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Contents

Focus

Liberalized Growth in Indian Agriculture: NAP 2000 and beyond

C. S. Sundaresan

The Government had taken several initiatives from 2000 onwards to ensure agricultural growth in India. This paper analyses how far Indian agriculture has responded to these new initiatives and discusses how the national farm policy framework can reverse the risks for farmers in order to bring the agricultural sector back onto the growth track.

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The economic performance of India in the post-reform period has been characterized by positive features across sectors. The average growth rate in the decade from 1992-93 to 2001-02 was around 6.0 percent. Though this new growth phase upgraded India's position to the group of fast growing developing countries in the 1990s, this growth was not significantly better than the annual average of 5.7 percent in the 1980s.

The value addition in this phase of economic growth, however, had been that it contained the characteristics of sustainability compared to earlier phases. The policy directions gained in the economic sectors have been attributed to this sustainability perception. For instance the economic growth experienced by India in the 1990s was accompanied by a remarkable stability in the external front, despite the East Asian (financial) crisis. At the social front, the poverty level also declined significantly in the post-reform period, at a faster rate than in the 1980s (Ahluwalia, 2000). From a financial perspective, India's growth during this phase had been largely accelerated by the availability of domestic savings, which had increased over the decades. Further, the efficiency of resource use has been observed as high, with a long incremental capital output ratio of around 4, which is comparable to best in the world (R Mohan, 2008).

Agriculture, being the dominant player for employment and livelihood of majority of the population, the common criticism of India's economic growth arising out of the reforms was that it has been excessively focused on industrial and trade policy, with less focus on farm sub-sectors for sustainable and inclusive growth. The stagnation or deceleration witnessed in the sector since the mid-90s has been one criticism, which was substantiated by the low (natural) growth levels in the agriculture sector in comparison to the high (explosive) growth experienced in the manufacturing and service sectors since the large-scale reform initiatives. This criticism was, however, countered by the notion that trade policy reforms would help agriculture (indirectly) for higher

growth. This in fact was the beginning of a market driven growth perception for the sector through a demand side approach against the prevailing supply side management in the farm fronts. It has shown signs in the positive direction too. For instance the reduction of protection to industry, and the accompanying depreciation in the exchange rate tilted the relative prices in favour of agriculture and accelerated the phase of agricultural exports. The index of agricultural prices relative to manufactured products has increased by almost 30 percent in the 1990s (Ministry of Finance, 2003). The share of India's agricultural exports increased from 1.1 percent in 1990 to 1.9 percent in 1999.

The paradigm shift in the farm sector, however, could not catch up with the desired speed in the short run with the declining public investment (capital formation). It is worthwhile to mention in this context that public investment in agriculture has declined from 4.08 percent of the agriculture GDP in 1980 to 1.54 percent in 2002 (see fig 1). During the same period the food subsidy as share of the total government expenditure has increased from 2.33 percent to 3.64 percent. What this highlights is that India continued to pursue more of a supply side management strategy against the sustainable demand driven growth module. This inertia has adversely contributed to the efficiency of growth agents. The low investments implicated the crucial input sectors such as irrigation and drainage, soil conservation and water management systems, rural roads and transportation. Though the decline in crucial farm sector investments started much before the reform initiatives, it become sharper during the 1980s and 1990s (Gulati and Bathla, 2001). The reforms in the sector also could not accelerate the phase of investment from the market players. For instance, the growth in private investment in agriculture after the reforms was not enough to offset the decline in public investments. There is no clear documentation on why the private sector capital formation could not come up in the agri value chain. But generally it is agreed that the agri-eco system is not developed enough for private capital to go forward. In other words the viability gaps existing in much of the farm fronts pull the private capital from investing. It is believed in this context that enhanced initial public investment will be imperative in establishing a competitive agri-ecosystem for the private sector to gain confidence and thereby bring in higher investments gradually.

State of Capital formation

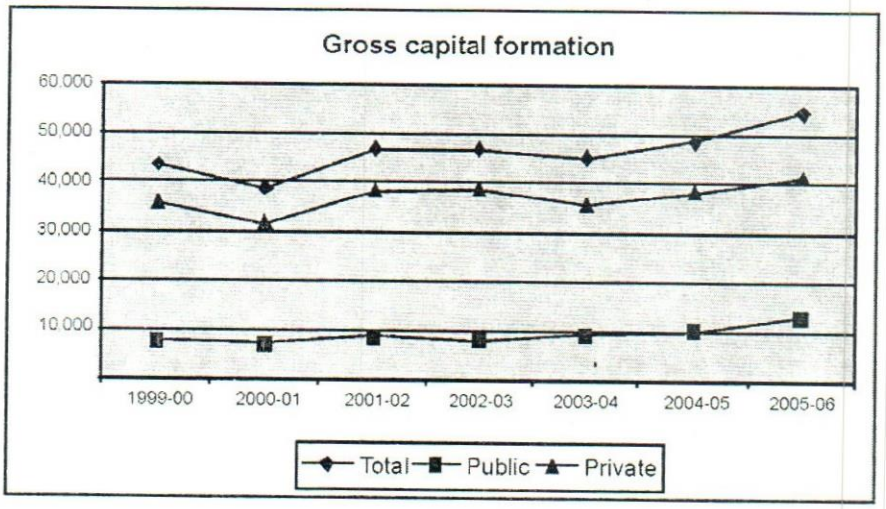

Chart.1 State of Capital formation in Indian Agriculture

The declining public investment in rural infrastructure has been attributed to the deteriorating fiscal position of the state governments and the tendency for politically popular but inefficient and even iniquitous subsidies against productive investments in crucial inputs and infrastructures (Ahluwalia, 2000). (Agriculture remains in the state list of the Indian Constitution and therefore the state governments are the decision makers of the micro level farm practices. The capital formation in the agriculture sector, therefore, will have its reflection in the fiscal policy of the states.) The inefficiency of subsidies emanates mainly out of the incapability of making the benefits reaching the target segments. For example, the direct benefit of subsidizing fertilizer and under pricing water and electricity goes mainly to fertilizer producers and high income farmers. This derives negative effects on the environment and production systems of the target farmers. On the other hand it leads to indiscriminate exploitation of water resources and also

extends damage to soil. Inference, therefore, is that a phased elimination of fertilizer subsidies and the imposition of economically rational user charges for irrigation and electricity could raise resources to finance investment in rural infrastructure sectors, benefiting both growth and equity. But competitive populism often makes it politically unviable to restructure subsidies.

Some of the crucial defensive policies initiated for promoting foodgrain self-sufficiency in earlier years—when the country was short of food materials—continue to hinder agricultural diversification. For example, Government price support levels for foodgrains (minimum support price[1]) such as wheat are accordingly set on the basis of the recommendations of the Commission on Agricultural Costs and Prices (CACP)[2]. This technical body calibrates price supports levels without getting into the rational of it from economic and market angles. In recent years, support prices have been fixed at higher levels to encourage production levels. What is not happening, however, is that the support price system is getting aligned to the market prices whereby the farmers are encouraged to select the remunerative crop mix form a diversified production base.

Agricultural diversification in India is constrained by obsolete farm laws. For example the Essential Commodities Act[3] empowers state governments to impose restrictions on movement of agricultural commodities across states and sometimes even district boundaries and to limit the maximum stock wholesalers and retailers can carry for certain commodities. This was designed to prevent exploitation – mainly of traders from diverting local supplies to other areas of scarcity or from hoarding supplies to raise prices. The practical consequence, however, is that farmers and consumers are denied the benefit of an integrated (single) national market. It also prevents the development of modern trading establishments, which have a key role to play in the next stage of agricultural diversification. The government has recognized the need for change and accordingly removed certain products—wheat, rice, coarse grains, edible oil, oilseeds and sugar - from the purview of the Act. However, this is not likely to make things better, since state governments decide on their priority areas before any policy intervention. What is needed is a repeal of the existing Act and a centralized legislation that would make it illegal for government authorities at any level to restrict movement or stocking of agricultural products (Planning Commission, 2001). This involves the constitutional makeovers to bring the subject from the state list to the concurrent list. Can India initiate a constitutional amendment to save its agriculture is the question currently under debate.

Accordingly the Task Force on economic sectors[4] has made comprehensive proposals for review of several other outdated agricultural legislations (Planning Commission, 2001). For example, laws designed to protect land tenants, discouraging marginal farmers from leasing out nonviable holdings to larger farmers for fear of being unable to reclaim the land from the tenant etc. The constraints, however, prevails like the Agricultural Produce Marketing Committee (APMC)[5] Act in various states compel traders to buy agricultural produce only in regulated markets, making it difficult for commercial traders to enter into contractual relationships with farmers. Development of a modern food processing sector, which is essential to the next stage of agricultural development, is also hampered by outdated and often contradictory laws and regulations regarding quality standards. A new set of legislation is therefore expected to evolve in the farm sector to make it vibrant for enhanced and integrated growth.

Policy interventions and the renewed farm thrust

The Government of India initiated a new set of farm policies to augment the sector for its enhanced contribution. The renewed thrust of the new policy framework was to break the inherited inward looking approach in a planned and regulated economy approach since independence, which aimed at averting the occurrence of famines to feed the domestic population. The thrust therefore aimed at delinking India's agriculture policy from a food supply perspective to a market perspective for growth, equity and inclusiveness. It included the alignment of production and distribution systems to benefit the farmers as well as consumers through a mediation of markets.

The first ever National Agriculture Policy was announced in India in July, 2000. The new Policy framework hence sought to actualize the vast untapped growth potential of Indian agriculture - strengthening rural infrastructure to support faster agricultural development, promote value addition, accelerate the growth of agri businesses, create employment in rural areas, secure a fair standard of living for farmers and agricultural workers and their families, discourage migration to urban areas and face the challenges of inequality arising out of economic liberalization and globalization. The new policy envisaged to attain a growth rate in excess of 4 per cent per annum over the next two decades, by way of efficient use of resources and professional management of farms. It, therefore, included means for conserving soil, water and bio-diversity. The new policy recognized that growth needs to be demand driven and it should cater to domestic markets and maximizes benefits from exports of agricultural products in the face of the opportunities emerging from economic liberalization and globalization. Ultimately, it looks forward to growth, which is sustainable—technologically, economically and environmentally.

The new policy, therefore, specifically puts emphasis on promoting technically sound, economically viable, environmentally non-degrading, and socially acceptable use of natural resources (land, water and genetic endowment) to promote sustainable growth of agriculture. The policy provides for the promotion of bio-technologies for evolving plants which consume less water, are drought resistant, pest resistant, more nutritious, high yielding and are environmentally safe. Conservation of bio-resources through their preservation in Gene Banks and its conservation in their natural habitats through bio-diversity parks are prioritized. Higher priority is given to prevention of depleting bio-diversity. Balanced and conjunctive use of bio-mass, organic and inorganic fertilizers and controlled use of agro chemicals through integrated nutrients and pest management (INM & IPM) are prioritised.

A region specific strategy has been evolved, taking into account the agronomic, climatic and environmental conditions to realize the full growth potential of every region. Attention is attached to development of new crop varieties, particularly of food crops, with higher nutritional value. Major thrust in this context has been the development of rain-fed and irrigated horticulture, floriculture, roots and tubers, plantation crops, aromatic and medicinal plants, bee-keeping and sericulture respectively for augmenting food supply, export promotion and generation of employment in the rural areas.

Development of animal husbandry, poultry, dairying and aqua-culture is recognized as high potential areas in the efforts for diversifying agriculture. Increasing the availability of animal protein in the food basket and generating exportable surpluses has been identified as the tasks. An integrated approach to marine and inland fisheries was designed to promote sustainable aquaculture practices. The regionalization of agricultural research based on identified agro-climatic zones is expected to boost the farm activities. Application of frontier sciences like bio-technology, remote sensing technologies, pre and post-harvest technologies, energy saving technologies, technology for environmental protection through national research system as well as proprietary research were identified as means to establish technology diffusion in the farm front. The research and extension linkages were identified to be strengthened through collaborations to improve quality and effectiveness of research and extension system.

Given the debate on the role of the state and industry in the rejuvenation of the sector sustainable growth and inclusiveness, the new policy recognized the importance of the Government's role in strategic areas where viability gaps exists for the private sector to intervene and make an impact in the short run. Accordingly supply of quality inputs such as seeds, fertilizers, plant protection chemicals, bio-pesticides, agricultural machinery and credit at reasonable rates to farmers were kept under the endeavour of the Government. Further, the role of the Government was envisaged greatly to create a favourable economic environment for increasing capital formation and the farmer's own investments by removing distortions in the incentive regime for agriculture, improving the terms of trade with manufacturing sectors and bringing about external and domestic market reforms. Rural electrification has been brought forward for higher priority as a prime mover for agriculture growth. The policy, therefore, proposed for the provision of quality power supply to farmers and ensures its reliability and affordability.

Bridging the gap between irrigation potential created and its utilization is a major theme of the new policy. Completion of all on-going projects, restoration and modernization of irrigation infrastructure including drainage, evolving and implementing an integrated plan of augmentation and management of national water resources, therefore, received special attention for augmenting the availability and use of irrigation water. Similarly, emphasis is laid on the development of marketing infrastructure and techniques of preservation, storage and transportation with a view to reducing post-harvest losses and ensuring a better return to the grower. The setting up of agro-processing units in the producing areas to reduce wastage, especially of horticultural produce, increased value addition and creation of off-farm employment in rural areas was encouraged. Institutional reforms are envisaged to channelise energies for achieving greater productivity and production. The Government, therefore, has committed to provide active support for the promotion of cooperative form of enterprises, to ensure greater autonomy and operational freedom as a means to improve their efficiency.

Debate over the capability of state infrastructure (like irrigation) to facilitate the crop diversification and high value agriculture will continue to get its momentum. One of the major observations in this regard has been that the state sponsored infrastructure systems promote traditional agriculture and crop mixes. For instance, the water release by the Government sponsored canal irrigation system will be during the grain crop seasons so that the farmers cultivating high value crops cannot depend on the same system for irrigating their crops. Hence, private irrigation systems are the option for the promotion of crop diversification and value added agriculture systems. Infrastructure creation at the private domain in the Indian agriculture, therefore, holds high priority for farm sector growth and sustainability.

Financing the farms remains the critical area for farmers. The credit markets – both formal and informal—

are incompatible with the farmers' requirements and therefore it brings in massive distress in the rural production systems. According to recent reports around 46 farmers end their lives every day[6]. The new agriculture policy envisages to provide a package insurance policy for the farmers, right from sowing of the crops to post-harvest operations, including market fluctuations in the prices of agricultural produce. The price structure and trade mechanism is proposed to be continuously reviewed to ensure a favourable economic environment for the agriculture sector and to bring about an equitable balance between the rural and the urban incomes. Initiatives are proposed to establish quality consciousness amongst farmers and agro processors. Grading and standardization of agricultural products are promoted for export enhancement. Application of science and technology in agriculture is highlighted through a regular system of interface between Science and Technology institutions and the users/potential users to make the sector globally competitive. Towards ensuring the implementation of the proposed new policy framework, database for the agriculture sector was strengthened to ensure greater reliability of estimates and forecasting which could help in the process of planning and policy making.

Given these policy initiatives, the obvious question that arises is about the translation of these policies on the ground, given the multiple implementation agencies, the unchanged constitutional obligations and the interest groups (governments, farmer lobbies etc.) remaining in the sector. Three-fifths of a decade has already been passed since the new policy initiative was made and various Central Sector and Centrally Sponsored Schemes are being implemented by the Government of India and the state governments for development of agriculture and allied activities. For instance, the Macro Management Scheme has been launched after integrating 27 ongoing Centrally Sponsored Schemes to enable a shift from a programmatic approach to a macro management mode of assistance to the states in the form of crop/area specific work plans, region-based strategies, to provide flexibility to state governments and to ensure timely and effective application of limited financial resources. Common guidelines have been issued for National Watershed Development Project for Rain-fed Areas to harmonize the implementing norms with other watershed development programs. A Watershed Development Fund with a corpus of Rs 200 crores each from National Bank for Agriculture and Rural Development (NABARD) and the Department of Agriculture & Cooperation (DAC) has been created.

As envisaged, for region-specific strategies to develop high value agriculture, technology missions for the Integrated Development of Horticulture in general and the backward regions has been launched. Seed Legislation is revised to provide fillip to varietal research and plant breeding. Legislation was enacted for the Protection of Plant Varieties and Farmers' Rights. This is likely to stimulate investment and initiative both in public and private sector for development of new plant varieties and a vibrant seed industry. The new National Seed Policy therefore was expected to substantiate the efforts in the farm sector for growth and sustainability. A Scheme for Seed Crop Insurance has been launched to cover the risks involved in seed production. The Seed Bank has been established to meet contingent requirements of seed in the wake of natural calamities.

To increase the availability, flexibility and security in the flow of credit to the farmers, all eligible farmers are proposed to be covered under the Farmer Credit Cards scheme within three years. A personal insurance package is proposed to be extended to card holders covering them against risk to life and injury. Also a scheme has been introduced for provision of capital subsidy for construction/ modernization and expansion of cold storages and storages for horticultural produce. Rural Infrastructure Development Fund corpus has been increased in 2001-02 with an interest rate reduction for the loans disbursed by NABARD.

Creation of a single market for agriculture commodities still remains as a distant dream. Despite the amendments in the APMC acts, the implementation of it in its full spirit is pending. There are fears that some states may lose while other gain in the process of establishing the uniform markets, and therefore compensating the states remain a task to realize the new farm policy. Networking of market information has been launched with the objective to provide farmers latest information on price movements of agricultural commodities and other essential data. For Cooperative Sector Reforms, a new Bill has been formulated and introduced in Parliament replacing the existing Multi-State Cooperative Societies Act, 1984. Formulation of new subsidy linked scheme enabled for the establishment of rural godowns. Promotional schemes are introduced in Food Processing Industries for value addition in agriculture through the excise exemptions and other interventions. The Standing Committee of Union Ministers and Chief Ministers is constituted to consider issues concerning agricultural strategies, food management and promotion of agriculture exports. The committee has approved the outline of the proposed Grain Bank Scheme which will be extended to BPL families in identified areas. The Government has established commodity exchanges to trade in farm commodities. But the Government interference continues in the futures markets with the fluctuating price and inflation levels[7].

Changing Profile: The Quiet Revolution

Has Indian agriculture has been responding to the new policy initiatives? The undergoing structural changes in its operational and management spheres suggest that the answer is a "yes." While contributing to around 18 % of the national GDP, it constitutes around 13 % of the country's exports. If the agriculture operations were confined to traditional grains, in the earlier years it acquired a paradigm shift to high value crops in the current phase of growth. This is perceived as the outcome of the renewed thrust in agriculture through the new policy initiatives. This transition includes an increasing diversity in a range of crops and greater sophistication of the sector with the creation of critical infrastructure facilities. For instance, the abolition of licensing and automatic investment approvals for food processing (except few critical ones) enhanced the incentive of the private sector.

One of the main indicators of the changing profile of the farm economy has been the shift in the crop composition and the level of crop diversification accordingly. The crop composition of Indian agriculture has undergone structural change in the recent years with a bias towards high value crops which are likely to yield better returns to the farmers. The shift from traditional grain crops to high value crops like fruits, vegetables, floriculture and spices indicates the quest for commercial farming, with the Indian

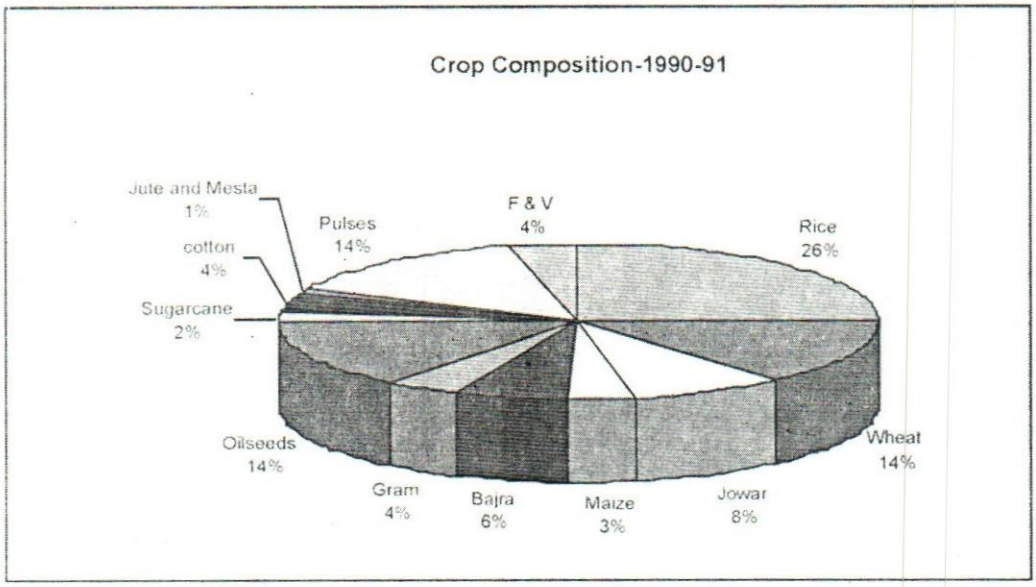

Chart 2. Crop composition –1990-91

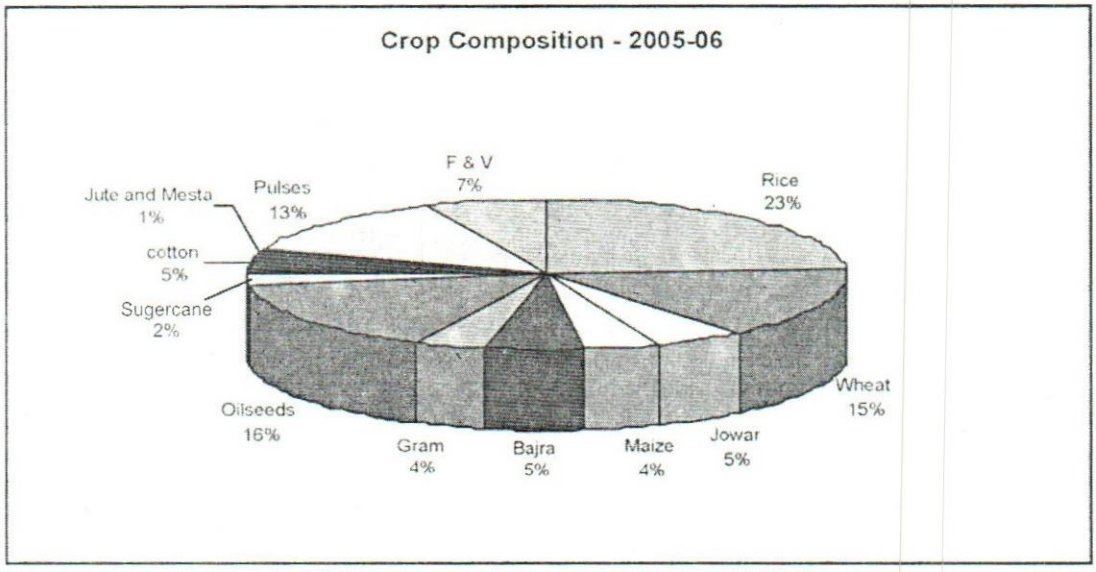

Chart 3. Crop Composition –2005-06

farmer awaiting a competitive market ambience. The charts (2 & 3) below depict the structural transformation of crops in India between 1990-91 and 2005-06.

At a macro level, along with the structural transformation in the crop composition, the direction of agriculture trade also has undergone an upward shift. For instance, India's agricultural exports increased from US $ 5.9 billion during 2001-02 to US $ 6.4 billion during 2003-04. Agricultural exports constitute 12 percent of the total merchandise exports of India (see chart 4). Commodity-wise analysis of the export basket proposes that the high value farm produce has contributed mostly to this hike in the share of international trade in farm products. The main segments are plantation produce, fruits and vegetables as well as spices and marine products.

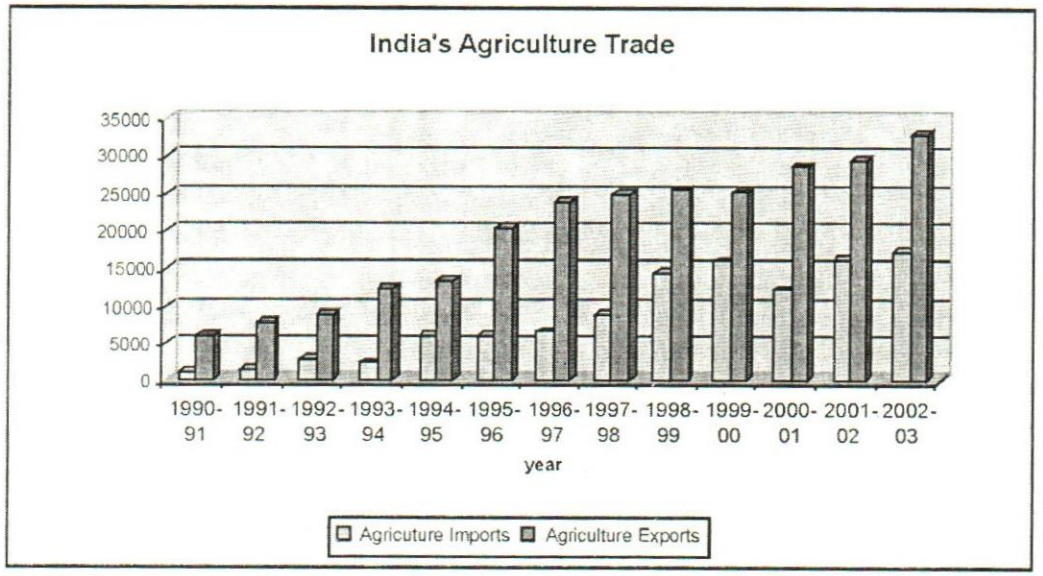

Chart 4. India's Agricultural Trade since 1991

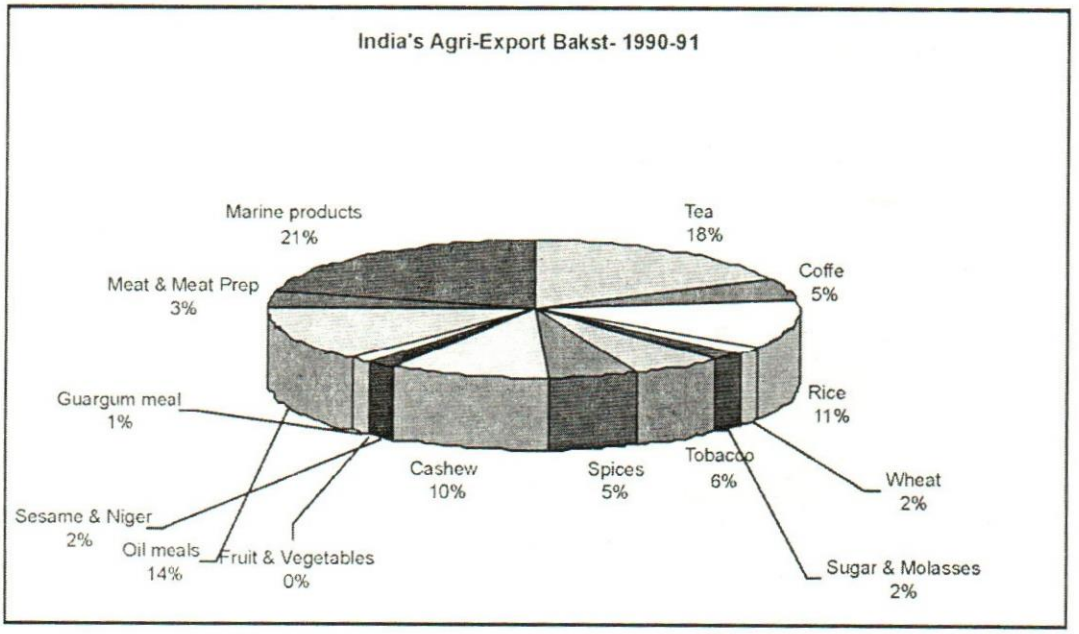

Chart 5. India's Agricultural Trade since 1991

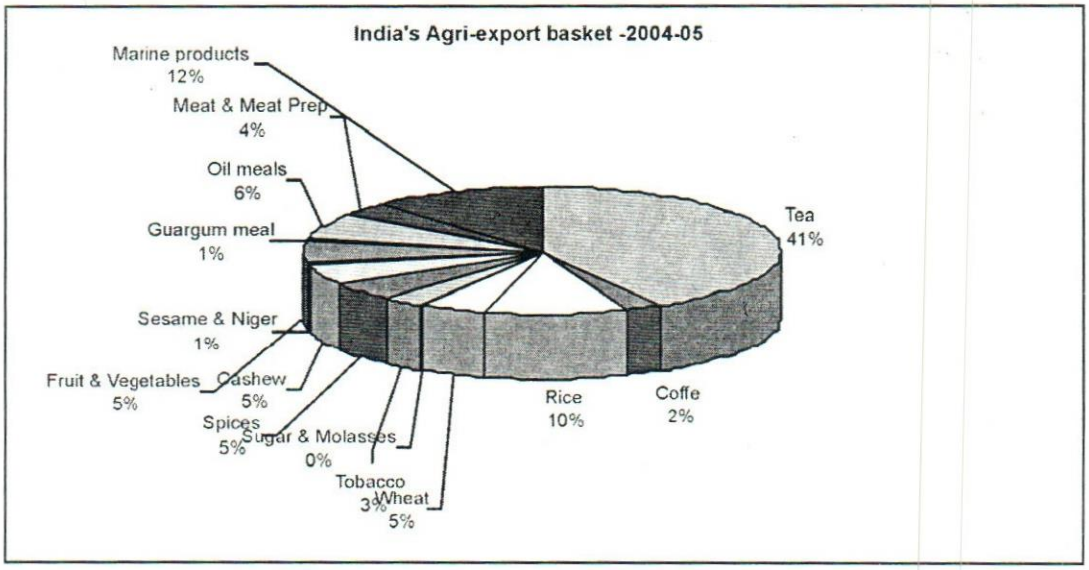

Chart 6. Commodity-wise exports 2004-05

High Value agriculture

Since 1990 the share of high value crops are growing in the Indian crop basket. Horticulture crops find a significant place in the new crop basket of the Indian agriculture sector. The growth of high value crops are reflected in terms of area production and yield. The major crop segments within horticulture are fruits, vegetables, floriculture, spices and plantation crops. There is a significant increase in the area and production of fruits in India. The vegetables sector registers a high growth in terms of area, production and productivity. Floriculture crops also register high levels of growth in area, production and yield. Spices crops are growing at very impressive rate of 6.98 % and 7.33 % in terms of area and production respectively. This has been driving Indian agriculture to a demand-led growth track with higher export potential for sustainability.

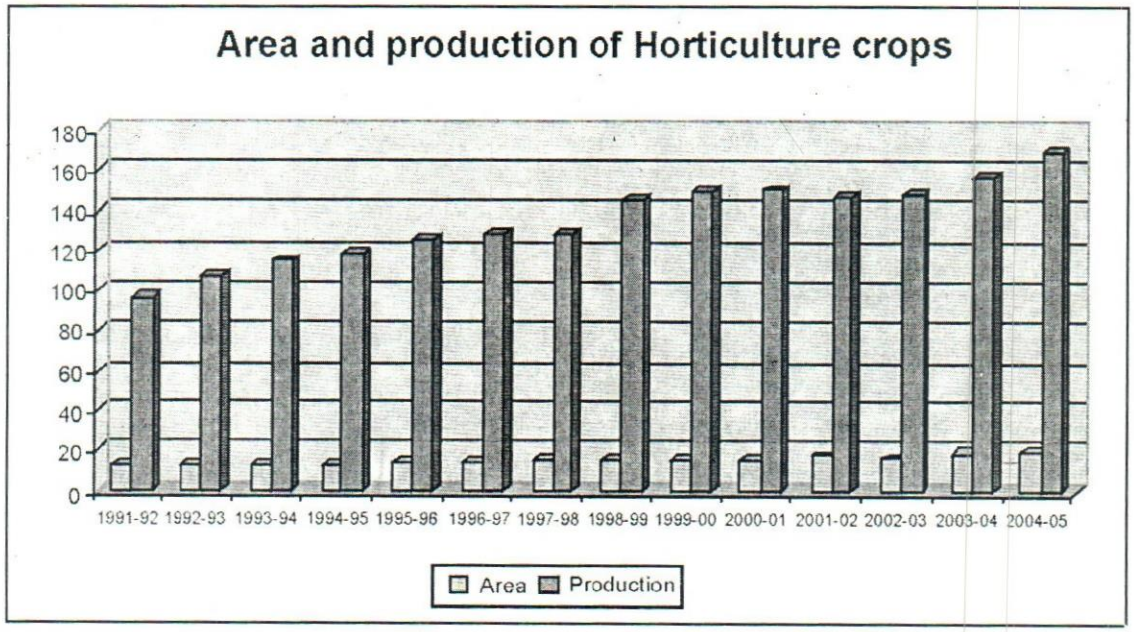

Chart 7. Trend in area and production under Horticulture

Source: Indian Horticulture Database, 2005

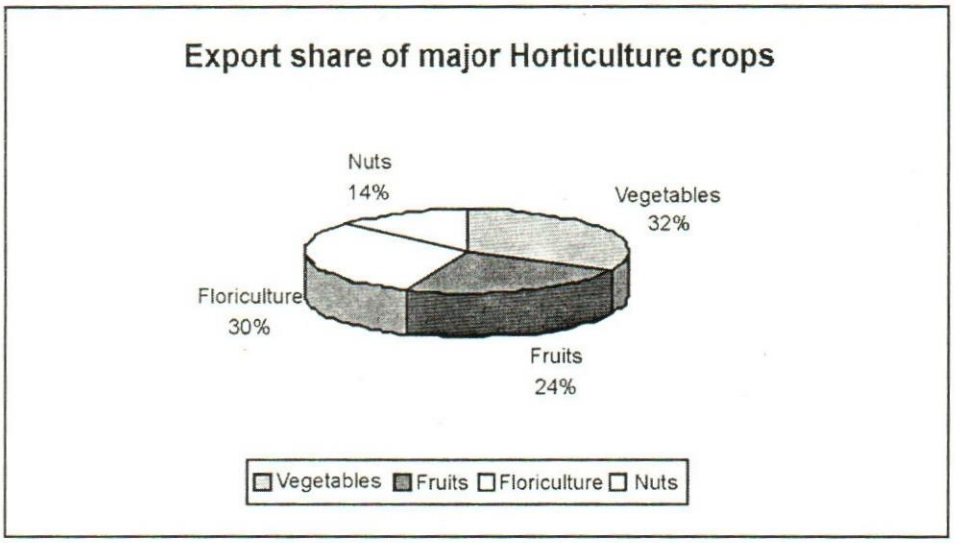

Chart 8. Export share of Horticulture Crops

Farmer risk and sustainability of agriculture growth

With the above structural transformation in the farm sector, one is yet to conclude that the sector is set to gain the desired growth and sustain it. The risk perceptions of farmers are varied and its mitigation options still remain grey. One of the major risks in the Indian farming sector has been the difference between the policy perception at the Government level and the realities at the farm levels. This, in other words, implies the incompatibility of policies with the farmers' actual operations. Reducing the risk that farmers cultivate in the farm sector remains the major task towards bringing agriculture to its potential growth path. In this context the farmer suicides in India can be explained more in the context of economics than politics. It is seen as a manifestation of the failure of farmers to carry out a profitable or sustainable economic activity.

Everyone knows for sure that supply side constraints continue to hamper Indian agriculture growth, which in turn pulls the national economic growth down. Constraints related to production, lack of effective linkages between agriculture research and technology, crop development/ diversification, extension programs, effective linkage to markets, infrastructure in the value chains, sustainable model for agriculture credit and risk cover and the complex regulatory regimes, are a few examples in this context. Given the structural lag and the system complexities, commercialized agriculture with adequate levels of technology, credit and marketing interventions requires the induction of value added (high value) agriculture with proper risk cover and linkage with the markets. It has, therefore, been widely believed and acknowledged that only by addressing the high risk constraints of the farmers, that the agriculture development strategy can make the requisite impact through technology and other policy interventions.

There remains significant variation in the farm risk perception and dimensions. Farm sector innovations for productivity enhancement and growth in India is limited to the extent that farmers themselves are capable of taking the risk of such innovations. Often it happens that the farmers are not very sure of the harvest and therefore they limit the farming activity to selected crops—as a means to avert potential internal and external risks. One of the major risks in the farm sector currently has been the perception of risk itself by different stakeholders. The general perception of farm risk (among the bureaucrats) in India is related to the post-harvest infrastructure, weather fluctuations or market failures. Do the farmers really perceive the risk along with these official perceptions or do they view this differently? Such questions are rarely asked. The fact of the matter is that farmers perceive risks differently given the farm ambience and the modes and relations of production works in the spatial unit. Mitigating the farming risk, therefore, involves the analysis of internal and external risk factors from a spatial perspective.

