goals and higher-level self-actualizing needs, rather than external pay-offs (Bass and Avolio, 1990b).

In comparison to the results of transactional leadership, those of transformational usually lead to greater improvements and are generally considered to be 'of a higher order with respect to effort, development and performance' (Bass and Avolio, 1990b, p.241). Further, Bass (1997) has stated that in general, in many parts of the world, the prototype and idea for leadership is that of a transformational leader.

It is worth noting that several models have been proposed by various researchers to understand and explain the concept of various types of leaderships in commercial organizations, military organizations, sports organizations etc., but there is a severe lack of leadership models in case of non-governmental organizations (NGOs).

In light of the above discussion, the present paper develops and proposes a conceptual model that links transformational leadership with the different dimensions of NGO effectiveness.

Non-Governmental Organization (NGO)

'NGO' is a broad term encompassing a wide array of diverse organizations. These are private and non-profit organizations that are supposed to pursue activities to relieve suffering, promote the interest of the poor, protect the environment, provide basic social services, or undertake community development (World Bank, 1989). This, however, does not mean that all NGOs need to pursue all of the above activities to qualify as an NGO. Sen (1987) has viewed NGOs as a sector of society that had diverse entities operating under different paradigms and represents the nucleus of experimentation in grassroots development. According to the World Bank (1990), such organizations are, at times, referred to as not-for-profit organizations (NPOs). However the terms NGO and NPO have been used interchangeably in the NGO literature and as such no clear cut distinction has been made (Vakil, 1997: NGO Workshop, 1988). In this paper the term NGO is used to mean all such organizations.

The diversity of NGOs strains any simple definition. Nalinakumari and Maclean (2005) have reviewed different definitions of NGOs based on their classification. NGOs could be private agencies that support international development, or indigenous or religious groups organized nationally or regionally. They can be a group of citizens that raise awareness among the public and influence government policies. Various charitable and religious asscciations and groups that mobilize private funds and use them for development of society also are considered NGOs.

A workshop organized at the Asian Institute of Technology, Bangkok, in October 17-21, 1988 (*http://www.gdrc.org/ngo/wb-define.html*) adopted the following definition of an NGO:

- A nonprofit-making, voluntary, service oriented/ development oriented organization either for the benefit of its members or for other members of the population.
- An organization composed of private individuals who believe in certain basic social principles and who structure their activities to bring about development to communities that they are servicing.
- An independent, democratic non-sectarian people's organization working for the empowerment of economic and/or socially marginalized groups.
- Organizations established by and for the community, with or without interaction from the government, they include not only charity organizations, but also those that work in socio-economic-cultural activities.

Types of NGOs

Vakil (1997) has identified 17 types of NGOs and Flower (1997) has identified eight more types. However, Nalinakumar and Maclean (2005) have termed and categorized these eight types identified by Flower as 'NGO Pretenders', meaning that although they may be registered legitimately as NGOs but that serve none of the intended purposes.

The overwhelming varieties of NGOs make the problem of assessing the effectiveness even more problematic and challenging (Hermen and Renz, 1997).

Internationally, the main classification categories for NGOs cited in the literature are 'Northern' and 'Southern' NGOs. Northern NGOs work in industrialized and developed markets, while southern NGOs work in the Third World countries (Nalinakumari and Maclean, 2005).

World Bank classification

The World Bank has classified NGOs into two basic categories (The World Bank, 1990):

- Operational NGOs that design and implement development-related projects.
- Advocacy NGOs that defend or promote specific causes and influence policies and practices.

Some Indian cases

It has been observed that at times operational NGOs may also act as an advocacy NGO under certain circumstances. For instance in the vicinity of the proposed steel plants sites in the East Singhbhum and Seraikella-Kharsawan districts of the Jharkhand state in India, some NGOs which were previously working either independently or as support NGOs, changed their focus and took a stance to defend the interests of the people who would be displaced by the proposed steel plants.

Considering some more examples, NGOs like CARE that functions in the area of childcare and Pradan, which works for sustainable rural development, are operational NGOs because they are addressing the various developmental issues. NGOs like PETA, CRY and similar others could be termed as advocacy NGOs as they advocate for various causes, like PETA for ethical treatment of animals; CRY is India's leading advocate for child rights (*http://www.cry.org*). International NGOs such as Greenpeace, advocate for initiating environmental protection measures. Some NGOs can have both the advocacy and the operational components, for instance, the international NGO Oxfam, which provides aid as well as advocacy for health, education, and other social issues.

Based on the geographical coverage, the World Bank (1990) has further broken down these two NGOs types into three groups namely: community-based NGOs that serve a specific population in a narrow geographical area, national NGOs that operate in developing countries, and international NGOs that have their headquarters in developed countries and that carry out operations in more than one country.

Further classifications

Bratton (1989) has classified NGOs into two types: Indigenous and international. Esman and Uphoff (1984) have classified NGOs as local development associations, cooperatives, and interest associations. Fowler (1985) has classified NGOs based on accountability and resource control characteristics. Salaman and Anheier (1992) have proposed an International Classification of Non-Profit Organizations (ICNPO) that places NGOs into 12 major groups based on their primary economic activity. Brown (1991) has classified NGOs into four types of organizations: People organizations, which are basically community-based; developmental NGOs, which operate at the national level; international voluntary agencies; and bridging organizations, which act as mediatory institutions performing a range of functions including building associations, networking, and forming partnerships and coalitions among organizations.

Linda et al. (2001) have reported that the National Center for Charitable Statistics at the Urban Institute, San Francisco, U.S.A., has developed a system to classify the programme, services, and activities of public charities, called the Non-Profit Program Classification (NPC) System. Designed to serve a wide range of potential users, the system has been used to code the activities of each organization.

Effectiveness and Organizational Effectiveness

According to Pennings and Goodman (1977), effectiveness refers to an absolute level of either input acquisition or outcome attainment. Organizational effectiveness (OE) has been defined in a variety of ways but no single definition has been accepted universally (Cameron and Whetten, 1983). This is perhaps due to the fact that the concept of effectiveness is linked to the concept of the organization. The obvious approach to both defining and evaluating OE is to ask, to what extent does an organization reach its goal (Herman and Renz, 1997)? The underlying assumption in the question is that all organizations have measurable goals (Pfeffer, 1982; Elmore, 1978; Mohr, 1982).

Georgopoulous and Tannenbaum (1957, p. 534) have defined OE as 'the extent to which an organization as a small system, given certain resources and means, fulfils its means and resources without placing undue strain upon its members'. Concern with effectiveness, productivity, efficiency or excellence of organizations is a subject that has motivated the writings of economists, organization-theorists, philosophers, financial analysts, management scientists, consultants and practitioners (Lewin and Minton, 1986). Yet the empirical research has not contributed much to the development of the field of organizational effectiveness (Goodman, Atkin and Schoorman, 1983; Van de Ven, 1986).

Many researchers have realized that the approach to organizational effectiveness are conceptually conflicting (Cameron, 1986; Zammmuto, 1984), conceptually arid (Connoly et al, 1980), and that there is only a rudimentary understanding of what is actually involved in or con-

stitutes the concept of organizational effectiveness (Steers, 1975). Thus the explanation of effectiveness variation and the search for its true causal structure represent one of the most enduring themes in the study of organizations (March and Sutton, 1997).