From an internal perspective, the major risk that farmers perceive emanate from internal (controllable) variables. This includes the non-availability of quality seed at the time of sowing, the supply constrains of fertilizers and pesticides during crop development and the lack of extension services to adopt improved farming systems. There are instances in which the farmers are unable to get the quality paddy seeds so that the seed replacement ratio goes to zero or the replacement period stretches four to five years. Similarly, the fertilizer supply is inadequate in that the traders charge exorbitant rates for

fertilizer, due to which farmers find it uneconomical to carry on with farming activities. It is worthwhile to mention in this context that interaction with farmers in a few villages of Orissa reveal that fertilizer is sold at around 50 % premium during normal crop sowing seasons due to supply shortages by state agencies. There are instances where this premium goes up to seven times higher that of the normal prices, if the farmer is availing it on credit (barter for paddy at the time of harvest). In other words, the exploitation at the farm level is yet a major risk for Indian farmers to deal with.

With the limited scope of irrigation cover in the farm land, monsoon failure comes next to inputs in the risk priority of Indian farmers. The lack of technology for accurate warning systems and also the lower levels land addition under irrigation cover accelerates this risk element. At the same time innovation of newer seed varieties and other inputs depends largely on the education (awareness) of farmers and their capacity to take the risk associated with it. It is, however, true that there is little extension and farm services available in the system whereby farmers are checked from innovation of newer technologies in the farms. Though the concept of weather-based insurance schemes are seen, of late, as a means to mitigate farmer risks, hardly any conceptual framework remains for the diffusion of information and extension services to enable farmers to find ways and means to benefit from innovative farm practices. This opens up the scope for further research on the real effect of information and communication technologies (ICT) in reaching out to farmers to imbibe any useful inference on their farming practices.

Technology specific risks prevent the farmers from innovative farming practices significantly. Incompatibility between technology and investment capacity of farmers leads to improper adoption of technologies and hence ends up in loss of faith in the extension system. The question arises, therefore, whether the extension system can reach to a level of sophistication wherein it is feasible to customize and reconfigure the technology packs to suit the requirements of farmers varying across circumstances and according to the capacity of investments. Rural last mile delivery of services still remains a far reality. Hence, the need is to develop the technology matrix (scenarios) which will help farmers to determine the adoption-level, like:

Low Investment – Low risk	High Investment – Law risk
Low Investment – High risk	High Investment – High risk

The external risk factors remain in areas related to the price of the produce, output levels, institutional and technology related fields. Crop failures arising out of erratic weather conditions, loss occurred due to pests, diseases and market failure, are the main concerns for the farmers. There are strategies in which risks are shared with or transferred to others. But the top risk management choice of farmers from the external angle has been crop insurance. The crop insurance scheme in India was started in a limited way in 1972. Between 1972 to 1979 and 1979 to 1985, pilot crop insurance schemes were introduced in many crop segments. During 1985 to 1999, the comprehensive crop insurance scheme was established. The National Agricultural Insurance Scheme (NAIS), however, is not flexible to the regions and crops which are climatically and geographically sensitive to risk from various local specific sources. Private participation in this service delivery again is constrained by viability constraints.

In a nutshell, the farmers' risk mitigating system in India is not developed enough to command the desired growth rates in agriculture through a technology-led and market-driven path. The integration of risk cover systems combining provision of inputs, extension and farm services along with technology, innovation and market linkages, holds the potential for India's agriculture recovery and productivity enhancements. The uncertainty of markets and unreliable weather conditions prevents insurance agencies from extending the services uniformly across the regions and states in the country. Simultaneously, India lacks a technology policy for the agricultural sector to take the sector forward and integrate it with the national economy for growth and sustainability.

Intervention areas identified, therefore, are in mitigating the critical risks of farmers, which can rejuvenate the farm sector and establish a growth synergy in the farm economies.

a. *Input Risk* – Availability, quality and price through better administration, regulation and supply management.

b. *Technology Risk* – Customization of technology to suit the risk-bearing ability of farmers and provision of farm finance

c. *Natural and Biological Risk* – Risk management instruments.

d. *Market Risk* – Efficient market mechanisms and farmers' access to such prices, price support in distress situations.

The question to be addressed is that do loan waiver acts as a potential instrument to mitigate the high level of risk that farmers are shouldering? One argument in this regard has been that loan waiver promotes the farmers' willingness to access farm credit and thereby sustain the level of farm operations. But it is unlikely to expand the operational spheres given the unchanged risk scenarios

in other critical areas. It is in this context that it is worthwhile to suggest a comparative cost benefit analysis of the waived loan amount and the opportunity cost of not using those funds for risk cover activities of farmers, which potentially could have enhanced the productivity and confidence level of farmers. This is difficult economics in a complex political environment. It is, therefore the national farm policy framework which will reverse the risk scenario of farmers to bring the sector back onto the growth track.

Conclusion: A Strategic Way Forward

It is generally agreed that India possesses four outstanding competitive advantages in agriculture in comparison to any other country. First, it has regions which are climatically favourable for cultivation of every commercially important plant species grown in other parts of the world – ranging from temperate orchard crops such as almonds and apples to tropical mangos and pineapple. Second, the country already possesses the largest acreage of irrigated land in the world with 40% of the potential still to be tapped. Third, the gap between present productivity and proven technological potential is very large for most crops; yet even so, the country is already among the world's top three producers of tea, cotton, sugar, foodgrain, groundnut, coffee, eggs and milk. Fourth, the country has an abundance of available skilled, educated, technical and scientific manpower. These diverse advantages call for location-specific and crop-specific strategies for India to leverage the domestic and global competitiveness.

Constant and sustained value addition in agriculture is one way to enhance the share of agriculture in the GDP in the medium term. The demand for high value crops has, for instance, been growing at 3 to 5 per cent per year, while demand for foodgrain is stagnant. The projections suggest that the food basket in India will continue to diversify with the rise in the per capita incomes. Consumption of milk, fruits, vegetables, meat, eggs and fish etc. are on the rise. The income effect on consumption of cereals is negative and that of high-value commodities is positive and significant (Joshi, Gulati 2006). The average and marginal propensities to consume high value foods among the rural and urban consumers are high in India (Sundaresan 2007)[9]. Hence the policy needs to be pro-crop diversification and high value agriculture. The need, therefore, is to gradually shift the rural consumption base to a market-led food security establishment by reducing the levels of subsidies and increased investments. The policy framework should, therefore, reflect the options for small and marginal farmers to integrate into a virtuous cycle and effectively participate in the market mechanism in the long run towards enhancing the income levels to access the desired food from market. The interplay of market and prices can create incentives for farmers, which will work better than subsidies, and therefore procurement of foodgrain at the ruling market price would be more beneficial.[9]

Food security remains the focal point of India's agriculture policy and therefore arriving at a sustainable food security approach is vital for pulling up the agricultural sector through the value chain. Justification for pursuing a policy framework hampering the scope and opportunities of diversified agriculture in India remained largely in perceptive spheres than in actuality. The fluctuating foodgrain stock levels and the stagnating or declining land coverage under major foodgrain crops remains the source of such perceptions. For example, the total area under foodgrain has declined from 127 million hectares in 1990-91 to 113 million hectares in 2002-03. Similarly the 2006 food procurement shortage accelerated the speculation of a decelerated foodgrain stock levels for the future. The 2006 foodgrain crisis, however, led to an imbalance in wheat procurement, as a result of an interplay between Government and private players in an environment of competitive prices and markets. The high ruling market price for wheat was facilitated by a host factors like increased demand from the private sector, higher international price levels associated with the anticipation of higher future prices (indicated by futures market) and thereby the decision of farmers to hold their produce. The spot markets responded in tandem with the future and the price of wheat in the spot market rose to about Rs 900 quintal (Hapur market). This forced the Government to announce a bonus for the farmers and finally the Government declared its decision to import from the international market to meet the domestic food requirements.

The manifestation of food security concerns, distorting farm policies and the hampering of the scope of crop diversification, are quite vivid from other perspectives like the continuance of MSP as tool of foodgrain procurement, increasing subsidy levels and reducing investments in farm infrastructures and excessive grain procurement levels in Food Corporation of India (FCI) godowns, while hunger levels are on the rise.

The relevant questions in addressing the food security concerns and the establishment of a diversified agriculture policy in India have been: What should be the ideal policy that will balance food security and crop diversification, which can help to solve the short and long-term concerns? How does one ensure adequate supply of cereals and staples (wheat, rice, pulses, edible oils, sugar etc.) to the marginalized population in the short and medium-term? What are the instruments that can be deployed and how should they be deployed?

The second phase of agriculture reforms in India, therefore, has to address such broad policy questions and establish an enabling framework for (a) long-term strategy on crop diversification, insurance and forward trading (b) limiting the scope and coverage of minimum support price and (c) fixing a price band to trigger the open market operations in agriculture markets. Under this policy framework, the procurement operations were to be organized strictly as business operations, the responsibility of PDS to be passed on to the states and later to Panchayati Raj institutions and linkages were to be established between price and trade policies. These policies, however, could not be implemented on the pretext of perceived negative implications on the domestic food security front. This further confirms the fact that food security issues continue to hamper the growth potential of the agricultural sector in India. The agricultural sector has to achieve the triple bottom lines viz. competitiveness, sustainability and inclusiveness.

Notes

[1]. With a view to ensure remunerative prices to farmers and to enhance the supply of essential food commodities, the Government of India announces a Minimum Support Price (MSP) for major agricultural commodities and organizes purchase operations through public and cooperative organizations such as the Food Corporation of India (FCI), Jute Corporation of India (JCI), Cotton Corporation of India (CCI), National Agriculture Cooperative Marketing Federation of India (NAFED), Pulses, Oil Seed & Tobacco Boards, besides other agencies designated by the state governments. The support prices for various agriculture commodities are decided after taking into account the recommendations of the Commission for Agriculture Costs and Prices, views of the state governments and the central Ministries.

[2]. Commission for Agriculture Costs and Prices (1985) is the technical agency that advises the Government on the Minimum Support Price of major agricultural commodities with a view to evolving the balance and integrating the price structure in the perspective of the overall needs of the economy and with due regard to the interests of producers and consumers. To formulate the recommendations on the level of minimum support prices and other non-price measures, the Commission takes into account, apart from a comprehensive view of the entire structure of the economy of a particular commodity or group of commodities, the factors like (i) Cost of production, (ii) Changes in input prices, (iii) Input-output price parity, (iv) Trends in market prices, (v) Demand and supply, (vi) Inter-crop price parity, (vii) Effect on industrial cost structure, (viii) Effect on cost of living, (ix) Effect on general price level, (x) International price situation, (xi) Parity between prices paid and prices received by the farmers, (xii) Effect on issue prices and implications for subsidy.

[3]. The Essential Commodities Act, 1955, gives powers to control production, supply and distribution of essential commodities for maintaining or increasing supplies and for securing their equitable distribution and availability at fair prices. Using the powers under the Act, various Ministries/Departments of the Central Government have issued Control Orders for regulating production, distribution, quality aspects and movements pertaining to the commodities which are essential and administered by them.

The Essential Commodities Act is being implemented by the State Governments/UT Administrations by availing of the delegated powers under the Act. The State Governments/UT Administrations have issued various Control Orders to regulate various aspects of trading in Essential Commodities such as foodgrain, edible oils, pulses, kerosene, sugar etc. The Central Government regularly monitors the action taken by State Governments/ UT Administrations to implement the provisions of the Essential Commodities Act, 1955.

[4]. The Planning Commission, Government of India, constitutes task forces on various sectors for the preparation of the provisions for Five Year Plans. The task force holds an interaction with different stakeholders to arrive at the changes required to be brought in the economic sectors for enhanced growth and sustainability.

[5]. Under the APMC Act, only the state governments were permitted to set up markets. Monopolistic practices and modalities of the state-controlled markets have prevented private investment in the sector. The licensing of traders in the regulated markets has led to the monopoly of the licensed traders acting as a major entry barrier for a new entrepreneur. The traders, commission agents and other functionaries organize themselves into associations, which generally do not allow easy entry of new persons, stifling the very spirit of competitive functioning.

[6]. The rural distress arising out of credit and financing systems of agriculture is evident from the suicide rates. The farmer suicides explain the incompatibility of farm credit systems with the market structures, whereby, farming becomes uneconomical and non-sustainable. The average daily farmer suicide rate (2007) in India is reported to be 46, with a total of 16,632 farmer suicide cases reported, including 2,369 women. According to the National Crime Records Bureau (NCRB) farmer suicide constitutes around 15 percent of the total suicides happening in the country (TOI, 16th December 2008, p. 7.)

[7] The Forward Contract Regulation (FCR) Bill 2006 was enacted for the modernization of the commodity market system in India. Currently there are four main commodity exchanges in India – Multi Commodity Exchange of India (MCX), National Commodity and Derivatives Exchange (NCDEX), National Multi Commodity Exchange of India (NMCE) and the National Board of Trade (NBOT).

[8] The National Sample Survey Organization (NSSO) 43rd round survey of consumption expenditure reports suggest that the average and marginal propensities to consume food items like milk, fish, meat and egg is higher amongst rural and urban consumers. The marginal propensity to consume these goods are higher among the lower income categories indicating the emerging trend in the consumption patterns towards high value foods (See C S Sundaresan, 2007).

[9] There are observations that the state intervention was one of the reasons for the grain (wheat) market chaos in 2006 and the instruments used by the Government were not compatible with the forces of the market (Subramani, 2006; Bhatt, 2006). The major wheat producing states have exerted pressure on the private sector from procuring wheat at a price ruled by the market. For instance the UP Government has fixed a ceiling for purchase by the private traders and big corporate firms directly from the farmers. These instances raised significant questions like (a) Should MSP be a tool for food procurement? (b) Can Government interventions in agriculture be done away with?

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We are what our thoughts have made us;
so take care about what you think.
Words are secondary. Thoughts live; they travel far.

—Swami Vivekanand

Focus

Farming System Research & Extension Approaches

C Prasad & P C Bhatia

This paper highlights the approaches to be adopted through different farming system approaches and extension strategies for achieving enhanced and sustained productivity. The focus is on different ecosystems and proven technologies which will help the farmers gain better economic returns and lead to better conservation of natural resources on the one hand, and increased efficiency of essential inputs on the other.

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India has to support 16% of the world's population with 2.4% land and roughly 4% of the world's fresh water resources; the total number of operational holdings stands at 115 million. Eighty percent of these (92.8 million) are managed by small and marginal farmers. Medium and large size operational holdings comprise 7.3%. Obviously, most of the marginal farmers are resource poor; they can hardly implement modern agro-technologies involving high cost. Our efforts so far have been to exploit the yield potential of crop varieties in different regions and ecosystems through application of costly inputs like fertilizers, water, pesticides, and hormones etc. However, considerable increase in the prices of these inputs in recent years has created a different scenario. As a result, the cost of cultivation enhanced has been tremendous and the profitability per unit area has thus declined.

Farming is both a way of life as well as the principal means of livelihood for more than 65 percent of India's population 117 crores. It is estimated that per capita availability of land is about 0.4 hectare, which is likely to be reduced to 0.12 hectare by the year 2020. Thus the average plot-holding size is becoming smaller each year and the cost of risk-return structure of farming is becoming adverse, with the result that farmers are getting increasingly indebted, and marketing infrastructure is generally poor, particularly in perishable commodities. At present 26% of country's total population is still below poverty line (BPL). A recent NSSO survey revealed that really 40 percent of farmers would like to quit the farming profession if they have an alternative option to adopt; this is because the economic, ecological, technological and social problems facing small farmers are yet to receive the integrated approach by concerned organizations, institutions and authorities.

As per the Planning Commission, the agricultural growth over the years has not kept pace with required food production levels; as it was 4.69, 2.06 and 3.97 in VIIIth, IXth and Xth five year plans respectively. Practically all the growth so far has come from the expansion of irrigation and increased productivity of irrigated land; rainfed agricultural productivity has been more or less stagnant. Another disquieting feature is that some of the sunrise sectors e.g. livestock, fisheries and horticulture, have also started showing declination.

Pulses are a major source of protein in the country. The per capita availability per day was 60.7 gms in 1951, declined to 35.6 gms per day in 2003, and thus the Farming System Approach with diversified cropping system is very essential to meet the mutritional requirements of children and expectant mothers.

The steering committee appointed by the Planning Commission for formulation of the Eleventh Five Year Plan (2007-2012) has recommended as follows:

"The Steering Committee is of the considered opinion that it should be possible to reverse the process of deceleration in agriculture growth and step it up significantly (8.0 to 9.0%) during the 11th plan period."

Further the land resources are getting degraded through soil erosion, salinity and alkalinity and chemicalisation. Productive capacity of soil is declining due to poor soil health, its mining and imbalance use of essential and micro-nutrients. The water table in several states is depleting at an alarming rate. It has been reported that even after exploiting full irrigation potential, 50% of land area will still depend on vagaries of rainfall in different agro-eco-zone of the country. Hence, the watershed development approach is a key sector in rainfed situations.

Productivity in India has largely been increased through investment in research education, extension generating location specific technologies and their transfer to the end users. The ICAR, which is the apex body for supporting agricultural research at present has a network of 96 research Institutes/PDS/NRC, one Central University, four Deemed Universities, 43 SAUs, 61 All India Coordinated Research Projects and 558 Krishi Vigyan Kendras (KVKs). The total country's productivity has increased through improved technologies generated through Indian Public Research Efforts, International Research Centres, manpower development by educational institutions and the TOT Projects. However, 26% population of country is still below the poverty line and more than 65% population is agricultural based. Hence in view of these facts it is imperative to strengthen rural-based programmes and take stringent measures for raising the income level of this vulnerable population. Hence, diversification of agriculture through different agro-eco-based farming system modes are the need of the hour for conserving and efficiently managing the natural resources and achieving enhanced productivity per unit area under different agro-eco regions of the country.

Major production constraints

The major crop production constraints under different farming systems can be enumerated as: (i) Inherent low soil fertility, (ii) weather dependence, (iii) low level of mechanization, (iv) weather forecast not very perfect, (v) unscientific and poor rain water management, (vi) low and erratic rainfall and droughts, (vii) low literacy levels, (viii) inadequate credit and marketing infrastructure, (ix) poor socio-economic status of people and (x) extremely poor extension education/TOT system/sub-systems.

In the commodity-oriented market scenario, the focus is usually on a singular production system. The crop-based research and development approach further isolated different farming systems from each other. An Integrated approach in the farming system has several distinct advantages like: (i) security against complete failure of a system, (ii) minimization of dependence for external inputs, (iii) optimum utilization of farm resources, (iv) efficient use of natural resources, (v) minimizing risks, and (v) efficient and effective over all management.

The major production systems in agriculture sector are as under:-

(i) Arable crop farming system, (ii) horticultural production system, (iii) agro-forestry production systems, (iv) livestock-based farming system, (v) aqua-based production system, and (vi) pastoral production system.

The Indian Council of Agricultural Research (ICAR) has delineated the country into 20 agro-eco-regions (AER) and 60 agro-eco-sub regions (AESR) using criteria of soils, physiography, bio-climate (climate, crops, vegetation) and length of growing period. The ICAR under National Agricultural Technology Project (NATP) had identified five major agro-eco-systems. Within each of the major ecosystems 2-4 different production systems which require support in an interdisciplinary mode responsive to farmer's specific needs were identified (Table 1).

Table 1: Different Production Systems within the five major agro-ecosystems

Major Eco-systems	Production systems
(i) Arid Agro-Ecosystem	(i) Agri-silvi-horti-pastoral production system. (ii) Livestock and fish production system
(ii) Coastal Agro-Ecosystem	(i) Fish and livestock production system. (ii) Agri-horti production system.
(iii) Hill and Mountain	(i) Agri-horti production system. (ii) Livestock and fish production system
(iv) Irrigated Agro-Ecosystem	(i) Rice-wheat production system (ii) Cotton-based production system (iii) Sugarcane-based production system. (iv) Dairying and fish production system.
(v) Rainfed Agro-Ecosystem	(i) Arable farming system. (ii) Agro forestry production system. (iii) Livestock based farming system.

Source: (ICAR, 1997)

Farming systems perspectives

Major Characteristics

In attempting to combat hunger and poverty, developing countries face the challenges of identifying specific agricultural and rural development needs and opportunities, and focusing investment in those areas where the greatest impact on food insecurity and poverty could be achieved. The delineation of farming systems and strengthening research efforts in this direction will provide a useful framework within which appropriate agricultural development strategies and interventions can take place.

As per FAO studies a farming system is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate.

The key factors for classification of suitable farming system include: (i) the available natural resource base; (ii) the dominant pattern of farm activities and household livelihoods including relationship to markets; and (iii) the intensity of production activities. Based on these criteria, eight broad categories of farming systems have been identified:

- irrigated farming systems, embracing a broad range of food and cash crop production;
- wetland rice-based farming systems, dependent upon seasonal rains supplemented by irrigation;
- rainfed farming systems in humid areas, characterized by specific dominant crops or mixed crop-livestock systems;
- rainfed farming systems in steep and highland areas which are often mixed crop-livestock systems;
- rainfed farming systems in dry or cold low potential area with mixed crop-livestock and pastoral systems merging into systems with very low current productivity or potential because of extreme aridity or cold;
- dualistic (mixed large commercial and small holders) farming systems, across a variety of ecologies and with diverse production patterns;
- coastal artisanal fishing systems, which often incorporate mixed farming elements; and
- urban based farming systems, typically focused on horticultural and livestock production.

Except for the dualistic systems, the systems within each category are dominated by smallholder agriculture. The names chosen for individual farming system reflect the eight categories outlined above. They also reflect key distinguishing attributes, notably: (i) water resource

availability, e.g. irrigated, rainfed, moist, dry; (ii) climate, e.g. tropical, temperate, cold; (iii) landscape relief/altitude, e.g. highland, lowland; (iv) farm size, e.g. large scale; (v) production intensity, e.g. intensive, extensive, sparse; (vi) dominant livelihood source, e.g. root crop, maize, tree crop, artisanal fishing, pastoral; (vii) dual crop livelihoods, e.g. cereal-root, rice-wheat, mixed farming system; and (viii) location, e.g. forest based, coastal, urban based etc.

In broad terms, five main farm household strategies that could contribute to improved farm household livelihoods and an escape from poverty can be summarized as:

- Intensification of existing production patterns.
- Diversification of agricultural activities.
- Expanded operated farm or herd size.
- Increased off-farm income, both agricultural and non-agricultural and
- Complete exit from the agricultural sector within a particular farming system.

In order to present the analysis of farming systems and their future development within a framework that is broadly comparable between systems and across different regions, key biophysical and socio-economic determinants of system evolution have been grouped into five categories:

- Natural resources and climate.
- Science and technology.
- Trade liberalization and market development
- Policies, institutions and public goods. and
- Information and human capital.

Approach and Different Farming Systems

As a matter of fact, the Scientific Farming System Research has never been an important component of research activities of different organization covering ICAR Institutes/SAU and State Departments of Agriculture. In the initial stages monoculture – single crop cultivation has been practiced under different agricultural eco-systems. However, with the introduction of irrigation facilities the "Cropping System" approach was adopted and consequently the research efforts were also reoriented towards developing production technologies for predominant crop rotations/cropping systems of a specific region. The farming system approach which comprises non only crops, but also horticulture, livestock, fisheries, and agro forestry did receive the attention of agricultural scientists in an integrated manner at a very few locations. Some sporadic results have been reported by a few agricultural universities and ICAR Centers only. In fact, the cropping system research was being understood as an attempt towards farming system research, which was actually a misnomer.

Therefore, in the present scenario of national food security and importance of conservation of natural resources, farming systems research and development need concerted efforts by research, education and extension institutions and systems.

Different farming systems are prevailing in the country primarily due to varied agricultural base, available resources, and location specific needs of humans and animals. Farmers through their experience have established these farming systems to meet their food, fuel and fibre requirements in a manner that they are least dependent on the external sources. In India, work on selection of appropriate farming systems has been very sporadic and no systematic research netework has been implemented. Preliminary work has been undertaken at TNAU, Coimbatore, HAU, Hisar and ICAR-NEH complex, Barapani, Shillong. The objective of the present farming system approach is to make farming profession much more stable, sustainable and profitable, benefiting the farming communities in general and the resource poor farmers in particular.

The issues and features of important farming systems are discussed below:

Rainfed Farming

Rainfed agriculture in India has been practiced since time immemorial. The rainfed agricultural area in the country can be broadly classified into four regions: (i) Arid, (ii) Dry semi-arid, (iii) Wet semi-arid, and (iv) Dry sub-humid. The National Commission on Agriculture in 1976 predicted that even when the full irrigation potential is tapped by 2013 AD, over 50% of the arable land will continue to remain rainfed in the foreseeable future. Rainfed farming comprises about 91% area of coarse cereals (sorghum, pearl millet, maize and finger millet), 91% of pulses (chickpea and pigeonpea), 80% of oilseeds (groundnut, rapeseed, mustard, and soyabean), and 65% of cotton (mostly *Desi* cotton and short staple cotton) besides supporting major animal production systems. Also, about 50% area under rice and 19% area under wheat is rainfed. To develop a sound strategy for research and development for these areas, it is necessary to critically examine the changes

in area and productivity, and efficiency of production systems in relation to these commodities.

The Royal Commission on Agriculture in India in 1920 noted that "the problems of cultivation of crops in tracts entirely dependent upon rainfall are deserving far closer attention than they have received from the Agricultural Departments." The Bombay Scheme was started in 1993 at Sholapur and Bijapur, which were centers of famine tract. The work in Madras was started at Hagari near Bellary from 1934 and in Hyderabad State in Raichur in the same year. The Punjab Scheme was carried out at Rohatak from 1935. Based on the studies conducted between 1933 and 1943 a package was developed for better crop production under dry farming situations. During 1954 the soil conservation Training and Demonstration Centres were established by ICAR at eight locations including low rainfall areas such as Bellary. These Centres devoted their efforts to soil conservation techniques and training of officers.

During 1970 the All India Coordinated Research Project on Dryland Agriculture (AICRPDA) was launched at 23 locations in different agroclismatic regions. Lack of responsive plant material was a major drawback that constrained the adoption of the improved Dry Farming Method. Central Research Institute for Dryland Agriculture (CRIDA) was stailed in Hyderabad in 1985. With this background, 47 model watersheds were developed; of these; 29 model watersheds were developed by CRIDA and remaining 18 by central soil conservation and training institute, Dehradun. This was a holistic approach to rainfed agriculture. Of the several components of watershed development, water storage structure received the highest priority. Such structures substantially improved the income of farmers and productivity of lands. Based on the experience of the model watersheds, the National Watershed Development Programme for Dryland Agriculture was conceived and initiated throughout the country. A watershed in location specific and the available natural resources such as land, water, vegetation, and animal and human resources are integrated for development.

Watershed Approaches for rainfed farming

The current strategy for rainfed farming is based on the concept of scientific conservation of rainwater for integrated development of watersheds (including special problem areas) and promotion of farming systems approach. This strategy was formulated with a view to evolve models of sustainable agriculture in rainfed areas, which are cost effective and easily replicable together with indigenous technologies available with the farming community.

Based on this strategy a Centrally Sponsored Scheme namely the National Watershed Development Project for Rainfed Areas (NWDPRA) was launched in October, 1990. The goal of the watershed management approach is to evolve models of sustainable agriculture in rainfed areas which can be replicated at a much larger scale over contiguous areas in a phased manner through active participation of villagers, community-based organizations, research organizations, and government departments including panchayats.

Considerable research efforts were made to develop effective alternate land-use systems such as alley cropping, silvipastoral, silvi-horticultural, agri-silvicultural components. Major emphasis was also placed on integrated watershed management and the concept of an ORP at each model watershed was evolved.

The Joint efforts of CRIDA and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Hyderabad were started in 1985. The collaborative projects wre aimed at evaluating hydrological effects in watersheds due to soil water conservation practices, socio-economic changes in the watershed program area, efficient week control, losses due to crop pests, multilocation testing of animal-drawn implements, and biological nitrogen fixation.

Integrated watershed management is the key to conservation and efficient utilization of natural resources of soil and water, particularly in rainfed agriculture where water is the foremost limiting factor of crop productivity. Apart from moisture stress to crops, mismanagement of rainwater also entails serious land degradation converting vast areas across the country into wastelands.

Rice-Wheat Farming System (Cropping System Approach)

This system is characterized by a summer paddy crop followed by an irrigated winter wheat crop (and sometimes also a short spring vegetable crop) and forms a broad swathe from Northern Pakistan through the Indo-Gangetic plain to Northwest Bangladesh. The total area is 97m ha with an estimated 62m under cultivation, of which around 78 percent is irrigated. Within this system, 254m people are classified as farmers. There is a

significant level of crop-livestock integration with an estimated 119m bovines and 73m small ruminants. Poverty is extensive and also quite severe. In India this system covers more than 10-00 million hectares in the Indo-Gangetic Belt.

Three-Tier Farming Systems in NEH-Region

The North Eastern Hill Region, comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura has a geographical area of 255,090 km. The region in endowed with rich natural resoursces but their indiscriminate exploitation has resulted in environmental and resources degradation due to non-adoption of proper soil and water conservation measures. The ICAR NEH Shillong Research Institute has recommended a three-tier farming system approach for containing soil erosion, conserving soil and water and achieving enhanced productivity sloppy hilly terrain. In three-tier farming system method important cereal and vegetable crops are grown in lower terrain, suitable grasses in middle portion, horticulture high altitude and cold resistant cereals and plant/tree species in the upper terrain sloppy lands.

Highland Mixed Farming Systems

This mixed crop-livestock farming system, generally intermediate between the rice-wheat plains of the lowlands and the sparsely populated high mountain areas above, extends along the length of the Himalayan range as well as in pockets in Afghanistan, Southern India and Sri Lanka. Major products include cereals, legumes, vegetables, fodder trees, orchards and livestock. The total area in 65m ha with an estimated 19m ha under cultivation of which around 14 percent is irrigated. Nearly 53m people are classified as agricultural, and there are about 45m bovines and 66m small ruminants. Poverty is aggravated by remoteness and the lack of social services, and is rated between moderate and extensive. Major Farming Systems predominating in South Asia are presented in Table-2.

Integrated Agro-forestry system

- In simple terms agro-forestry is growing trees for timber, food, fodder, fruit and fuel in cultivated areas.

Table 2: 4 Major Farming Systems of South Asia

Farming Systems	Land Area (% of region)	Agric. Popu. (% of region)	Principal Livelihoods
Rice	7	17	Wetland rice (both seasons), vegetables, legumes, off-farm activities
Coastal Artisanal Fishing	1	2	Fishing, coconuts, rice, legumes, livestock
Rice-Wheat	19	33	Irrigated rice, wheat, vegetables, livestock including dairy, off-farm activities
Highland Mixed	12	7	Cereals, livestock, horticulture, seasonal migration
Rainfed Mixed	29	30	Cereals, legumes, fodder crops, livestock, off-farm activities
Dry Rainfed	4	4	Coarse cereals, irrigated cereals, legumes, off-farm activities
Pastoral	11	3	Livestock, irrigated cropping, migration
Sparse (Arid)	11	1	Livestock where seasonal moisture permits
Sparse (Mountain)	7	<1	Summer grazing of livestock
Tree Crop	Dispersed	1	Export or agro-industrial crops, cereals, wage labour
Urban Based	<1	1	Horticulture, dairying, poultry, other activities

- Agro-forestry is also defined as a farming system that integrates agricultural crops and/or livestock with trees and shrubs. The resulting biological interaction provide multiple benefits including diversified sources of income, increased biological production, better water quality and improved habitat for both humans and animals. The multiple sources of income from agriculture and trees/ shrubs cover, to some extent, the risk in farming.
- Agro-forestry is a multidisciplinary approach which draws inputs from agriculture, forestry, horticulture and animal husbandry. The products available from such a land use-systems are diverse like food, fuel, fodder, fruit, fiber, spices vegetable, timber and non-timber materials. Besides in such a system, services of soil improvement and environmental ameliorations are simultaneously performed.
- Thus for sustainable production, the adoption of multidisciplinary and integrated land use systems of agro-forestry need emphasis: they are socially and decologically safe, advantageous and remunerative.

Numerous agro-forestry systems have been evolved for different areas. Following are the common agro-forestry systems prevailing in the country:

- Agrisilviculture (trees + crops),
- Boundary plantation (tree on boundary + crops)
- Block plantation (trees + crops),
- Energy plantation ((trees + crops during initial years),
- Alley cropping (hedeges + crops),
- Agrihorticulture (fruit trees + crops),
- Agrisilvihorticulture (trees + fruit tree + crops),
- Agrisilvipasture (trees + crops + pasture),
- Hortipasture (fruit tree + pasture),
- Silvipasture (trees + pasture),
- Forage forestry (forage tree + pasture)
- Shelter-belts (trees + crops),
- Wind-breaks (trees + crops),
- Live fence (shrubs under tree on boundary),
- Homestead (multiple combination of trees, fruit trees, vegetables etc.),
- Entomoforestry (trees + sericulture), and
- Aqua-forestry (trees + fishes).

Area under agro forestry can be covered depending upon the land capability classification. Land capability classification is the systematic arrangement of different kinds of land according to properties which determine the ability of land to produce virtually on a permanent basis. The classification is based on land feature and inherent potentials. Land classes I-III or IV are categorized for agricultural or arable land use whereas land classes IV/V-VIII are categorized for non-agricultural or non-arable land use. It is being increasingly realized that in order to derive maximum benefits from the available resources and prevailing patterns of agriculture, a land use planning is essential to achieve a sustainable use of land, water and vegetation. In India 175 m ha low productive wasteland is the potential area for agro-forestry developmental activities.

Land Reclamation and Integrated Farming System

It is estimated that about seven million hectares of land in this country is affected by varying degrees of soil salinity and sodicity. Such problematic soils are inhibiting agricultural production in the affected areas. The farmers, generally unaware of the magnitude of the problem, continue to grow crops without soil reclamation measure and harvest very poor crop yields. In the spread of Saline Sodic Sols West Bengal ranks third, after UP and Gujarat, having an area of 0.85 Midnapore districts. Sundarbans areas of 24 Parganas district alone constitute about 94 per cent salt affected area of the State.

Waterlogging also adds to soil salinity considerably reducing the productivity of these soils. Rice-wheat system is generally followed by the integration of fruit frees like Aonwla, Guava, Mango and livestock-buffalo, cow, goat etc.

In India shifting cultivation is practiced on 4.91 million hectares covering NEH and parts of Orissa.

Organic Farming Systems

The green revolution technologies involving greater use of synthetic agrochemicals such as fertilizers and pesticides with adoption of nutrient – responsive, high-yielding varieties fo crops have boosted the production output per hectare in most of the cases. However, this increase in production has slowed down and in some cases

there are indications of decsline in growth of productivity and production. Thus more emphasis need to be given to non-chemicalisation approach with focus on organic farming. Synthetic materials may harm soil micro-flora and environment in general. Organic farming i.e. recycling of all farm wastes, use of farm yard manure and adoption of composting, will go a long way in improving and sustaining soil health and improving productivity of different farming systems invouge. Vermi-compost is emerging as a potential nutrient in put in organic farming.

Alternative Farming Systems

Based on survey reports on existing natural resources, crops, cropping systems/farming systems along with their performance level and constraints there in, agricultural scientists have made commendable efforts countrywide to develop appropriate alternate cropping/ farming technologies to make the agricultural production system more and more sustainable.

For alternative farming system, priority has been given to high value crops like pulses, oilseeds, cash crop (sugarcane, spices, cotton), horticultural crops, fruits and vegetables, medicinal and aromatic plants and major farm enterprise viz. animal husbandry, agro-forestry, aquaculture, poultry, sericulture, apiculture, mushroom cultivation, pig, goat and duck keeping, etc.

While working on alternative farming system the following considerations were made

- The alternative cropping/farming system should be compatible in the system as a whole when introduced. It should be socially acceptable and site specific.
- It must possess the inbuilt potential to improve the overall productivity, profitability and sustainability of the system.
- Such efforts are to be based on multi-season, long-term field testing in farmers fields with farmers participation.

Shifting/Jhumming Cultivation System

In NEH region shifting or 'Jhum' cultivation accounts for 85% of the cultivated area and supports over 2.2 million people largely tribal communities. The tribal families once food self-sufficient, are now barely able to produce enough food for the whole year. Despite advocacy and promotion of Jhum substitution technology packages for settled farming, the system continues the ecological prudence of Jhum farming families which should be combined with techniques which could help to enhance the productivity and sustainability of the system.

In addition to sluggish growth in agriculture, resource degradation and environmental safety issues have also become major concerns of the planners and policy makers. Out of the constraints to agriculture development, the following are unique to this region:

- Primitive agro-economic system in hilly terrain under shifting cultivation leading to land degradation. Limited exploitable water balance in the plains and low ground water potential in the hills have resulted in low level of irrigation. The management of land and water resources, therefore, assumes enormous importance in improving the agricultural economy in the region.
- Inappropriate land tenure (community land for Jhum) and private property rights system in the hilly areas discourage investment and private sector participation in agriculture development. High cost of infrastructure development and relatively low return delays modernization. Such concerns are essentially linked with policies on land reforms, institutional reform, banking and credit and effective governance.

Farming System Research

Overall, research has been focused principally upon production intensification, usually requiring purchased inputs. There has been far less research on increasing labour productivity or on integrated technologies for diversifying the livelihoods of small and marginal farmers and increasing the sustainability of land use. Similarly, there has been limited research in Integrated Pest Management (IPM) or in weed control. These are topics of little interest to the private sector, but also ones which are in danger of neglect by public research institutions. The use of genetically modified crops appears to offer considerable potential for reduced input use and higher levels of production, but their development and introduction have been severely constrained by industrialized country concerns over food safety.

Despite these gaps, the global research agenda is gradually moving from a focus on individual crop performance to a growing acceptance of the importance of increased system productivity. This is viewed largely in terms of better-managed interactions among diversified farm enterprises, sustainable resource management, and

improved targeting of technologies towards women farmers and poorer households. Perhaps even more importantly in the long-term, more emphasis is now being given to public-private partnerships (PPP) driven mainly by the demands of clients. These changes are being accompanied by a growing understanding of farmers problems and opportunities and a greater willingness to blend indigenous knowledge and modern technologies.

The availability of new production, post-harvest and transport technologies will also change demand patterns, by making possible the delivery of new products – or established products in new forms – to markets where they have been previously unattainable.

Over 75% of the cultivated area in rainfed areas have low yield and poor infrastructure of storage and marketing. A farming system approach comprising crops, vegetable, fruits A.H. and fisheries will be tested at different sites for adoption under farmers field. In this context, the research work undertaken by different ICAR Institutes and SAUs and other local agricultural organizations have indicated that introduction of appropriate farming system will help substantially to improve the present yield levels and economic status of the farmers.

Therefore, the adoption of integrated faring system approach is very essential to conserve natural resources and sustaining productivity in all the eco-system.

This farming system research should focus on the following major aspects:

- intensification of existing production pattern,
- diversification of agricultural activities,
- increased farm income,
- sustained productivity,
- conserving soil and water,
- environment protection, and
- enhanced employment and income.

The NGOs or voluntary organizations that are well known for their grassroot level contacts, network dedication and innovative approaches can play an important role in promoting the objectives of the watershed development programme and sustainable rainfed/dryland agriculture.

Sustainability of Farming Systems

Sustainable agriculture seeks to achieve three main goals: economic efficiency, environmental quality and social responsibility. Economic efficiency means meeting an increasing global demand for food at the lowest cost, while responding to changing preferences for different foods and adjusting to structural change within the agro-food sector and in the overall economy. At the same time, sustainable agriculture requires farmers to satisfy the public demand for improved environmental performance by reducing pollution from agriculture, conserving the natural resource base and generating environmental benefits. And agriculture must achieve all of this in socially acceptable ways, by increasing farmers' education and skills, taking account of animal welfare concerns and ensuring that working the land can provide an acceptable level of income.

Lately, organic farming system has been receiving the attention of researchers, planners and progressive farmers, but is organic farming better than "conventional" farming systems as a way to ensure sustaibability? At first glance, perhaps yes. Organic farming uses only organic-based fertilizers, like manure and vegetable-based compost and natural pesticides, like predator animal species. Antibiotics and other animal-health products are used only to cure sick animals and not to enhance yields. The main problem is that compared to conventional farms, organic yields on a give area of land tend to be variable and low, and the small farm size does not permit economies of scale. The focus is more on ensuring ecological balance rather than maximizing output and growth.

Moreover, in practice many different farming systems can be sustainable if properly managed and on farmers adopting appropriate technologies and practices in the specific agro-ecological conditions. And importantly, different systems can co-exist, though here again this requires a high level of farmer skills and management. In other words, human capital on the farm (and knowing how to stimulate that capital) is of primary importance. In short, any comprehensive assessment of the value of different farming systems needs to take account of the relative economic, environmental and social costs and benefits of these systems in terms of varying yields, soil and water depletion, pollution, landscape, wildlife habitats, and animal and human health.

In the past, the agricultural systems and the knowledge that went into them were largely directed at increasing the quantity of production, but they are now also responding to the demand for output of higher quality produced in environmentally and animal friendly ways. But it is not always clear which technologies and farm practices

will make farming systems more sustainable in the long-term, and more research work needs to be done to measure progress.

The whole agro-food chain, therefore, has to increase productivity and be more efficient in its use of scarce resources especially land and water. It has to produce enough and conserving resources environment, sustainable production.

Decentralization and democratization of the farming community will lead to sustainability and conservation of valuable natural resources. Inter-cropping and mixed farming must received priority in all farming system programmes.

Extension Design And Strategy

Basic Issues

We are looking for the second phase of the Green Revolution, which very much depends on the growth of rainfed agriculture. Lately the pace of agricultural growth has declined from about 3.0 percent to around 2.0 percent. When the rain God is favourable, we harvest good crops, but in one or two droughts, our buffer stock dwindles. We have imported wheat lately from Australia. We have not achieved stability and sustainability in our green revolution. And the major stumbling block is the weak Extension Education System in the country which is not very well organized and efficiently managed.

We have taken three pillars of agriculture as research, education and extension. While the investment in research and education is appreciable, the investment in extension education, considering the budgets of the Extension Division of the ICAR as well as the Directorate of Extension of the Ministry of Agriculture, Govt. of India is not matching the needs of the extension system catering to the basic needs of the farming communities. When the Union Ministry had some external/international projects, they gave liberal funding to States, but without it, the Directorate of Extension (DOE/M) has suffered. See what happened after the Training & Visit System of the world? Virtually, there is no presence of extension personnel and workers in the field in North India, whereas in South, the States being relatively resourceful, the extension system is somehow surviving. Govt. of India bodies like National Horticulture Mission (2005-06) should launch such missions in Animal Husbandry and Fisheries as well, when the States could get added resources from the Centre. But such resources are not wisely being utilized at the State levels, it is reported which raises management issues.

Common Conceptual Understanding

Agriculture is defined as all the land-based activities including crops, horticulture, animal husbandry, fisheries, and other allied areas. But in actual practice, agriculture is taken for all the crops; Agriculture, Horticulture, Animal husbandry and fisheries are separate departments and by and large have separate extension systems/sub-systems and programmes. Thus, we have to take it as they are—four extension systems or sub-systems in practice? The problem is how they can be functionally linked and integrated, for the farmer is the only one who is involved in all of these—crops, animal husbandry, horticulture or fisheries. The system has to be visualized so as to integrate all these sub-components in the best interest of integrated and well coordinated extension activities, bearing in mind effectiveness and efficiency.

Resources Distribution

As per policy in the ICAR/SAU System, 10% of the total budget and 20% time of the scientists are expected to be spent on TOT. This is a reasonable proposition but is this happening? If we add to this, the Extension education role of the Ministry of Agriculture/State Governments (exclusive of services role), the budget, staff etc. should be more than one-third of the total agricultural budget? Are we investing that in the extension education programmes?

Extension Functionaries

There are two categories of staff who are directly involved in Extension Education Programmes, like two sides of the coin: (i) Extension Education Professionals, and extension workers and (ii) the Subject Matter Specialists SMSs (Agronomists, Horticulturists, Entomologists, Animal Scientists etc.). This dimension of TOT has to be understood by both the professionals – one cannot do without the other. At present, the understanding is that TOT means the job and responsibilities of the extension professionals only or if at all, the SMSs are the light support to extension programmes without owning it as their own programmes or responsibilities. This dichotomy has to be cleared so that both feel responsible for the extension programmes and they share the credits accruing from these activities. Staffing of the TOT System has to be planned accordingly.

Zonal Planning & TOT

The NARP/ZRSs, though a wonderful basic concept towards generating need-based and agro-climatically specific technologies, is almost a dying institution in absence of adequate funds after withdrawal of the World Bank support. They need to be revived with adequate fundings. The statements that the primary objective of NARP being "technology generation" rather than "technology transfer", agro-climatic resources and prevailing conditions received greater consideration in the delineation of NARP ZONES (Ghosh, 1991), which was was not a correct proposition. The NARP effort was to generate appropriate technologies for effective transfer. This has not, perhaps, been clearly understood by the NARP management and scientists affecting the research outcomes, and the hue and cry of inappropriate technologies in many farming situations. The NARP was also provided with a few extension staff and a farmers hostel that NARP was also alive to transfer to technology. The NARP book has also delineated 'farming situations' in each States/zones, which give way to 'farming system research' and 'farming system extension'. But largely we have devoted our researchers to cropping system, perhaps, inadvertently. This should be the future approach in our research endeavours, which takes into account several conditions influencing the productivity of crops. The sufferer basically is rainfed agricultural research and hence rainfed agricultural extension.

Whether or not the institutions dealing with the agro-climatic zoning and mapping have any linkages and relationship either for economizing the costs or for utilizing the zonal agro-climatic exercises for research as well as extension is doubtful. To a lay observer it seems there should be a uniform and common platform for such a difficult but essential planning corporating the basic agro-ecological factors as well as the socio-economic factors; the latter has been completely ignored. The research has not followed the path of pro-poor, pro-women or pro-environmental issues as always highlighted by eminent scientists.

Demand & Market Driven Extension

The conventional extension system has been criticized that it has been a top-down mechanism rather than a bottom-up approach. This has not been easy for the Farm Scientists or the extension personnel, even though, the extension design has talked of bottom-up importance and scope. In order to make it practical, the simile of PRA was thought of, which compels extension people to sit with the farmers in their villages for understanding the village/farming problems. On this analogy the author (Prasad, 1996) thought of using the model farms – some partially existing and some to be developed or the old ones improved. Such model farms should be developed for situations – marginal model farms, small model farms and big model farms. Such farms should be scientifically planned and developed and these should be the starting points of extension work – the hub of extension. Such extension could be most realistic and pragmatic and locally visible and assessable.

For connecting marketing with the TOT, the value addition should be done by post-harvest technologies including food processing – partially or fully. The AMUL/ NDDB model is an excellent example of holistic extension dairying organizing the diary farmers to marketing of the project – all in one Chain, an international innovation on A to J, approach. Such efforts have been made in Bulgaria in case of vegetables and fruits, what they call as promoting agro-industrial complex; in 1970s they had over 119 such complexes in the small country.

Using para extension workers by training educated rural youth is another device to strengthen bottom-up extension.

Need for Major Organizational Reforms

After T & V extension system of the World Bank, there is virtually no national agricultural extension system in totality. The Directorate of Extension of the Ministry of Agriculture has been promoting ATMA, which is basically an integrating mechanism at the district level; and the ICAR has been promoting the KVK which is mainly devoted to vocational agricultural training and the First-line Extension Advisory Services – the major responsibility for national extension services rest with the Ministry of Agriculture and the State Governments, which is at the cross-road now, a weak link in the agricultural development system.

The major reform required is to merge the Directorate of Extension (DOE) of the Ministry of Agriculture, and the Division of Extension of the ICAR into a Council for transfer of technology. This alone can provide the most needed "Voice & Teeth" to the national extension networks. Down below the said Council, it would have two arms: (i) ICAR First-line extension system including KVK; and (ii) the State Departments of Agriculture should develop a cadre of extension education personnel, which they do not have

today – their extension staff are doing the extension services, not extension education.

There is another alternative if the government is bold enough to adopt the USA System of Agricultural development – education, research and extension totally integrated. In view of this there would be only one SAU per state as per the initial policy of the government. But there are now more than one SAU in each of the major states – reducing the area jurisdiction and increasing the scientific staff for each university. Therefore, the ICAR/ SAU Model, like the USA, will now be the ideal model most suited for the most effective national extension system in the country.

Professional Management – a Missing Link in Agriculture:

The issue of governance has in the recent times emerged at the forefront of the development agenda. Good governance is one of the most crucial factors required if the targets of the Tenth Plan are to be achieved. It is also this factor, or rather lack of it, which could be the cause of immense disappointment and missed development opportunities.

The universally accepted features of good governance are the exercise of legitimate political powers; and formulation and implementation of policies and programmes that are equitable, transparent, non-discriminatory, socially sensitive, participatory, and above all accountable to the people at large. There could, however, be aspects of governance that are contextually driven and geared to address the local concerns.

Experience shows that while good governance can help secure human well being and sustained development, it is equally important to recognize that poor governance could well erode the individual capabilities, as well as institutional and community capacities to meet the needs of sustenance (Planning Commission, 2002–07). Management is a Social Science; it is defined as working with people of an organization/institution devoted to certain mandates, specific objectives and goals. Management would mean working and managing men, money and allied resources of an organization/institution for achieving its goal most effectively and efficiently. Management is an applied social science which can be utilized by any organization or group or institution and hence the names are likewise designated. For instance, Agricultural Management, Research Management, Extension Management or industrial management. It has several components or processes, such as Planning, Organizing, Staffing, Directing, Coordinating, Reporting and Budgeting (POSDCoRB) – Gullick, 1973. These processes being relatively broad and abstract, seven more processes were added to this list namely, Supervision, Communication, Linkage, Human Relations, Decision-making, Evaluation and Monitoring (MEDHLiCS) – Prasad, 1993 (Fig. 1). This means that for the study of any institution/organization, we have to deal with these processes/components of management. By virtue of our experience (non academic training), we deal with some of them but not all of them; and also not in proper relationship and linkages. Private business houses and corporate sectors have taken full advantage of the concept, approach and mechanisms of management; we have not. We should compare business and corporate management *vi-a-vis* management in the public sectors.

Likewise, linkage process is extremely important for mutual interactions between scientists and workers of an organization, where fuller division of labour can take place and they mutually reinforce each other in working as teams. But, there is a basic pre-requisite for proper linkage, i.e. they must have common objectives and goal, and they must share rewards or punishments equally, as it happens at any point of working together. But in a team, conventionally, reward is taken by somebody and punishment by somebody else. Under such circumstances, how can linkage take place? There are several such prerequisites for good linkages, governance and implementation of the programmes. We need to study them.

Strategies for Adoption of Farming System approaches:-

For successful adoption of proven farming systems under different eco-regions of the country the following issues may need immediate attention by Administrators, Extension Scientists and Planners:–

- More "in village" training needs to be organized, and mobile training centers created. Residential vocational courses are needed. KVKs should have necessary orientation to enlist greater involvement of farmers/women/youth and develop their technical competence in areas of farming system.
- Apart from crop specific training, farmers need to be trained in organic farming practices, integrated nutrient and pest management practices, conservation and efficient use and maintenance of handtools; appropriate measures to increase

cropping intensity, agro-forestry and silvipasture with a focus on soil and water conservation practices, post-harvest technologies, marketing, processing, bee-keeping, where horticulture is prominent, mushroom cultivation, construction and usage of smokeless chulhas and non-conventional energy devices.

- Trainers should be trained in PRA techniques, community mobilization, group formation, communication nmethods and strategies for achieving better results from farming system approaches. These programmes should be oriented to building up awareness and confidence among the farming community, motivating farmers to form Self Help Groups groups.
- Approaches suitable for the participatory planning of extension strategy for crop production programme need to be developed.
- There is a need for farming situation specific fine-turing of technologies for predominant cropping. Farming Systems technologies must be location specific to be ecologically, economically and culturally sustainable.
- Research and extension systems currently operating should be reviewed to suggest ways and means of good coordination with responsibility and accountability of each organization.
- Research studies should focus on the problems of concern and relevance for enhancing productivity of predominant and proven farming systems.
- Appropriate and effective communication strategies must be developed and field-tested to reach all regions and remote areas.
- Efforts are to be made for the collection of indigenous practies and scientific rationale behind each of these worked out.
- Suitable low cost agriculture implements to be developed for specific agricultural operations through adequate field trials.
- Technologies for income generation from crop/Horti/ Animal Husbandary-based farming system should be generated, field tested and operationalized.
- Operational research on development and popularization of value added products obtained from different type of farming system should be taken up.

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"Management is doing things right; leadership is doing the right things."

—Peter F. Drucker

An Economic Analysis of Technology Mission on Linseed Crop in India

J M Singh & D K Grover

Linseed is the second major non-edible oilseed crop grown in India. The present study was designed to examine the trends in area, production and yield of linseed in India and Punjab and to see the impact of various oilseed development programmers on the area, production and yield of linseed. The analysis brought out that increase in area was witnessed in Assam only while in other major linseed growing states there was increase in yield only. Concerted efforts such as effective market/price support, technological upgradation and extension efforts are required to increase the area under linseed crop in major growing states to enhance the non-edible oil requirement in the country.

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India is the third largest producer of oilseeds in the world. In spite of this India's dependent on huge quantities of edible oil import in order to fed its ever-increasing population is a cause of concern. The government of India launched a series of measures towards to end of the sixth plan to enhance oilseed production in the country. These included National Oilseed Development Project (NODP), started in 1985-86, and 'Technology Mission on Oilseeds (TMO)' in May 1986.

The objective of TMO was to improve the production technology and marketing mechanism for the oilseeds in the country. Even After this a number of oilseed development projects were initiated by the government for increasing oilseeds production. Linseed is second important non-edible oilseed crop after castor, having a 2.22 per cent the area and accounting for 3.16 per cent of total oilseeds during 2003-04. In Punjab the area under linseed dwindled from 5.4 th.ha in 1967-68 to 0.2 th.ha during 2006-07 which is just 0.28 per cent of total area under oilseed crops in the state. The present paper aims to study trends and the impact of technology on the acreage and yield performance of linseed in India with particular reference to Punjab.

The specific object of the study were:

1. To examine thetrends in area, production and yield of linseed in India and Punjab.
2. To study the impact of oilseed development programmes on production performance of linseed in India and Punjab.
3. To suggest policy measures to enhance the production base of linseed in India in general and in Punjab in particular.

Methodology

This study was based on secondary data, obtained from various sources. Time series data on area, production and yield of linseed crop for major growing states in India were obtained from the Centre for Monitoring Indian Economy (CMIE) from 1970-71 through 2003-04, while for Punjab district-wise data from 1965-66 to 2004-05 were collected from various issued of 'Statistical Abstract of Punjab'. The data for linseed crop were divided into two periods i.e. pre-TMO (before 1985-86) and post-TMO (after 1985-86).

The analysis of data was undertaken by applying different statistical tools such as mean, coefficient of variation (CV), compound growth rate (CGR) AND Student's-test etc. to make the result more relevant.

The data on area, production and yield of linseed in India and Punjab were detrended by the method of moving averages. For this 3 year, 5 year, 7 year and 9 year moving averages were calculated and 5 year moving average data were retained for analysis on the basis of minimum variation in the date i.e. the irregular variation in the yearly data were eliminated by averaging the yearly values over the years and 5 year average came out to be the best. The compound growth rate was calculated by employing the power function as given below:

$$Y = a\, b^{t}$$

Where, Y = dependent variable

a = Constant term

b = (l+r), regression coefficient

r = (b-l)* 100, compound growth rate in percentage

t = time variable

Besides, coefficient of variation for a given series was also calculated by employing the formula given below:

$$C.V. = (S.D./Mean)*100$$

Where, C.V. = coefficient of variation

S.D. = standard deviation

In order to seed the impact of technology, difference of means in two periods were calculated and their significance was tested by applying t-test for difference of two independent population means under null hypothesis and alternate hypothesis :

Ho: $\mu_2 = \mu_1$ i.e. there is no difference in means of area, production and yield of linseed crop in post TMO and pre-TMO periods

H_1: $\mu_2 > \mu_1$ i.e. the means of area, production and yield of linseed Crop in post TMO period are more than pre-TMO periods

(one tailed test)

The formula of test for difference of two independent population means was

$$T - (m_2 - m_1) - (\mu_2 > \mu_1) / SE\,(m_2 - m_1)$$

Under H_o: if, $\mu_2 = \mu_1$ then

$$T_{ca} = (m_2 - m_1)/SE(m_2 - m_1)$$

i.e. $t = (m_2 - m_1) / \sqrt{S2\,(1/n_2 + 1n_1)}$

Where, $S^2 = [(n_1 - 1)\, s12 + (n_2 - 1)s_2^2] / n_1 + n_2 - 2)$

m_1 = mean of area/production/yield in first period

m_2 = mean of area/production/yield in second period

n_1 = number of observation in first period

n_2 = number of observation in second period

s_1^2 = standard error of observations in first period

s_2^2 = standard error of observation in second period

Impact of technology was tested by comparing calculated t=value with table at (n_1+n_2-2) degrees of freedom.

Results and Discussion

The results have been discussed under the following sub-heads:

I. Trends in area, production and yield of linseed.

II. Impact of TMO on production performance of linseed

III. Policy Suggestions

State-wise Trends In India

The state-wise trends in area, production and yield of linseed crop in India from 1970-71 to 2003-04 are shown in table 1. The table shows that positive and significant growth rate in area was seen in Assam only while in Rajasthan, Karnataka, Maharashtra, Madhya Pradesh, Andhra Pradesh and Bihar growth was negative and significant at 1 per cent level of significance. The growth in yield was positive and significant in Rajasthan, Madhya Pradesh, Uttar Pradesh, Karnataka, Bihar, Assam and Maharashtra, while it was negative in Andhra Pradesh only.

Table 1: State-wise trends in area, production and yield of linseed crop in India 1970-71 to 2003-04

('000 ha, '000 tns. Kg/ha)

State	Estimates of				
	Variables	Mean	C.V	CGR	R^2
Andhra Pradesh	Area	10.24	34.08	-3.23**	0.73
	Production	1.94	40.98	-4.06**	0.68
	Yield	184.67	14.68	-0.98**	0.30
Assam	Area	7.31	35.04	4.99**	0.75
	Production	3.43	40.32	5.81**	0.82
	Yield	458.20	7.78	0.79**	0.82
Bihar	Area	76.65	22.51	-2.61**	0.4
	Production	35.26	13.18	-1.20**	0.60
	Yield	474.7	17.18	1.50**	0.85
Karnataka	Area	45.68	41.56	-4.66**	0.92
	Production	10.40	35.13	-3.29**	0.76
	Yield	236.93	17.18	1..47**	0.56
Madhya Prasdesh	Area	362.54	36.50	-3.67**	0.91
	Production	106.65	25.05	-2.11**	0.66
	Yield	306.27	14.87	1.64**	0.86
Maharashtra	Area	198.58	32.16	-3.95**	-0.80
	Production	44.86	29.88	-3.43**	0.73
	Yield	227.30	6.33	0.53**	0.53
Orissa	Area	29.78	16.56	0.54	0.07
	Production	12.41	20.32	0.47	0.03
	Yield	412.97	5.57	-0.10**	0.02
Rajasthan	Area	55.08	56.16	-8.63**	0.84
	Production	19..97	48.54	-6.55**	0.80
	Yield	411.90	25.99	2.45**	0.82
Uttar Pradesh	Area	89.06	10.73	-0.46	0.10
	Production	30.63	20.73	1.92**	0.43
	Yield	335.82	22.18	2.88**	0.88
India	Area	1306.19	37.08	-4.44**	0.98
	Production	368.77	25.27	-2.93**	0.96
	Yield	297.83	14.65	1.62**	0.90

**,*, indicate significance at 1 per cent and 5 percent level of significance

At the All-India level, yield was having a positive growth but production declined due to negative growth in area which was more than growth in yield. The coefficient of variation in area was in the range of 32.56 per cent in Rajasthan, Karnataka, Madhya Pradesh, Andhra Pradesh and Maharashtra showing high area variability. In Bihar, Orissa and Uttar Pradesh, area variability ranged between 10 to 22 per cent. The coefficient of variatioin in yield ranged between 14 to 25 per cent in Rajasthan, Uttar Pradesh, Karnataka, Bihar, Madhya Pradesh and Andhra Pradesh. The yield variability was less in Assam, Maharashtra and Orissa, which varied between 5 to 7 per cent. At the all- India level, area variability was more than yield variability. Thus, due to more fluctuation of area under linseed crop. Production had declined because it is sown on marginal and sub-marginal lands, having least amount of irrigation facilities.

District-wise Trends

The district-wise trends in area, production and yield of linseed crop in Punjab are given in table 2. It is evident from the table that negative and significant growth in area was found in Amritsar, Gurdaspur, Hoshiarpur, Jalandhar, Ludhiana, Patiala and Ropar. However, in yield the growth was positive and significant in Amritsar, Gurdaspur, Hoshiarpur, Jalandhar, Ludhiana, Patiala and Ropar. At the Punjab level, negative and significant growth was seen in area while positive and significant growth in yield was observed. The coefficient of variation in area varie between 29 to 63 per cent in all the major linseed growing districts while in yield, coefficient of variaion varied between 15 to 36 per cent. Thus, area variability was much more than yield variability in linseed.

Table 2: District-wise trends in area, production and yield of linseed crop in Punjab, 1965-66 to 2004-05

('000 ha, '000 tns. Kg/ha)

			Estimates of		
District	**Variables**	**Mean**	**C.V**	**CGR**	**R^2**
Amritsar	Area	0.13	29.36	-4.07**	0.72
	Production	0.11	15.31	-1..58**	0.39
	Yield	857.72	15.59	-2.63**	0.73
Gurdaspur	Area	0.53	62.10	-6.95**	0.92
	Production	0.27	40.13	-4.05**	0.83
	Yield	635.64	35.16	3.13**	0.89
Hoshiarpur	Area	0.38	63.49	-7.50**	0.96
	Production	0.15	44.09	-4.38**	0.75
	Yield	436.12	34.69	3.40**	0.7
Jalandhar	Area	0.28	33.50	-3.38**	0.76
	Production	0.19	24.09	-1.33**	0.28
	Yield	726.11	27.28	2.11**	0.67
Ludhiana	Area	0.14	48.93	-6.13**	0.44
	Production	0.11	30.03	-3.45*	0.33
	Yield	872.07	16.33	2.85**	0.42
Patiala	Area	0.23	46.17	-8.67**	0.99
	Production	0.11	26.57	-2.92**	0.49
	Yield	576.28	36.94	6.14**	0.77
Ropar	Area	0.16	33.22	-5.83**	0.86
	Production	0.09	7.78	0.52	0.11
	Yield	620.56	34.69	7.01**	0.84
Punjab	Area	1.58	63.76	-6.62**	0.93
	Production	0.80	46.82	-4.28**	0.94
	Yield	606.36	31.83	2.51**	0.75

**,*, indicate significance at 1 percent and 5 percent level of significance

State-wise Technological Impact

The impact of technology on area. Production and yield of linseed crop various states of India is given in table 3. Impact of technology mission was visible as increase in area under linseed crop in Assam only and this increase was significant at 1 per cent level of significance. However, there was impact of technology in terms of significant increase in yield in the states of Assam, Bihar, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh during second period. Thus, there was no dearth of technology, but it was not reflected in terms of increase in area in the major linseed growing states.

Table 3: Impact of various development Programmes on area, production and yield of linseed crop in various states of India

('000 ha. '000 tns, kg/ha.

State	Variables	Before development programmes (1970-71 to 1985-86)				After development programmes (1986-87 to 2003-04)				Impact of y m_2-m_1	t-value (Cal.)
		Estimate of				Estimate of					
		Mean (m_1)	C.V.	CGR	R^2	Mean (m_2)	C.V.	CGR	R^2		
Andhra Pradesh	Area	13.10	21.80	-2.58	0.29	7.76	20.06	-2.62*	0.32	-5.34	-6.475
	Production	2.61	21.07	-3.30	0.45	1.36	31.26	-2.52	0.14	-1.26	-7.065
	Yield	201.64	8.65	-1.10	0.24	169.81	14.89	0.14	0.002	-31.83	-3.955
Assam	Area	5.16	41.93	12.71	0.93	9.20	8.48	1.66**	0.79	4.04**	6.977
	Production	2.24	43.30	13.09	0.94	4.46	15.19	3.11**	0.83	2.22**	7.325
	Yield	431.36	1.68	0.38	0.82	481.69	7.05	1.43**	0.84	50.33**	5.427
Bihar	Area	92.08	5.74	-0.35	0.06	63.15	18.93	4.16**	0.93	-28.93	-8.355
	Production	39.22	7.18	1.10	0.33	31.80	8.80	-.75**	0.82	-7.43	-7.234
	Yield	425.57	6.56	1.51	0.84	517.75	13.30	2.65**	0.90	92.18**	4.676
Karnataka	Area	63.90	15.38	-2.72	0.49	29.73	22.89	-4.02**	0.82	-34.17	-11.187
	Production	13.66	20.85	-3.70	0.45	7.55	9.40	-0.69	0.12	-6.11**	-8.312
	Yield	209.14	8.84	-0.82	0.13	261.25	15.03	3.18**	0.83	52.11**	4.538
Madhya Prasdesh	Area	463.83	26.87	-5.76	0.86	273.91	17.94	-3.25**	0.92	-189.91	-5.627
	Production	121.75	24.79	-4.74	0.67	93.44	13.83	-2.77**	0.85	-28.32	-3.418
	Yield	262.71	7.82	1.09	0.33	344.38	5.85	1.05**	0.69	81.66**	10.977
Maharashtra	Area	253.80	5.90	0.23	0.05	150.26	32.91	-7.23**	0.97	-103.54	-7.523
	Production	55.99	8.25	0.98	0.20	35.12	30.52	-6.59**	0.94	-20.87	-6.744
	Yield	219.43	5.03	1.09	0.73	234.19	5.72	0.63*	0.27	14.76**	3.264
Orissa	Area	28.37	18.97	4.73	0.82	31.02	13.30	-2.79**	0.87	2.65	1.524
	Production	11.77	21.68	5.41	0.20	12.97	18.16	-3.84	0.84	1.20	1.341
	Yield	411.86	3.30	0.59	0.51	413.94	6.96	-1.17	0.59	2.08	0.247
Rajasthan	Area	84.32	8.31	-1.15	0.32	29.49	63.24	-14.94**	0.96	-54.83	-10.361
	Production	28.90	9.94	0.58	0.06	12.15	50.72	-11.32**	0.96	-16.75	-9.309
	Yield	340.29	8.53	1.78	0.72	474.56	23.41	4.71**	0.92	134.28**	4.385
Uttar Pradesh	Area	90.69	10.96	1.90	0.30	87.94	10.36	-.03**	0.72	-2.75	-0.742
	Production	25.50	23.34	5.30	0.51	34.16	9.79	-0.61	0.08	8.66**	4.839
	Yield	253.46	9.43	1.80	0.36	392.44	9.08	1.79**	0.73	138.98**	11.272
India	Area	1765.04	13.65	-3.26	0.87	904.70	23.06	-5.04	0.97	-890.35	-10.485
	Production	453.33	11.44	-2.59	0.86	294.79	15.90	-3.44**	0.93	-158.54	-8.795
	Yield	257.86	6.16	0.75	0.24	332.81	8.11	1.75**	0.96	74.96**	9.096

**,*, indicate significance at 1 per cent and 5 percent level of significance

District-wise Technological Impact

The Impact of technology in area, production and yield of linseed crop in various districts of Punjab is seen in table 4. The table shows that the impact of technology was seen in terms of increase in yield only in Gurdaspur, Hoshiarpur and Jalandhar, which was also statistically significant. At Punjab level also, the impact was seen in terms of increase in yield only. In other districts of Punjab, the area under linseed is negligible. So, in spite of the technology, due to better comparative profitability of competing crops, no impact of technology was observed in terms of increase in area under linseed.

Policy Measures

The foregoing analysis has brought out that positive and significant increase in linseed area was obtained in Assam only, while in yield significant positive increase was witnessed in Rajasthan, Madhya Pradesh, Uttar Pradesh, Karnataka, Bihar, Assam and Maharashtra. So, there is a need to bring more area under linseed crop in order to enhance the linseed production base in these states to boost up the non-edible oil production. In Punjab, area under linseed had declined significantly while productivity had increased. Thus, emphasis should be laid to further enhance the productivity and provide effective price support to make linseed relatively more profitable

Table 4: Impact of various development Programmesd on area, production & yield of linseed crop in various district of Punjab

('000 ha. '000 tns, kg/ha.)

State	Variables	Before development programmes (1970-71 to 1985-86)				After development programmes (1986-87 to 2003-04)				Impact of y	t-value (Cal.)
		Estimate of				Estimate of				m_2-m_1	
		Mean (m_1)	C.V.	CGR	R^2	Mean (m_2)	C.V.	CGR	R^2		
Amritsar	Area	0.13	29.36	-4.07	0.72	-	-	-	-	-	-
	Production	0.11	15.31	-1.58**	0.39	-	-	-	-	-	-
	Yield	857.72	15.59	2.63**	0.73	-	-	-	-	-	-
Gurdaspur	Area	0.78	27.28	-4.11**	0.77	0.24	58.30	-10.34**	0.92	-0.54	-8.907
	Production	0.35	19.39	-2.48**	0.48	0.18	38.87	-7.42**	0.89	-0.17	-7.205
	Yield	454.26	11.50	1.72**	0.64	838.35	18.80	-3.27**	0.64	384.09**	10.039
Hoshiarpur	Area	0.46	51.92	-8.65**	0.97	0.17	21.84	-9.58**	0.86	-0.29	-3.170
	Production	0.17	41.74	-6.78**	0.94	0.11	13.24	3.67	0.37	-0.06	-2.303
	Yield	389.63	12.57	2.10**	0.80	662.57	28.21	14.63**	0.98	272.94**	6.015
Jalandhar	Area	0.33	14.77	-2.44**	0.77	0.21	41.37	-8.03**	0.92	-0.12	-5.127
	Production	0.19	19.99	2.58**	0.42	0.18	27.82	-4.81**	0.70	-0.02	-1.158
	Yield	577.79	11.23	-0.14	0.005	891.88	18.18	3.50**	0.68	314.09**	7.784
Ludhiana	Area	0.14	48.93	-6.13**	0.44	-	-	-	-	-	-
	Production	0.11	30.03	-3.45*	0.32	-	-	-	-	-	-
	Yield	872.07	16.33	2.85*	0.42	-	-	-	-	-	-
Patiala	Area	0.23	46.17	-8.67**	0.99	-	-	-	-	-	-
	Production	0.11	26.57	-2.92**	0.48	-	-	-	-	-	-
	Yield	576.28	36.94	6.14**	0.77	-	-	-	-	-	-
Ropar	Area	0.16	33.22	-5.83**	0.86	-	-	-	-	-	-
	Production	0.09	7.78	0.52	0.12	-	-	-	-	-	-
	Yield	620.56	34.69	7.01**	0.84	-	-	-	-	-	-
Punjab	Area	2.27	36.08	-6.13	0.95	0.79	60.16	-10.26**	0.91	-1.48	-0.512
	Production	1.06	31.11	-5.32**	0.91	0.51	28.24	-5.59**	0.95	-0.54	-6.279
	Yield	472.00	7.40	0.86**	0.40	756.53	24.65	5.20**	0.77	284.53**	6.535

than wheat so as to increase area under the crop in these states. There is a need to start more oilseed development programmese in those states where productivity of linseed had declined, as in case of Andhra Pradesh and Orissa.

Thus, to fulfil the demand of non-edible oils, emphasis should be laid to bring more are under linseed crop in Rajasthan, Madhya Pradesh, Uttar Pradesh, Maharashtra, Karnataka and Bihar. For diversification of Punjab agriculture area under linseed should be increased, which is the need of the hour due to various ecological and environmental problems created by paddy-wheat cropping system in the state. But for this, assured marketing and effective price support along with technological breakthrough is a prerequisite.

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Freedom is not worth having if it does not include the freedom to make mistakes.

—Mahatma Gandhi

Evaluating Market and Price Integration among International Tea Markets

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Evaluation of market integration has usually been undertaken by analyzing price interactions. The study of spatial price relationships helps to explain market performance and the degree of integration. A Vector Error Correction Model (VECM) is appropriate to study spatial price linkages between the Indian and international black tea auction markets. The VECM allows us to consider, simultaneously, the long-run implications of co-integration and the short-run adjustments. The results indicate that Indian and international black tea auction markets are integrated, not only in the long-run but in the short-run as well, and the price transmission process is more efficient in the tea industry.

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Evaluation of market integration has usually been undertaken by analyzing price interactions. Different methods report on distinct aspects of these linkages and, hence, alternative empirical definitions of spatial market integration exist. Nevertheless, the non-stationary prices has led to widespread use of co-integration. Co-integrated prices do not drift apart in the long-run and tend to move towards a shared equilibrium path. Thus, co-integration only tests for long-run market integration. Moreover, this technique does not solve the limitations of previous methods derived from the exclusion of transfer costs and poses new questions in a multivariate setting (for example, interpretation and identification of multiple co-integration vectors). Nevertheless, while no reliable and periodic data on transaction costs and trade flows exist, methods based on prices will prevail.

A more flexible approach that integrates co-integration with previous methodology not only depicts a more accurate description of the spatial prices relationships but avoids misleading interpretations derived from the use of a single technique. In particular, long-run price transmission can be extended to evaluate patterns of Granger causality and dynamic features as in Goodwin et.al. (1996). As markets become more integrated, it is expected that each market employs information from the others when forming its own price expectations, and therefore bi-directional causality should be present. Likewise, more integration will be accompanied with a greater interdependence among prices in the short-run, such that every price contributes to explain the evolution of the others. This can be analyzed with the forecast error variance (FEV) decomposition obtained from a vector authoregressive (VAR).