Despite the plethora of research that has been done in this field it lacks unanimity in even defining 'organizational effectiveness' (Strasser et. al., 1981). The research in this area has resulted in a host of conflicting models of organizational effectiveness (Likert, 1969; Pfeffer, 1982; Zammuto, Quinn and Rohrbaugh, 1981, 1983; Cameron, 1986; Rainey and Steinbauer, 1999). A perusal of the above literature shows that there is no clarity about the factors that explain the term 'organizational effectiveness' and how it can be measured (Rainey and Steinbauer, 1999).

Organizational Effectiveness: A Review of Literature

Various researchers have attempted to bring an order to the various approaches to explain the concept of organizational effectiveness at different points of time.

A review of literature brought out the following basic approaches to understand the concept of organizational effectiveness:-

- The Goal Approach, that views the organizational effectiveness in terms of the extent of the goal achieved by an organization (Price, 1972; Frisby, 1986).
- The Systems Approach, views organizations as systems. Organizational effectiveness is conceptualized as the relationship between an organization and its environment (Yuchtman and Seashore, 1967) and is measured in terms of an organization's ability to acquire scarce resources.
- The Process Approach, that refers to the internal processes and general functioning within an organization such as the work environment and employee satisfaction. These processes enable the conversion of inputs to outputs (Chelladurai and Haggerty, 1991). 'The best known proponents of a process model are from the human relations approach to organizations' (Daft, 2004, p.70).
- The Multiple Constituency Approach, that has been believed to have been put forward in an attempt to ameliorate the weakness of the Goal, Process and Systems models by combining these perspectives (Tsui, 1990)

The goal approach of defining OE has been criticized by different commentators. First, according to Etzioni (1960) one of the major shortcomings of the goal approach was that studies in general found that most organizations did not effectively realize their goals. Second, an organization's formal goals might inadequately reflect its true purposes and so an evaluation based on such goals would be fruitless (Ghorpade, 1970).

Steers (1975) has studied 17 models of organizational effectiveness in terms of their primary evaluations, their normative or descriptive nature, their generalizations and has found little consistency in the evaluation criteria. Cameron (1986) has described five models of organizational effectiveness that include the following: system pressure, internal process, multiple constituency, competing value and fault driven. Meyer and Gupta (1994) have compared five models of organizational effectiveness, namely, the maximizing model, the political model, the contingency model, the business model and the paradoxical model and have observed that as over the last few decades the number of measures of business performance has increased many times and as the old measures of assessing effectiveness have become run down, there is a need to create new measures of effectiveness. Quinn and Rohrbaugh (1981) have reviewed the various models of organizational effectiveness and have tried to portray them with the help of one integrated model, which basically consists of three dimensions to describe organizational effectiveness. They have presumed that this model can cover all types of organizations.

Level of specificity for criteria

Cameron (1978) and others have observed that each type of organization, because of its different goals, attributes, environment, constituents, and histories, requires a unique set of effectiveness criteria. A study carried out by Jobson and Schneck (1982), designed to assess the organizational effectiveness of a police organization rejected using universal indicators of effectiveness (for instance, adaptivity, flexibility, participants satisfaction and turnover) and instead chose criteria specifically related to a police organization. Consequently, the current state of knowledge may not permit a proper understanding of the concept of OE as applicable to NGOs.

Mahoney (1967) has described OE from the standpoint of managers. More recently, Walton and Dawson (2001) have described OE using a manager's perspec-

tive. Their result suggests that similar values help describe the effectiveness criteria in a cohesion-based solution for managers and academics. Kimberly and Rottman (1984) have used the biographical approach to investigate the concept of OE. Shetty (1978) has used managerial power as the basis to study OE. He has explained the concept in terms of five sources of managerial power, namely, legitimate power, reward power, coercive power, expert power, and referent power. Blankhom and Gaber (1995) have used 'warm fuzzies' to assess organizational effectiveness. 'Warm' implies there are corporate ideals that few managers could take exception to, but 'fuzzy' implies that measurement issues make most managers uncomfortable with having their personal performance evaluated on these dimensions.

Thus, the complexity in defining OE arises primarily due to two underlying factors - there are different types of organizations, and there are differing perspectives of viewing these organizations. This has given rise to the multiplicity of the approaches to express the concept with the help of models.

Studies related to OE models

Since the beginning of the study on OE, there have been efforts to find a model which explains organizational effectiveness comprehensively (Rojas, 2000) such as Georgopoulos and Tanneubam Model (1957), the Mahoney Model (1967), the Friedlander and Pickle Model (1968), the Paine Model (1971) and the Georgopaolous and Matejko Model (1967), and the Competing Value Framework Model (Quinn and Rohrbaugh, 1981, 1983). Some of the models that explain organizational effectiveness have focused on the input or resource acquisition, some on the internal processes and some others on the outcomes or goals (Daft, 2004). The above are some of the examples of OE models for organizations in general. The Webb Model (1974) and the Mott model (1972) in contrast, are some of the models for explaining the effectiveness of NGOs in particular.

Quinn and Rohrbaugh (1981) have tried to give an integrated approach and combined all the above three approaches, namely, the resource acquisition approach, the internal processes approach, and the outcomes or goal approach. However, this study of literature has brought out the paucity of research work that address the issues of definition and measurement of effectiveness of non-governmental organizations.

Recently, Brainard and Siplon (2004) have identified two models that describe the roles of the non-governmental organization: The economic model, that emphasizes business-like methods, and the voluntary spirit model, that emphasizes participation and membership. According to them highly visible and professional nonprofit organizations must constantly struggle with the extent to which they are to emphasize their role as efficient and competitive economic actors or their role as institutions important to their democracy.

Some of the researchers believe that all the organizations are same, so a common set of variables can explain all the organizational effectiveness. However, studies have shown that this was not always true and that there were specific variables that determine the effectiveness of different kinds of organizations (Campbell, 1977; Cameron, 1986; Chelladurai and Haggerty, 1991; Herman and Renz, 1997). And this leads us to the fundamental questions of what is NGO effectiveness, how can it be measured, and hence how does one develop a model of NGO effectiveness.

The Concept Of NGO Effectiveness

The concept of NGO effectiveness too has been an elusive one. There have been various studies and approaches to define and make operational the concept of NGO effectiveness. Sorenson (1976) has studied 'Control Theory' to study the relationship between the type and extent of control on OE in 17 Scandinavian voluntary organizations and has reported that OE is more closely associated with the combination of high total control, democratic distribution of control and high level of agreement in the perception of control.

The twin problems of understanding and assessing the effectiveness of NGOs continue to challenge practitioners and scholars (Herman and Renz, 1997; Sowa et al., 2001). The self-evaluation too is ridden with difficulties (Sen, 1987). Factors such as diffused goals, lack of performance pressure, absence of formal systems and the perception of evaluation as a non-legitimate activity make self evaluation a non-priority area for most NGOs (Sen, 1987).