Geographically separated markets are integrated if goods and information flow freely among them and, as a

result, prices are linked. Arbitrage activities will preclude prices of a homogeneous product in separate locations to differ by an amount greater than transfer costs. When inter-market margins are larger than transfer costs, profitability opportunities are not being exploited and markets are not efficiently connected. However, in integrated markets, price changes in one region are transmitted to the other region's prices. The extent and the speed to which shocks are passed through, and the strength of the interdependence among prices are indicators of the degree of integration and global efficiency of markets performance. Different methods focus on distinct aspects of the spatial price linkages, such as causality patterns, dynamic interactions or long-run equilibria. Hence, they provide complementary knowledge about markets interrelationships.

Granger causality tests focus on the presence of at least unidirectional causality linkages as an indication of some extent of integration (Gupta and Mueller, 1982). Feedback implies that each market uses information from the others when forming its own price expectations, while unidirectional causality inform about leader-follower relationships in terms of price adjustments (Gordon et. al, 1993). Another avenue of research involves the dynamic dimension of market integration applying Ravillion's (1986) approach (Dahlgran and Blank, 1992; Jordan and Vansickle, 1993) or VAR models (Schroeder and Goodwin, 1990; Goodwin and Schroeder, 1991). The first one assumes a radial structure in the price formation process and provides definitions of short and long-run market integration. VAR models focus on the strength of interrelationships and the speed and magnitude of reactions in one price after a price in the system is shocked.

Finally, co-integration focuses on the long-run and avoids shortcomings of the previous approaches derived from neglecting (or solving inappropriately) the university properties of price series. In particular, conventional tests on causality and VAR models specification are inappropriate when prices are non-stationary. Co-integration among non-stationary prices means that a linear combination of them is stationary and, hence, prices tend to move towards this equilibrium relationship in the long-run (Ardeni, 1989; Baffes, 1991; Goodwin, 1992; Zanias, 1993; Silvapulle and Jayasuriya, 1994).

Since Ardeni (1989), co-integration has become the most applied method to evaluate market integration. However, some shortcomings still remain (Barrett, 1996; Fackler, 1996). First, the flack of co-integration may be due to non-stationary transaction cost and not to the flack of market integration; second, co-movement of prices can be due to some exogenous and common factor, such as inflation, and not to arbitragers' activities; and third, co-integration imposes a linear relationship among prices which is not compatible with discontinuous trade flows. However, the last two arguments are less likely to apply to international and developed markets than regional or developing countries. Some works have tried to cope with transfer costs and the non-linearities implied by discontinuous patterns of trade (Sexton et al. 1991 and Baulch, 1997). However, given that regular data on transaction costs and trade flows do not exist, methods based on prices still predominate.

Ravallion's model has been adapted to incorporate co-integration relationships (Palaskas and Harris-White, 1993; Alexander and Wyeth, 1994; Dercon, 1995). However, two limitations still remain: first, the assumption of a radial structure in the price formation process and, second, the vicariate nature of analysis. Although differences in the size of Indian and international black tea auction markets exist, it is not possible to delimitate deficit versus surplus or producing versus consuming countries as long as intra-industry trade prevails. On the other hand, the multilateral patterns of trade are likely to draw complex interactions and simultaneous determination of market prices that can be better described in a multivariate framework. As a consequence, a Vector Error Correction Model (VECM) is appropriate to study spatial price linkages between the Indian and international black tea auction markets. The VECM allows us to consider, simultaneously, the long-run implications of co-integration and the short-run adjustments. Hence, an attempt is made to study spatial price linkages between the Indian and international black tea auction markets.

Methodology

The present study aimed to estimate the price transmission between the domestic and international black tea auction markets. Testing was done for weekly prices of six regional auction markets in India namely, Kolkata, Guwahati, Siliguri, Cochin, Coonoor and Coimbatore and four international markets namely Colombo (Sri Lanka), Jakarta (Indonesia), and Lime (Malawi) for the period 1990-2005. The black tea auctions in these national and international markets are conducted weekly once on a specific day and the day of auction varies from market to market. The day of auction at Mombassa (Kenya), Colombo (Sri Lanka) and Kolkata falls on the same day i.e. on Monday exclusively for leaf and on Tuesday exclusively for dust. If the transactions are of larger quantities, then the auctions

are carried on the next day also. Hence the price series the weekly average auction prices of black tea.

The time series on the black tea prices are deflated to form real price series. In the case of domestic black tea auction market prices, the series are deflated by wholesale price index for tea. The US $ deflator taken from Oanda Corporation, an online international For-Ex dealing organization (Internet address http;/ www.oanda.com (accessed on July 17, 2007) was used to deflate the international black tea auction market prices. Then the prices are converted into domestic currency using official foreign exchange rate.

Stationarity

Before analyzing any time series data, testing for stationarity is a prerequisite since econometric relation between the time series has the presence of trend components (Davidson and Mackinnon, 1993). This involved testing for stationarity of the variables using tests such as Augmented Dickey Fuller (ADF) test. A stationary series is one whose parameters are independent of time, exhibiting constant mean and variance and having autocorrelations that are invariant through time. If the series is found to be non-stationary, the first differences of the series are tested for stationarity. The number of times (d) a series is differenced to make it stationary is referred as the order of integration, I (d). The ADF test mentioned above considers the null hypothesis that a given series has a unit root, i.e., it is non-stationary. The test is applied by running the regression of the following form: If the coefficient is not statistically different from zero, it implies that the series has a unit root, and, therefore, the series is non-stationary. The determination of order of integration of each variable is required for any time series analyses and, more importantly, for error correction equations, because each variable involved in the estimation of these models must be first differenced stationary series. To verify that the first differenced price series are indeed stationary, Augmented Dickey-Fuller (ADF) unit root tests are used. The null hypothesis of non stationarity is tested using a t-test. The null hypothesis is rejected if estimated variable is significantly negative.

The black tea auction market price series of domestic and international markets were tested for stationarity in the above equation (I), where Y, denoted price series of domestic and international markets and I=1,2,., 10 (1-KOLKATA; 2-GUWAHATI; 3-SILIGURI; 4-COCHIN; 5-COONOOR; 6-COIMBATORE; 7-COLOMBO; 8-JANAKARTA; 9-MOMBASSA and 10-LIMBE).

The critical values for this test are negative and larger than the standard t values and are given in Engle and Yoo (1987) and Mackinnon (1991). If the computed value (at level) is smaller than the critical "tau' statistics, we do not reject the null hypothesis of non-stationary series. In this case, the individual series may be integrated of order 1 or 2 i.e. 1(1) or (2) and may be more than this order. Once the variables are checked for stationarity and are of same order, integration between them can be tested using methods such as Augmented Dickey Fuller Test or Johansen Maximum Likelihood Test in a bivariate as well as multivariate framework. If the estimated value of error term exceeds critical values at one per cent, five per cent and 10 per cent levels of significance, the conclusion would be that the residual term is stationary and hence the two individual series, though non-stationary, are co-integrated in the long-run.

Johansen's Multiple Co-integration Framework

It is possible that individual time series of the commodity prices may be non-stationary in levels, but a linear combination of them may be stationary indicating a long-run equilibrium relationship between them (Engle and Granger, 1987). If a linear combination of two non-stationary series is stationary, then the two series are considered to be co-integrated. To test whether or not the residual term of the regression between the two time series in question is stationary, co-integration tests start with the premise that for a long-run equilibrium relationship to exist between two variables it is necessary that they should have the same inter temporal characteristics.

The ADF test is supplemented by Johansen-Juselius Maximum Likelihood Method. This test is considered to be better than other co-integration approaches as it addresses endogeneity and simultaneity problems being faced in other methods in bivariate models. Also, it is important when co-integration is tested between more than two variables. In this technique, the hypothesis of presence of co-integration vector is formulated on a group of non-stationary series, as the hypothesis of reduced rank of the long-run impact matrix. Likelihood ratio and maximum likelihood tests are applied to derive test statistics for the hypothesis of given number of co-integration vectors and their weights. Inference concerning linear restrictions on the co-integration vectors and their weights is performed using usual chi square methods (Johansen and Juselius, 1990 and Johansen, 1988). First, the order of integration is the same for each time series of prices, and then test for co-integration. Only variables of the same order of

integration qualify for the pair wise co-integrating relationships. The specific linear combinations tested are the residuals from a static co-integrating regression such as:

Where Y, and X, are (I=1,2,..6) price series in levels and Z. In the current study, the co-integration implies testing stationarity of the residual term Z. In the current study, the dependent variable Y, are (I=1,2,.6) prices of different black tea auction markets (I=1,2,.6) and the independent variables X, are (I=1,2,5) prices of other five black tea auction markets.

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For example, the co-integration equation for Cochin black tea auction market prices with the other five black tea auction markets prices is represented as follow:

In the current study, the relationship between the different black tea auction markets prices are studied through the multiple co-integration analysis under errors correction framework. The integration of global markets with the domestic markets for black tea auction market prices are studied in Johansen's multiple co-integration framework. The world black tea auction markets price transmissions are analyzed through vector error correction procedures. The time series econometric analyses are carried out using E-views 3.1.

Error Correction Mechanism (ECM)

An Error Correction Model (ECM) is a neat way of combining the long-run, co-integrating relationship between the levels variables and the short-run relationship between the first differences of the variables. It also has the advantage that all the variables in the estimated equation are stationary; hence there is no problem with spurious correlation. The last step in co-integration analysis involved application of error-correction mechanism. Since the procedure of differencing results in loss of valuable long-run information in the data, an error correction (EC) term is introduced in the theory of co-integration that integrates or ties short-run dynamics of a series to its long-run value. The residuals obtained from the linear equation are introduced as explanatory variable into the system of variables in levels. The error correction term, thus, captured the adjustment towards long-run equilibrium.

Engel and Granger (1987) demonstrated that once a number of variables are found to be co-integrated, then there existed a corresponding error correction representation which implied that changes in the dependent variable are a function of the level of disequilibrium in the co-integrating relationship (captured by the error correction term) as well as changes in other variables. The importance of including a constant term without a time trend has been addressed by Dickey and Fuller (1979) and Miller and Russek (1990). Based on their suggestions, ADF equations are estimated with an intercept and no time trend.

If the price series are I (1), then one could run regressions in their first differences. However, by taking first differences, we lose the long-run regressions in their first differences. However, by taking first differences, we lose the long-run relationship that is stored in the data which implied that use of variables in levels as well. Advantage of error correction methodology is that it incorporates variables both in their levels and first differences. By doing this, ECM captures the short-run equilibrium situations as well as the long-run equilibrium adjustments between prices. Even if one demonstrates market integration through co-integration, there could be disequilibrium in the short-run i.e., price adjustment across markets may not happen instantaneously. It may take some time for the spatial price adjustments. ECM can incorporate such short-run and long-run changes in the price movements. A generalized ECM formulation to understand both the short-run and long-run behaviour of prices can be considered by first taking the autoregressive distributed lag (ADL) equation as follows:

If all the variables are I (1), i.e., they are integrated of order 1, they are stationary in first difference. Therefore, all the summations in the above equations are also stationary. Moreover, if the variables are co-integrated, the ECM term, i.e., the linear combination of variables represented in parentheses is also stationary. The **a** coefficients capture the short-run effects and **m** coefficients represent the stationary long-run impacts of the right hand side variables. The parameter **mo** measures the rate of adjustment of the short-run deviations towards the long- run equilibrium. Theoretically, this parameter lies between O and 1. The value 0 denotes no adjustment and 1 indicates an instantaneous adjustment. A value between 0 and 1 indicates that any deviations will have gradual adjustment to the long-run equilibrium values.

So the Vector Error Correction Mechanism is used to distinguish short-term from long-term association of the variables included in the model. When the variables are not integrated, then in the short-term deviation from this long-term equilibrium would feedback to the changes in the dependent variable in order to force the movement

according to the long-run equilibrium relationship. The long-term causal relationship among the black tea auction markets is implied through the significance of the 't' tests of the lagged error correction term as it contains the long-term information because it is derived from the long-term relationship. The coefficient of the lagged error correction term is a short-term adjustment coefficient and represented the proportion by which the black tea auction market market adjusted in response to the long-run disequilibrium.

Before computing the error correction mechanism, the order of lag for the variables to be included in the models is to be ascertained. The orders of lag for the variables are chosen by the smallest Akaike Information Criterion (AIC)/ Schwartz Bayesian Criterion (SBC) of the black tea auction markets price series. In the present study, all the variables are found to have minimum AIC/SBC values at the first lag. Hence throughout the analyses, first lag of the variables are included wherever necessary.

The commodity prices are said to be integrated because of the globalization process. In view of that, the price linkages between the domestic black tea auction markets and the international black tea auction markets prices are studied through co-integration and VECM approach.

Results and Discussion

Market integration implies that the price changes that occur in one market would immediately be transmitted to the other market. Integration of markets is a good indicator of efficiency in the marketing system. Co-integration analysis was used to test the integration of black tea prices.

Co-integration test starts with the pre-condition that if two time series variables could be integrated, they should be of the same order of integration. To have the same order of integration, these variables should be stationary when they are differenced the same number of times. Hence, the test of co-integration starts with a test of stationarity at different differenced levels. To verify whether the level and first differenced price series were indeed stationary, Augmented Dickey-Fuller (ADF) unit root test was used. The equations were estimated with an intercept and no time trend for each price series. The ADF test results are presented in table 1.

The null hypothesis of non-stationarity was tested based on the critical values reported by MacKinnon (1990). Some of the price series appeared non-stationary in the Levels, but all the series were stationary in first differences. The price series of Kolkata, Guwahati, Siliguri and Jakarta (Indonesia) were stationary in the levels itself and hence omitted for further analysis. The remaining markets Cochin, Coonoor, Coimbatore, Colombo (Sri Lanka), Mombassa (Kenya) and Limbe (Malawi) were taken for further analysis.

Having confirmed that the price series were stationary in their first differences, co-integration between the markets was tested using Johansen's maximum likelihood procedure for the presence of short-run and long-run relationship between the domestic and international black tea auction

Table 1: Results of Unit Root Test (ADF Based) for Black Tea Prices at Different Auction Markets

Variable	Level	First Difference	Lags	Critical Value
Kolkata	-4.0214*	-	(0)	-3.4665
Guwahati	-4.0825*	-	(0)	(at 1 per cent level)
Siliguri	-4.4963*	-	(0)	
Cochin	-3.2612**	-5.5116*	(0)	
Coonoor	-3.3466**	-6.0989*	(0)	-2.8770 (at 5 per cent level)
Coimbatore	-3.2670*	-5.3984*	(0)	
Colombo	-2.1208***	-6.4071*	(0)	
Jakarta	-3.8343*	-	(0)	-2.5749 (at 10 per cent level)
Mombassa	-2.1858***	-6.9592*	(0)	
Limbe	-2,9260**	-6.8220*	(0)	

Note: Critical value based on MacKinnon (1991). *significant at 1 and ** at 5 per cent level.

markets and associated price transmission and resultant price volatility in the domestic markets for black tea.

Integration of global markets with the domestic markets for black tea was studied in Johansen's multiple co-integration framework. The world black tea auction markets price transmission to the domestic markets was analyzed through estimates of the VECM framework.

Results of Johansen's multiple co-integration tests revealed that the domestic black tea auction markets of Cochin, Coonoor, and Coimbatore were integrated with international black tea auction markets each with four co-integrating equation proving the spatial market integration of black tea auction markets. The results are presented in table 2 proving the long-run association between domestic black tea auction markets with international black tea auction markets.

As discussed in the methodology, before proceeding to vector error correction mechanism, lag order of variables to be included in the model had to be ascertained. The optimal lag length was identified as one for all the variables under research investigation.

For the present study, the vector error correction mechanism (VECM) was adhered for the domestic black tea auction markets which were having long-run association with global black tea auction markets. Accordingly, VECM results are presented in Table 3.

The estimates of error correction coefficients for all the black tea auction markets indicated that all the South

Table 2: Results of Multiple Co-integration Tests for Different Black Tea Auction

Auction Markets	Eigen Value	Likelihood Ratio (LR)	5 per cent Critical Value	1 per cent Critical	Hypothesized No. of CE (s)	Co-integrating Equations
Cochin	0.26764	164.5205	94.15	103.18	None*	
Coonoor	0.21629	105.6492	68.52	76.07	At most 1*	
Coimbatore	0.13868	59.58536	47.21	54.46	At most 2*	4
Colombo	0.08165	31.36936	29.68	35.65	At most 3**	
Mombassa	0.04744	15.27098	15.41	20.04	At most 4	
Limbe	0.03168	6.084987	03.76	06.65	At most 5**	

Note: Critical values based on MacKinnon (1991).

LR test indicated number of co-integrating equations at 1(*) and 5(**) percent level.

Indian markets were significant and their signs were negative indicating the short-run price movements along the long-run equilibrium path was stable. It authenticated a strong association between these markets. About 65 per cent of disequilibria corrected for each week in Cochin auction market by changes in its own prices and the remaining was influenced by other internal and external market forces. Similarly, 49 and 28 per cent of disequilibria corrected for each week in the Coonoor and Coimbatore auction markets respectively by changes in its own prices and the remaining was influenced by other internal and external market forces respectively. The coefficients of the error correction term indicated the speed of convergence to the long-run growth path as a result of shock of their own prices. About 30.4, 24 and 32 per cent disequilibria corrected with one week lag in the Cochin auction market prices with relation to Coonoor, Coimbatore and Colombo Auction market prices respectively.

The coefficients of own lagged price of Cochin auction market price was found significant and revealed that the impact of its own price took place with two weeks lag period indicating the short-run price movements along the long-run equilibrium path was stable. Whereas, the coefficient of own lagged price of Coimbatore auction market price was found to be significant and revealed that the impact of its own price took place with one week lag period and the speed of convergence was marginal at 27 per cent with short-run price movements along the long-run equilibrium path.

In the long-run, the coefficients of own lagged price of Coonoor, Coimbatore, Colombo and Mombassa auction market prices were found significant and the impact of Cochin price took place with one week lag period, while in Limbe auction market, the impact took place with two weeks lag period as a result of shock of both Cochin

Table 3: Reduced Form Vector Error Correction Estimates for Different Auction Markets

	D(COC)	D(COO)	D(COI)	D(COL)	D(MOM)	D(LIM)
ECM	-0.6532 (-6.6045)	-0.4915 (-3.7618)	-0.2851 (-2.5117)	-0.188 (-1.4530)	-0.067 (0.4571)	0.0683 (0.5536)
D(COC)(-1)	0.0338 (-.0.3044)	0.3049 (2.0772)	0.2417 (1.896)	0.3292 (2.2646)	0.07265 (0.4410)	-0.0948 (-0.6841)
D(COC)(-2)	-.0.2470 (-2.3512)	-0.0348 (-0.2507)	-0.1462 (-1.2130)	-0.0666 (-0.4849)	-0.0192 (-0.1233)	0.0136 (0.1044)
D(COO)(-1)	0.3784 (4.1210)	-0.1151 (-0.9487)	0.2296 (2.1793)	0.1398 (1.1635)	0.3283 (2.411)	0.1220 (1.0658)
D(COO)(-2)	0.1742 -1.8503	-0.0420 (-0.3376)	0.1495 (1.384)	0.1671 (1.3561)	0.1279 (0.9163)	0.0993 (0.8458)
D(COI)(-1)	-0.3195 (-2.4553)	-0.0269 (-0.1568)	-0.279 (-1.8685)	-0.4249 (-2.4953)	-0.3569 (-1.8498)	0.0253 (0.1561)
D(COI)(-2)	0.0486 (0.4043)	0.0472 (0.2972)	0.0293 (0.2127)	-0.095 (-0.6034)	-0.2608 (-1.4616)	-.0.1027 (-0.6844)
D(COL)(-1)	0.0486 (3.2231)	0.1776 (2.1835)	0.1742 -2.4647	O.O831 (1.0321)	-0.0915 (-1.0029)	0.0323 (0.4208)
D(COL)(-2)	0.1236 (-2.0117)	-0.0799 (-0.9850)	-0.0902 (-1.2797)	-0.0462 (-0.5755)	0.0960 (1.0539)	-0.1056 (-1.3784)
D(MOM)(1)	0.1091 -2.0187	-0.0024 (-0.0342)	0.1719 (2.7721)	0.1114 (1.5752)	-0.0445 (-0.5556)	-0.0869 (-1.2894)
D(MOM)(-2)	-0.0289 (-0.5176)	-0.1075 (1.4561)	-0.0989 (-1.5419)	0.0792 (1.0834)	-0.0732 (-0.8833)	0.0009 (10.0140)
D(LIM)(-1)	-0.0200 (-0.3088)	-0.0113 (-0.1331)	-0.0552 (-0.7431)	0.0181 (0.2140)	0.0423 (0.4411)	-0.1574 (-1.9493)
D(LIM)(-2)	0.1849 (2.9324)	0.1099 -1.3196	0.1773 (2.4501)	0.0999 (1.2109)	0.0367 (0.3926)	0.059 (0.7507)
C	-0.0086 (-1.6289)	-0.0070 (-1.0092)	-0.0069 (-1.1337)	-0.0004 (-0.0707)	-0.0005 (-0.0701)	0.0016 (0.2530)
R-Squared	0.41179	0.176488	0.26900	0.11484	0.08645	0.07303
Adj. R-Squared	0.36809	0.11531	0.2147	0.04909	0.01559	0.00417
F-statistics	9.424	2.885	4.9538	1.7466	1.2739	1.0605
Log likelihood	236.0724	183.439	210.0494	185.2224	161.6364	194.3241
AIC	-2.3499	-1.7930	-2.0745	-1.8118	-1.5622	-1.9081
SBC	-2.1098	-1.5528	-1.8344	-1.5717	-1.3221	-1.6680

Note: Figures in Parentheses indicate t-ratio.

COC- Cochin Auction Market; : COO-Coonoor Auction Market;
Coi- Coimbatore Auction Market; : COL-Colombo Auction Market (Sri Lanka)
MOM-Mombassa Auction Market(Kenya) : LIM-Limbe Auction Market (Malawi)

and Coimbatore auction market prices. The shock in Colombo and Mombassa auction market price revealed that the impact in prices of Coimbatore auction market took place with a one week lag period. The coefficient of own lagged price of Limbe auction market was found to be significant and revealed that the impact of its own price took place with one week lag period marginally. Further the error correction estimates for Limbe auction market indicated that it was not affected by the international black tea auction market prices and it was

found to be a separate market, might be because of relatively low volume of transactions and the low quality of tea traded there.

Summary

The results provided empirical evidence about the efficiency of domestic and international black tea auction markets, showing a high degree of integration in terms of price transmission. The removal of trade barriers, with the aim of achieving the Unified black tea auction markets, has provoked intense flows of black tea and, therefore, has increased price efficiency. Moreover, distortion on market price transmission mechanisms could emerge by non-homogeneous intervention measures and more widespread application of intervention mechanisms. Likewise, heterogeneity in black tea production systems, highly dependent on environment and huge investment conditions, and the influence of external markets on internal black tea prices, might be additional factors explaining the weaker linkages found among domestic and international black tea auction markets prices. Limbe auction market indicated that it was not affected by the international black tea auction market prices and it was found to be a separate market, might be because of relatively low volume of transactions and the low quality of tea traded there.

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Always bear in mind that your own resolution to succeed is more important than any one thing.

—Abraham Lincoln

Crop rotation and economic sustainability of agriculture: A case study of farming practices

Nagarajan Naidu & K K John

The present paper aims to measure and compare the economic sustainability of cropping practices between crop rotated and non-rotated farms in Kaduthurithy block of Kerala. The empirical analysis indicates that the rotated farms are better compared to non-rotated farms with respect to many indices pertaining to economic sustainability.

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In the phase of rapid growth in manufacturing and service sectors augmented by technological development, many developing countries are facing stagnation in the agriculture sector with respect to value addition per unit of area under cultivation. The lop-sided technological and innovative practices adopted in the agricultural sector in many developing countries made agriculture unprofitable and economically unsustainable. However, innovative practices are being adopted in many parts of the world to make agriculture economically sustainable so as to save the rural community, maintain social equity and justice and ensure growth in agriculture production to satisfy the growing needs of manufacturing and service sectors. Crop rotation is one of the innovative agriculture practices being adopted in many parts of the world to make the agriculture avocation sustainable both environmentally and economically.

The present paper aims to measure and compare the economic sustainability of cropping practices between crop rotated and non-rotated farms. The paper is arranged into four parts.

Crop Rotation — Meaning and Purpose

Crop rotation may be defined as a process of growing different crops in succession on a piece of land in a specific period of time without decreasing the soil fertility. Crop rotation is a planned sequence of growing different annual or perennial crops in the same field. Rotations are the opposite of continuous cropping which is growing the same crop in the same field year after year. The term crop rotation implies the planting of sequence of different crops or cropping systems on the same plot and the repetition of the sequences over time (Jodha and Singh, 1996)[1]. Some of the general purposes of rotations are to improve or maintain soil fertility, reduce erosion, reduce the build up

of pests, spread the workload, reduce the risk of weather damage, reduce reliance on agricultural chemicals and increase net profits (ibid)[2].

Among various objectives of crop rotation, the important among them are:- (1) Proper utilization of nutrients from upper and lower levels of soil, (2) Economy in the use of manures and fertilizers, (3) Use of labour, animal and implements throughout the year, (4) Control of diseases and insect pests, (5) Control of soil erosion and (6) Economy in the use of irrigation water (Sahai, 1992)[3]. Further crop rotation enables the farmer to spread his risks. If he concentrates on one product, a harvest failure or a price collapse may ruin him; by producing several saleable goods he avoids putting all his eggs in the same basket, since it is unlikely that many products will fail during the same year. For all these reasons, the total cost of growing a number of products on one farm are often, but not always, lower than if each product were grown in a farm specializing on it alone.

Sustainable Development in Agriculture: Meaning and Definitions

The word 'sustainable' has been derived from two Latin words "sus", meaning "from below" and "tenere", meaning "to hold". Sustainable development is "development that meets the needs of the present generation without compromising the ability of the future generation to meet their own needs" (WCED, 1987).[4]

Coming to agriculture, the concept of sustainable development has been perceived and interpreted in various ways. It is often used as the synonym for natural or organic farming. The simplest definition has been given by Conway (1985)[5] who maintains that an agricultural system that can overcome a stress, defined as discontinuity system, can be referred to as sustainable. Sustainability refers to the ability of the agricultural system to maintain a certain well defined level of performance over time, and if required to enhance the same through linkages with other systems without damaging the ecological integrity of the system (Jodha, 1991)[6]. Sustainable agriculture protects the natural resource base, prevents the degradation of soil, water and air quality and conserves bio-diversity, contributing to economic and social well being of all people, ensures a safe and high quality supply of agricultural products and safeguards the livelihood and well being of agricultural and agri-food workers and their families. To be sustainable, a farm must produce adequate food of high quality, be environmentally safe, protect the soil resource base and be profitable (Reganold P. John et al, 1990)[7].

The Food and Agricultural Organisation of the United Nations Organisation (F.A.O.) (1989)[8], observed that sustainable agriculture should involve the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources. Sustainable agriculture integrates three main goals—environmental health, economic profitability and social and economic equity. Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of the future generations to meet their own needs. John Ikerd (l990)[9] describes sustainable agriculture as "farming that is capable of maintaining their productivity and usefulness to society indefinitely. Such systems must be resource conserving, socially supportive, commercially competitive and environmentally sound". Achieving sustainability suggests balance and cooperation between growth, stability and equity. While saying that growth and sustainable development can take place simultaneously, if a proper balance between them is not maintained, there is the risk of the former taking precedence over the latter.

Economic Sustainability of Cropping Practices — Components and Methodology of Estimation

Sustainable practices in agriculture must bring out sufficient produce in an economically viable manner by using both off farm and in farm inputs in judicious combination so as not to have any long term detrimental effect on the eco-system. Along with ecological sustainability, the farming practices must have economic sustainability with respect to income generation, productivity and equity. In the present study, the components used to measure the economic sustainability are: (1) Index of average productivity of crops, (2) Stability of crops, (3) Equity, and (4) Income sustainability. All these individual components of economic sustainability are combined together to prepare the Aggregate Sustainability Index. Following is the methodology used for measuring the various components of sustainability index.

(1) **Average Productivity of Crops**: It implies the average productivity of all crops cultivated in money units. Initially the productivity of different crops cultivated by farmers per one cent is calculated. Secondly, the sum total of productivity of all crops in money terms per one cent is calculated. Thirdly, the sum total of productivity of all crops cultivated in a particular farm is divided by the number of crops raised in that farm. The arrived value gives the average productivity of all crops cultivated per one cent of land.

(2) **Stability**: It is measured by the absolute deviations of average productivity of all crops from the mean value i.e., (X- mean X).

(3) **Equitability**: This is measured by the inverse of the absolute deviation of net income (profit) per one cent of cultivation from its mean net income.

(4) **Income sustainability**: This is measured by net income (profit) per one cent of the cultivated area.

After calculating the actual value of each component, an index is calculated by using the following formula

(Actual Xij - Minimum Xij)/ (Maximum Xij - Minimum Xij) In this formula,

Actual Xij = the actual value of i^{th} particular component of sustainability derived to j^{th} individual

Minimum Xij = the minimum value of i^{th} component of sustainability for the entire farmers

Maximum Xij = the maximum value of i^{th} component of sustainability for the entire farmers.

Initially, the index is calculated for each component of sustainability separately and finally all these individual indices are combined together to represent the aggregate or composite index of sustainability. The value of derived index lies between zero and one. The value of zero indicates the lowest score of the index and value one, represents the highest value of the index.

Profile of Crop Rotation Practice in the Study Area

The innovative practices of crop rotation have been practiced in many parts of Kerala in different forms. The Kaduthuruthy Block in Kerala is taken for the sample study. It is situated in the eastern part of the Vaikom Taluk in Kottayam District in Kerala with a total area of 187.75 sq. km. The major traditional crops of this area were coconut, rice, tapioca and banana. Recently, there has been significant increase in the cultivation of rubber and rubber emerges as the single largest crop in the garden lands. Another significant change in the cropping pattern is the drastic reduction of paddy cultivation which is replaced by coconut, banana and vegetables.

Kaduthuruthy Block had witnessed large-scale crop rotation in Kerala, due to many unique factors specific to the region. The important factors which led to the phenomena of rotating crops on the same farms are: the shifting cropping pattern, the scope for profitable utilisation of wet lands, growth of marketing facilities for crops, the spread of disguised tenancy system and government intervention for marketing of crops and technical facilities.

Kaduthuruthy Block is a typical example of crop rotation throughout the 1980s and 1990s. The owners of paddy fields would cultivate paddy for one season — say from June to September and would lease out their wetland for vegetable cultivation for the period from October to May. In the low-lying paddy fields, vegetable cultivation is possible in one season but in other areas two vegetable crops are possible in the same year. Different systems of vegetable cultivation started in this area. They include:-

(1) The owner himself cultivating vegetables in wetlands.

(2) The entire wetland being leased out to tenants and marginal farmers.

(3) The owner-cum-tenant cultivation. In this the small and marginal farmers cultivate vegetables in their own lands and in leased in lands. In this case, the farmer is owner- cultivator on the one hand and tenant on the other hand.

Characteristic Features of Sample Farmers Selected

The various dimensions of the economics of crop rotation are examined based on a sample of 430 farmers from the study area, which consist of 348 farmers rotating their crops and the remaining 82 not practicing crop rotation.

Crop Rotation and Nature of Land Ownership

The degree of crop rotation depends to a great extent on the size of land ownership. The relationship between crop rotation and land ownership pattern is given in Table 1.

Table 1: Crop Rotation and Nature of Land Ownership

Nature of ownership	Rotation	Non Rotation	Total
Ownership	103 (59.2%)	71 (40.8%)	174 (100%)
Tenancy	175 (94.6%)	10 (5.4%)	185 (100%)
Ownership-cum-tenancy	70 (98.6 %)	1 (1.4%)	71 (100%)
Total	**348 (80.9%)**	**82 (19.1%)**	**430 (100%)**

Source: - Field Survey

Out of the 430 farmers, 348 farmers are found rotating among various crops and the remaining 82 farmers are non-rotators. Among the 430 farmers, 174 of them cultivate in their owned lands only while 71 of them cultivate in both owned lands and in leased lands. This is because these farmers have insufficient land ownership and hence they cultivate in leased in lands also in addition to their owned land. The remaining 185 farmers are tenant farmers. They constitute 43 per cent of the total cultivators. Kerala is one of the few states, which has implemented land reforms successfully. However, tenancy farming is widespread in this area, though in a disguised manner. Taking the exclusive tenants and the ownership-cum-tenants together there are as many as 256 cultivators who cultivate in hired lands. This comes to 59.5 percent of the total cultivators. Among the non-rotated farmers, 67.6 per cent are landowners and 8.6 per cent of them are both landowners and tenants. The remaining 23.8 per cent of them are only tenants.

Types of Rotation

The important crops cultivated are vegetables, paddy and banana and hence the important types of rotation practiced in the study area are: (1) vegetable-vegetable, (2) paddy-vegetable, (3) paddy-banana, and (4) paddy-banana-vegetable. In addition to the rotated crops, farmers also cultivate crops without any rotation. Table 2 shows the type of crops cultivated between rotated and non-rotated farms.

Table 2: Type of Rotations

Type of Rotations	Rotation	Non Rotation	Total
Vegetable-Vegetable	161		161
	(46.26%)		
Paddy-Vegetable	116		116
	(30.05%)		
Paddy-Banana	19	-	19
	(5.46%)		
Paddy only	—	67	67
		(84.22%)	
Vegetable Only	—	12	12
		(14.63%)	
Banana Only	—	3	3
		(3.66%)	
Paddy-Banana-Vegetable	4		4
	(0.57%)		
Banana-Vegetable	48		48
	(13.79%)		
Total	**348**	**82**	**430**

Source: - Field Survey

As given in Table 2, there are 116 farmers who rotate between paddy and vegetables. In fact, this is the oldest form of crop rotations in the study area. Banana-vegetable rotation is taking place in 48 farms i.e. 13.79 per cent of the farms. The number of farmers who rotate between paddy-banana-vegetable is very low in this area. There are 19 farmers who rotate between paddy-banana and they comprise 5.46 percent of the farmers. Recently another tendency has been developing in many parts of this area. The increased demand for land for vegetable cultivation has raised rent for vegetable and banana cultivation. Hence, many landowners have stopped paddy cultivation and have begun to let the land out for vegetable cultivation throughout the year. Now vegetable-vegetable rotation is also very much widespread. Out of the 348 farmers who rotate between various crops, 161 of them rotate between different varieties of vegetables. Vegetable-vegetable rotation is the single largest type of crop rotation in this area. Nearly 46 per cent of the cultivators practise this type of rotation. The most important types of vegetables cultivated in this area are snake gourd, cowpea, bitter gourd and little gourd. Among the non-rotated farms, the majority are paddy farms (84.22%) followed by vegetables (14.63%) and banana (3.66%). Among the non-rotators, 67 farmers cultivate paddy.

Classification of Area between Rotated and Non-Rotated Area

The average area owned varies between rotated and non-rotated farms. Table 3 shows the average area owned by rotated and non-rotated farms. The total area cultivated by farmers consists of both owned and hired areas.

As shown in Table 3, the average owned area among all the cultivators is 81.28 cents but the same is only 48.75 cents among the rotating farmers. Among the non-rotators, the average area owned is more than five times

Table 3: Average Size of Land between Rotated and Non-Rotated Farms

Nature of cultivation	Owned area	Hired area	Total
Rotation	48.75	52.53	100.60
Non Rotation	222.19	8.90	231.09
Total	**81.28**	**44.21**	**125.49**

Source: - Field Survey

of the area owned by the rotating farmers. In the case of the hired area, the rotators have an average area of 52.53 cents whereas the non-rotators have 8.9 cents of land. Table 3 provides the inference that the rotated farms are mainly sustained by hired land.

The field study shows that 152 cultivators started the practice of crop rotation only within 5 years. Of these, 65 are owner cultivators, 60 cultivators are tenant cultivators and while 27 of them have both owned lands and leased in lands. Another 131 farmers have started crop rotation within a period of 5 to 10 years. Among them, 64 are tenant farmers while the number for the owned farmers and ownership-cum-tenancy is 33 and 34 respectively. There are only 36 cultivators who started crop rotation for the last 15 years. Among them 20 are tenant farmers and 10 are land owner cultivators and the remaining six have small pieces of land and they also cultivate in leased in lands. There are only 50 cultivators who started crop rotation before 20 years.

Area under Different Crops between Rotated and Non-Rotated Farmers

The important crops cultivated in the study area are paddy, banana and various types of vegetables. Farmers are practicing crop rotation in all these crops. However, the intensity of crop rotation varies across different crops. Also the percentage of owned and hired area used for rotation also varies between crops. Average area under different crops is given in Table 4.

Table 4: Average Area under Various Crops (in cents)

Crops	Nature of cultivation	Total area	Owned area	Hired area
	Rotation	100.33	86.97	18.23
	Non-Rotation	257.23	256.49	0.76
Paddy	All farms	152.11	142.64	13.38
	Rotation	108.50	58.53	56.93
	Non-Rotation	48.66	26.66	20.00
Banana	All farms	105.96	57.31	55.51
	Rotation	93.48	41.23	50.51
	Non-Rotation	90.38	42.69	47.69
Vegetables	All farms	93.35	41.29	52.56

Source: - Field Survey

Table 4 shows the area under different major crops in the study area. Farmers cultivate on both owned and hired area. The table shows that the average area under paddy is 152 cents in the case of rotated farms. Among this, the average area under paddy cultivation in the owned land is 86 cents while it is 18.24 cents in hired lands. In the non-rotated farms the average area under paddy cultivation is 257 cents. The average owned area under paddy cultivation is 256 cents while the hired area under paddy cultivation is insignificant. There are 204 paddy cultivators of which 137 cultivators practice crop rotation while the remaining 67 paddy cultivators do not rotate crops and are satisfied with paddy cultivation. The paddy cultivators are mainly using the owned land and hired area is very little. Also, the rotated farmers mainly use the hired area.

The average area under banana cultivation in the rotated farms is 105 cents.In the case of banana cultivation in the owned land, the average area is 58.5 cents and in the hired land, it is 56.93 cents. In the non-rotated farms, the average area under banana cultivation is 48.66 cents. The average area under banana cultivation in the owned farms is 26.67 cents and in hired farms it is 20 cents. There are 78 banana cultivators of which 75 are practicing crop rotation. Thus, compared to non-rotated farmers in banana cultivation, the owned as well as hired areas is higher among rotated farms. The hired area is mainly used by the rotated farmers.

The average area under vegetable cultivation in the rotated farms is 93.47 cents. In the case of the owned lands, the average area under vegetable cultivation is 41.23 cents and in the hired lands it is 50.5 cents. There are 338 vegetable cultivators of which 325 cultivators practice rotation. There is not much difference in average total and

owned area under vegetables between rotated and non rotated farmers. However, the rotated farmers have a higher preference for hired land compared to non-rotated farmers. Thus the ownership of land and cultivation of various crops under rotated and non rotated farming practices indicates that the possibility of hired land facilitated more for crop rotation among farmers.

Economic Sustainability between Rotated and Non-Rotated Farms

The methodology as discussed in Part 2 is applied for estimating various indices of economic sustainability of farming practices between rotated and non-rotated farms. Table 5 shows the values of various dimensions of economic sustainability and its aggregate index.

Table 5: Mean Value of Various Indices of Economic Sustainability in Rotated and Non-Rotated Farms

Type of farm	Index of average productivity of crops	Index of stability of productivity	Index of equality	Index of encome sustainability	Aggregate index of sustainability
Rotated	0.38	0.84	0.96	0.29	0.66
Non- Rotated	0.08	0.60	0.99	0.11	0.21
All farms	0.33	0.79	0.97	0.26	0.57

Source: - Field Study

The result in the table reveals that the rotated farms are far ahead in all individual sustainability indices as well as aggregate index compared to non-rotated farms. Among the various sustainability indices, the performance of non-rotated farms is very poor with respect to productivity index. Only in the case of equality component, the non-rotated farms are better compared to rotated farms. The aggregate sustainability index of the rotated farms is three times higher than the non-rotated ones.

The following ANOVA in Table 6 shows the statistical significance of variation in various sustainability indices

Table 6: ANOVA Results on Various Indices of Sustainability between Rotated and Non-Rotated Farms

Variables	squares	Sum of	df	Mean square	F	Sig.
Index of average productivity	Between groups	6.19	1	6.19	341.00	0.00
	Within groups	7.77	428	0.01		
	Total	13.96	429			
Index of stability productivity	Between groups	3.85	1	3.85	213.49	0.00
	Within groups	7.72	428	0.01		
	Total	11.57	429			
Index of inequality	Between groups	0.09	1	0.09	6.71	0.01
	Within groups	6.07	428	0.01		
	Total	6.16	429			
Index of income sustainbility	Between groups	2.25	1	2.25	211.72	0.00
	Within groups	4.55	428	0.01		
	Total	6.81	429			
Aggregate index of sustainbility	Between groups	13.27	1	13.27	561.71	0.000
	Within groups	10.12	428	0.02		
	Total	**23.39**	**429**			

Source: - Field Survey

between rotated and non-rotated farms. The result reveals that the differences in variability of aggregate sustainability index and its various components are highly statistically significant.

Sustainability Index and Types of Cultivation

Within the rotated and the non-rotated farms, the sustainability index may vary across farms with respect to the types of crops cultivated. Table 7 shows the value of sustainability index between various crops.

Table 7: Average Value of Sustainability Indices between Different Types of Crops

Type of rotation	Index of average productivity of crops	Index of stability of productivity	Index of equality	Index of income sustainability	Aggregate index of sustainability
Paddy-Vegetable	0.29	0.90	0.97	0.26	0.62
Banana-Vegetable	0.43	0.84	0.91	0.30	0.67
Paddy-Banana	0.19	0.81	0.99	0.16	0.45
Vegetable-Vegetable	0.46	0.79	0.96	0.326	0.71
Paddy- Banana-Vegetable	0.23	0.86	0.99	0.20	0.54
Paddy only	0.009	0.53	0.99	0.09	0.12
Banana only	0.390	0.87	0.99	0.16	0.62
Vegetable only	0.41	0.85	0.99	0.18	0.63
Total	0.33	0.79	0.97	0.26	0.57

Source: Field Survey

Table 7 shows that the index of average productivity of crops is the highest in vegetable-vegetable rotation, which is 0.46 and the lowest in paddy cultivation (non-rotation). The overall average index of productivity is 0.33. The index of stability of productivity is 0.90 for paddy-vegetable type of cultivation and for paddy cultivation only it is 0.53. The index of equality is 0.97 for paddy-vegetable and 0.99 for paddy-banana, 0.99 for paddy only. The average index of equality is 0.97. The index of equality equal to zero means perfect inequality and equal to one means perfect equality. The index of sustainability is 0.26 for paddy-vegetable type of cultivation, 0.30 for banana-vegetable, 0.16 for paddy-banana and 0.20 for paddy-banana-vegetable. The average index of sustainability is 0.26 for all the crop combinations. Among the various crops, the sustainability index is the highest in vegetable rotated farms. At the same time, the lowest value of sustainability index is reported in the case of paddy only farms. Thus within the rotated farms, the vegetable-vegetable farms are more sustainable while the non-rotated farms, particularly paddy only farms are not economically sustainable.

Sustainability and Number of Crops Cultivated

Table 8 shows the sustainability index of various farms with respect to number of crops cultivated.

Table 8: Average Value of Sustainability Indices between Different Numbers of Crops Cultivated

Number of crops cultivated	Index of average productivity of crops	Index of stability of productivity	Index of equality	Index of income sustainability	Aggregate index of sustainability
1.00	0.08	0.59	0.99	0.11	0.21
2.00	0.38	0.83	0.94	0.25	0.60
3.00	0.40	0.85	0.99	0.35	0.73
4.00	0.43	0.84	0.99	0.45	0.82
Total	0.33	0.79	0.97	0.26	0.57

Source: Field Survey

The average aggregate index of sustainability is 0.57. The sustainability of farms increases along with the number of crops raised on a particular farm in a year. The land becomes more and more efficiently utilized when the number of crops cultivated increases.

Sustainability and Farm Size

The economic sustainability to a greater extent depends on the farm size. Table 9 shows the value of economic sustainability between different farm sizes.

The result shows that the value of economic sustainability decreases along with increase in farm size in this particular area. The small farms are more economically sustainable compared to the large farms. The reason is that the larger farms are mainly devoted either for paddy or banana cultivation without any rotation, which has lower sustainability. At the same time, rotated farms are smaller in size and are more sustainable. This inverse relationship between sustainability and farm size is applicable with respect to aggregate sustainability index as well as various components of sustainability.

Table 9: Average Value of Sustainability Indices between Different Sizes of Cultivated Area

Classification of total area cultivated	Type of farm	Index of average productivity of crops	Index of stability of productivity	Index of equality	Index of income sustainability	Aggregate index of sustainability
Less then 50 cents	Not Rotated	0.33	0.79	0.99	0.17	0.53
	Rotated	0.39	0.85	0.94	0.27	0.65
	Total	0.38	0.85	0.95	0.26	0.63
Between 50 and 100 cents	Not Rotated	0.08	0.58	0.99	0.10	0.20
	Rotated	0.38	0.83	0.95	0.29	0.65
	Total	0.36	0.82	0.96	0.28	0.62
Between 100 and 150 cents	Not Rotated	0.12	0.67	0.99	0.11	0.29
	Rotated	0.37	0.85	0.98	0.29	0.67
	Total	0.32	0.81	0.98	0.26	0.60
Above 150 cents	Not Rotated	0.02	0.54	0.99	0.09	0.13
	Rotated	0.41	0.80	0.99	0.33	0.70
	Total	0.19	0.66	0.99	0.20	0.38
Total	Not Rotated	0.08	0.60	0.99	0.11	0.21
	Rotated	0.38	0.84	0.96	0.29	0.66
	Total	0.33	0.79	0.97	0.26	0.57

Source: Field Survey

Sustainability and Size of Owned Land

Type of land cultivated influences the level of sustainability. The relationship between economic sustainability and size of owned area is given in Table 10.

The value of the index of average productivity of crops decreases with the increase in the average area of land cultivated. The index of stability of productivity for the various sizes of land is 0.82, 0.83, 0.80 and 0.60 respectively. In the case of the index of equality, the value increases with the increase in the area of owned land under cultivation. The index of sustainability on the other hand decreases with the increase in the area of owned land under cultivation. The aggregate index of sustainability also shows similar tendencies i.e. the values decrease with the increase in the area of owned land under cultivation.

Table 10: Mean Value of Indices of Sustainability and Size of Owned Land

Classification of owned area	Nature of culativation	Index of average productivity of crops	Index of stability of productivity	Index of equality	Index of income sustainability	Aggregate index of sustainability
Less than 50 cents	Not Rotated	0.35	0.81	0.99	0.16	0.56
	Rotated	0.41	0.82	0.95	0.29	0.66
	Total	0.41	0.82	0.95	0.29	0.66
Between 50 and 100 cents	Not Rotated	0.03	0.56	0.99	0.10	0.15
	Rotated	0.33	0.87	0.97	0.28	0.64
	Total	0.29	0.83	0.97	0.26	0.59
Between 100 and 150 cents	Not Rotated	0.04	0.58	0.99	0.10	0.18
	Rotated	0.34	0.88	0.96	0.28	0.65
	Total	0.26	0.80	0.97	0.24	0.53
Above 150 cents	Not Rotated	0.02	0.54	0.99	0.09	0.13
	Rotated	0.38	0.78	0.99	0.32	0.66
	Total	0.11	0.60	0.99	0.15	0.26
Total	Not Rotated	0.08	0.60	0.99	0.11	00.21
	Rotated	0.38	0.84	0.96	0.29	0.66
	Total	0.33	0.79	0.97	0.26	0.57

Source: Field Survey

Sustainability and Size of Hired Area Used for Cultivation

Another important factor which influences the economic sustainability of farming is the size of hired area used for cultivation. Table 11 shows the relationship between sustainability of farms and the area of hired land used for cultivation.

Table 11: Mean Value of Indices of Sustainability and Size of Hired Land

Classification of hired area	Nature of culativation	Index of average productivity of crops	Index of stability of productivity	Index of equality	Index of income sustainability	Aggregate index of sustainability
Less than 50 cents	Not Rotated	0.06	0.58	0.99	0.10	0.19
	Rotated	0.35	0.87	0.96	0.27	0.64
	Total	0.27	0.79	0.97	0.23	0.52
Between 50 and 100 cents	Not Rotated	0.46	0.80	0.99	0.16	0.62
	Rotated	0.44	0.79	0.94	0.33	0.68
	Total	0.44	0.79	0.95	0.32	0.68
Between 100 and 150 cents	Not Rotated	0.34	0.97	0.99	0.15	0.65
	Rotated	0.44	0.80	0.99	0.31	0.70
	Total	0.43	0.82	0.99	0.29	0.70
Above 150 cents	Rotated	0.46	0.79	0.99	0.34	0.73
	Total	0.46	0.79	0.99	0.34	0.73
Total	Not Rotated	0.08	0.60	0.99	0.11	0.21
	Rotated	0.38	0.84	0.96	0.29	0.66
	Total	0.33	0.79	0.97	0.26	0.57

Source: Field Survey

The analysis reveals that the economic sustainability increases along with the increase in hired area for cultivation. The higher the hired area for cultivation, the higher would be the economic sustainability. It implies that most of the hired area is used for rotated crops particularly vegetables which give a higher economic return per one cent of land cultivated. Since most of the rotated crops are produced in the hired area and also the rotated farms are more economically sustainable, the increase in hired area naturally increases the sustainability of cultivation.

Variability of economic sustainability indices

The following Table shows the F-Statistics of Anova result on variability of these sustainability indices among farms with respect to various factors.

Table 12: F- Statistics for ANOVA and its significance with respect various independent factors

	Factors	F- Statistics	Sig.
Index of average productivity of crops	Type of cultivation	228.69	0.000
	Number of crops cultivated	115.48	0
	Farm size	25.96	0.00
	Size of owned land	76.531	0.00
	Size of hired area	35.667	0.000
Index of stability of productivity	Type of cultivation	68.863	0.000
	Number of crops cultivated	80.016	0
	Farm size	29.82	0.00
	Size of owned land	44.490	0.00
	Size of hired area	0.234	0.873
Index of inequality	Type of cultivation	2.521	0.015
	Number of crops cultivated	7.809	0
	Farm size	3.049	0.029
	Size of owned land	2.208	0.08
	Size of hired area	1.092	0.352
Index of income sustainability	Type of cultivation	47.615	0.000
	Number of crops cultivated	148.39	0
	Farm size	9.35	0.000
	Size of owned land	24.162	0.00
	Size of hired area	20.574	0.000
Aggregate index of sustainability	Type of cultivation	210.51	0.000
	Number of crops cultivated	266.14	0
	Farm size	30.546	0.000
	Size of owned land	76.696	0.00
	Size of hired area	18.338	0.000

Source: - Field Survey

The result indicates that there exists significance variation in sustainability indices among farms with respect to type of cultivation, number of crops cultivated, farm size and size of owned area for cultivation. In the case of hired area under cultivation, the indices on stability of productivity and equality components, the variation between farms is not very significant. However, in the case of the aggregate index of sustainability and productivity index, the variation between farms is very significant.

Conclusion

Thus, the foregoing empirical analysis indicates that the rotated farms are better compared to non-rotated farms with respect to many indices pertaining to economic sustainability. The aggregate sustainability index of rotated farms is three times higher than non-rotated one. Within the rotated farms, the vegetable-vegetable farms are more sustainable while the non-rotated farms particularly paddy only farms are not economically sustainable. Also sustainability increases when the number of rotation increases. Within the rotated farms, farms with smaller size have more sustainability. The economic sustainability increases along with the increase in hired area for cultivation. It implies that most of the hired area is used for rotated crops, particularly vegetables, which give a higher economic return per one cent of land cultivated.

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If A is success in life, then A equals X plus Y plus Z. Work is X; Y is play; and Z is keeping your mouth shut.

—Albert Einstein

Spatial and Temporal Variation in Total Productivity: The case of Paddy in India

Swagata Kole & Kalyan Bhattacharyya

This study purports to give an account of Total Factor Productivity (TFP) and Real Cost (RC) for the crop paddy in India broadly for the period 1990-91 to1997-98. It shows the extent of variation in TFP and RC in different years and states. This study also attempts to examine the impact of different factors such as yield of the crop, labour productivity and total input cost per hectare of paddy crop on Total Factor Productivity. It has been observed that TFP and yield of the crop have a fair degree of positive correspondence.

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Agriculture is still the predominant sector in India. Attainment of a desirable commodity composition is likely to vary from region to region due to variation in natural and economic conditions. It is obvious that the external and causes of inter-regional variation is that the cost of production will vary from crop to crop. For an individual crop the extent of variation of such a cost will depend on the differences of technology, resource endowment and natural conditions between different regions.

If there is uniformity in the state of technology in different regions, inter-regional variation in the cost of production can be either due to the difference in resource endowment or in natural conditions or in both. It is also important that the inter-regional variation in the cost of production per unit of land may not truly reflect the extent of variation in the physical level of utilization of various inputs. When inter-regional variation in cost of production per unit of output of an individual crop is considered, the yield rate per unit of land may have a dominating influence indictating the extent of inter-regional variation at such a cost. One cannot preclude the possibility of inter-regional variation in cost of production per unit of oitput of individual crops, even if variation in input prices or in the level of utilization of various inputs per unit of land over regions are absent.

The impact of spread of technology on the regional differences in agricultural performance has drawn considerable attention in recent years. Studies covering the 1970s have revealed variation in productivity between high and low technology regions and the unit cost of production was found to be higher in high technology regions. There are some studies showing that the production gain in new technology have been achieved at greater cost per unit of output, while others show that widespread adoption of new technology in subsequent years leading to higher yield has resulted in lower per unit

cost. This highlights the role of Total Factor Productivity (TFP) in determining unit cost of production. TFP depends on various factors of which market infrastructure, research, irrigation and balanced use of fertilizers are most important.

The broad objective of that study is to find out the extent of spatial and temporal variation in cost production of paddy crop in India. In other words this purports to examine whether high yielding regions invariably represent the regions with higher total factor productivity. Similarly it seems worthwhile to examine whether, the regions exhibiting higher cost of cultivation pr unit of land necessarily represent the regions with lower factor productivity. Examination of the relationship between Labour Productivity and Total Factor Productivity across the regions also seems to be a worthwhile exercise.

Methodology

Data of cost of cultivation of paddy crop for the period 1991-91 to 1997-98 collected under the Comprehensive Scheme for Studying Cost of Cultivation of Principal Crops in India, Directorate of Economics and Statistics, Government of India, have been used for the study. Cost A_1 representing the cash and kind expenses incurred in paddy production by owner operator has been used for the purpose of analysis.

Total Factor Productivity, an index of output per unit total factor inputs, measures the amount of increase in total output which is not accounted for by increase in total inputs. For the proposed study the procedure adopted for estimation of Total Factor Productivity (TFP) and Real Cost of production per unit of output (RC) of paddy crop are as follows

$$TFPpt = \frac{\text{(Value of output (main \& by product) per hectare of paddy in year 't')}}{\text{(Total input cost per hectare of paddy in year 't')}}$$

Uniform price constellation for inputs and output has been used for the purpose of a meaningful inter-state and inter-year comparison of Total Factor Productivity and Real Cost per unit of land and per unit of output. Real Cost per unit of output has been worked out as a ratio of real cost per unit of land and yield of the crop recorded for an individual year. The steps involved in the calculation of TFP_{pt} may be stated as follows:

$$V_{pt} = Y_{pt} \times P_{po}$$

Where,

V_{pt} = Value of paddy crop per hectare in year 't'

Y_{pt} = Yield of paddy crop per hectare in year 't'

P_{po} = Output price of paddy in the base year

Real cost of total input per hectare of paddy crop in year 't'(CTPT)^n $\sum_{i=1}^{n}$ lit x Prior

When,

I_{it} – Level of use of i^{th} input in year 't'

P_{i0} = Price of i^{th} input in the base year

Real Cost per unit output of paddy crop in year

$$t\ (Rc_{pt}) = \frac{CT_{pt}}{Y_{pt}}$$

$$\text{Total Factor Productivity } (TFP_{pt}) = \frac{V_{pt}}{CT_{pt}} \times 100$$

For the estimation of TFP_{pt} and RC_{pt} the cost on account of five important physical and material inputs like seed, fertilizer, manure, human labour, animal labour (bullock) have been aggregated in money terms in view of non-additive nature of these inputs in physical terms. These five inputs together account for the major portion of the operational cost recorded for different regions producing paddy. The operational cost is inclusive of the cost on account of machine labour, insecticides, irrigation charges, interest on working capital and miscellaneous items, besides cost on the aforesaid five inputs.

In view of difference in reference period of data of different states growing paddy in India all the states could not be brought under a single comparative framework. Hence for meaningful inter-state comparison with respect to TFP_{pt} and RC_{pt} number of states have been framed.

In the first set, the states having compatable data at least for three consecutive years have been considered. Accordingly, five states namely Andhra Pradesh, Assam, Madhya Pradesh, Orissa and West Bengal have been considered for calculating TFP_{pt} and RC_{pt} for the yeas 1994-95, 1995-96 and 1996-97. Same constellation of prices based on the average of the prices of inputs and outputs recorded for the five states for the year 1994-95 have been used for working out respective TFP_{pt} and RC_{pt} for different years.

In the second set, TFP_{pt} and RC_{pt} have been calculated for eight states namely Andhra Pradesh, Assam, Madhya Pradesh, Orissa, Punjab, Uttar Pradesh and West Bengal for the year 1996-97 only. Averages of input and output price recorded for different states for the year 1996-97 have been for a meaningful comparison of states in real terms.

In the third set, TFP_{pt} and RC_{pt} have been calculated for eight states namely Andhra Pradesh, Assam, Bihar, Haryana, Karnataka, Madhya Pradesh, Orissa, Punjab, Uttar Pradesh and West Bengal for the year 1991-92. For the generation of uniform price constellation, average input and output price recorded for different states for the year 1991-92 have been considered.

Results and Discussion

The study purports to examine the extent of inter-state and inter-year variation in real cost (per unit of output and total factor productivity. It also tries to find out the relationship among total factor productivity, land productivity, labour productivity and total input cost of paddy crop. The data available for the time period 1990-91 to 1997-98 have been used for eliciting the extent of inter-state and inter-year variation in total factor productivity and real cost.

The percentage share of the five major inputs in the total operational cost per hectare of paddy for each of the ten states of India having comparable data for the year 1991-92 is presented in table 1.

Table 1: Percentage Share of 5 Selected Inputs in Total Operational Cost per Hectare of Paddy for Different States for the Year 1997-92

↓ State Inputs→	Seed	Fertilizer	Manure	Human labour	Animal labour	Total
Andhra Pradesh	4.33	15.64	4.36	45.13	9.27	78.73
Assam	7.77	0.875	0.73	62.25	22.89	94.57
Bihar	6.25	8.28	-	58.01	21.42	93.99
Karnataka	4.78	14.18	6.67	49.72	12.05	87.35
Madhya Pradesh	9.73	11.70	9.84	41.96	20.31	93.54
Orissa	6.63	9.69	6.22	54.13	18.88	95.55
Uttar Pradesh	8.41	8.94	0.59	45.89	13.97	77.8
West Bengal	2.42	9.59	5.71	54.83	15.08	87.63
Haryana	2.19	13.56	0.23	41.73	6.22	63.93
Punjab	3.23	17.82	1.05	33.21	1.88	57.19

It is observed from Table-1 that for the particular year 1991-92, the five inputs (seed , fertilizer, manure, human labour and animal labour) together account for more than 90 percent of total operational cost in 4 states and more than 75 percent in 8 out of 10 states. Punjab and Haryana are exceptions where the percentage share of these five inputs in total operational cost is recorded to be below 65 percent. So it is very difficult to get the picture of comprehensive cost in real terms when only the five major inputs (seed, fertilizer manure, human labour, animal labour) are considered. So, the total cost of the five major inputs obtained from the uniform price constellation based on the average inputs and output prices for a particular year have been added with costs of the other inputs (except the five major inputs) for the particular year in money terms (as the physical and material data are not available for these inputs) in order to obtain the total operational cost per unit of land (ha).

The total factor productivity for the states included in the first set can be seen in table-2

Table 2: Total Factor Productivity of Paddy for Different States of India (set-1)

↓Year States→	Andhra Pradesh	Madhya Pradesh	Assam	Orissa	West Bengal
1994-95	176.633	147.334	109.184	146.005	154.255
1995-96	169.761	135.159	108.242	140.005	141.114
1996-97	166.656	124.700	105.459	121.960	149.736

The result of analysis of variance (ANOVA) attempted on the basis of TFP_{pt} furnished in Table 2 are presented in Table-3.

**Significant at 1% profitability level

* Significant at 5% profitability level

C.D. (state) at 5% profitability level = 11.366

C.D. (state) at 1% profitability level = 16.537

C.D. (state) at 5% profitability level = 8.804

Table-3: Inter-state and Inter-year Variation in the Level of TFP_{pt} : ANOVA

Services of variation	df	SS	MS	F_{cal}	F_{tab}	
					5%	1%
Due to year	2	427.576	213.576	5.86*	4.45	8.64
Due to state	4	6341.912	1585.478	43.5***	3.83	7.00
Error	8	291.536	36.442			

Table 4: Real Cost (Rs.) of Paddy for Different States of India (set-1)

↓Year States→	Andhra Pradesh	Madhya Pradesh	Assam	Orissa	West Bengal
1994-95	203.773	244.296	329.655	246.518	233.333
1995-96	212.021	266.301	332.523	257.083	255.063
1996-97	215.972	288.636	341.297	295.122	240.377

It is observed from table-3 that variation on Total Factor Productivity (TFP_{pt}) due to state is significant at 1% probability level Variation in TFP_{pt} between Andhra Pradesh and each of the other four states are observed to be significant at 1% profitability level for all the years. The variation in TFP_{pt} between Orissa and West Bengal is noted to be significant at 1% level of significance for the year 1996-97 only. Considering C.D. values clearly indicates that Madhya Pradesh and Orissa display comparable level of total factor productivity in all the years under consideration.

The Real Cost (RCpt) for the states included in the first set is furnished in table-4.

It is observed from table-4 that there is broadly an increasing trend in real cost in all the years and states under consideration. The results of analysis of variance are presented in table-5.

Table 5: Inter-state and Inter-year Variation in the Level of TFP_{pt} : ANOVA

Services of variation	df	SS	MS	F_{cal}	F_{tab}	
					5%	1%
Due to year	2	1534.997	767.498	5.33*	4.45	8.64
Due to state	4	24830.334	6207.584	43.112**	3.83	7.00
Error	8	1151.913	143.989			

**Significant at 1% profitability level

* Significant at 5% profitability level

C.D. (state) at 5% profitability level = 32.87

C.D. (state) at 1% profitability level = 22.59

C.D. (state) at 5% profitability level = 17.51

It is observed from table-5 that variation in real cost due to state is significant at 1% probability level. Inter-year variation in real cost is observed to be significant only at 5% probability level. Significant variation in real cost between Andhra Pradesh and each of the other four states is observed at 1% probability level (except with West Bengal in the years 1994-95 and 1996-97 at 5% level) C.D. values clearly indicates that Madhya Pradesh and Orissa display comparable level of real cost of production in either of the years under consideration. Similarly observation is found between Orissa and West Bengal for all the years except the year 1996-97 showing significant at 5% probability level.

In the second set, total factor productivity and real cost have been calculated for the year 1996-97, considering same price constellation for all the separate stages. Non-availability of separate information on seed rate and price of seed per unit for the state Punjab, Haryana and Uttar Pradesh has imposed limitation on the comparability of these states included in the second set in real terms. For these states unlike others actual expenditure on seed has been considered for the year 1996-97, TFP_{pt} and RC_{pt} worked out for the 8 states included in the 2nd set are given in table-6.

It is observed from Table-6 that is general the northern states (i.e. Punjab & Haryana) have higher TFP_{pt} that the southern state (Andhra Pradesh). Again the eastern states (Assam and West Bengal) have been TFP_{pt} than the northern states mentioned earlier.

Table 6: Total Factor Productivity and Real Cost of Paddy for Different States for the year 1996-97 (set-2)

States	TFP_{pi}	RC_{pt}
Andhra Pradesh	159.025	264.973
Assam	127.106	331.638
Haryana	184.521	228.446
Madhya Pradesh	113.723	370.665
Orissa	103.359	407.831
Punjab	214.283	196.717
Uttar Pradesh	178.998	235.495
West Bengal	134.208	314.088

In the third set, TFP_{pt} and RC_{pt} have been worked out for ten states with the inclusion of Bihar and Karnataka in list of states considered for second set. The comparable year in this case is 1991-92 and average price constellation for the same year have been considered for working out TFP_{pt} and RC_{pt} for different states.

The TFP_{pt} & RC_{pt} thus worked out for the states considered in the third set are given in table-7.

Table 7: TFP_{pt} and RC_{pt} of Paddy for Different States for the Year 1991-92 (set-3)

States	TFP_{pi}	RC_{pt}
Andhra Pradesh	173.218	171.105
Assam	161.223	183.843
Bihar	146.271	202.625
Haryana	193.615	153.078
Karnataka	172.646	171.671
Madhya Pradesh	100.995	293.461
Orissa	148.232	199.945
Punjab	243.507	121.714
Uttar Pradesh	233.538	126.913
West Bengal	171.936	172.379

It is observed from the table that the state Punjab has the highest TFP_{pi} among the 10 states. The rank of the 10 states according to descending order of TFP_{pi} is, Punjab, Uttar Pradesh, Haryana, Andhra Pradesh, Karnataka, West Bengal, Assam, Orissa, Bihar, Madhya Pradesh. It is needless to mention that there exist an inverse relationship between TFP_{pt} and RC_{pt} in all the years and states.

The variation of TFP_{pt} along with the changes of yield, labour productivity, total input cost is furnished in table-8

From table-8 it is clear that there exists a broadly positive correspondence between total factor productivity and yield of the crop in all the years and states under consideration. Again labour productivity [which has been defined as the productivity per unit of labour use (man hrs.) i.e. as the ratios of yield (qtl.) per unit of land (ha.) and quantity of labour use (man hrs.) i.e. as the ratios of yield (qtl.) per unit of land (ha) and quantity of labour use (man hrs.) per unit of land (ha.)] and Total Factor Productivity broadly shows a positive relationship. From the table we cannot explain any definite relationship between Total Factor Productivity and total input cost. From the table, it is observed that there is a decreasing trend in Total Factor Productivity in all the states and years under consideration. The exception is there in the state West Bengal in the year 1996-97.

Conclusion

Results of the study have indicated significant inter-case as well as inter-year variation in Total Factor Productivity and real cost. It has been observed from the study that there is broadly an increasing trend in real cost

Table 8: Relationship among TFP_{pt} Yield of the Crop (q/ha), Labour Productivity and Total Input Cost in Different Years and States

States	1994-95				1995-96				1996-97			
	TFP	Labour Productivity	Yield	Total Input Cost	TFP	Labour Productivity	Yield	Total Input Cost	TFP	Labour Productivity	Yield	Total Input Cost
Andhra Pradesh	176.633	0.0410	47.73	9726.087	169.761	0.0394	45.12	9566.401	166.656	0.0418	47.04	10159.311
Madhya Pradesh	147.334	0.0308	21.22	5183.963	135.159	0.036	22.21	5914.547	124.700	0.0299	22.61	6526.037
Assam	109.184	0.0293	20.50	6757.934	108.242	0.0308	21.47	7139.272	105.459	0.0315	23.01	7170.652
Orissa	146.005	0.0275	30.27	7462.112	140.005	0.0270	28.23	7257.448	121.960	0.0232	24.18	7136.056
West Bengal	154.255	0.0285	33.53	7823.68	141.114	0.0269	28.33	7225.94	149.736	0.0308	37.20	8942.026

for the states Andhra Pradesh, Madhya Pradesh, Assam, Orissa and West Bengal during the period 1994-95 to 1996-97. It is also revealed from the study that in a particular year among the different states growing paddy in India, in general the northern states have lower total factor productivity then the southern states. Again the eastern states have lower lower total factor productivity than the northern states. The study has highlighted positive correspondences between total factor productivity and land productivity (i.e. yield of paddy crop). So the factors which determine the yield of paddy crop will also have an effect on Total Factor Productivity. Again labour productivity also shows a positive relationship with total factor productivity. The results of the study cannot explain any defined relationship between Total Factor Productivity and total input cost.

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Ten thousand fools proclaim themselves into obsecurity, while one wise man forgets himself into immortality

—Martin Luther King Jr.

Contribution of Surface Soil and Subsoil Towards Economic Returns from Important Crops in Hill Agriculture

B S Chauhan, D C Kalita, Manoj Dutta, Sewak Ram & R C Nayak

Contribution of surface soil and subsoil towards economic returns from maize, paddy, soybean and rapeseed was evaluated under field conditions on soils subjected to simulated erosion rates of 0, 5, 10 and 15 cm. This study reveals that the contribution of surface soil and subsoil towards gross return varied with the crops.

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Water erosion is one of the main processes of land degradation in the North Eastern region of India. Erosion brings about considerable changes in physical, chemical and biological properties of the soil and thus adversely affects soil conditions that influence plant growth. After removal of 5, 10 and 15 cm of surface soil, the sand, p^H, organic C, available N, P and K levels in the resultant surface soils decreased whereas the silt and clay content increased as compared to original soils (Lalmuanpuia, 1992; Hussain, 1998; Zheite, 2005, Naropongla, 2007). Soil erosion reduces the thickness of the plough layer and thereby rooting volume. The on-site soil loss is accompanied by the loss of organic matter and plant nutrients with it. The combined effect of erosion induced on-site changes brings about a significant reduction in the production potential of the land. The consequences of soil erosion are agronomic, environmental and socio-economic (Chauhan *et al.*, 2007).On progressive erosion, subsoil becomes a part of plough layer together with remaining surface soil and eventually may replace surface soil under severe erosion conditions. The removal of 15 cm of surface soil caused a reduction of 30.5 per cent in paddy yield (Hussain, 1998) and 71.4 per cent in soybean (grain+dry matter yield) productivity (Zheite, 2005). Further, none of the fertilizer N. dose added could compensate for the entire yield loss due to simulated erosion in these crops. This together suggested the contribution of subsoil towards crop per performance is substantial and increase in monetary input in form of fertilizers may or may not be profitable. In labour intensive hill agriculture, contribution, of surface soil and subsoil towards the economic returns, particularly gross return from important crops, needs to be evaluated for land use planning as well as developing management strategy for crop production on soils of hill

slopes eroded or otherwise so that need based conservation efforts on the farm are introduced in the interest of mankind. Hence, an attempt is made in this paper to evaluate the contribution of surface soil and subsoil towards economic returns from important crops in hill agriculture under agro-climatic conditions of Nagaland.

Materials and Methods

Field experiments were conducted to evaluate the effect of simulated erosion and nitrogen levels on the performance of maize (*Zea mays L*), paddy (*Oryza sativa l.*) soybean (*Glycine max Merr.*) and rapeseed (*Brassica campestris L. var. toria Duth.*) at the Department of Soil Conservation, School of Agricultural Sciences and Rural Development, Medziphema (Lamuanpuia, 1992; Hussain, 1998; Zheite, 2005; Naropongla, 2007). The experiments were laid in split-plot design with three replications using soil removal depths of 0, 5 (0-5 cm), 10 (0-10) and 15 (0-15)cm in main–plots and nitrogen levels in sub-plots. The mean grain yield of maize, paddy, soybean and rapeseed and related inputs used in cultivation of these crops in soils subjected to simulated erosion rates of 0,5, 10 and 15 cm were taken into account to evaluate various parameters of economic return and contribution of surface soil (Plough layer 0-15 cm) and subsoil (soil below surface soil) towards gross return. Cost of inputs and income from these crops was computed using market prices/procurement rates of 2007 for different commodities. The cost of seed was estimated as per procurement price of Rs.38.00, 10.00, 48.00 and 51.00 kg^{-1} seed of maize, paddy, soybean and rapeseed cultivars, respectively. In case of soybean, the cost of treating the seeds with Rhizobium culture (Rs.35.00 ha^{-1}) was also added towards the cost of seed. The cost of fertilizers N, P_2O_5 and K_2O was estimated by taking into account procurement prices of Rs. 16.52 kg^{-1} N, Rs. 43.75 kg^{-1} P_2O_5 and Rs.15.00 kg^{-1} K_2O as urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. The cost of plant protection was computed as per procurement prices of chemicals (Rs. 20.00 kg^{-1} of B.H.C 10%, Rs. 350.00 lt^{-1}—1 of Aldrin E.C. Rs. 40.00 100 ml^{-1} of Endosulfan, Rs.63.00 100g^{-1} of Bavistine and Rs. 40.00 ml^{-1}-of Fenvalerate) used. The value of grain (Rs. Ha^{-1}) was estimated using grain yield ha^{-1} of the crops together with their respective support prices (Rs. 620.00 q^{-1} of maize, Rs. 645 q^{-1} of paddy. Rs 1050.00q^{-1} for soybean and Rs. 1800.00 q^{-1} of rapeseed) of Government of India. The value of bye-product (stover/straw) Rs.ha^{-1}) of a crop was taken as 25% of the value of the grain of respective crop. The daily wage rate of Rs.100.00 $person^{-1}$ was taken into account for estimating the cost of labour.