Theoretical perspectives

There are many approaches to measure organizational effectiveness relevant to the NGO sector. The contingency effectiveness approach of measuring the NGO effectiveness focuses on different parts of the organization. The focus could be on the way an organization acquires its resources (a resource-based approach), or it could be on the internal processes (internal processes

approach), or it could be the goal approach to assessing the organizational effectiveness.

Herman and Renz (1997) have found the contemporary perspective on OE to be especially relevant to research on NGOs, namely, the multiple constituency model (which is a modification of the goal approach) and the social constructionist, which is a more general or ontological perspective. The multiple constituency model recognizes that there are multiple stakeholders or constituents who are likely to use different criteria to evaluate OE (Kanter and Brinkoff, 1981; Zammuto, 1984, Tsui 1990). D'Anno (1992) has discussed multiple constituency models in relation to human service organizations.

Rojas (2000) has examined four organizational effectiveness models to determine which was more reliable for comparing the for-profit and non-profit organization effectiveness. According to him, the competing value framework (CVF) model developed by Quinn and Roharbaugh (1981) was the most dependable one. Yet the literature review reveals that there is a severe lack of models exclusively developed for the NPO effectiveness (Herman and Renz, 1997; Bradshaw, 1998; Sowa et al 2004).

Clearly, there are so many perspectives that it is sometimes suggested that NGO effectiveness may be described by the parable of the blind men and the elephant (Herman and Renz, 1997).

Indicators of NGO effectiveness

A number of indicators have been identified by senior non-profit executives using the Delphi process (Herman and Renz, 1997). In this process they have sought the views of the practitioners like chief executive officers, board members, staff, and funding agencies working in the field of NGOs, and have arrived at a number of indicators of OE. But there is hardly any universal set of indicators that can be used to measure NGO effectiveness (Herman and Renz, 1997).

Bradshaw (1998) has proposed four non-profit governance models based on the four dimensions namely: The extent of stability, the extent of innovation, the unitary dimension and pluralistic dimension. He has put these for dimensions on the two perpendicular axes. The four quadrants depicted the four models: The constituency model, the policy governance model, the entrepreneurial model and the emergent cellular model. He has proposed a hybrid model embracing the strength of the four models.

Determining what the best indicators to select could be an almost impossible task to perfect, as there are numerous measures (Campbell, 1977; Cameron, 1986) that have been argued to be important for assessing effectiveness (Sowa et al., 2004). Also, there is a significant lack of agreement on the definition and on how to make the concept of effectiveness operational for different types of organizations, especially NGOs. In addition, little work has been done to study the relationship between transformational leadership and organizational effectiveness in general, and NGO effectiveness, in particular. The present conceptual paper introduces a multidimensional model to capture the relationship between transformational leadership and effectiveness of non-governmental organizations (NGOs). All NGOs have a management function and carry out certain programmes. Now, these two aspects of functioning of NGOs – management and programmes, could be measured in terms of their capacity and outcomes, thus giving rise to the four dimensions of organizational effectiveness, namely, *management capacity*, *programme capacity*, *management outcomes*, and *programme outcomes*, as described by Sowa et al. (2001). Finally, the model proposes that *programme outcomes* could be a useful and measurable indicator of NGO effectiveness.

Dimensions of variables in the model

Transformational leadership

The early studies on leadership led to understanding of leadership and laid the groundwork for the development of transactional and transformational theories. Bass and Avolio (1995) have introduced the characteristics or dimensions associated with transformational leadership: *individualized consideration, idealized influence (charisma-attributed), idealized influence (behaviour), inspirational motivation, and intellectual stimulation.*

Individualized consideration involves a leader paying special attention to the needs for achievement and growth of each individual by acting as a mentor. By using this characteristic, leaders develop each employee successively higher levels of potential within the organization.

Idealized influence (behaviour) involves leaders acting as role models for subordinates. The leader models behaviours that indicate high standards of moral and ethical conduct. The leader has a vision and a strong sense of mission that he or she shares with subordinates. Also he or she makes sure to share risks with employees, causing subordinates to identify with them and try to emulate them (Bass and Avolio, 1990a, 1994, 1995).

Idealized influence (charisma-attributed) refers to the situation where the leader uses behaviours such as considering the needs of others over his or her own, in order to inspire trust, respect, and admiration of their employees (Bass and Avolio, 1995).

Inspirational motivation involves behaving in a way that provides meaning and challenge to subordinates' work. This helps to motivate and inspire those around the leaders. The leader makes sure that he or she communicates clearly stated expectations and motivates employees to strive to meet these goals. This can include the use of symbols and metaphors to increase understanding (Bass and Avolio, 1994; Ohman, 2000).

Intellectual stimulation encourages creativity among employees. Employees are facilitated to become more effective and creative problem solvers and are challenged to meet their full potentials (Bass and Avlio, 1995, Ohman, 2000).

NGO-related dimensions

One of the greatest challenges facing the NGOs today is the ability to effectively measure the impact of the programmes they are bringing to the community and ultimately to the beneficiaries. This is simply a measurement of how effective the programme is, and is called programme capacity (http://www.allwildup.com/Effectiveness.html, dated 11-10-2006). An assessment of how closely the NGO's mission is aligned with community needs and how well its programmes advance its mission and achieve their desired outcomes is the matter of importance to the funding sources, donors, clients and other partners. This assessment of programme effectiveness also helps in identification of the needed improvements.

Management capacity is composed of the following management practices and systems: A formal mission statement, a strategic plan, the human resource systems, an independent financial audit, and an information technology system or systems (Sowa et al., 2004).

Management outcomes captures how well the management capacity, the structures and processes, work in terms of the degree to which the employee of the organization are successfully managed and the degree to which the management structures and processes generate sufficient resources to maintain the operations of the organization (Hall, 1999; Rainey,1997; Scott,1998).

Programme outcomes measure the impact or effect of the outcomes on the consumers of the outcomes. It has objective measures which measures the extent of the goal achieved against a set benchmark or target. It has a perceptive measure which measures the client satisfaction (Sowa et al., 2004).

Operationalizing the dimensions

Our model could be conceptualized as an output-oriented model for the NGO sector since in the ultimate analysis, the outcome of the functions being carried out by these organizations would reflect the effectiveness of these organizations. The outcomes may be measured using objective measures such as human resource measures (e.g. employee turnover), existence of mission statement and that of written financial policies. The measurement of outcome or results would also include some perceptive measures, as the perception or 'meanings' the employees and clients assign to these sub-dimensions of management and programmes has an impact on how phenomena influence organizational operations (Herman and Renz, 1999). Some of the perceptive measures are perception of training provided, perceptions of management infrastructure, job-satisfaction, etc. (Sowa et al. 2001, 2004). A list of these objective and perceptual measures is given in Table 1.

Proposed conceptual model

Different commentators have attempted to tap the multi-dimensional aspects of organizational effectiveness (Cameron, 1978; Quinn and Roharbaug, 1981, 1983; Rojas, 2000; Herman and Renz, 1997; Sowa et al., 2001). In line with the above, a multi-dimensional model is proposed here to capture ramifications of multiple facets of the functions and programmes being undertaken by NGOs.