The cost of cultivation was estimated based on various cost concepts like Cost-A_1 Cost-B_1 and Cost-C_1 and Cost C_2 along with net income (Rs. ha^{-1}) and gross return (Rs. ha^{-1}) following tabular analysis (Sharma *et al.*, 1989). The cost and income concepts used in the present study are as under:

Cost A_1 includes cost of seed, fertilizer, labour and plant protection and interest on total working expenses. Cost B_1 was estimated as sum total of Cost A_1+ interest value on fixed cost. Cost C_1. was estimated as sum total of Cost B_1 + imputed value of family labour. The later being zero in the present investigation, Cost B_1 and Cost C_1 remained the same and are presented together. Cost C_2 represents 10% of the total Cost C_1 on account of managerial function performed by the growers (Department of Soil Conservation). Variable costs included the cost of seed, fertilizer, labour, plant protection and interest on working expenses (13.00%). Fixed cost was computed as the sum total of the rental value of the land under cultivation (Rs. 5267.00 ha^{-1}), depreciation on implements (Rs.76.00 $crop^{-1}$) and interest (13%) on fixed capital excluding land. Labour income was calculated by deducting cost B_1 from gross return. Net income was calculated by deducting Cost C_1 from gross return. As the value of both labour income and net income were same in the present investigation, these are also presented together. Return from management was calculated by deducting Cost C_2 from gross return. Benefit cost ratio (BCR) based on total cost was estimated by dividing gross return with total cost. BCR based on variable cost was computed using following formulate:

$$\text{BCR at variable cost} = \frac{\text{Gross return}}{\text{Variable cost}}$$

The contribution of surface soil and subsoil towards the gross return from maize, paddy, soybean and rapeseed was estimated by considering that the gross return in 0 cm eroded soil (control) in these crops was a contribution of both surface soil and subsoil and was taken as 100%. The gross return obtained in soil subjected to simulated erosion rate of 15 cm (0-15 cm of surface soil removed) was taken as contribution of subsoil. The difference between the yield of control (100%) and subsoil contribution was taken as the contribution of surface soil towards the gross return. Similar approach has been used to evaluate the contribution of the surface soil and subsoil towards the N.P. and K uptake by important crops (Chauhan *et al.*, 2007).

The effect of soil removal on income from various crops was examined by applying simple linear regression equation of the following forms with depth of soil removal as one of the independent variable.

$$Y=a+bx+e$$

Where,

Y=Income of various crops (Rs.)

X=Depth of soil removal (cm)

E=Error term

a and b are the unknown parameters estimated with the help of Ordinary Least Square (OLS). Negative and statistically significant regression co-efficient (b) would indicate the negative impact of soil depth removal on the gross return from different crops.

Results and Discussion

(i) Variable cost, fixed cost and total cost of production (Rs ha^{-1}) of various crops at different levels of simulated erosion

A perusal of the data in Table 1 shows that the cost (Rs ha^{-1}) of seed was highest in soybean followed by paddy, rapeseed and maize and did not vary with the simulated erosion rates. The per cent contribution of the cost of seed towards total cost increased marginally with erosion. It was lowest in underused soils (0.82 to 9.44%) as compared to soil subjected to simulated erosion rates of 5 cm (3.82 to 9.62%), 10 cm (0.84 to 9.91%) and 15 cm (0.84 to 10.14%). On an average, cost of seed contributed 3.82% towards total cost. Cost of fertilizers was highest in maize followed by rapeseed, paddy and soybean and did not change with the simulated erosion rates. However, its contribution towards total cost increased marginally with the increase in simulated erosion rates. The cost of fertilizers contributed from 8.79 to 14.16% towards total cost in uneroded soils with an average of 12.59%. It contributed on an average, 12.7% (8.95 to 14.25%) 12.88% (9.23 to 14.39) and 12.97% (9.40 to 14.55) towards total cost in soils subjected to erosion rates of 5,10 and 15 cm, respectively. The contribution of cost of fertilizers towards total cost averaged 12.79%,

Both the cost of labour (Rs. ha^{-1}) and its per cent contribution towards total cost varied among crops and were highest in uneroded soils in all crops (See Table 1). These parameters showed an inverse relationship with the increase in simulated erosion rates. The cost of labour was highest in soybean at all the rates of simulated erosion followed by paddy, maize and rapeseed. However, the percentage contribution of labour cost towards total cost was highest in rapeseed followed by paddy, soybean and maize at all levels of simulated erosion. In soils subjected different rates of simulated erosion, it decreased from 53.17 to 52.19% in maize; 55.55 to 55.08% in paddy; 55.07 to 55.59% in soybean and 56.03 to 55.30% in rapeseed. Labour cost was found to be the single largest component of total cost and on an average, contributed 54.37% towards the same. The cost of plant protection (Table 1) varied with the crop but did not change with the rate of erosion and was highest in maize followed by paddy and both rapeseed and soybean. The percentage contribution of plant protection cost towards total cost was highest in maize, followed by paddy, rapeseed and soybean and increased marginally with the increase in the rates of simulated erosion. It varied from 2.83 to 2.91% in maize; 0.59 to 0.60% in paddy; 0.33 to 0.36% in soybean and 0.39 to 0.40% in rapeseed. On an average, plant protection cost contribution 1.05% towards total cost. The data in (table 1) clearly shows that unlike labour cost, the contribution of the cost of seed, fertilizers and plant protection towards total cost increased marginally with the increase in the depth of soil removal.

Total working expenses (Table 1) were highest in soybean followed by maize, paddy and rapeseed at all the rates of simulated erosion. This might be due to the fact that the cost of seed, labour and plant protection was highest in soybean. Total working expenses exhibited a decreasing trend with the increase in the rates of simulated erosion. This may perhaps be due to lower labour cost in eroded soils. Similar trends were exhibited by the percentage contribution of total working expenses towards total cost.

Total working expenses on an average contributed 72.30, 72.14, 71.89 and 71.76% towards total cost in soils, subjected to 0, 5, 10 and 15 cm of simulated erosion rates, respectively. The interest on working expenses and its contribution towards total cost was highest in soybean followed by maize, paddy and rapeseed. Both these parameters decreased with the increase in soil depth removal. Average contribution of interest on working expenses towards total cost was 9.40%, 9.38%, 9.35% and 9.33% in soils subjected to erosion rates of 0, 5,10 and 15 cm of erosion respectively. The total variable cost (Table 1) was recorded to be the highest in soybean followed by maize, paddy and rapeseed and decreased with the increase in simulated erosion rates in all the crops. Variable cost in uneroded soils was a larger than eroded

Table: 1: Variable cost, fixed cost and total cost (Rs. Ha^{-1}) of production of various crops in soils subjected to different levels of simulated erosion (cm)

Crop/simulated erosion (cm of Soil removed)		Cost of seed	Cost of fertilizers	Cost of Labour protection	Cost of plant expenses	Total working expenses	Interest on working Cost	Total Variable (A)	Fixed cost (B)	Total cost (A+B)
Maize	0	760 (2.28)*)	4712 (14.16)	17700 (53.17)	943 (2.83)	24115 (72.45)	3135 (9.42)	27250 (81.86)	6037 (18.14)	33287 (100.00)
	5	760 (2.30)	4712 (14.25)	17500 (52.93)	943 (2.85)	23915 (72.34)	3109 (9.40)	27024 (81.74)	6037 (18.26)	33061 (100.00)
	10	760 (2.32)	4712 (14.39)	17200 (52.56)	943 (2.88)	23615 (72.17)	3070 (9.38)	26685 (81.55)	6037 (18.45)	32722 (100.00)
	15	7.60 (2.35)	4712 (14.55)	16900 (52.19)	943 (2.91)	23315 (72.00)	3031 (9.36)	26346 (81.36)	6037 (18.64)	32383 (100.00)
Paddy	0	750 (2.34)	4275 (13.34)	17800 (55.55)	189 (0.59)	23014 (71.82)	2992 (9.34)	26006 (81.16)	6037 (18.84)	32043 (100.00)
	5	750 (2.36)	4275 (13.44)	17600 (55.32)	189 (0.59)	22814 (71.7)	2966 (9.32)	25780 (81.03)	6037 (18.97)	31817 (100.00)
	10	750 (2.37)	4275 (13.54)	17400 (55.08)	189 (0.6)	22614 (71.58)	2940 (9.31)	25554 (80.89)	6037 (19.11)	31591 (100.00)
	15	750 (2.37)	4275 (13.54)	17400 (55.08)	189 (0.6)	22614 (71.58)	2940 (9.31)	25554 (80.89)	6037 (19.11)	31591 (100.00)
Soybean	0	3395 (9.44)	3160 (8.79)	19800 (55.07)	120 (0.33	26475 73.64)	3442 (9.57)	29917 (83.21)	6037 (16.79)	35954 (100.00)
	5	3395 (9.62)	3160 (8.95)	19200 (54.43)	120 (0.34)	25875 (73.35)	3364 (9.54)	29239 (82.89)	6037 (17.11)	35276 (100.00)
	10	3395 (9.91)	3160 (9.23)	18300 (53.42)	120 (0.35)	24975 (72.9)	3247 (9.48)	28222 (82.38)	6037 (17.62)	34259 (100.00)
	15	3395 (10.14)	3160 (9.4)	17600 (52.59)	120 (0.36)	24275 (72.53)	3156 (9.43)	27431 (81.96)	6037 (18.04)	33468 (100.00)
Rapeseed	0	256 (0.82)	4366 (14.05)	17400 (56.03)	120 (0.39)	22142 (71.29)	2878 (9.27)	25020 (80.56)	6037 (19.44)	31057 (100.00)
	5	256 (3.82)	4366 (14.15)	17200 (55.79)	120 (0.39)	21942 (71.17)	2852 (9.25)	24794 (80.42)	6037 (19.58)	30831 (100.00)
	10	256 (0.84)	4366 (14.37)	16800 (55.3)	120 (0.4)	21542 (70.91)	2800 (9.22)	24342 (80.13)	6037 (19.87)	30379 (100.00)
	15 10	256 (0.84)	4366 (14.37)	16800 (55.3)	120 (0.4)	21542 (70.91)	2800 (9.22)	25342 (80.13)	6037 (19.87)	30379 100.00

*Figures in parenthesis indicate percentage to total cost.

soils irrespective of the crops. This was perhaps because a larger number of labour required for crop production in uneroded soils as compared to eroded soils. Variable cost (Rs ha^{-1}) in soils subjected to 0 cm of simulated erosion varied from 25020 to 29917 Rs. Ha^{-1} with an average of 27048 Rs. Ha^{-1}. For soils subjected to 5 cm simulated erosion, variable cost varied from 24794 to 29239 Rs. Ha^{-1} with an average of 26201 Rs. Ha^{-1}, and for 15 cm from 24342 to 27431 Rs. Ha^{-1} with an average of 25918 Rs ha^{-1} . Variable cost constituted on an average, 81.70, 81.52, 81.24 and 81.09% of total cost in soils subjected to 0, 5, 10 and 15 cm of simulated erosion rate, respectively. The data established that the variable cost and its percentage contribution decreased with the increase in simulated erosion. Overall, variable cost represented on an average 81.38% of the total cost, of which 72.02% was represented by total working expenses and the remaining 9.3% by the interest on it.

The data pertaining to the fixed cost (Rs ha^{-1}) in production of different crops in soils subjected to various rates of simulated erosion revealed that fixed cost did not vary with the crop and degree of simulated erosion. Fixed cost remained the same because of the fact that its constituent parameters (rental value of land, depreciation

on implements and interest on fixed capital excluding land) did not change with crop and degree of erosion. However, its percentage contribution towards the total cost varied with the crop and increased with the increase in simulated erosion rates. On an average, fixed cost contributed 18.62% towards total cost. Total cost decreased with the increase in simulated erosion rates in all the crops. It was highest in soybean followed by maize, paddy and rapeseed at all the rates of erosion. The erosion induced reduction in labour cost was perhaps responsible for decrease in total cost in eroded soils.

(ii) Costs and returns from various crops in eroded soils

Cost A_1

Cost A_1 (Table 2) and variable cost (Table 1) were same in comparable situations and therefore depicted similar trends. In all crops, Cost A_1 decreased with the increase in simulated erosion rates. At 15 cm of simulated erosion, the Cost A_1 decreased by 3.32, 1,74, 8.31 and 2.71% in maize, paddy, soybean and rapeseed, respectively. This might be due to the fact that labour cost which constituted on an average, 54,37% of the total cost decreased with the increase in simulated erosion rates in all the crops. In paddy, Cost A_1 decreased at 5 cm of simulated erosion and remained constant thereafter. In case of rapeseed, cost A_1 decreased up to 10 cm of simulated erosion and did not change thereafter. The cost A_1 was found to be highest in the soybean as compared to other crops irrespective of simulated erosion rates. This perhaps was due to higher variable cost that incurred in soybean production as compared to other crops.

Cost B_1 and Cost C_1:

As the imputed value of family labour in the present investigation was nil, the values of Cost B_1 and Cost C_1 (Rs ha^{-1}) were identical and therefore have been presented together (Table 2). Cost B_1 and Cost C_1 varied among the crops and decreased with the increase in the rates of simulated erosion. Both these parameters were highest in soybean followed by maize, paddy and rapeseed at all the levels of erosion. In all the crops, Cost B_1 and Cost C_1, decreased with the increase in soil depth removal. At 15 cm of simulated erosion, reduction in the value of these parameters in maize, paddy, soybean and rapeseed was 3.24, 1.69, 8.13 and 2.64% as compared to uneroded soil, respectively. Further, Cost B_1 and Cost C_1 were higher than Cost A, in all situations. This perhaps was due to the fact that unlike Cost A_1, the interest on fixed capital was included in Cost B_1 and Cost C_1.

Cost C_2:

The Cost C_2 (Rs ha^{-1}) showed similar trends as depicted by Cost C_1. This was because of the fact that Cost C_2 represented a fraction (10%) of Cost C_1. Like Cost B_1 and Cost C_1, Cost C_2 also decreased with the increase in soil depth removal. At 15 cm of simulated soil erosion, per cent reduction in Cost C_2 in maize, paddy, soybean and rapeseed was similar to that depicted by Cost B_1 and Cost C_1 (3.24, 1.69, 8.13 and 2.64%, respectively). This might be due to lower variable cost incurred in soil subjected to 15 cm soil depth removal in all crops.

Gross return:

A perusal of data on gross return (See table 2) revealed that in uneroded soils maximum gross return (Rs ha^{-1}) was obtained in soybeans (Rs. 57750.0 ha^{-1}) followed by paddy (Rs 33661.0 ha^{-1}). Maize (Rs.31752.0 ha^{-1}) and rapeseed (Rs.9045.0 ha^{-1}), which decreased with the increase in simulated erosion rates in these crops. The data clearly established that while rapeseed produced lowest gross return in soils subjected to different rates of simulated erosion, soybean produced highest gross return when erosion was 10 cm or less. Paddy on the other hand produced highest gross return in soils subjected to simulated erosion of 15 cm. The implication of this is that soybean is economically more suitable than paddy and maize on soils that are eroded 10 cm or less. However, paddy is most suitable than soybean and maize on soils subjected to simulated erosion of 15 cm. Rapeseed cannot be considered economically suitable for cultivation in *rabi* season on soils eroded or otherwise. The magnitude of decrease in gross return in eroded soils varied with the crop and was highest in rapeseed at all the levels of erosion. It was lowest in maize at 5 cm (8.3%) and in paddy at 10 (25.0%) and 15 cm (32.5%) of simulated erosion. The gross return in maize, paddy, soybean and rapeseed decreased by 56.58, 32.48, 61.18 and 80.60%, in soils subjected to 15 cm of simulated erosion as compared to underoded soils, respectively. This might be due to low crop production in eroded soils of less desirable properties for crop growth as compared to uneroded soil.

Labour income and Net income

The estimates pertaining to labour income and net income (Rs ha^{-1}) were same because of similar Cost B_1 and Cost C_1 (See Table 2). Labour income and net income varied among the crops and decreased with the increase in the rates of simulated erosion. In uneroded soils, both these parameters were highest in soybean (Rs 27139) followed by paddy (Rs.6961) and maize (Rs.3807). Rapeseed, however, generated negative labour income and

Table 2. Cost and return (Rs ha^{-1}) from various crops at different levels of soil depth removal (cm)

Crop/simulated erosion (cm of soil removed)		Cost A_1	Cost B_1/ Cost C_1	Cost C_2	Gross Return	Labour income/ Net income	Return from manage-ment	BCR Based on variable cost	BCR Based on Total Cost
Maize	0	27250	27945	2794	31752	3807	28958	1.17	0.95
	5	27024	27719	2772	29116	1398	26344	1.08	0.88
	10	26685	27380	2738	21940	-5439	19202	0.82	0.67
	15	26346	27041	2704	13787	-13253	11083	0.52	0.43
Paddy	0	26006	26701	2670	33661	6961	30991	1.29	1.05
	5	25780	26475	2647	26203	-271	23556	1.02	0.82
	10	25554	26249	2625	25236	-1013	22611	0.99	0.80
	15	25554	26249	2625	22728	-3520	20103	0.89	0.72
Soybean	0	29917	30612	3061	57750	27139	54689	1.93	1.61
	5	29239	29934	2993	47250	17317	44257	1.62	1.34
	10	28222	28917	2892	30188	1271	27296	1.07	0.88
	15	27431	28126	2813	18375	-9751	15562	0.67	0.55
Rapeseed	0	25020	25715	2571	9045	-16670	6474	0.36	0.29
	5	24794	25489	2549	4860	-20629	2311	0.20	0.16
	10	24342	25037	2504	2115	-22922	-389	0.09	0.07
	15	24342	25037	2504	1755	-23282	-749	0.07	0.06

net income at all the levels of simulated erosion. Therefore, its cultivation in the *rabi* season could not be considered economic even in uneroded soils. Similarly, maize was also not economically viable at 10 and 15 cm of simulated erosion from the view point of labour income and net income. Paddy was found was found to be economically viable only in uneroded soil. Soybean however, was economically viable at 0, 5 and 10 cm of simulated erosion rates. None of the crops was economically viable at 15 cm of simulated erosion. The low labour income and net income in desurfaced soils was mainly due to lower gross return in these crops.

Return from management:

The return from management (Rs. ha^{-1}) was found to be highest in soybean followed by paddy, maize in soils subjected to 0 and 10 cm of simulated soil erosion. At 5 cm of simulated erosion rate it was again highest in soybean followed by maize and paddy. In rapeseed, return from management was lowest at all the levels of simulated erosion. It was in fact negative at 10 and 15 cm of simulated erosion. Higher return from management in soybean may be due to its higher yield and higher support price as compared to other crops. However, at 15 cm of soil depth removal, return from management was highest in paddy followed by soybean, maize and rapeseed. This, perhaps, may be due to the combined effect of higher yield and lower working expenses in paddy cultivation on severely eroded soil as compared to other crops. The return from management from maize, paddy, soybean and rapeseed in uneroded soil was estimated to be 29958, 30991, 54689, and 6474 Rs. ha^{-1}, respectively, which decreased with the increase in simulated erosion rates. This was computed to be 9.0, 33.7 and 61.7% in maize, 24.0, 27.0, 35.1% in paddy and 19.1, 55.1 and 71.5% in soybean in soils subjected to simulated erosion rates of 5,10 and 15 cm, respectively. In rapeseed, return from management decreased by 64.3% at 5 cm of soil depth removal and thereafter it was negative. From the data it could be established that average decline in the return from management in eroded soils was lowest in paddy (28.7%) followed by maize (34.8%) and soybean (48.6%).

Benefit Cost Ratio (BCR)

The benefit-cost ratio based on variable cost was found to vary between 1.17 to 0.52 in maize; 1.29 to 0.89 in paddy: 1.93 to 0.93 to 0.67 in soybean and 0.36 to 0.07 in rapeseed in eroded soils. The BCR over variable cost was found to be less than equity in case of rapeseed at all the levels of simulated erosion depicting the economic

infeasibility of cultivating it in rabi season even on uneroded soil. The BCR further established that on soils subjected to erosion rates of 0 cm (uneroded) and 5 cm, the cultivation of maize, paddy and soybean was found to be economically profitable. Of these crops, soybean was the most profitable crop followed by paddy and maize on uneroded soils. Soils subjected to 10 cm of simulated erosion can be used for economically profitable production of soybean. The BCR results further established that in hill agriculture BCR based on variable cost for maize and paddy was less than soybean in soils subjected to erosion rates up to 5 cm indicating flow economic profitability of traditional crops in labour intensive hill agriculture. The data clearly established that cultivation of maize and paddy in soils subjected to simulated erosion beyond 5 cm was not economically profitable. However, cultivation of soybean could be economically profitable in soils subjected to simulated erosion rates up to 10 cm. The BCR based on total cost depicted that in uneroded soils cultivation of paddy and soybean only would be economically preferred. However, in soils subjected to simulated erosion of 5 cm, only soybean cultivation could be profitable. In soils subjected to simulated erosion rates of more than 5 cm, cultivation of any of these crops would not be economically profitable. Interestingly, on an average BCR based on variable cost in eroded soils fluctuated minimum in paddy (25.1%) followed by maize d(31.1%), soybean (42.0%) and rapeseed (66.6%) making paddy to be a relatively viable proposition for cultivation on eroded soils.

An analysis of the data in table 2 revealed that the magnitude of reduction in gross return varied with the crop and simulated erosion rates. The data further revealed that on removal of 5 cm of surface soil, the gross return from maize, paddy, soybean and rapeseed was 91.7, 77.8, 81.8 and 53.7 per cent , respectively of the gross income obtained in uneroded soils (100%). Similarly, on removal of 10 and 15 cm of surface soil, the gross return from these crops was 69.1, 75.0, 52.3 and 23.4 per cent and 43.4, 67.5, 31.8 and 19.4 per cent of control, respectively. The average gross return generating potential of the soil left after the removal of 5, 10 and 15 cm of surface soil worked out to be 76.3, 54.9 and 40.5 per cent of the control (100%), respectively. Thus on an average, the gross return generating potential of the soil subjected to these erosion rates was reduced by 23.7, 45.0 and 59.5 per cent, respectively. The values pertaining to the gross return generating potential of the soil left after removal of 5, 10 and 15 cm of surface soil are comparable with the soil fertility value of 80, 60 and 30 per cent of the control reported by Stefanovits (1985) for weekly eroded, moderately eroded and strongly eroded soils, respectively.

An in-depth analysis of the gross return data (Table-2) revealed that the contribution of surface soil and subsoil towards gross return varied with the crops. The gross return in maize, paddy, soybean and rapeseed on surface soil to subsoil level was 43.4, 67.5, 31.8 and 19.4 per cent of the gross return observed in control, respectively. This obviously is the contribution of subsoil towards gross return as the same has been obtained by cultivating the resultant top soil after complete removal of surface soil. On complete removal of surface soil, gross return reduced by 56.6, 32.5 68.2 and 80.6 per cent in maize, paddy, soybean and rapeseed, respectively. Obviously, this is the contribution of the surface soil towards gross return from these crops which was lost on its removal. The contribution of surface soil towards gross return from maize, paddy, soybean and rapeseed was estimated to be 1197.6, 928.9, 2625.0 and 486.0 Rs. ha^{-1} cm^{-1}, respectively. Assuming that only 15 cm of subsoil contributed towards crop production and thereby gross return, the contribution of subsoil towards gross return from these crops worked out to be 919.2, 1515.2, 1225.0 and 117.0 Rs. ha^{-1} cm^{-1}, respectively.

Gross return data analysis further revealed that the surface soil contributed more than subsoil towards the gross return of maize (56.6%) soybean (68.2%) and rapeseed (80.6%) but not in paddy (32.5%). The data thus established beyond doubt that the contribution of subsoil towards gross return particularly in paddy was substantial (67.5%) as compared to maize (43.4%), soybean (31.8%) and rapeseed (19.4%). Subsoil limitations therefore, must be given due importance in crop production strategy. Soil properties induced poor plant growth conditions in subsoil need to be improved to ensure better soil quality and crop performance and thereby higher income from eroded soils.

The results of the simple linear regression analysis for the effect of simulated soil erosion on the gross return from various crops are presented in Table 3. The results revealed that the regression co-efficient (b) of the soil depth removal was negative and significantly related ($p > 0.5$, $n=16$) to gross return in maize ($r=0.9786$), paddy ($r=0.9267$), soybean ($r = 0.9959$) and rapeseed ($r=0.9440$). Regression analysis clearly established negative impact of simulated soil erosion on the gross return from all the crops. The soil depth removal explained about 95.76, 85.76, 85.91.19 and 89.11 per cent variation in the gross return of maize, paddy, soybean and rapeseed, respectively

Table 3: Results of simple regression analysis for the effect of simulated erosion on the gross income from various crops

Variable/ crops	Inercept	Regression coefficient	t-value	R^2
Maize	33309.25	–1221.38 (181.62)	–6.7248*	0.9576
Paddy	32021.86	–675.32 (193.40)	–3.4918*	0.8591
Soybean	58668.75	–2703.75 (172.13)	–15.71*	0.9919
Rapeseed	8136.00	–492.3 (121.69)	–4.05*	0.8911

Significant at 5% popularity level.

indicating a good fit to the variable used in the regression model. One unit removal of soil layer would decrease the gross return by 1221.38, 675.32, 2703.75 and 492.38 and unit of gross return of maize, paddy, soybean and rapeseed, respectively. The results also highlight the fact that soil removal had an inverse relationship with the gross return in all the crops.

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It is possible to fail in many ways...while to succeed is possible only in one way.

— Aristotle

Extent of Yield Gap and Constraints in Crop Production Among Different Categories of Farmers

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There is tremendous potential for increasing yield and income, which largely remains untapped for want of suitable infrastructure and appropriate technology. This study was undertaken in Punjab to understand the extent of yield gap prevailing in different categories of farmers, and major constraints faced by them.

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Many studies have revealed that in Indian agriculture a majority of the farms have not been able to approach the potential yield levels (Kalirajan, 1990; Mythili and Shanmugham, 2000). According to Taylor and Shankusler (1986), the technical efficiency was as low as 30 per cent in Brazilian agriculture. Likewise, Ali and Film (1989) concluded that the profit of the farmers in Pakistan's Punjab could be increased by 28 per cent through improved efficiency. These reviews firmly suggest that considerable scope exists for raising the income of farmers by improving their efficiency in using the available technology.

There is a tremendous potential for increasing yield and income, which remains largely untapped for want of suitable infrastructural and institutional facilities as well as appropriate technology-cum-policy measures (Govt. of India, 1990; Swaminathan, 1983). Various studies suggested that there is need to examine the adoption of new technology by small and marginal farmers and gradual commercialization of farms. What makes the small and marginal farmers adopt new production technology slowly? Do we need to further strengthen government driven and other institutional facilities of credit, marketing and irrigation, to enable the small and marginal farms to generate sufficient output and income for their subsistence? These are some of the questions, which remain unanswered, particularly in the context of agriculturally-developed region of the country.

The present investigation was undertaken in order to understand the extent of yield gap prevailing in different categories of farmers; and major constraints faced by them. Considering the dominance of crops in the net sown area, the present investigation was confined to paddy, maize and wheat in sub-mountainous and central regions and

paddy, cotton and wheat in south-western region of the state for marginal, small and other categories of farms for the year 2005-06, with the following objectives

(i) to estimate the yield gaps for important crops among different regions, and for different size categories of farmers,

(ii) to work out the index of realized potential yield (IRPY),

(iii) to analyse the factors affecting the crop productivity among different region, and

(iv) farmers' perception about production and marketing constraints faced by the farmers.

Approach of the study

The present study was undertaken in Punjab, which was divided into three regions on the basis of agro-climatic parameters; sub-mountainous region (9%), central plain region (65%) and south western region (26%). The three stage stratified random sampling technique was adopted for the study. Two blocks from sub mountainous zone, five blocks from central plain zone and three blocks from south western zone was selected at the first stage. Two villages from each block and 15 families; five marginal (up to 1 ha), five small (1.01 to 2 ha) and five from other categories (>2ha); and a total of 300 farm families were selected.

A well-structured comprehensive schedule was designed and pre-tested in Ludhiana district of Punjab. It was personally administered to obtain the yield level and input use and tribulations faced by the farmers in various regions of the Punjab state. Data related to potential yield of different crops were obtained from the respective Department of Plant Breeding and Genetics, PAU Ludhiana. The simple tabular analysis was used to estimate the magnitude of yield gaps of major crops namely paddy, wheat, cotton and maize for different size categories of farmers for various regions. The percentage and the appropriate indices to yield gaps were computed. Resource use efficiency was examined as a determinant of yield differential among different regions. The Cobb Douglas type Production Function was estimated using the Ordinary Least Square (OLS) technique, which is a measure of average performance of the sample observation evaluated at the mean input levels. In regression analysis the dependent variable per acre was taken as value productivity (Rs.); and independent variables such as human labour (hrs), seed (Rs), fertilizers (Rs), insecticides costs (Rs) and machinery costs (Rs).

Potential yield (Y_p) is defined as the yield per acre realized at the experimentation station. This yield is considered to be the maximum absolute production potential of the crop. This is because at the research station, the agronomic and other management practices are carried out by the scientists themselves according to the schedule. The experiments are conducted on small size plots and the research station is endowed with all the requisite resources including the technical know-how.

Potential farm yield (Y_d) is defined as the yield per acre obtained at the demonstration plots. The agronomic practices at these demonstration plots are managed and approved by the extension workers and not by the farmers. The demonstration plots represent the conditions of farmer's field with respect to environment and more close availability as compared to those of research station plots. Therefore, it is often more relevant and appropriate to consider the demonstration plots yield as the potential farm yield.

Actual yield (Y_a) is the yield per acre realized by the farmers on their own farm with their own resources and management practices.

Total yield gap (GT) is calculated as the difference in the potential yield (Yp) and the actual yield (Ya). Thus $GT = Yp - Y_a$. The total yield gap has been split into two components namely yield gap-I and yield gap-II. The yield gap-I (G-I) is estimated as the difference between the potential yield (Y_p) and the potential farm yield (y_d). Thus $G\text{-}I = Y_p - y_d$. The yield gap-II (G II) is computed as the difference between the potential farm yield (Y_d) and the actual yield (y_a). Thus, $G\text{-}II = Y_d - Y_a$ Total yield gap = Gap I plus Gap II (GI + GII).

Index of realized potential yield (IRPY) was computed by subtracting the total yield gap from 100. IRPY = 100–TG.

Gaps in technology adoption

Yield gap is an important concept used as proxy for technology adoption as it affects the production potential of the crop. Productivity gains can be achieved by minimizing yield gaps. Yield gap may arise due to the comparison between the yields obtained on research/ demonstration farms under ideal or controlled conditions and the actual yield realized by the farmers at the farm level.

Table 1 depicts the potential yield demonstration yield and yield gap I, which is computed as the difference

between the potential yield and demonstration yield in percentage terms for different crops. The yield gap I was as high as 25 per cent for cotton crop followed by wheat (20.83%), maize (16.67%) and paddy (15.00%). The higher yield gap I implied that greater amount of potential yield was entrapped on the demonstration plots. The yield gap I was attributable partly to the significant environmental differences and partly to the non-transferable component of technology like cultural practices. Hence, the technology developed in research institute could not be fully replicated on demonstration plots.

Table 1: Potential yield, demonstration yield and yield gap I among different Crops in Punjab, 2005-06.

Particulars	Paddy	Maize	Cotton	Wheat
1. Potential yield	40	24	16	24
2. Demonstration yield	34	20	12	19
3. Yield gaps I (%)	15.00	16.67	25.00	20.83

Source: Respective department of Plant breeding and Genetics, Punjab Agricultural University, Ludhiana

Mean yield and yield gaps of different crops in different regions

Sub-mountainous region

Actual yield (mean yield of sample farmers) and yield gap-II was worked out for different crops of different farm size categories in various regions of the Punjab state and incorporated in Table 2. Paddy, maize and wheat are the important crops grown in the sub-mountainous region of Punjab. In case of paddy, the actual yield was the highest for the other categories of farms 21.72q/acre, followed by marginal farms i.e. 21.26 q/ acre and it was the lowest on

Table 2: Mean yield and yield gaps of different crops; size category-wise among different regions of Punjab, 2005-06

Crop /yield	Farm size categories								
	Sub-mountainous region			Central region			South-western region		
	Marginal	Small	Others	Marginal	Small	Others	Marginal	Small	Others
1. Paddy									
(i) Actual yield	21.26	19.42	21.72	23.78	23.92	25.47	24.34	22.50	24.48
(ii) Yield gaps II (%)	37.47	42.88	36.12	30.06	29.65	25.09	28.41	33.82	28.00
(iii)Total yield gap	52.47	57.88	51.12	45.06	44.65	40.09	43.41	48.82	43.00
Index of potential yield realization	47.53	42.12	42.88	54.94	55.35	59.91	56.59	51.18	57.00
2. Maize									
(i)Actual yield	13.26	11.71	11.60	11.04	13.54	12.56	10.00	11.00	11.00
(ii) Yield gaps II (%)	33.70	41.45	42.00	44.80	32.30	37.20	16.67	8.33	8.33
(iii)Total yield gap	50.37	58.12	58.67	61.47	48.97	53.87	41.67	33.33	33.33
Index of potential yield realization	49.63	41.88	41.33	38.53	51.03	46.13	58.33	66.67	66.67
3. Wheat									
(i)Actual yield	11.29	12.05	12.52	17.66	17.69	19.00	18.15	18.01	18.75
(ii) Yield gaps II (%)	40.58	36.58	34.11	7.05	6.89	0.00	4.47	5.21	1.32
(iii)Total yield gap	61.41	57.41	54.94	27.88	27.72	20.83	25.30	26.04	22.15
Index of potential yield realization	38.59	42.59	45.06	72.12	72.28	79.17	74.7	73.96	77.85

the small farm size category i.e. 19.42 q/ acre. Similarly the yield gap-II for the paddy crop was the highest on small farm size categories to the tune of 42.88 per cent followed by marginal farmers 37.47 per cent and large farmers 36.12 per cent. The total yield gap was estimated to 57.88 per cent in small farms, 52.47 per cent among marginal farms and 51.12 per cent among other categories of farms in sub-mountainous region of Punjab, which implies that only 42.12 to 42.88 per cent of the potential yield of the paddy crop was realized by the sample farmers in this region.

In case of maize crop, which is kharif crop of the sub-mountainous region, the yield gap I was 16.67 per cent. The yield gap-II was the lowest for the marginal farmers i.e. 33.70 per cent followed by small farmers and other categories of farmers with yield gap-II to the extent of 41.45, 42.00 per cent respectively indicating direct relationship of yield gaps-II with the farm size. The maize crop is a labour intensive crop and might be the reason for having a direct relationship of yield gap with the farm size. The total yield gap in case of maize crop in the sub-mountainous region worked out to be 50.37, 58.12 and 58.67 per cent among marginal, small and other categories of farms respectively, implying that only 41.33 to 49.63 per cent of the potential maize yield was realized by the sample farmers in the sub-mountainous region of the Punjab state. Wheat is main rabi crop in Punjab and so is the sub-mountainous region of the state. The yield gap I was 20.83 per cent for this crop. The yield gap II is calculated for different categories of farms was 40.58 per cent for marginal farmers followed by small (36.58%) and other categories of farmers (34.11%) respectively. Total yield gap was the maximum in the marginal farm size category.

Central region: In the central region the mean yield of paddy crop was 23.78, 23.92 and 25.47 qtl/acre on marginal, small and other categories of farms in the central region, which is an indication of the direct relationship of paddy yield and farm size. Yield gap II worked out to inversely relate to the farm size. It was 30.06, 29.65 and 25.09 per cent for marginal, small and other categories of farms, resulting in a total gap of 45.06, 44.65 and 40.09 per cent for the respective categories of farms. The index of potential yield realization was about 60 per cent in other categories of farms, whereas it was about 55 per cent for marginal and small farmers in the central region.

In case of maize, the yield gap II was the highest on marginal farms i.e. 44.80 per cent and the lowest among small farms i.e. 32.30 per cent, whereas the total gap ranged from 48.97 per cent to 61.47 per cent. Potential yield realization was as low as 38.53 per cent i.e. in case of marginal farms, and as high as 51.03 per cent in case of small farms.

Wheat crop is a traditional rabi crop of Punjab state grown all over the state. Yield gap II is lower in this crop. It was as low as nil in case of other categories of farms and 6.89 and 7.05 per cent among small and marginal farms respectively. Total yield gap varied between 20.83 and 27.88 per cent among different categories of farms having inverse relationship with farm size. Potential yield realization of wheat crop was 72.12, 72.28 and 79.17 per cent among marginal, small and other categories of farms respectively.

South-western region

Actual yield and yield gaps of paddy, cotton and wheat crops for different categories of farms were worked out. It was observed that the yield gap II of paddy crop was to the tune of 28.41, 33.82 and 28.00 per cent among marginal, small and other categories of farms resulting into a total yield gap of 43.41, 48.82 and 43.00 per cent for marginal, small and other categories of farms for paddy crop in south-western region, implying that 56.59, 51.18 and 57.00 per cent of the potential yield was realized by the sample farmers of respective categories in case of paddy crop. Cotton crop is an important kharif crop of south western region of the Punjab state. Yield gap I i.e. difference between potential yield and potential farm yield was 25 per cent. The yield gap II worked out to be 16.67, 8.33 per cent resulting into total yield gap of 41.67, 33.33 and 33.33 per cent for the marginal, small and other categories of farms respectively. The potential yield realization was less than 60 per cent to 67 per cent for this crop among all categories of farms.

Wheat is the less risky rabi crop of this region and yield gap II for this crop was worked out to the maximum of five per cent among small farm size categories; and lowest to the tune of 1.32 per cent for other categories of farms. Total yield gap for this crop was worked out to the maximum of 26.04 per cent and minimum of 22.15 per cent among different categories of farms. It was higher on marginal and small farm size categories than on other farm size categories. The potential yield realization varied between 73.96 and 77.85 per cent among different farm size categories in this region.

Production Function Approach: The adoption of technology level directly impact the output of the crop. Timely sowing, use of appropriate proportions of manures

and fertilizers, pesticides, irrigation and seed, are the basis of any production activity in agriculture. To work out this relationship a production function approach of Cobb-Douglas type was used. The output elasticities with respect to OLS estimation results are presented in Table 3; which analyses the factors affecting the productivity of crops in different regions. In sub-mountainous region the quantity of fertilizers used significantly contributed to the value productivity per acre indicating that the variation in yield will be lessen by increased use of fertilizers. The coefficient of human labour was negative, indicative of somewhat economic use. In the central region all the variables namely, human labour, fertilizer used, expenditure on insecticides machine costs except value of seed, contributed positively and significantly to the gross value per acre in crop production. This given an indication of the optimum use of these inputs.

In the south western region the coefficient value of fertilizers was –0.25, which was significant at the five per cent level. This gives an indication that farmers are not using a desirable level or proper combination of fertilizers in crop production. The coefficients of seed, insecticides

Table 3: OLS estimates of the production function, region-wise, Punjab, 2005-06

Variables	Regions/coefficients		
	Sub-mountainous	Central region	South western
Constant	6.37**** (8.24)	5.81**** (16.77)	6.20**** (6.48)
Human labour	–0.18**** (–2.02)	0.21**** (7.34)	–0.04 (–0.56)
Seed	0.05 (0.29)	0.01 (0.30)	0.14**** (2.16)
Fertilizers	0.35**** (2.28)	0.10**** (2.50)	–0.25**** (–2.56)
Insecticides	0.08 (0.77)	0.05* (1.49)	0.26*** (2.50)
Machine costs	0.10 (0.72)	0.26**** (4.80)	0.36**** (2.34)

*, **, ***, **** indicate significance at 20%, 10%, 5% and 1% level respectively.
Figures in the parenthesis are the t values of respective coefficients.

and machine costs, significantly contributed in the variation of yields in major crops in this region.

Farmers' Perception about Major Constraints

Agriculture is usually exposed to three kinds of constraints: production constraints, marketing constraints and institutional constraints. Production constraints hinders the growth at the first stage, but as production technology improves, constraints rate lower down, yield improves, total output expands and commercialization of agriculture grows, while marketing constraints become the most crucial. Small and marginal farmers are more sensitive to these constraints due to their limited marketable surplus, hence access to markets.

Production of agricultural commodities is of prime importance in the economy of the farmer, as marketable surplus depends upon the production of crops. Production constraints start with the smallholder as their size of holding is so small, that it is not sufficient to produce a sizeable surplus to earn a handsome income. Farmers' perceptions about production constraints of sub-mountainous region central region and south-western region in the Punjab state are highlighted in Table 4. The perusal of data indicated that 60 per cent of marginal farmer in the sub-mountainous region felt the pinch of higher cost of inputs, followed by 75 per cent of small and 90 per cent of other categories of farmers. As most of the small and marginal farmers did not have any access to their own machinery, the availability of custom hiring services was also not so easy for them 65 per cent marginal, 76 per cent small and 10 per cent of other categories of farmers have faced the problem of custom hiring of machinery. Sharing of irrigation structure irritated 65 and 81 per cent of marginal and small farmers respectively. Frequent attacks of pests and diseases on crops affect 80 per cent of large farmers. Changes in weather conditions, lowering down the water table and other natural calamities disturbed 83, 79 and 55 per cent

Table 4: Farmers perception about production tribulations in the Punjab State, 2005-06 (% Multiple response)

Specification/Region	Farm size categories		
	Marginal	Small	Others
A. Sub-mountainous region			
1. Higher cost of inputs	60	75	90
2. Availability of custom hiring services	65	76	10
3. Scarcity of labour in peak periods	-	10	70
4. Sharing of irrigation structure	65	81	-
5. Frequent attacks of pests and diseases	40	55	80
6. Natural calamities (Weather conditions, poor soil quality & lowering water level)	83	79	55
B. Central-region			
1. Higher cost of inputs	50	67	60
2. Availability of custom hiring services	70	75	15
3. Scarcity of labour in peak periods	10	10	25
4. Sharing of irrigation structure	85	86	10
5. Frequent attacks of pests and diseases	48	41	60
6. Natural conditions (Weather conditions, poor soil quality & lowering water level)	87	75	73
C. South-western region			
1. Higher costs of inputs	65	80	83
2. Availability of custom hiring services	80	60	5
3. Scarcity of labour in peak periods	-	-	75
4. Sharing of irrigation structure	85	90	12
5. Frequent attacks of pests and diseases	55	45	80
6. Natural calamities (Weather conditions, poor soil quality & lowering water level)	70	87	71
Punjab			
1. Higher cost of inputs	67	73	73
2. Availability of custom hiring services	72	71	11
3. Scarcity of labour in peak periods	5	7	74
4. Sharing of irrigation structure	81	86	7
5. Frequent attacks of pests and diseases	48	45	70
6. Natural calamities (Weather conditions, poor soil quality & lowering water level)	83	79	68

of marginal, small and other categories of farmers in sub-mountainous regions of Punjab.

In the central region of Punjab sharing of the irrigation structure was the main tribulation for 85, 86 and 10 per cent of marginal, small and other farms category respectively. Natural conditions of weather, power, soil quality and lowering of the water table turned into a misfortune for about 80 per cent of farmers of all categories in region II. Labour scarcity only affected large farmers and availability of custom hiring service to marginal and small farmers. In south-western region inputs became costly for 65, 80 and 83 per cent of marginal, small and other categories of farmers respectively. In this region, cotton crop is a main kharif crop and due to frequent attacks of American boll worm the crop needs higher dozes of insecticides, which had shaken the economy of south-western farmers. Sharing of irrigation structure were an intricate for 85, 90 and 12 per cent of marginal, small and

other categories of the farmers respectively. Frequent attacks of diseases were also thorny for about 50 per cent of marginal and small and 80 per cent of large farm size categories. The farmers' perception about production tribulation in the Punjab state reveals that higher cost of cultivation becomes hard for even large farmers (73%) and marginal (67%) and small (73%) respectively.

Custom hiring services were used by mainly marginal and small farmers, and they felt the hard pinch of this. Sharing of the irrigation structure was also the main tribulation for marginal (81%) and small (81%) the farmers in the Punjab state. Attacks of pests and diseases on crops are the major concern for large farmers.

Large farm size categories have their own irrigation structure (78%).

Marketing constraints

Agricultural marketing is of crucial significance to the earnings, well being and living standards of rural households in general and agricultural households in particular. Home produced seed was used mainly in the south-western region of the state and was bought from the farmer friend in the central region. In comparison to other farmers small and marginal farmers have not been satisfied with the supply of seed and other inputs. Supply of inputs is a pre-requisite for production, both timely supply and required quality of inputs matter in the production process.

Seed used for production is brought from the shop or home produced or from other farmers. About 32, 52 and 58 per cent of the marginal, small and other farmers used home produced seed (See Table 5). Fertilizers and pesticides were largely bought by farmers from cooperatives (85%, 75%), whereas marginal and small farmers bought it from commission agents/shops (more than 50%). Other farm size categories hardly faced any difficulty in the timely supply of fertilizers and pesticides in different regions of Punjab. Irrigation structure was shared by 25 per cent and 18 per cent of marginal and small farmers, which is

Table 5: Source of inputs and their supply in Punjab (% multiple response)

Particulars	Farm size categories		
	Marginal	Small	Others
1. Seed			
a) Source			
(i) Shop	43	56	62
(ii) Home produced	32	52	58
(iii) Other farmers	18	27	26
(b) Timely supply	40	54	92
2. Fertilizers			
(a) Source			
(i) Shop	47	62	71
(ii) Cooperative	29	68	85
(iii) Timely supply	35	53	86
3. Pesticides			
(a) Source			
(i) Shop	54	54	75
(ii) Cooperative	14	30	75
(iii) Timely supply	33	61	91
4. Irrigation			
(i) Owned	25	18	78
(ii) Rent	28	44	30
(iii) Shared	45	18	3
(iv) Timely supply	37	43	75

not available timely. Large farm size categories have their own irrigation structure (78%). Home produced seed was used mainly in the south-western region of the state and bought from farmer friend in the central region. In comparison to other farmers, small and marginal farmers have not been satisfied with the supply of seed and other inputs. Farmer's perception about market tribulation has been given in Table 6. This table reveals that low prices of agricultural commodities, availability of inputs, quality of inputs, price fluctuation and storage of produce particularly in vegetable and sometimes non-cooperation of market official were the major marketing tribulation according to the selected farmers of different region of Punjab.

Forty per cent of marginal farmers felt prices of agricultural commodities were low; 16 per cent low quality of inputs and 14 per cent felt price fluctuations and storage of produce. Although marketable surplus is higher in case of large farmers, still they are not happy with prices of crops.

Table 6: Farmers perceptions about marketing tribulations in Punjab

Specification/Region	Farm size categories		
	Marginal	Small	Others
1. Low prices of crops	20	22	19
2. Poor quality of inputs	14	21	14
3. Price fluctuations in vegetables	14	10	8
4. Non-cooperation of market officials	8	6	2
5. Supply of electricity	9	16	36
6. High rate of Interest	10	12	13
7. Delay in bank credit	11	7	11
8. Awareness about KCCs (No.)	24	29	34
9 Membership of Kisan Credit Card	20	12	16

Conclusion

The main conclusion from the above exercise is that yield Gap I was mainly due to factors generally not transferable such as the environmental stipulation and some build-in component of technologies offered at research fields. These gaps were as high as 25.00, 16.67 and 15.00 in wheat, maize and paddy. It is improbable that this can be narrowed down. The yield gap II, which is the gap between the farm potential yield and the actual yield, varied between 28 per cent and 43 per cent for paddy crop, between 32 per cent and 44 per cent for maize crop and between eight and 17 per cent for cotton crop among marginal and small farm size categories in different regions of Punjab state. The yield gap II was lower for wheat crop but it was again high in case of sub-mountainous region. The yield gap II was lower for wheat crop varied between five per cent and 41 per cent among the marginal and small categories of farms in different regions, which implies that exploitable yield could be increased with the technology package adopted by demonstration farmers. Expectable yield gaps are often caused by various factors including physical, biological, socio-economic and institutional constraints, which can be effectively improved through participatory and or a holistic approach and action by the Government (Cornwell, 1996 and IRRI, 1998).

In a nutshell the maximum yield gap was found in case of paddy and wheat in the sub-mountainous region in marginal and small category of farmers, for the maize in central region for marginal farmers and cotton in south western for marginal farmers. These yield gaps can be abridged by using the suitable doses of inputs or their combination to increase the production level at the existing level of technology. The optimum use of inputs like fertilizers in sub-mountainous, labour fertilizers and machinery in central regions, seed, fertilizers, insecticides, and machinery in south-western regions will result in lowering down the yield gaps and improves the production level and income of the farmers. The extension workers need to target those farmers, which are unable to follow the recommendation due to any reason. Regarding major constraints faced by farmers the overall picture emerges as higher cost of cultivation becomes hard for marginal (67%) and small farmers (75%) in different regions respectively.

Higher costs also adversely affected the large farmers (73%) in the Punjab state. Custom hiring services

had been used mainly by marginal and small farmers; more than 70% of them felt the hard pinch of it. Sharing of irrigation structure was also the main tribulation for about 80 per cent of marginal and small farmers in the Punjab State Frequent attacks of insect, pests and diseases are thorny for large farmers only.

Paddy, wheat, maize and cotton crops were mainly grown in the Punjab state by all categories of farmers. About sources of seed, 32, 52 and 58 per cent of the marginal, small and other farmers used home produced seed. 85 per cent of large farmers bought fertilizer from cooperatives; 75 per cent large farmers pesticides bought from cooperatives, whereas marginal and small farmers bought these from commission agents. The data reveals that low prices of agricultural commodities, availability of inputs, quality of inputs, price fluctuation and storage of produce, especially vegetables and sometimes non-cooperation of market officials were the major marketing tribulations according to the selected farmers of different regions of Punjab. Forty per cent of marginal farmers felt prices of agricultural commodities were low; 16 per cent felt there was a low quality of inputs and 14 per cent felt there were problems due to price fluctuations and storage of produce.

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Success is the ability to go from one failure to another with no loss of enthusiasm.

—Sir Winston Churchill

Resource Use Efficiency of the Inland Fish Farms of Thanjavur District

S Gurunathan

In view of the vast potential for fish farming in Thanjavur district,this paper probes into the economic aspects of fish farming. The Cobb-Douglas production function was selected among different types of production functions for the present study because of its relative advantages over others. The t-test showed that the $\sum$ bi significantly deviated from unity, showing increasing returns to scale. The ratio of marginal value product (MVP) to opportunity cost (MFC) of fertilizer on fish farms was more than unity, indicating the scope of increasing the yield of fish by further use.

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In recent years the search for inexpensive alternative sources of protein has led to a substantial interest in aquaculture. Aquaculture has definite advantages over capture fisheries. In capture fisheries less effort is required, but there is no guarantee of catch. The environmental conditions can be controlled in aquaculture and genetic improvement of the species can be made to increase the fish production. Further, fish are efficient converters of feeds and of low quality plant materials and wastes. The cost of production of a ton of protein from fish is said to be a half that of beef and one third that of pork.

Besides these production advantages, aquaculture has advantages with regard to marketing. The market demand for fish from aquaculture can be expanded more easily than for wild fish. Integrated Thanjavur district has a vast potential of fishing sources of long coastal length of 145 km., 2166 hectares of inland water spread area and 638 km of canals, and 2135 inland fishermen are engaged in fishing as a subsidiary occupation. In view of the vast potential for fish farming in Thanjavur district, it is felt desirable to probe into the economic aspects of fish farming and an attempt has been made to study the economics of fish farming in Thanjavur district with the specific objective of estimating the resource use efficiency of fish farms in the district.

Data and Methodology

For the study, Orathanadu taluk of Thanjavur district of Tamil Nadu was selected. Sixty farmers were randomly selected in this taluk. Data was collected with a suitably designed and pre-tested schedule. The survey method was adopted for collecting primary data needed to achieve the set of objectives of the study.

The farmers were categorized into two sizes viz., small and large groups. Those farmers with 2 hectares and more of water spread area were considered as large and farmers with less than 2 hectares as small. Sixty

farmers from the small group and 40 farmers from the large group were selected at random in probability proportion to their number in each group, thus taking the sample size of the study to hundred.

Production Function Analysis

The Cobb-Douglas production function was selected among different types of production functions for the present study because of its relative advantages over others. Elasticities of production of inputs can be obtained directly, which indicate the percentage change in output due to one per cent change in a particular input. The sum of elasticities of production provides the estimate of returns to scale. It has great use in economic analysis indicating marginal product at geometric mean level of inputs.

The Cobb-Douglas production function is specified in the following form with four inputs.

$$y = ax_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4} e^{u}$$

Where, Y = The fish yield in tonnes

X_1 = Human labour in man days

X_2 = Feed in tonnes

X_3 = Fertilizers in kgs

X_4 = Manures in tonnes

a = Intercept

u = Stochastic term

e = Napier base.

It can be presented in double logarithmic form as

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + \ln U$$

Marginal Value Products

Equality of MVP to factor cost is the basic condition that must be satisfied to assess the efficient resource use. In Cobb-Douglas production function, MVP of Xj, the j [th] input factor is given by the following formula.

$$y = ax_{1i}^{b_1} x_{2i}^{b_2} x_{3i}^{b_3} x_{4i}^{b_4} \ldots\ldots\ldots x_{ji}^{bj} e^{ui}$$

Where,

i = 1 to n farms, j = 1 to k inputs

MPP of Xj input = bj Y/ Xj

MPP = Marginal physical product of j[th] input

bi = Partial elasticity co-efficient

Y = Output at its geometric mean levels.

X_j = j th independent variable at its geometric mean level.

The MVP for each factor is obtained by multiplying the MPP of each factor with unit price of the input i.e, MVP = MPP * Py

Where Py = Price per unit of output

Marginal value productivities are compared with acquisition costs in order to study the resource use efficiency. A resource is said to be efficiently used when its MVP equals MFC.

Returns to Scale

The sum total of production elasticities of all the inputs (sum of bi s) indicates returns to scale. Returns to scale are said to be increasing, constant or decreasing if I bi is greater than unity or equal to unity or less than unity respectively. To know whether sum of bi (Sbi) is significantly deviating from unity or not, 't' test was carried out. The formula is

$$t = \frac{\sum_1^n b_i - 1}{SE(\sum_1^n b_i)}$$

$$= \frac{\sum_1^n b_i - 1}{S\sqrt{(C_{11} + C_{22} + \ldots\ldots + C_{nn}) + 2(C_{12} + C_{13} + \ldots + C_{mn})}}$$

Where,

S = Sum of squares due to error/ Error degrees of freedom

C_{11}, C_{22}, ... Cnn, C_{12}, C_{13},.....Cmn. are the elements of variance - covariance matrix inverse.

Results

The ultimate objective of the farmers in any business is to maximize the returns from their farming activities with the limited resources they have. Hence adjustment in the allocation of those limited resources is inevitable to operate the farm business at economic optimum level. It is important to study how the resources are used on the fish farms in Thanjavur district of Tamil Nadu. With this view in mind, resource use efficiency is estimated on the selected sizes of fish farms. The regression coefficients of different inputs included in the production function were

estimated separately for each size group of fish farms and the results are presented in the table.

Small farms

The coefficient of multiple determination (R^2) was 0.91 and it was significant at 5 per cent level. This indicated good fit to the data and 91 per cent of variation in the yield of fish was explained by selected variables. The analysis of small farms exhibited that out of four explanatory variables included in the model, only fertilizer was significant at five per cent level.

The production elasticity of human labour was negative and non-significant. The co-efficient of manures and feed were positive but found to be non-significant. The regression coefficients are the elasticity coefficients of the Cobb-Douglas production function, as they show the percentage change in output due to one per cent change in input. Keeping other factors constant, at their geometric mean level, one per cent increase in fertilizer would result 0.79 per cent increase in the yield. The sum of elasticities was 0.8605. The results of 't' test proved that Σ bi was not found deviating significantly from unity, indicating the prevalence of constant returns to scale.

Large farms

The coefficient of multiple determination (R^2) for large farms was 0.89, which indicated that the variables included in the function explained 89 per cent variation in the fish yield of large farms. The elasticities of feed (X_2) and manures (X_4) were positive and significant at 1 per cent and 5 per cent respectively. Keeping other inputs constant, at their geometric mean level, one per cent increases in the feed and manures would result in 0.67 and 0.43 per cent increased in fish yields respectively. The elasticities of

Table 1: Production elasticities, marginal value products of resources and marginal value product to opportunity cost ratios in fish farming

Sl. No.	Particulars		Small farms	Large farms	Pooled farms
1.	Number of farmers (n)		35	25	60
2.	Intercept (a)		-3.14405	-0.35730	-1.59443
3.	Human labour (X1)		-0.0681 (0.1052)	0.0590 (0.0687)	0.0489 (0.0567)
4.	Feed (X2)		0.0292 (0.0692)	0.6669** (0.1742)	0.3259** (0.0704)
5.	Fertilizer (X_3)		0.7944** (0.2728)	-0.1202 (0.1772)	0.5290** (0.1563)
6.	Manure (X_4)		0.1050 (0.2713)	0.4316* (0.2358)	0.5917** (0.1688)
7.	Returns to scale Σb_i		0.8605 ((-0.024))	1.0373 ((4.302))	1.4955** ((4.882))
8.	Coefficient of multiple determination (R^2)		0.91**	0.89**	0.96**
9.	MVPs (Rs)	Human labour X_1	-	-	-
		Feed X_2	-	6663	6982
		Fertilizer X_3	4.38	-	4.192
		Manure X_4	-	4.019	12.158
10.	MFCs (Rs)	Human labour X_1	-	-	-
		Feed X_2	-	4895	4895
		Fertilizer X_3	3.58	-	3.58
		Manure X_4	-	200	200
11.	MVP/MFC Ratio	Human labour X_1	-	-	-
		Feed X_2	-	1.361	1.4263
		Fertilizer X_3	1.223	-	1.1709
		Manure X_4	-	0.02010	0.06079

Note: Figures in ( ) are standard errors. Figures in (( )) are 't' values.
* Significant at 5% level** Significant at 1% level

human labour and fertilizers were non-significant. The sum of elasticities was 1.0373. The t-test showed that the E bi was significantly deviated from unity showing increasing returns to scale.

Pooled farms

The coefficient of multiple determination (R^2) was 0.96 in the pooled farms, which indicated that the variables included in the function explained 96 per cent of variation in the fish yield. Among the selected variables the elasticities of feed (X_2) fertilizer (X_3) and manure (X_4) were positively significant at 1 per cent level. Keeping all other variables constant, one per cent increase in feed, fertilizer and manure would result in an increase of fish output by 0.33, 0.53 and 0.59 per cent respectively. The elasticity of human labour was positive but non-significant. The sum of the elasticities was 1.4955, significantly deviated from unity indicating the existence of increasing returns to scale.

Allocative Efficiency

To examine the economic efficiency of resource use, the Marginal Value Product (MVP) of each input was compared with its acquisition cost i.e., Marginal Factor Cost (MFC). Marginal factor costs are the unit costs of inputs. Marginal factor costs of feed (tonnes), manures (tonnes), fertilizers (kgs) and human labour (man-days) were their respective prices. MVP/MFC ratios indicate the potentiality of factors for their further use. Its higher value (greater than unity) shows greater potentiality for further use. Its value of less than one indicates lesser profitability of its use. The negative ratio indicates over use of the resources and suggests reduction in the present level of resource use. The resource is said to be allocated efficiently if the MVP=MFC. The ratio of MVP to their acquisition cost was computed only for the significant factors for each size of fish farm and is presented in the table.

It is seen from the table that ratio of marginal value product (MVP) to opportunity cost (MFC) of fertilizer on small farms was more than unity indicating the scope of increasing the yield of fish by further its use. In respect of large farms also the ratio of MVP to MFC was more than unity, suggesting the potentiality of feed to increase the fish yield with its further use. In respect of pooled farms the ratio of MVP to MFC for feed and fertilizer was found to be more than unity revealing the possibility of furthering their use for increased fish yield.

Conclusion

Though the producers were found to obtain greater share in the consumer's rupee promotion, producer's cooperatives help the farmers to protect themselves against the price instability. Greater efforts are needed to reinstate the Fish Farmers' Development Agency in the dissemination of production technology to fish farmers, as the farmers feel that they did not have adequate access to this aspect. This information certainly makes fish farming much more attractive to the farmers.

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If an idea's worth having once it's worth having twice.

—Tom Stoppard

Productivity Response of Drip Irrigated Cabbage under Variable Irrigation Levels

Eno Rai, Dharambir Dhan & M. Imtiyaz

A field experiment was conducted at the Irrigation Research Farm of Allahabad, Agricultural Institute–Deemed University, during the winter crop growing season of 2003 – 2004 on clay loam soil, to investigate the effect of four different irrigation levels on yield, yield components, irrigation production efficiency and economic return of cabbage. The potential evapotranspiration replenishment irrigation scheduling methods resulted in higher gross return, net return and benefit cost ratio. The seasonal water applied and marketable yield, gross return net return and benefit-cost ratio exhibited strong quadratic relationship under each irrigation scheduling methods, which in turn can be used for optimizing productivity yield and economic return under limited water supply conditions. The results revealed that the drip irrigation system is profitable for cabbage production in spite of a high initial investment.

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Water shortage is the major limiting factor for crop diversification and productivity. Due to rapid growth, the competition of limited water resources for domestic, industrial and agricultural needs is increasing considerably. For the ever-growing population, water for irrigation is becoming both scarce and expensive due to fast depletion of surface and subsurface water resources, caused by over exploitation and erratic rainfall. Thus the right amount and frequency of irrigation is vital for effective use of water resources for crop production. Improper irrigation management practices not only waste expensive and scarce water resources but also decrease crop yield, quality, water use efficiency and economic return as well as leading to water logging and salinity, which can be partly corrected by expensive drainage system.

The meteorological approach of scheduling irrigation is relating the evapotranspiration from crop to evaporation from an open pan, as it is well known that the rate of evapotranspiration is related to open pan evaporation. The meteorological approach such as pan evaporation replenishment, cumulative pan evaporation and ratio between irrigation water and cumulative pan evaporation for scheduling have been used by many researchers as it is easy for farmers to use and is adoptable (Imtiyaz *et al.* 2000 a, b, d, e; Imtiyaz *et al.* 2002).

The drip irrigation method with its ability to apply small but frequent water application, has been found superior in terms of water economy, yield, quality and water use efficiency. (Theodore, 1980; Srivastava *et al.*1994; Fekadu and Teshome, 1998; Imtiyaz *et al.* 2000d). The drip irrigation system is beneficial in terms of yield and water economy. The irrigation water requirements with the drip systems are less than that of traditional irrigation methods, primarily because irrigating a smaller portion of the soil volume results in decreased surface evaporation, reduced irrigation runoff from the field and controlled deep

percolation losses below the crop root zone. The drip system reduces the salinity hazards to plants as high frequency irrigation dilutes the soil solutions' salt concentration. It protects the plants from leaf burn as it applies water directly to the root zone without touching the leaves. It also makes possible the application of fertilizers and other chemicals along with water application to match the plants' requirements at various growth stages. The drip irrigation system impedes the growth of weeds as it wets only a fraction of the soil surface. This irrigation system can also be automated thereby reducing the labour requirements and making the irrigation water application cheaper than the conventional irrigation systems.

Materials and Methods

A field experiment was conducted during the winter crop growing seasons of 2003 to 2004, in order to study the effect of different irrigation schedules on marketable yield, irrigation production efficiency and economic return of cabbage. The climate in this part of the country has been classified as semi arid with cold winters and hot summers. The soil in the experimental field was clay loam (35.5% sand, 25.8% silt and 38.6 % clay). The soil moisture content at field capacity (-1/3bar) and wilting point (-15 bar) was 19.5% and 9.1% on an oven dry weight basis respectively. The average bulk density of the soil was 1.31 g/cm^3. The plant available soil moisture was 136.2mm/m.

The experiment was laid out in a single factor randomized block design with three replications. The experiment comprised of four treatments under each irrigation scheduling methods. The area of each experimental plot was 5m^2 (2.5m x 2m). The plant to plant and row to row spacing was 0.5m x 0.5m. A buffer zone spacing of 1m was provided between the plots. The seeds of Cabbage (F_1 Hybrid Var. Manisha) were sown at a depth of 0.05m with a spacing of 10cm between the plant rows. The total area of seedbed was 9m^2. The seedbed was irrigated regularly and covered with dry straw of 6 cm thickness and treated with chlorotox in order to facilitate emergence.

The experimental field was ploughed, pulverized and levelled to provide good tilth. After the land preparation, the experimental plots were given 67 kg/ha N, 94.3 kg/ha P_2O_5 and 62.5 kg/ha K_2O as a basal dose. Cabbage (hybrid var. Manisha F1) seedlings were transplanted on 20th December, 2003. The crop received 67 kg/ha N after 5 and 9 week of planting.

The experiments consisted of four irrigation levels under each irrigation scheduling method.

Method of Irrigation Schedules

Irrigation Levels:

0.5 ETp -Irrigation at 50% of Potential evapotranspiration replenishment

1.0 ETp -Irrigation at 100% of Potential evapotranspiration replenishment

1.5 Etp -Irrigation at 150% of Potential evapotranspiration replenishment

2.0 ETp -Irrigation at 200% of Potential evapotranspiration replenishment

The daily mean evaporation data from USWB class A open pan for a period of 5 years (2000-2003) were collected. The daily mean potential evapotranspiration estimated by Modified Penman model was taken from the Department of Soil, Water, Land Engg. and Management, Allahabad, Agricultural Institute Deemed University for the period of five years. ETp replenishment the crop was irrigated when the sum of the daily mean of pan evaporation potential evapotrenspiration respectively reached approximately to the pre-determined value of 16.3mm (rooting depth in mm x plant available soil moisture in mm/m x readily available soil moisture in fraction).

The crop was irrigated by the drip irrigation method. The drip irrigation system was designed and installed to meet the objectives of proposed research work. PVC pipes of 50mm and polyethylene pipes (LDPE) of 12 mm were used for main, sub-main and lateral lines respectively. Plants were watered by an individual four liters per hour online drippers. A control valve was connected to each experimental plot in order to deliver the desired amount of water. The sub-main line was connected to a water meter and a control valve in order to monitor the amount of water application in respective treatments. The screen filter was installed on the main line to minimize dripper blockage. Standard cultural practices were adopted during the crop-growing season. At the harvest, yield and yield components of cabbage were determined.

In order to assess the economic viability of drip irrigation system, both fixed and operating costs were included. Total cost of production, gross return, net return and benefit cost ratio were estimated on the following assumptions.

Salvage value	= 0
Useful life of Tube-well, pump, motor and pump house	= 25 years
Useful life of drip irrigation system	= 8 years
Useful life of weeding and spraying equipment	= 7 years
Interest rate	= 14 %
Repair and maintenance	= 7.5 % of fixed cost
No. of crops per year	= 2

The fixed cost including water development (tube-well, motor, pump, pump house and other accessories), irrigation systems (PVC and LDPE pipe for main, sub-main and laterals, filter, fertilizer unit, pressure gauges, control valves, water meter, drippers, and other accessories) and spraying and weeding equipments were calculated by the following approach (James and Lee, 1971).

$$CRF = \frac{i(1+i)^n}{(1+i)^n-1} \quad (1)$$

Where,

CRF = Capital recovery factor,

i = Interest rate, fraction

N = Useful life of the component, years

Annual fixed cost/ha = CRF x fixed cost /ha (2)

$$\text{Annual fixed cost/ha/season} = \frac{\text{Annual fixed cost /ha}}{2} \quad (3)$$

The operating cost including labour (system installation, irrigation, planting, weeding, cultivation, fertilizer and chemical application and harvesting and packaging etc.), land preparation, land rent, fertilizers, chemicals, water pumping and repair and maintenance (tube-well, pump, electric motor, pump house, irrigation systems etc.) were estimated. The gross return was calculated taking into consideration the marketable yield and current wholesale price of cabbage. Subsequently, the net return for cabbage was calculated considering total cost of production (fixed and operating) and gross return.

Net return (Rs/ha) = Gross return (Rs/ha) — Total cost of production (Rs/ha) (4)

The benefit cost ratio (B/C) was calculated as follows:

$$B/C = \frac{\text{Gross return (Rs/ha)}}{\text{Total cost of production (Rs/ha)}} \quad (5)$$

Results and Discussion

Yield and Irrigation production efficiency

The irrigation levels significantly influenced the marketable yield of cabbage (Table 1). The marketable yield for different irrigation levels ranged from 56.42 to 88.43 tonnes per hectare. Irrigation at 150% of potential evapotranspiration replenishment resulted in significantly higher marketable yield (88.43 t/ha) due to considerably higher number of heads/m^2 and head weight. A further increase in irrigation level resulting from 200% of potential evapotranspiration replenishment reduced the marketable yield (84.37 t/ha) due to significant reduction in number of heads/m^2 and mean head weight. Significantly minimum mean marketable yield (56.42 t/ha) was recorded when irrigation during the crop growing season was applied at 50% of potential evapotranspiration replenishment due to severe reduction in number of heads/m^2 and mean head weight. The irrigation schedules had significant effect on irrigation production efficiency of cabbage. The irrigation production efficiency decreased significantly with the increase in irrigation levels because increase in yield was less as compared with the seasonal water application. Significantly higher irrigation production efficiency (42.10 kg /m^3) was recorded when irrigation during the crop growing season was applied at 50% of potential evapotranspiration replenishment because reduction in yield was considerably low as compared with seasonal water application. Significantly minimum irrigation production efficiency (15.74 kg/m^3) was recorded when irrigation during the crop growing season was applied at 200 % of potential evapotranspiration replenishment because it increased the seasonal water application considerably but reduced the marketable yield (see table 1).

Applied water–yield relationship

The relationship between seasonal water applied and marketable yield of cabbage is shown in Fig 1. The seasonal water applied ranged from 134 to 536, whereas the marketable yield ranged from 56.42 to 88.43t/ha. The seasonal water applied and marketable yield of cabbage exhibited a strong quadratic relationship (R^2=0.9847). The marketable yield of cabbage increased with an increase in seasonal water application up to approximately 482mm and thereafter yield tended to decline.

Table 1: Effect of potential evapotranspiration replenishment on marketable yield and irrigation production efficiency of cabbage

Treatments (Potential evapotranspiration replenishment,%)	Seasonal water applied (mm)	Mean marketable yield (t/ha)	Mean irrigation production efficiency (kg/m³)
50	134	56.42	42.10
100	268	75.65	28.23
150	402	88.43	21.99
200	536	84.37	15.74
C D (0.05)	–	2.20	0.82

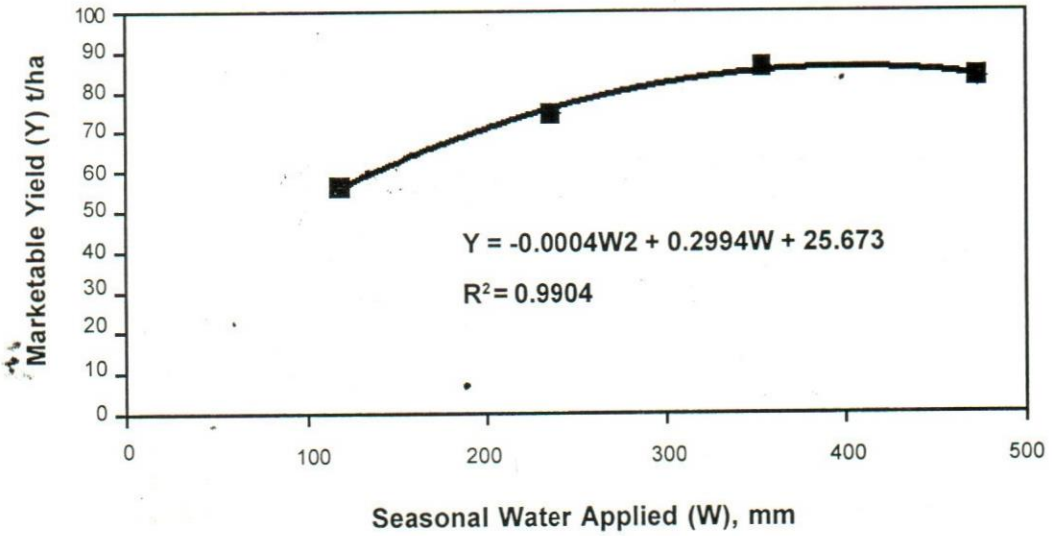

Fig. 1. Relationship between Seasonal water applied and marketable yield of cabbage under pan evaporation replenishment (EP) irrigation scheduling method

The results revealed that higher seasonal water application beyond the above mentioned value did not increase evapotranspiration as well as marketable yield, but it increased the deep percolation. The quadratic yield–water applied relationship resulted from nutrients leaching through deep percolation and poor soil aeration.

Economic return

The total cost of production for cabbage at different irrigation levels are presented in Table 2. The total cost of production (fixed and operating cost) in potential evapotranspiration replenishment (irrigation levels), because the pumping cost (which includes diesel and oil)

Table 2: Economic analysis of cabbage under different irrigation levels

Treatments (%)	Total cost of production(Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit cost ratio (B/C)
0.5 ETp	72692	141041	68157	1.93
1.0 ETp	74108	189133	114641	2.54
1.5 ETp	75560	221058	144958	2.90
2.0 ETp	76952	210916	133208	2.71

was insignificant as compared to other expenses. The labour cost to perform major farm activities was 27.03 percent of total expenditure. The fixed costs and costs for repairs and maintenance were 36.12 percent and 2.56, respectively of the total costs.

The total cost of production for different irrigation levels ranged from 72884 to 77708 Rs./ha. The total cost of production increased slightly with an increase in irrigation levels due to the small contribution of pumping cost in total cost of production. The gross return for different irrigation levels ranged from 141041 to 221058 Rs/ha. The gross return (221058 Rs/ha) was maximum when irrigation during the crop growing season was applied at 150% of potential evapotranspiration replenishment due to significantly higher marketable yield. A further increase in irrigation level resulting from 200% of potential evapotranspiration replenishment reduced the gross return (210916 Rs./ha) considerably due to significant reduction in marketable yield. The net return increased considerably with an increase in irrigation level up to 150% of potential evapotranspiration replenishment due to significant increase in gross return. The maximum net return (144958Rs./ha) was obtained when irrigation during the crop growing season was applied at 150% of potential evapotranspiration replenishment due to significant increase in gross return. A further increase in irrigation level resulting from 200% of potential evapotranspiration replenishment reduced the net return considerably because it increased the total cost of production but reduced the gross return. The benefit-cost ratio also increased with an increase in irrigation levels up to 150% of potential evapotranspiration replenishment. The benefit-cost ratio (2.90) was maximum with irrigation at 150% of potential evapotranspiration replenishment due to higher increase in gross return as compared with total cost of production. A further increase in irrigation level resulting from 200% of potential evapotranspiration replenishment reduced the benefit cost ratio (2.71) considerably because it decreased the gross return but increased the total cost of production.