The external factors have not been explicitly captured in our model, though a review of literature indicated that non-profit organizations are subjected to a range of external factors, such as political change, pressure to demonstrate performance, change in donor profile and the donor agencies, and so on. Some authors have focused on external factors in developing criteria of performance or effectiveness emphasizing the relationship of an organization to its environment (Seashore and Yuchtman, 1967). Snavely and Tracy (2002) have found that a number of environmental factors such as location of the NGOs, race relations, government policies and mandates, nonprofit leadership, and organization financial and political resources have powerful effects on the NGOs and on creation and collaboration of trust. But the external factors are too many and not all of them are

Table 1: Dimensions and their measures

Dimensions Management Outcomes	Objective measures Employee turnover	Perceptual Measures Job satisfaction (Employees' perception)
Management Capacity	• Informational Technology systems. • Existence of a mission statement and the extent of adherence to it. • Existence of written financial policies and the extent of adherence to them. • Training expenditure per staff per annum. • Annual performance evaluation. • Starting salary of employees (both office and field staff).	• Management infrastructure (employees' and beneficiaries' perception). • Perception of feedbacks (by the staff). • Perception of training provided (by the staff). • Satisfaction with salary (staff's perception).
Programme Capacity	• The extent to which the physical and the financial aspects of the programme are matched to their goals. • Educational level of the staff. • Number of years of experience of the field staff in the field programmes	• The perceived relevance of the programmes (beneficiaries' perception).
Programme outcome	• The extent of goal achieved: a) Financial goals b) Physical goals • The measurable change occurred to target population.	• Perception of the beneficiaries of the programme. • Change resulted from the programme (the perception of the beneficiaries).

determinable. So they can, at the best, be assumed to just exist. Hence, they are part of this model, keeping in mind that we are not measuring the effect of these externalities or external factors but are simply trying to propose a model under a given set of external factors.

As explained above the proposed model attempts to capture the link between transformational leadership and NGO effectiveness through a measure of programme outcomes. Transformational leadership, which is posited to be an exogenous latent variable, is measured on four dimensions, namely, idealized attributes, idealized behaviour, inspirational motivation, intellectual motivation and individualized considerations. These dimensions have been explained above. The model seeks to measure management capacity, programme capacity, management outcomes, and programme outcomes with the help of the subjective and objective measures as detailed in Table 1.

Based on these assumptions and theoretical framework a conceptual model has been developed that posits the inter-relationship among transformational leadership and the dimensions such as management performance, programme performance, management outcomes, and programme outcomes. The model is presented in Fig. 1.

The proposed model seeks to capture the nuances of NGO effectiveness in terms of the outcome of the interplay among the functions and roles of NGOs in terms of management capacity, management outcomes, programme capacity, and programme outcomes. In the model, transformational leadership is an exogenous latent construct, whereas, management capacity, programme capacity, management outcomes and programme outcomes are endogenous latent constructs. In general, in comparison to the results of transactional leadership, those of transformational usually lead to greater improvements and are generally considered to be 'of a higher order with respect to effort, development and performance' (Bass and Avolio, 1990b, p.241). An improved quality of transformational leadership may lead to an increased level of management capacity. It is posited that management capacity leads to the certain management outcomes, which in turn, has a bearing on the programme outcomes. On the other hand, the programme capacity too leads to certain programme outcomes. Further, the model posits that quality of transformational leadership may directly influence the programme outcome, and would indirectly affect the programme outcomes through management capacity, programme capacity and management outcomes.

Our model posits that under a given set of external factors, NGO effectiveness could be explained in terms of programme outcomes. This is primarily due to the fact that in the case of NGOs, the beneficiaries are the ones for whom the whole mechanism of organization primarily thrives. The management of the NGOs functions to

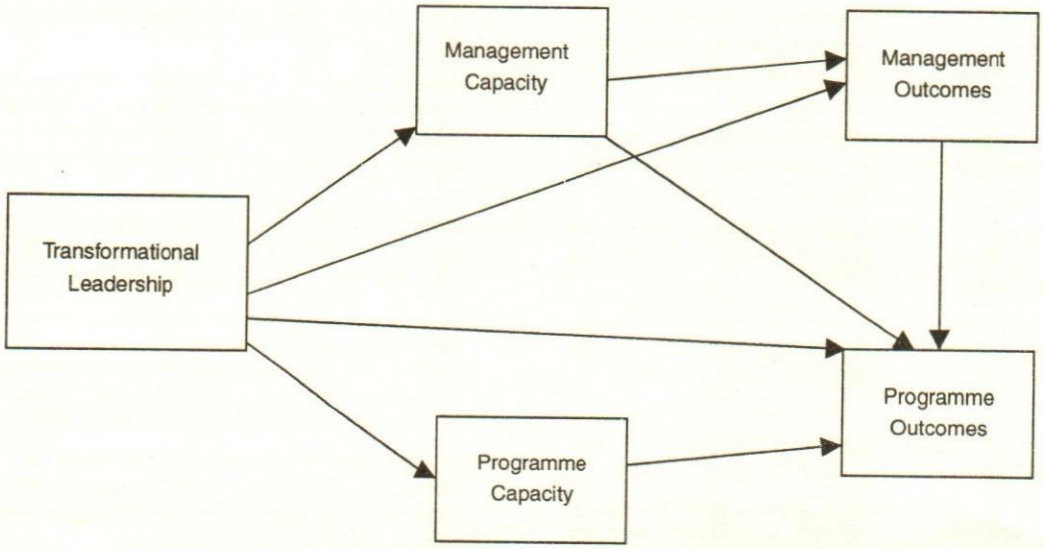

Fig. 1. The Proposed Model

effectively deliver the goods to the target population for whom the NGOs were created in the first place. The programmes too are directed towards the serving these beneficiaries. The management may be working efficiently, the programmes may also be very ambitious, but they may not get translated into the outcomes that would be real benefit to the target audience. Therefore, the actual effectiveness of the outcomes of the programmes being carried out by of the NGOs, as perceived by the beneficiaries, could reflect NGO effectiveness.

Conclusions

The paper has attempted to fill the gap that exists in the field of understanding the relationship between transformational leadership and NGO effectiveness by proposing a model that is both simple and has the requisite flexibility in the sense that it can be used and adopted for a variety of NGOs.

The indicators of all the constructs used in the model have been incorporated. In the proposed conceptual model presented, transformational leadership in non-governmental organizations working in different regions in India is posited to have a direct impact on the effectiveness of these organizations and indirectly through other factors that impact NGO performance such as management outcome or programme capacity.

The significance of this proposed model is apparent in both its contributions to the literature as well as to the organizations in general and NGOs in particular. The proposed model can be tested for various types of NGOs and the results thereof can serve to advance the understanding of relations among leadership, and organizational effectiveness in such organizations.

The model has not yet been tested and an advanced modeling tool such as structural equation modeling could be used to validate the proposed conceptual model. The paper and the model could impact a clearer conceptual understanding of the functioning and effectives of NGOs in the Indian context.

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Feature

Economic Impact of Cement Dust Pollution on Workers with Special Reference to Virudhunagar District of Tamil Nadu

A. Marimuthu & D.B. Varadarajan

This paper presents the result of a survey carried out during 1999-2000 on a cement industry in Virudhunagar district, Tamil Nadu. It draws attention to the need of keeping the factory area and its surroundings as pollution-free as possible.

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One of the most serious threats faced today by mankind is the pollution of our environment. In fact, most of the developed countries have already realized the fact that the very existence of life on the earth may be endangered, if suitable steps are not taken for prevention, control and abatement of environmental pollution. This is why industrialized and developed nations are spending large amounts of money to control the environmental pollution. The developing countries are beginning to follow their example within the constraints imposed by the limited financial resources and the scarcity of trained manpower.

Problem Focused

The cement industry is a major source of pollution. It is a major energy consumer, that is, all the cement units need to use a little over five per cent of all energy sources. Making of a ton of cement would require grading of about 2.5 tons of raw materials, intermediate products and solid fuels.

Cement kiln dust emanating from cement factories is a mixture of calcium, potassium, aluminum, sodium and silica oxides.

The cement factory is one such source of particulate air pollutants, emitting large quantities of cement kiln dust into the atmosphere. Generation of dust form a cement factory is mainly through rotary kiln, coal mill and cement crushers. Majority of the kiln dust is emitted through the chimney at the top of the stack if there is not proper emission control device.

Even with heat saving methods, about 100-110 kg of coal and flame temperature over 1500°c would be needed

per ton of cement. Depending on the process employed and the degree of sophistication, manufacture of one kg of cement would give rise to sometimes 14 m^3 of exhaust air and gas; 35 per cent of raw materials would be driven away as carbon and water vapour. These quantities of air and gas have to be cleaned before being discharged into the atmosphere.

Most of the cement units in India use coal as fuel, and coal is a highly polluting fuel. The main problem with the Indian cement factories is that they were not adopting proper pollution prevention processes. They generated more than 600 grams of dust per cubic metre of air.

In the process of manufacturing cement, the emission of dust particles immediately and constantly affects the residents residing in nearby factories, affecting even breathing. It affects the health of people and reduces their life expectancy rate. This leads to loss of mandays, thereby reducing the productivity of labour.

This paper attempts to present the results of a research study carried out during 1999-2000, on a cement industry located in Ramasamay Raja Nagar of Virudhunagar District of Tamil Nadu.

So far no serious and scientific investigations have been carried out on the environmental and economic problems of Madras Cements Limited, Ramasamy Raja Nagar of Virudhanagar district of Tamil Nadu. The available literature on the study of economic impact of dust pollution of cement industry like Madras Cements Limited is very scanty. The present study is an attempt to fill this gap in order to analyse the economic impact of cement dust pollution on workers.

Hypothesis

- Medical expenses in no way correlate to the years of service of the workers in Madras Cements Limited.
- Services and number of days suffered by diseases are independent.
- Medical expenses are not related to the number of days lost on account of a disease.
- Years of service and the number of days suffered by nuisance are independent.
- Private treatment is not associated with the medical expenses, the number of days lost by disease and nuisance.

Methodology

It is understood that the impact of cement dust pollution is causing concern not only in the neighbourhood of the factory, but also in the surrounding areas/villages in a 5 to 10 km radius distance. The manpower in the Madras Cement Limited, Ramasamy Raja Nagar are classified into three categories namely, executives, staff and workers in the factory, mining and in marketing. The total strength is 745.

Out of this, 445 are working in the factory. 50 executives are not included in the study, because they are not affected by the dust pollution, since they live away from the factory, and within the factory they work in non-polluting sophisticated rooms.

Hence, the present study has drawn samples only from staff and workers within the factory. Among these two categories (395) 150 are selected by simple random sampling technique. This forms 37.98% of the total number of staff and workers working within the factory.

Tools for Analysis

The correlations coefficient has been used for the relationship between the services and medical expenses, services and number of days suffered by diseases, and medical expenses for diseases, services and number of days suffered by nuisance and private treatment of the workers in the study unit.

Whether change in the medical expenses between working section and category of the workers, the ANOVA has been used.

Results and Discussion

It is inferred from Table 1, that there is a positive and significant correlation among the variables, namely, services and medical expenses (0.5117), number of days suffered by disease (0.6147) and number of days suffered by nuisance (0.5056). It shows that any change in the services effects a change in other variables namely medical expenses, number of days suffered by disease and nuisance in the same direction.

Further, the results revealed that established null hypothesis, namely medical expenses, is in no way related to the services of the workers of the cement factory service, number of days suffered by disease are independent and service and number of days suffered

Table 1: Correlation Matrix Between Inter-Related Variables of Occupational Diseases and Nuisance

Variables	Years of Services (1)	Medical Expenses (2)	No. of days Suffered by Diseases (3)	No. of days Suffered by Nuisance (4)	Private Treatments (5)
Years of Services (1)	–				
Medical Expenses (2)	0.5117*	–			
No. of days Suffered by Diseases (3)	0.6147*	0.6546*	–		
No. of days Suffered by Nuisance (4)	0.5056*	0.1042	0.1712	–	
Private Treatments (5)	0.1481	0.6068*	0.5147*	0.5461*	–

* Indicates the correlation coefficients are significant at 5 per cent level.

Table 2: Analysis of Variance of Medical Expenses for Disease Between Working Section and Category of the Workers

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F	Significant of F
Between working section (X_4)	5	36418510.614	7283702.123	2.491	S
Between Category	2	22714857.095	11357428.548	3.885	S
Between working section and category	9	83411018.551	9267890.950	3.170	S
Explained	16	132304807.569	8269050.473	2.828	S
Residual	133	388862153.931	2923775.593	–	–
Total	149	521164961.500	3497764.842	–	–

S – Significant at 5 per cent level.

by nuisance are rejected. Hence, it is concluded that medical expenses, number of days suffered and nuisance are associated with the services of workers in Madras Cements Limited.

Further, the computed correlation coefficient between the number of days suffered by disease and medical expense (0.6546) is positive. Hence, the established null-hypothesis is rejected and it is enclosed that there is a correlation between medical expenses and number of days suffered by the disease.

The correlation coefficient between the variable, namely, medical expenses, number of days suffered by diseases and nuisance and private treatment, are statistically significant and positive. It shows that any increase in this variable effects increase in the same direction of private treatment. Hence, the stated null-hypothesis is also rejected. Thus, it is concluded that the private treatment is highly dependent as medical treatment of workers and number of days suffered by disease and nuisance.

To test the significance of difference in medical expenses for disease between working section and category of the workers, a two-way ANOVA test is carried out.

It is observed from Table 2 that there is a significant variation in the Medical Expenses for diseases between working sections of the workers (2.491) and other categories (skilled, semi-skilled and unskilled) of the workers (3.885). The two interactions effect between groups and between worker is also significant.

For the null-hypothesis that there is no significant variation in medical expenses for nuisance between working section and category of workers, the two-way ANOVA test is carried out.

The results of two-way analysis of variance test revealed that the observed F-value (1.697) was not significant for workers between working section. It indicates that there is no significant variation in the medical expenses for nuisance between the workers in different working sections in the Madras Cements Limited, Ramasamy Raja Nagar. Further, the observed 'F' value (6.100) was found to be significant for workers between

Table 3: Analysis of Variance of Medical Expenses for Nuisance Between Working Section and Category of the Workers

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F	Significant of F
Between working section (X_4)	5	1096132.551	219226.510	1.697	NS
Between working Category (X_5)	2	1576271.672	788135.836	6.100	S
$X_4 - X_5$	9	5829363.032	647707.004	5.013	S
Explained	16	7721460.577	482591.286	3.735	S
Residual	133	17182710.256	129193.310	–	–
Total	149	24904170.833	161742.086	–	–

NS - Not Significant, S - Significant at 5 per cent level.

different categories. It implies that there is a significant variation in the medical expenses for nuisance between workers in different categories.

But, the two-way interaction effect between working section and category of workers is found to be significant (5.013) at 5 per cent level. It implies that workers working in different sections and categories have caused the variations in the medical expenses for nuisance. Hence, the null-hypothesis does not hold good. Thus, it concluded that different categories and sections of workers have contributed for variations with medical expenses for nuisance in the study area.

Findings of the Study

It is inferred that out of 150 workers, the number of workers affected by asthma, allergy, tuberculosis, heart problem, skin disease, breathing problem, digestion problem and eye irritation are 28, 25, 10, 5, 11, 4, 38, 2 and 2 respectively.

It is inferred that there is a positive and significant correlation among the variables, namely services and medical expense (0.5117), number of days suffered by disease (0.6147) and a number of days suffered by nuisance (0.5056). It shows that any change in the service effects changes in other variables, namely medical expenses, number of days suffered by disease and nuisance in the same direction.

Further, the computed correlation coefficient between the number of days suffered by disease and medical expenses is positive (0.6546). Hence it is concluded that there is a correlation between medical expenses and number of days suffered by disease. The ANOVA test showed that there is a significant variation in the medical expenses for diseases between working section and the category of the workers (skilled, semi-killed and unskilled). The interaction effect between groups and between workers is also significant.

The results of Two-way ANOVA revealed that the observed 'F' value (1.697) was not significant for workers between sections. It indicates that there is no significant variation in the medical expenses for nuisance between the workers in different working sections and in different category. Further, the observed 'F' value (6.100) was found to be significant for workers. It implies that there is a significant variation in the medical expenses for nuisance between workers in different categories.

The two-way interaction between working section and the category of workers is found to be significant (5.013) at 5 per cent level. Thus, it is concluded that different categories and sections of workers have contributed to variations with medical expenses for nuisance as in Madras Cements Limited, Ramasamy Raja Nagar.

Suggestions

The Madras Cements Limited, Ramasamy Raja Nagar provided Rs. 25.96 per worker per month as dust allowance. This amount should be spent for the purpose for which the amount is given. Hence, it is the responsibility of the workers to safeguard their health. Steps should be taken by the government and the factory to educate the workers and advise them to undergo periodical medical check-ups. This will reduce the health problems. Further, various Departments of the State and Central Government, the employees, trade unions and the voluntary organizations should organize seminars, conferences, workshops and such other activities for the workers to raise the awareness of the impact of cement dust pollution, so that they can undergo periodical medical treatment.

The experiences of many industrial countries prove that a tall chimney or stack is the best answer to control air pollution problems. Hence, it is suggested that the height of the stack of the Madras Cements Limited is to be further raised.

The researcher observed that the maintenance cost of the pollution control equipment like electrostatic precipitators and bag filters is higher than the installation charges of these equipment. Therefore, many times these pollution control equipment are kept idle. Hence, the government should bear the maintenance cost of such equipment for the benefit of the society.

Conclusion

Being a highly profit oriented industry, the cement industry must have a social and moral responsibility to produce the product in a more clean manner and to follow the strict environmental standards prescribed by the Government. This voluntarism is the only way to overcome all kinds of environmental problems. If the present study has done a little to draw the concerted attention of the big tycoons of the cement factory and the concerned officials, to the needs for keeping the factory area and surroundings pollution-free as much as possible, the purpose of this research work would have been amply fulfilled.

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Markets change, tastes change, so the companies and the individuals who choose to compete in those markets must change.

– An Wang

News & Notes

Food Security in Asia: A Statistical Overview

Concepts of food security

The initial focus, reflecting the global concerns of 1974, was on the volume and stability of food supplies. Food security was defined in the 1974 World Food Summit as "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices"

In 1983, FAO expanded its concept to include securing access by vulnerable people to available supplies, implying that attention should be balanced between the demand and supply side of the food security equation "ensuring that all people at all times have both physical and economic access to the basic food that they need"

In 1986, the highly influential World Bank report "Poverty and Hunger" focused on the temporal dynamics of food insecurity. It introduced the widely accepted distinction between chronic food insecurity, associated with problems of continuing or structural poverty and low incomes, and transitory food insecurity, which involved periods of intensified pressure caused by natural disasters, economic collapse or conflict. This concept of food security is further elaborated in terms of "access of all people at all times to enough food for an active, healthy life".

By the mid-1990s food security was recognized as a significant concern, spanning a spectrum from the individual to the global level. However, access now involved sufficient food, indicating continuing concern with protein-energy malnutrition. But the definition was broadened to incorporate food safety and also nutritional balance, reflecting concerns about food composition and minor nutrient requirements for an active and healthy life. Food preferences, socially or culturally determined, now became a consideration. The potentially high degree of context specificity implies that the concept had both lost its simplicity and was not itself a goal, but an intermediating set of actions that contribute to an active and healthy life.

The 1994 UNDP Human Development Report promoted the construct of human security, including a number of component aspects, of which food security was only one. This concept is closely related to the human rights perspective on development that has, in turn, influenced discussions about food security. (The WIDER investigation into the role of public action into combating hunger and deprivation, found no separate place for food security as an organizing framework for action. Instead, it focused on a wider construct of social security which has many distinct components including, of course, health and nutrition).

The 1996 World Food Summit adopted a still more complex definition "Food security, at the individual, household, national, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life".

This definition is again refined in The State of Food Insecurity 2001 "Food security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"

This new emphasis on consumption, the demand side and the issues of access by vulnerable people to food, is most closely identified with the seminal study by Amartya Sen. Eschewing the use of the concept of food security, he focuses on the entitlements of individuals and households.

Table 1: Age group Share in Total Population (%)

Country	Age group	1969-71	1979-81	1990-92	2001-03	2002-04	2015	2030	2050
Bangladesh	00-04	17.8	16.8	15.7	13.5	13.2	10.8	8.5	6.5
	05-17	34.8	34.6	33.5	32.0	31.7	27.5	22.6	17.5
	18-59	41.7	43.4	46.0	49.4	49.9	55.5	59.1	59.4
	60+	5.8	5.2	4.8	5.1	5.1	6.3	9.8	16.6
China	00-04	15.9	10.0	10.0	7.2	7.1	6.5	5.4	5.2
	05-17	31.3	32.5	22.9	21.4	21.0	16.7	15.4	14.2
	18-59	46.0	50.0	58.4	61.0	61.4	61.9	55.5	50.6
	60+	6.8	7.4	8.7	10.4	10.5	14.8	23.6	30.0
India	00-04	15.6	14.1	13.5	11.4	11.1	9.3	7.4	6.1
	05-17	31.6	31.4	29.4	28.3	28.1	24.0	20.4	16.2
	18-59	46.8	48.1	50.2	52.5	52.9	57.1	58.4	57.5
	60+	6.0	6.5	6.9	7.7	7.8	9.6	13.8	20.1
Indonesia	00-04	16.5	14.7	12.1	10.0	9.8	8.4	6.7	5.8
	05-17	32.4	32.6	30.3	26.0	25.6	22.1	18.6	15.8
	18-59	45.8	47.1	51.4	56.0	56.5	59.9	59.8	55.2
	60+	5.2	5.5	6.3	7.9	8.0	9.7	14.9	23.1
Nepal	00-04	16.1	15.9	16.0	14.8	14.6	12.2	10.0	7.6
	05-17	31.5	32.4	32.4	32.5	32.4	30.2	25.3	20.4
	18-59	46.8	46.2	46.1	46.8	47.0	51.1	56.4	58.8
	60+	5.7	5.6	5.6	5.8	5.9	6.5	8.3	13.3
Pakistan	00-04	16.6	16.9	17.0	15.4	15.3	13.8	10.5	7.6
	05-17	32.2	32.0	32.4	33.5	33.3	31.1	27.1	20.7
	18-59	45.6	45.7	45.1	45.4	45.7	48.8	54.5	59.1
	60+	5.6	5.4	5.5	5.7	5.7	6.3	7.8	12.6
Philippines	00-04	17.3	16.2	14.8	12.5	12.2	10.0	7.9	6.3
	05-17	35.8	34.4	33.1	31.1	30.8	25.9	21.5	16.6
	18-59	42.0	44.5	47.1	50.7	51.1	56.3	58.8	57.3
	60+	4.8	4.9	4.9	5.7	5.9	7.7	11.8	19.8
Sri Lanka	00-04	13.6	12.3	10.0	8.0	7.9	7.0	5.9	5.3
	05-17	33.5	29.3	27.2	22.5	21.9	18.6	16.2	14.4
	18-59	46.9	51.3	54.1	59.4	59.8	60.6	56.7	51.0
	60+	6.0	7.1	8.7	10.2	10.3	13.9	21.2	29.3
Thailand	00-04	16.9	13.3	9.9	8.5	8.4	7.1	6.2	5.5
	05-17	35.5	33.8	27.8	22.4	21.9	19.3	16.5	14.8
	18-59	42.7	47.7	55.7	60.4	60.6	61.1	57.5	52.0
	60+	4.9	5.2	6.5	8.8	9.0	12.5	19.8	27.6
Viet Nam	00-04	17.1	15.4	14.1	9.5	9.5	8.7	6.5	5.9
	05-17	34.3	33.9	31.4	28.8	28.1	21.2	18.9	15.5
	18-59	41.2	43.3	47.2	54.2	55.1	61.4	59.5	53.8
	60+	7.5	7.4	7.3	7.4	7.4	8.7	15.1	24.8

Source: Calculated from data supplied by UN Population Division. 2002 Revision. *World Population Prospects.*

The international community has accepted these increasingly broad statements of common goals and implied responsibilities. But its practical response has been to focus on narrower, simpler objectives around which to organize international and national public action. The declared primary objective in international development policy discourse is increasingly the reduction and elimination of poverty. The 1996 WFS exemplified this direction of policy by making the primary objective of international action on food security halving of the number of hungry or undernourished people by 2015.

Essentially, food security can be described as a phenomenon relating to individuals. It is the nutritional status of the individual household member that is the ultimate focus, and the risk of that adequate status not being achieved or becoming undermined. The latter risk describes the vulnerability of individuals in this context. As the definitions reviewed above imply, vulnerability may occur both as a chronic and transitory phenomenon. Useful working definitions are described below.

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept to the family level, with individuals within households as the focus of concern. (*This Information is compiled from the website* http://www.fao.org/DOCREP/005/Y4671E/y4671e06.htm*).*

Table 1 shows the proportion of the population of different age groups to the total population and the data refer generally to the present-in-area (de facto) population, total and for different age groups, within the present geographical boundaries. The reference periods are following 3-year averages 1969-1971,1979-1981,1990-1992, 1993-1995,1995-1997,2001-2003, 2002-2004 including Long Term Projections (2015, 2030, 2050). China, refers to China Mainland, Hong Kong SAR, Macao SAR and Taiwan Province.

Table 2 gives the Agricultural Population density defined as the Agricultural Population per Hectare of Arable & Permanent crops Land (persons/ha). It is to be noted that the *"Agricultural Population"* is defined as all persons depending for their livelihood on agriculture, hunting, fishing or forestry and the estimate comprises of all persons actively engaged in agriculture and their non-working dependants. In this case, *"Permanent Crops Land"* is considered as the land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee and rubber; this category includes land under flowering shrubs, fruit trees, nut trees and vines, but excludes land under trees grown for wood or timber. Such data are regularly compiled by FAO.

Table 2: Agricultural Population per Hectare of Arable & Permanent crops Land (persons/ha)

Country	1969-1971	1979-1981	1990-1992	2001-2003
Bangladesh	6.1	6.7	8.0	9.1
China	6.3	7.4	6.4	5.5
India	2.3	2.6	2.9	3.3
Indonesia	2.9	3.1	3.1	2.7
Nepal	5.9	6.1	7.5	9.2
Pakistan	2.2	2.6	3.0	3.5
Philippines	2.8	2.6	2.8	2.8
Sri Lanka	3.6	4.1	4.4	4.5
Thailand	2.0	1.6	1.5	1.6
Viet Nam	5.4	5.9	7.4	6.0

Source: FAO Statistics Division.

Table 3: Poverty headcount, (share of population)

Country	Reference Year	(Percent)
Bangladesh	2000	49.8
China	1998	4.6
India	2000	28.6
Indonesia	1999	27.1
Nepal	2003	30.9
Pakistan	1998	32.6
Philippines	1997	36.8
Sri Lanka	1995	25
Thailand	1992	13.1
Viet Nam	2002	28.9

Source: World Bank.

Table 3 gives the National poverty rate or Poverty headcount index which is the percentage of the population living below the national poverty line deemed appropriate for the country by its authorities. National estimates are based on population-weighted subgroup estimates from household surveys. Here, China refers to only Mainland China.

Income inequality is the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within a country deviates from a perfectly equal distribution. The inequality of income is measured with a Gini coefficient ranging

from 0 (represents perfect equality) to 100 (implies perfect inequality). The Gini coefficient measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. A Lorenz curve plots the cumulative percentages of total income against the cumulative number of individuals or households, starting with the poorest.

Table 4: Food Need in Asia

Country	Minimum Dietary Energy Requirement (kcal/person/day)					
	1969-1971	1979-1981	1990-1992	1995-1997	2001-2003 provisional	2002-2004 preliminary
Bangladesh	1 720	1 730	1 740	1 750	1 770	1 780
China	1 850	1 890	1 910	1 920	1 930	#N/A
India	1 770	1 780	1 790	1 800	1 820	1 820
Indonesia	1 750	1 770	1 810	1 820	1 840	1 840
Nepal	1 800	1 800	1 800	1 800	1 810	1 810
Pakistan	1 760	1 760	1 750	1 760	1 770	1 770
Philippines	1 740	1 760	1 770	1 780	1 800	1 810
Sri Lanka	1 780	1 800	1 830	1 840	1 860	1 860
Thailand	1 740	1 780	1 840	1 850	1 860	1 870
Viet Nam	1 730	1 750	1 770	1 800	1 840	1 840

Source: FAO Statistics Division.

Food need of the population (table 4) is given in terms of minimum dietary energy requirement. In a specified age and sex group, the amount of dietary energy per person is that considered adequate to meet the energy needs for maintaining a healthy life and carrying out a light physical activity. In the entire population, the minimum energy requirement is the weighted average of the minimum energy requirements of the different age and sex groups in the population. This is expressed in kcal per person per day.

Please note that the dietary energy consumption varies due to socio-economic levels and due to the sex-age composition, body weight and physical activity level, i.e. the factors determining dietary energy requirements. The estimates of inequality prepared by FAO take into account these two main components of variation. Two measures are used: The coefficient of variation and the Gini coefficient. The **coefficient of variation of dietary energy consumption**, is defined as a composite of the coefficient of variation of dietary energy consumption due to income (CV_I) and the coefficient of variation of energy requirements (CV_R) as follows: $CV^2 = CV\_I^2 + CV\_R^2$. The CV_I is estimated using household Survey data. The CV_R is estimated using demographic and anthropometric data and recommendations on dietary energy requirements. The Gini coefficient of dietary energy consumption is derived by FAO from the coefficient of variation of dietary energy consumption defined above, under the assumption of log-normal distribution.

Table 5: Inequality in Access to Food and to Income

Country	Income		Dietary Energy Consumption		
	Survey year	Gini coefficient (%)	Last survey year	Gini coefficient (%)	Coefficient of variation (%)
Bangladesh	2000	32	1981-1982	18	32
China	2001	45	1990	17	32
India	1999/2000	33	1990	18	34
Indonesia	2002	34	1987	15	28
Nepal	1995/96	37	1995	15	28
Pakistan	1998/99	33	1988	18	33
Philippines	2000	46	1987	17	31
Sri Lanka	1995	34	1986	16	28
Thailand	2000	43	1990	16	28
Viet Nam	1998	36	1993	17	32

Source: FAO Statistics Division

Table 6 gives the *"Prevalence of undernourishment in total population (%)"* indicates the proportion of the population in a condition of undernourishment where Undernourishment refers to the condition of people whose dietary energy consumption is continuously below a minimum dietary energy requirement for maintaining a healthy life and carrying out a light physical activity. The *"Prevalence of underweight in children under five years"* indicates the proportion of children under-five with weight less than that of 2 standard deviations below the median (moderate underweight) including weight less than that of 3 standard deviations below the median (severe underweight) of weight-for-age of the reference population as adopted by the World Health Organization.

The food consumption in Table No 7 refers to the amount of food available for human consumption as estimated by the FAO Food Balance Sheets. However the actual food consumption may be lower than the quantity shown as food availability depending on the magnitude of wastage and losses of food in the household, e.g. during storage, in preparation and cooking, as plate-waste or quantities fed to domestic animals and pets, thrown or given away. The dietary energy consumption per person is the amount of food, in kcal per day, for each individual in the total population.

Table 6: Undernourishment Scenario

Country	Prevalence of undernourishment in total population (%)					Prevalence of under nutrition in children under the age of five years (%)		
	1969-1971	1979-1981	1990-1992	2001-2003 provisional	2002-2004 preliminary	Latest survey year	Less than - 3 s.d	Less than - 2 s.d
Bangladesh	31	39	35	30	30	2004	10.3	45.9
China	46	30	16	12	12	2000	1.2	10.0
India	39	38	25	20	20	1998-99	17.7	46.7
Indonesia	47	24	9	6	6	2002	8.0	27.3
Nepal	56	52	20	17	17	2001	12.6	48.3
Pakistan	27	29	24	23	24	2001	9.9	35.0
Philippines	51	27	26	19	18	1998	5.2	31.8
Sri Lanka	22	20	28	22	22	2000	4.8	33.0
Thailand	29	23	30	21	22	1995	1.5	17.6
Viet Nam	32	37	31	17	16	2000	6.0	33.8

Source: FAO Statistics Division & WHO. 2006. Global Database on Child Growth and Malnutrition.

Table 7: Food consumption in Asia

Country	Dietary Energy Consumption (kcal/person/day)					
	1969-1971	1979-1981	1990-1992	1995-1997	2001-2003 provisional	2002-2004 preliminary
Bangladesh	2120	1980	2070	2000	2200	2200
China	1990	2330	2710	2910	2940	2930
India	2040	2080	2370	2440	2440	2470
Indonesia	1860	2220	2700	2880	2880	2890
Nepal	1800	1850	2340	2230	2450	2430
Pakistan	2250	2210	2300	2440	2340	2320
Philippines	1810	2220	2260	2360	2450	2490
Sri Lanka	2290	2360	2230	2290	2390	2390
Thailand	2110	2280	2200	2360	2410	2400
Viet Nam	2100	2030	2180	2380	2580	2630

Source: FAO Statistics Division.

Share (%) of food aid in total consumption gives the contribution of food aid shipments (cereals and non-cereal products) in total food consumption. Data on food aid in tonnes are converted in kilocalories using conversion factors by commodities in order to calculate the share of the food aid in the total Dietary Energy Supply (Table 8).

Food consumption refers to the monetary value of acquired food, purchased and non purchased, including non-alcoholic and alcoholic beverages as well as food expenses away from home (bars, restaurants, work canteens, etc.) Total consumption refers to the monetary value of acquired goods for consumption, food and non-food items, consumed by members of household. (Excludes non-consumption expenses such as direct taxes, subscriptions, insurance premiums, etc.) Table No 8 also gives the share (%) of food consumption expenditure in total consumption.

Table 8: Share of Food Aid and Food consumption expenditure in total consumption

Country	Food Aid (%)		Food consumption expenditure (%)		
	1990-1992	2001-2003	Before 1990	(Reference Year)	
Bangladesh	4.3	1.3	63.0	54.6	(2000)
China	NA	N.A	52.0		NA
India	0.2	0.1	64.0	49.5	(2004)
Indonesia	0.1	0.3	57.0	51.7	(2002)
Nepal	0.1	0.1	49.0		NA
Pakistan	1.6	0.8	44.0	48.3	(2001)
Philippines	0.7	0.8	54.0	43.5	(2003)
Sri Lanka	7.1	1.7	61.0	44.5	(2002)
Thailand	0.1	0.0	39.0	39.0	(2000)
Vietnam	0.4	0.3	NA		NA

Source: FAO Statistics Division

This database is prepared based on the data/ information compiled from the website http://www.fao.org/es/ess/faostat/foodsecurity/index_en.htm for further information on "Food Security" please visit the FAO website www.fao.org

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