Relation between Water Applied, Gross Return, Net Return and Benefit-Cost Ratio

The relationship between seasonal water applied and gross return of cabbage under potential evapotranspiration replenishment irrigation scheduling method is presented in Fig 2. The gross return for different irrigation levels ranged from 141041 to 210918 Rs/ha. The seasonal water applied and gross return of cabbage exhibited a strong quadratic relationship (R^2 =0.9847). The gross return increased with an increase in seasonal water applied up to 446mm and thereafter gross return tended to decline.

The relationship between seasonal water applied and net return of cabbage under potential evapotranspiration replenishment irrigation scheduling method is presented in Fig 3. The net return increased from 68157 to 133208 Rs/ha. The seasonal water applied and net return of cabbage exhibited a strong quadratic relationship (R^2 =0.9831). The maximum net return was obtained at seasonal water application of 438mm and thereafter it tended to decline (Fig 3).

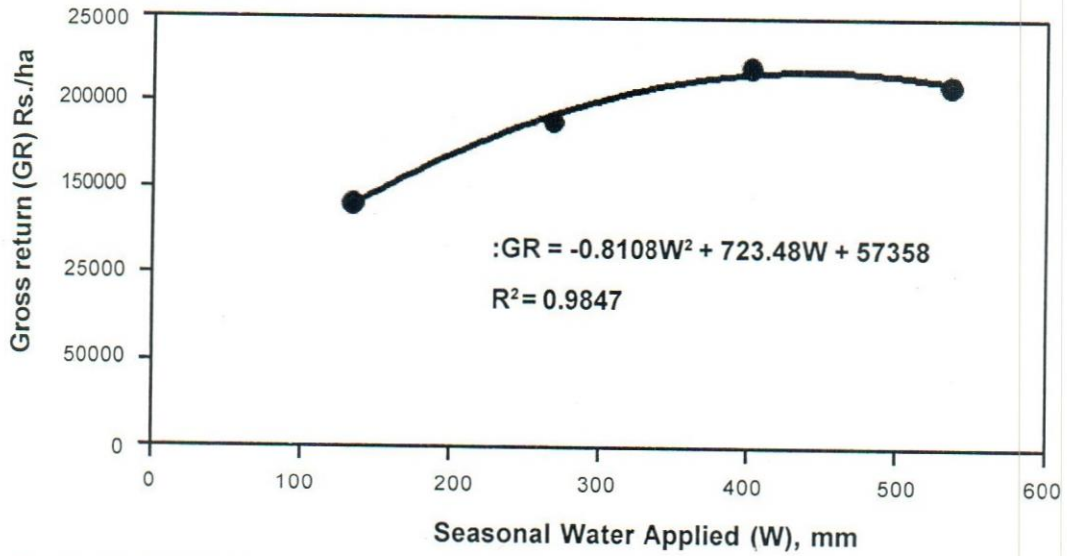

Fig. 2. Relationship between Seasonal water applied and gross return of cabbage under potential evaptranspiration replenishment (ETp) irrigation scheduling method

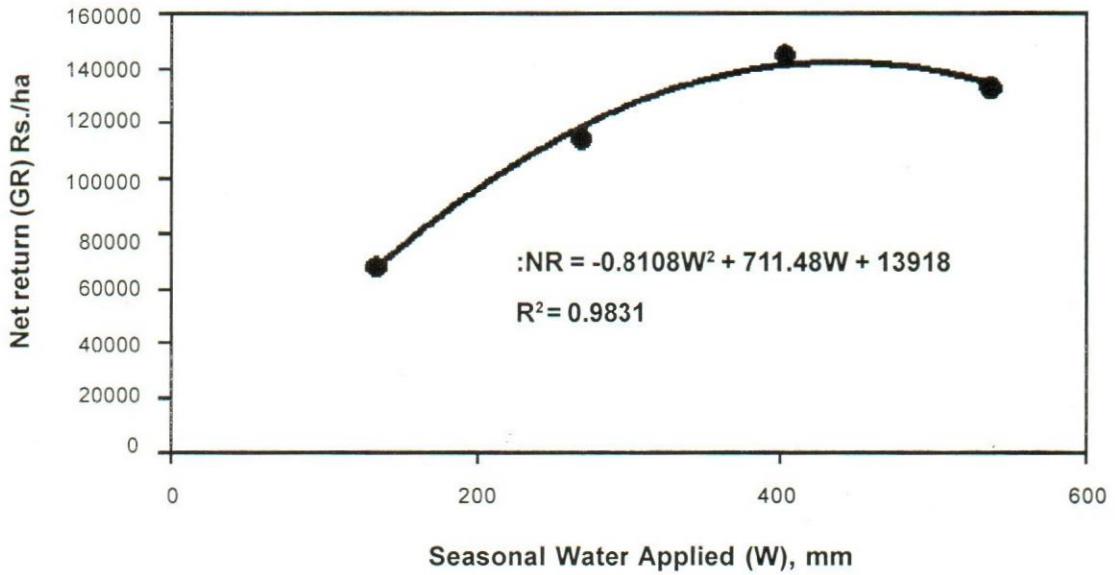

Fig. 3. Relationship between Seasonal water applied and net return of cabbage under potential evaptranspiration replenishment (ETp) irrigation scheduling method

The relationship between seasonal water applied and benefit-cost ratio of cabbage under potential evapotranspiration replenishment irrigation scheduling method is presented in Fig 4. The benefit-cost ratio ranged from 1.93 to 2.71. The seasonal water applied and benefit-cost ratio exhibit a strong quadratic relationship (R^2 =0.9842). The benefit-cost ratio increased with an increase in seasonal water application up to 475mm and thereafter it tended to decline (Fig 4).

Conclusions

The experimental result show that irrigation at 150% pan evaporation replenishment gave higher yield, gross return, net return and benefit-cost ratio of cabbage, but

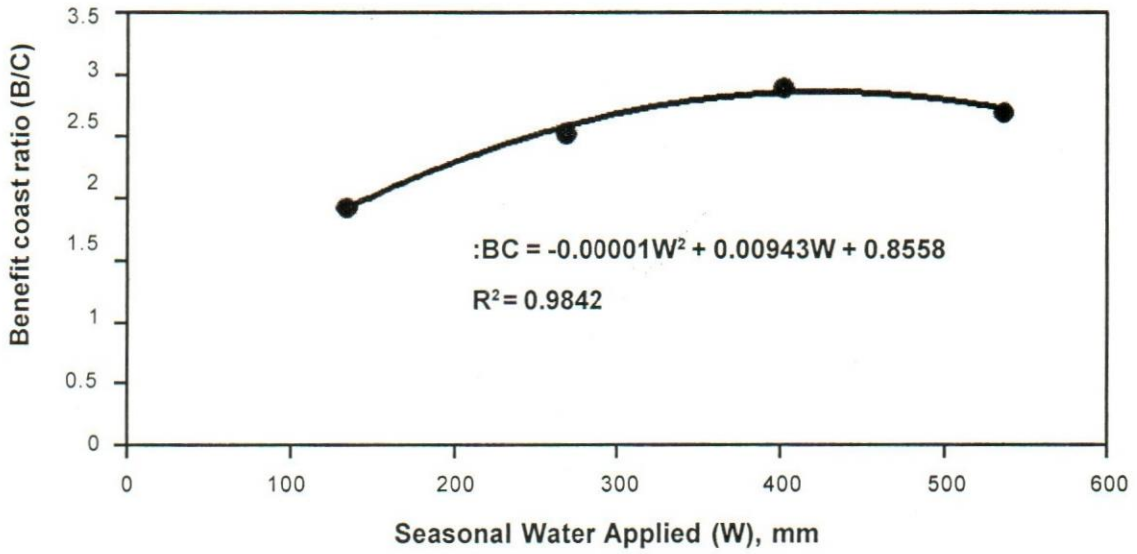

Fig. 4. Relationship between seasonal water applied and benefit coast ratio of cabbage under potential evaptanspiration replenishment (ETp) irrigation scheduling method

irrigation production efficiency was higher at 50% of potential evapotranspiration replenishment. The potential evapotranspiration replenishment irrigation scheduling approach gave higher yield, irrigation production efficiency and economic return of cabbage. The seasonal water applied and yield of cabbage under different irrigation scheduling methods exhibited strong quadratic relationship, which can be used for optimizing marketable yield of cabbage under limited water supply conditions. The seasonal water applied and gross return, net return and benefit-cost ratio exhibited strong quadratic relationship which in turn can be used for optimizing economic return under variable water supply condition.

Finally the overall results revealed that potential evapotranspiration replenishment irrigation scheduling approach was superior in terms of marketable yield, irrigation production efficiency and economic return. Furthermore, the drip irrigation system is economical for cabbage production in the Allahabad region.

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It is very simple to be happy, but it is very difficult to be simple.

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—Rabindranath Tagore

Knowledge and Adoption of Integrated Pest Management Practices among Tomato Growers

Venkata Shiva Reddy, A Bheemappa and C Sukanya

The study was conducted to assess the extent of knowledge and adoption of IMP practices in tomato crop of Gadag district in Karnataka. It was observed that majority of tomato growers had medium level of knowledge (66.67%) and could be placed in the medium category of adoption (63.33%). All the selected entrepreneurial characteristics viz., innovativeness, farm decision making, achievement motivation, risk taking ability etc. were positively and significantly related with the adoption of IPM practices.

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India ranks second in the world in the cultivation of vegetables. Vegetables, being rich in minerals and nutritional value, are grown in almost all states in the country under varied agro-climatic and soil conditions in plains as well as hilly regions. At present, India produces about 70 different varieties of leafy, fruity and starchy tuber varieties of vegetables, all of which are an important source of income for the small and marginal farmers in the country.

In the recent past, efforts have been made to increase the production of vegetables by developing suitable high yielding varieties and hybrids and by improving cultivation practices.

In order to control pests and diseases farmers resort to using chemical pesticides indiscriminately, thus leading to a resurgence of pests, destruction of natural enemies, and beneficial insects, besides reduction in fruit quality manifested as scaring, tissue destruction, aberrations in shape and colour of produce, and residual effect of pesticides in the produce.

It is the integrated pest management (IPM) approach which has been globally accepted for achieving sustainability in horticulture, with the advantages of safety to environment, low input-based production and pesticide-free food commodities. Hence, with the intention of supporting empirical results the present investigation was designed with the objectives of measuring the extent of knowledge and adoption of integrated pest management practices in tomato crop and to assess the study the relationship of entrepreneurial characteristics with the adoption of IPM practices and cost and returns of the IPM method.

METHODOLOGY

The study was conducted during 2005-06 in two taluks of Gadag district in Karnataka state. Based on maximum area under vegetable cultivation four villages each were selected from Gadag and Shirahatti taluk. From each village 15 farmers were selected by the random sampling procedure to constitute a sample size of 120 for the study.

The knowledge and adoption of IPM practices in tomato crop were the dependent variables selected for the study. The independent variables were carefully considered better through discussion with experts and a review of relevant research results. Entrepreneurial characteristics were included to study their relationship with adoption of IPM practices. Lastly, the economics of the IPM method was determined as a comparison to the the chemical method of plant protection. The suitable and appropriate measuring devices were employed to quantify the variables. Later the data were analysed by using frequencies, percentages and simple correlation.

RESULT AND DISCUSSION

Extent of knowledge of recommended IPM practices in tomato crop.

The results in table 1 reveal that cent per cent of the farmers possessed correct knowledge about summer ploughing, followed by practices of marigold as trap crop

Table 1: Extent of knowledge level of recommended IPM practices in Tomato crop (n=120)

Sl. No.	Practices	Possession of Correct knowledge among tomato growers	
		Frequency	Percentage
1.	**Cultural practices**		
	a. Summer ploughing	120	100
	b. Trap crop (marigold)	110	91.67
	c. Crop rotation	109	90.83
	d. Trimming of field bunds	100	83.33
2.	**Mechanical practices**		
	a. Use of mesh nylon net	90	75.00
	b. Use of pheromone trap	76	63.33
	c. Number of pheromone traps required per acre	31	25.83
	d. Distance between two traps	23	19.17
	e. Regular destruction of damaged fruits at each harvest	120	100
	f. Regular destruction of infected flowers of trap crop	103	85.83
3.	**Biological practices**		
	a. Use of NSKE	99	82.50
	b. Quantity of NSK required for one acre	92	76.67
	c. Volume of water to be mixed with NSKE for one acre	91	75.83
	d. Ratio of soap detergent powder to be mixed with NSKE	83	69.17
	e. Benefits of spraying NSKE	96	80.00
	f. Use of NPV	46	38.33
	g. Quantity of NPV required per acre	45	37.50
	h. Time of NPV to be sprayed in field	42	35.00
	i. Stage of the insect pest that can be controlled by the NPV spray	41	34.17
	j. Use of Trichoderma sp.	44	36.66
4.	**Chemical control**		
	I. Number of recommended chemical sprays	105	87.50
	a. Control of fruit borer	99	82.50
	b. Control of tomato leaf minor	33	27.50
	c. Control of leaf eating caterpillars	94	78.33
	d. Control of early blight	54	45.00
	e. Control of leaf curl disease	56	46.67
	f. Control of powdery mildew	42	35.00

(91.67%), crop rotation with cereals and pulses (90.83%) and trimming of field bunds (83.33%). The low cost of these practices and their simplicity to practice might be the reasons for the majority of the respondents to possess the recommended knowledge about cultural practices.

In the mechanical control measures, all the respondents had knowledge about regular destruction of damaged fruits at each harvest. Similarly a high per cent possessed the knowledge of regular destruction of infected flowers of trap crop (85.83%), using nylon mesh net (75.00%) and tieing pheromone trap (63.33%). But the knowledge about the recommended number of pheromone traps and keeping recommended distance between two pheromone traps was noticed with only 25.83 and 19.17 per cent respectively. The situation reveals that farmers were not bothered with following the practices as recommended. This may be due to a lack of skill training and non-supervision of practices and also due to a lack & conviction in the practices.

Among biological control measures, a high per cent (82.50%) of farmers had the correct knowledge about the use of NSKE and the benefits of the spraying neem seed kernel extracts (80.00%). Similarly the knowledge of using recommended neem seed kernel (kgs) and volume of water to be mixed with NSKE to spray in one acre and the ratio of soap detergent powder to be mixed with NSKE was noticed with 76.67m 75.83 and 69.17 per cent of farmers respectively. This reveals that farmers were inclined towards the use of NSKE, since the practice is in use with farmers as a best alternative to control pests when the chemicals failed to give desired results. Regarding use of NPV a less percentage (38.33%) of farmers had knowledge of using NPV, followed by quantity of NPV required per acre (37.50%), time of NPV to be sprayed in field (35.00%) and stage of the insect pest that can be controlled by the NPV spray (34.17%). Similarly the use of Trichoderma sp. was known to 36.66 per cent of farmers. This shows that farmers were very much lacking the knowledge about NPV application and this may be due to lack of conviction, non-availability of NPV, NSKE and bio-agents as the constraints expressed by them. Lack of technical knowledge, practical application and guidance about IPM practices might be the other reason. The complexity to practice bio-agents and fear of decline in the yield may also the other reasons which might have favoured the situation.

With regard to chemical control measures the majority (87.50%) of farmers had knowledge of the recommended number of chemical sprays, application of recommended pesticide concentration to control fruit borer (82.50%) and leaf eating caterpillar (78.33%). The use of recommended fungicide concentration for the control of leaf curl diseases and early blight was noticed with 46.67 and 45.00 per cent, respectively. This shows that farmers were possessing better knowledge about control of insect pests than the disease. This may be due to the inability of farmers to diagnose the diseases. On the contrary the routine pests attack with other crops might have favoured the situation. It is logical to conclude that the practices which are complex and difficult to remember are moderately known to farmers, while the practices which are simple and being practiced by their forefathers are known to a maximum extent. The findings were in conformity with the research results of Bhairamkar *et al.* (1998).

Extend of adoption of recommended IPM practices in tomato crop

Table 2 indicates that data on the extent of adoption of various IPM practices by tomato growers shows that all the farmers had adopted summer ploughing, followed by crop rotation with cereals (88.33%) and growing marigold as a trap crop (80.00%), whereas a smaller percentage of farmers were practicing trimming of field bunds (36.67%) and raising nursery beds (19.17%). This shows that farmers might have be aware of the consequence of leaving the field bund not trimmed and flat nursery beds. On the other side high adoption of other cultural practices might be due to the past experience.

In case of mechanical control measures, cent per cent of farmers were found to practice regular destruction of damaged fruits at each harvest, followed by regular destruction of infected flowers of trap crop (75.83%). Erecting mesh-nylon nets and pheromone traps was noticed among only 38.33 and 30.00 per cent of farmers respectively. The possible reason might be lack of scientific information and skill training about IPM practices.

With regard to biological control measures, a high percentage of farmers (86.67%) were growing pulses on the bunds to build up natural enemy fauna. On the other hand spraying of NSKE was noticed among 45.83 per cent of respondents. Similarly a less percentage of farmers were practicing NPV (30.00%) and release of *Trichoderma* sp. (27.50). It is quite obvious that the bio-control techniques are innovative practices and that tomato growers might lack the scientific knowledge about their use. Above all, non-availability of biocontrol agents as expressed by respondents might be the plausible reason for lesser adoption.

In the adoption of chemical control measures, around seventy per cent farmers (71.66%) were found to practice the recommended number of chemical sprayings. In the use of chemical concentration, more respondents were correctly applying for controlling fruit borer (68.33%) and leaf eating caterpillars (60.00%). A less percentage of

Table 2: Extent of adoption of recommended IPM practices in Tomato crop (n=120)

Sl. No.	Practices	Number of respondent noticed in		
		FA	PA	NA
1.	**Cultural practices**			
	a. Summer ploughing	120 (100)	-	-
	b. Trap crop (marigold)	96 (80.00)	-	24 (20.00)
	c. Crop rotation	106 (88.33)	-	14 (11.70)
	d. Raised nursery bed	23 (19.17)	-	97 (80.80)
	e. Trimming of field bunds	44 (36.67)	-	76 (63.33)
2.	**Mechanical practices**			
	a. Use of mesh nylon net	46 (38.33)	-	74 (61.70)
	b. Use of pheromone trap	36 (30.00)	-	84 (70.00)
	c. Regular destruction of damaged fruits at each harvest	120 (100)	-	-
	d. Regular destruction of infected flowers of trap crop	91 (75.83)		29 (24.16)
3.	**Biological practices**			
	a. Spraying of NSKE	55 (45.83)	34 (28.33)	31 (25.80)
	b. NPV spray	36 (30.00)	-	84 (70.00)
	c. Release of Trichoderma sp.	33 (27.50)	-	87 (72.50)
	d. Growing of pulse crop on the bunds to buildup natural enemy fauna	104 (86.67)	-	16 (13.33)
4.	**Chemical control**			
	I. Number of recommended sprays of chemicals	86 (71.66)	34 (28.33)	-
	a. Control of fruit borer	82 (68.33)	36 (30.00)	2 (1.67)
	b. Control of tomato leaf minor	25 (20.83)	91 (75.83)	4 (3.33)
	c. Control of leaf eating caterpillars	72 (60.00)	40 (33.33)	8 (6.67)
	d. Control of early blight	52 (43.33)	64 (53.33)	4 (3.33)
	e. Control of leaf curl disease	30 (25.00)	84 (70.09)	6 (5.00)
	f. Control of powdery mildew	42 (35.00)	74 (61.67)	14 (11.67)

Note: FA – Full adoption, PA-Partial adoption, NA-Non adoption,
* Figures in parentheses indicate percentages

respondents had adopted recommended concentration for early blight (43.33%) and powdery mildew control (35.00%). Thus the results clearly indicated that majority of the tomato growers practiced recommended chemical measures for controlling pests, rather than taking measures to control the disease. This might be due to lack of knowledge among the respondents to identify the disease, wherein the farmers need to be trained to facilitate large-scale adoption of plant protection measures. These findings were in contradiction to the results reported by Sumathi and Alagason (1998).

Socio-economic and entrepreneurial characteristics of the respondents

Table 3 reveals that results of correlation analysis for the selected entrepreneurial characteristics of tomato growers with their adoption level of IPM practices shows that the adoption of IPM practices in tomato crop was positively and significantly correlated at 1% level of significance with innovativeness, farm decision making, achievement motivation, risk taking ability information and seeking behaviour. The innovativeness was the interest and desire among the respondents to seek changes in the existing farming systems while favouring better adoption of new technologies (Suresh, 2004).

Table 3: Correlation coefficient between entrepreneurial behaviour and adoption level of IPM practices in tomato crop

(n=120)

Sl. No.	Independent variables	Karl Pearson's 'r' value
1.	Innovativeness	0.252**
2.	Farm Decision making	0.361**
3.	Achievement motivation	0.367**
4.	Risk taking ability	0.249**
5.	Information seeking behaviour	0.290**
6.	Cosmopoliteness	0.268**

Note: NS means non-significant, *Significant at 5% level & ** Significant at 1% level

Decision-making is the selection of best possible alternatives from among available alternatives, which is mainly dependent on information possessed by the individual. The contribution of farm decision-making ability in taking the right decision at the right time is the secret of success in any field. A farmer with rational decision-making will have high chance of success through effective utilization of available resources (Suresh Kumar, 1997). The achievement motivation is an excellence or perfection in what one does is determining the achievement motivation and to achieve this destination one needs to take adequate and meticulous care to achieve success in maximizing and sustaining yield and income (Chandrapaul, 1998). Risk taking ability might be due to the fact that it is the perceived risk in adopting a practice and perception of what chances and uncontrollable factors affect the successful adoption of new enterprises.

It is the timely guidance and anticipated high profits which might have influenced tomato growers to take risks in adopting the IPM practices. Information seeking behaviour might be due to the fact that a person, by gathering accurate information through various information sources and the opportunity of acting at the right time in adopting improved technologies, can take relative advantage of the information (Shashidhara, 2003). Cosmopoliteness plays an important role in adoption behaviour by broadening the mental horizons of farmers, information seeking behaviour and ultimately motivating farmers to adopt (Anitha, 2004).

IMPLICATIONS AND RECOMMENDATIONS

Based on the findings of the present study the implications are:-

1. Majority of respondents possessed medium level of knowledge about IPM practices, hence it is of utmost importance to design more skill trainings, demonstrations and exposure visits by the development departments, central and state plant protection training centers to convince farmers about the IPM method for higher diffusion of IPM technology.
2. The positive and significant relationship of selected entrepreneurial characteristics viz., innovativeness, farm decision making, achievement motivation, risk taking ability, information seeking behaviour and cosmopoliteness and adoption of the IPM method must be considered in creating a favourable situation and build the capacity of farmers to accept and adopt IPM technology on a large scale.
3. The constraints of non-availability of the IPM package and other required IPM inputs bring to focus that concerned input agencies and dvelopment departments should plan for arranging availability of the required inputs at affordable prices at the required time to promote complete adoption of IPM technology.

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Imagination is the beginning of creation. You imagine what you desire, you will what you imagine and at last you create what you will.

—George Bernard Shaw

Seasonal Scarcity of Water and the Change in Energy Use Pattern in *robusta* Coffee Plantation – A Study in Kodagu

Reshma Chengappa, S Indumati & H Jayaram

Kodagu, the coffee bowl of India, which is endowed with water sumptuousness, is experiencing acute seasonal scarcity of water. This scarcity is reflected in the robusta coffee production, the mainstay of the economy of Kodagu. Higher investment to cope with this seasonal scarcity of water through the adoption of sprinkler irrigation as an alternative measure during the critical growth period of robusta coffee, has led to substantial increase in the demand for commercial energy.

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Kodagu is one of the 27 districts of Karnataka, which is known for its geographical and natural beauty and its coffee plantation. The district accommodates a luxurious landscape with lush green vegetation, picturesque deep cultivated green paddy fields amidst hillocks, evergreen forests and coffee, orange and cardamom plantations. Though its physical features are varied the southern, western and north-western portions are intersected by hill ranges and forests which are subjected to heavy rainfall.

Kodagu has always been considered a water sumptuous district. Of the 14 heavy rainfall stations in India, with an annual rainfall of more than 5000 millimetres four are in Karnataka. Of these, except Agumbe in Shimoga district, the remaining three places viz. Bhagamandala (6032 mm), Pullingoth (5941 mm) and Makutta (5054 mm) are in Kodagu district. Kodagu receives major part of rainfall from South West and North East Monsoons, in the months of June to September and October to December respectively. There is some amount of rainfall in the other two seasons of winter and summer also, which determines the fortunes of the people of Kodagu. But it is a paradox that. Kodagu is experiencing acute seasonal water scarcity, threatening the food security and sustainability of the ecologically fragile area. This is due to several economic and environmental pressures competing for the extraction of natural resources, including water.

Cultivation of coffee is the mainstay of the economy of Kodagu. Water is the prerequisite for raising *robusta* coffee plantation, since the crop yield is determined by the 50 mm of blossoms and 25 mm of backup shower it receives during the critical growth period in the months of late February and March. This quantum of rainfall is necessary to stimulate flowering in *robusta* coffee plants when the flower buds are fully formed (forwarded spikes) in the month of February. During this period when the

spikes appear, 50 mm of blossom shower is very much required to wash away the thick and firm wax from the coffee spikes to enable the blossom. If the rainfall is scanty, the spikes start pudding or shaking off. After the blossom shower, the spikes blooms on the 9th day followed by the cross pollination by the insects (unlike the air pollination in arabica variety of coffee). From the day of the blossom showers, exactly after 15 to 20 days, 25 mm of rainfall is required as backing for the flowers to set as coffee berries, without which the flowers dry up. Thus, these two showers determine the crop yield for the following year and rest of the farm activities like weeding, application of manure and fertilizers, pruning harvesting etc. This will have direct bearing on the income and employment generation in the economy. Hence these two phases are considered as the critical growth period of robusta coffee.

For the last 30 years, this requirement of water during critical growth period, which was otherwise rainfed, has failed. The unavailability of required continuous rainfall of 50 mm in February for blossom and 25 mm in March for backing reflects the degree of seasonal scarcity of water. In such cases, providing irrigation through sprinkler for 15 to 20 days during February and March becomes inevitable. Hence, coffee planters resort to sprinkler irrigation as a mechanism to cope with the seasonal scarcity of water (coping mechanism). About 70 mm irrigation would be sufficient to overcome the drought. Sprinkler irrigation is thus in practice as an assurance against failure of blossom showers or backup showers.

This marked the beginning of intensive investment on water, its storage, transportation etc., which led to the economic scarcity of water (when extra cost is incurred to make good the unavailability of water). The degree of economic scarcity of water is reflected by the magnitude of investment on coping strategies. Investment incurred on construction of farm ponds in the paddy fields to store water for sprinkling, rigging borewells, wells and deepening wells reflect the economic access to water.

The scarcity of water has also led to the increase in the consumption of energy. Going by the additional need for higher productivity, and bringing additional area under cultivation, it is inevitable that the share of energy use would increase further considerably. Investment on the purchase of sprinkler sets (jets), pump sets, conveyance pipes and accessories are the subsidiary cost incurred to adopt coping mechanism i.e. sprinkler irrigation. If these are the fixed costs for the structures and equipments which are put to use only for 15 days in a year, a huge sum of operation and maintenance cost is incurred in the form of buying water (Rs. 100 to Rs. 150 per hour), hiring sprinkler set (Rs. 1800 per shift of 8 hours covering 0.75 acres in regular jet), diesel to run the pump set (4 litre for 1 hour = 48 litre per 0.75 acres for 70mm of shower), repair charges of the machines and additional human labour (2 man days per shift of 8 hours) to adopt sprinkler irrigation continuously, are considered as variable cost of investment on coping strategy which is recurring (incurred every year). All these fixed and variable costs on coping strategies led to the increase in energy use patterns in the *robusta* coffee plantation.

Methodology

Kodagu receives a normal average annual rainfall of 2718.2 mm. But the actual average annual rainfall has varied from 3992.8 mm in 1961 to 1958.3 mm in 2003. Though the quantity of rainfall in the district has reduced drastically, it is much higher when compared to the other districts of Karnataka. The rainfall runoff contributes to the flow of historical rivers like Cauvery, Hemavathi, Lakshmanathirtha, Barapole, Kumaradhara and their tributaries in the district, which are perennial and rainfed. The annual and the actual rainfall for the critical growth period of *robusta* coffee for the Madikeri and Virajpet taluks under which the present study was carried out, indicated that in the months of February and March it was much below the normal requirement of 50 mm and 25 mm respectively (Table 1).

Out of the three taluks of Kodagu district where *robusta* variety of coffee is being cultivated, the study was undertaken covering Madikeri and Virajpet taluks, as these had a major share of area under *robusta* coffee plantation. A primary data survey was conducted covering randomly selected 118 Planters in Medikeri and Virajpet (covering 8617 acres of *robusta* coffee plantation in the district of Kodagu).

The measurement of energy was done by expressing the equivalent energy unit in Mega Joules. Different forms of energy are equivalent and all can be expressed in same units. The energy equivalents (conversion factors) reported in this study are given by the Coordinating Cell of the All-India Coordinate Research Project on Energy Requirements in the Agricultural Sector (Devasenapathi et.al., 1991). They are used nationwide to convert various sources to energy.

Table 1: Normal and Actual Rainfall (mm) of the Study Area and the District During the Critical Growth Period of robusta coffee in February and March (1970 to 2003)

YEAR	TALUKS					
	MADIKERI			VIRAJPET		
	FEB	MAR	ANNUAL	FEB	MAR	ANNUAL
D.A*	5.3	19.3	2794	5.3	19.3	2794
NRF$	5.9	25	4397.4	5	17.6	2390.4
1970	Nil	53.8	3137.3	Nil	Nil	2733.4
1980	Nil	Nil	4152	Nil	28	3076
1990	Nil	Nil	3220	Nil	Nil	1985
1991	Nil	6	3352.7	Nil	22.8	2263.9
1992	Nil	Nil	4042.3	Nil	Nil	2788.9
1993	Nil	44.9	2698.4	Nil	Nil	1883.9
1994	Nil	Nil	4006.2	Nil	4.2	3096.2
1995	Nil	Nil	2902.8	Nil	Nil	1987.5
1996	Nil	1.1	3767.8	Nil	Nil	2185.5
1997	Nil	92.1	3452	Nil	35.8	2727
1998	Nil	4.6	3223.1	Nil	Nil	2376.4
1999	8.3	0.6	3135	26.4	Nil	2166
2000	1.6	2.6	3517	Nil	Nil	2180
2001	18.2	Nil	3113	41.2	Nil	1949
2002	2.5	Nil	2849.3	16.6	Nil	1809.6
2003	2.4	9.2	2753.6	30.6	19.4	1823.7

Note: Based on the average 1901-1970 (Indian Meteorological Department data) Kodagu
*D.A. is District (Kodagu) Average Rainfal (mm), which is calculated on the basis of data from 23 rain gauge stations of Kodagu and $NRF is Normal Rainfall (mm)
Source: Yearly District Statistical View of Kodagu, District Statistical Department, Zilla Panchayat, Kodagu (compiled)

Results and Discussion

The following energy equivalents were adopted to quantify the energy use pattern in *robusta* coffee in the study area (See Table 2).

Table 2: Energy Equivalents to quantify the energy use pattern in adopting coping mechanism in *robusta* coffee in Kodagu district.

Sl. No.	Source of Energy	Energy in Mega Joules(MJ)
1.	Electricity	11.93/kwh
2.	Diesel	56.31/litre
3.	Petrol	48.23/litre
4.	Tractor 32 HP	394.1/hour
5.	Draft power of one bullock	6.19/hour
6.	0.5 HP Motor	6.19/hour
7.	Nitrogen (N)	60.60/kg
8.	Phosphorous (P205)	11.10/kg
9.	Potash (K20)	6.70/kg
10.	Insecticide	140.75/litre
11.	Straw	12.50/kg
12.	Rice (paddy)	14.7/kg
13.	Farm Yard Manure*	(39.09/100kg) 0.39/kg
14.	Human Labour	1.96/hour
15.	Stalk (plant material)	18/kg
16.	Implements	62.70/kg

Note:* For the computation of energy units for Farm yard manure, the yard stick used is the content of N.P. and K status. It is reported that (Jayaram, et.al., 2002) the contents of Nitrogen in farm-yard manure ranges between 0.3 to 0.5%, phosphorous content ranged between 0.15 to 0.4% and potash to an extent of 0.3 to 0.5%. That is in every 100kgs of manure 500gms of N, 400gms of P205 and 500gms of K is found as nutrients. Hence, these quantities of NPK is converted to MJ which is equal to 30.30(N) + 4.44(P) + 3.35(K) = 38.09 MJ for 100 kgs of farm-yard manure. Therefore 1 kg of farm-yard manure = 0.39 MJ.

The energy requirement for the production of *robusta* coffee is calculated by applying the energy equivalents. Where there is no direct conversion factor, the cost is converted to Mega Joules in terms of diesel as, I litre diesel = 56.3 MJ = Rs. 24 (price at the time of calculation). Hence one rupee is equal to 2.35 MJ.

Robusta Coffee production is the main source of income to the economy of Kodagu. The economic scarcity of water is reflected by the degree of investment in the total production cost. This production cost is converted to the energy units in MJ with the conversion factors from Table 2. The energy required in the production of *robusta* coffee per acre per year is summarized in Table 3.

Table 3: Energy Used in the Production of *robusta* Coffee (per acre per year)

Sl. No.	Inputs Used	Units	QUANTITY			Energy Equivalent (MJ)	ENERGY UNITS (MJ)			PERCENTAGE TO THE TOTAL ENERGY		
			With coping strategy (n=37)	Without coping strategy (n=11)	TOTAL		With coping strategy (n=104)	Without coping strategy (n=14)	TOTAL	With coping strategy (n=104)	Without coping strategy (n=14)	TOTAL
1.	Apportioned cost on establishment of coffee plantation	Rs.	2486	2618	5104	2.35	5842.1	6152.3	11994	20.39	43.68	28.07
Operation and Maintenance of Plantation												
2.	Human Labour	Man hours	1037	576	1613	1.96	2032.52	1128.96	3161	7.1	8.02	7.4
3.	Manure	Kg	840	716.25	1556	0.39	327.6	279.34	607	1.14	1.98	1.42
4.	Fertilizer									(21.14)*	(28.93)*	(23.71)*
	Nitrogen	Kg	67.6	45.48	113	60.6	4096.56	27566.09	6853	14.3	19.57	16.04
	Phosphorous	Kg	54.08	36.4	90	11.1	600.29	404.04	1004	2.1	2.87	2.35
	Potash	Kg	202.8	136.44	339	6.7	1358.76	914.15	2273	4.74	6.49	5.32
5.	Interest on credit	Rs.	1174	1042	2216	2.35	2758.9	2448.7	5208	9.63	17.39	12.19
6.	Interest on fixed cost	Rs.	598.66	0	599	2.35	1406.85	0	1407	4.91	0	3.29
7.	Depreciation on Coping Strategy	Rs.	1324	0	1324	2.35	3111.4	0	3111	10.86	0	7.28
8.	**Operation cost of Coping Strategy**	Rs.	**3026.2**	0	3026	2.35	7111.57	0	7112	24.83 (40.60)**	0	16.64 (27.21)**
Total Energy Units		**MJ**					**28646.55**	**14083.57**	**42730**	**100**	**100**	**100**
Quantity of Production		**Kg**	**1850**	**850**	**2700**							
Gross Income		**Rs.**	**34097**	**15215**	**49312**							
Total area		**Acre**	**8313**	**304**	**8617**		**8313**	**304**	**8617**			
Energy required to generate one rupee income							**0.84**	**0.93**	**0.87**			

Note: *and** Figures in the parenthesis denote total percentage of fertilizers and coping strategy to the total energy units respectively.

In an attempt to study the level of resource use and the energy output relationships, water is found to be the most important source of energy in terms of contribution to total energy. Out of 8617 acres of *robusta* coffee plantation covered under the study 8313 acres have come under sprinkler irrigation (coping strategy). The production of *robusta* coffee is consuming 42730 Mega Joules to produce 2700 kgs of coffee cherry in one acre of plantation in a year. Coping strategy (i.e. the combined energy of sprinkler irrigation with its source of water, accessories, diesel and human labour to operate) is the major source of energy accounting for 27.21 per cent of energy followed by the fertilizers (23.71%), interest on credit (12.19%) and human labour (7.40%). In addition to this, share of energy used for the establishment of plantation includes energy of human labour as a major portion followed by fertilizers and plant material. Energy of human labour is used for clearing the vegetation, making 480 to 500 pits per acre, planting the seedlings, providing shade if necessary, weeding and manuring twice a year including replacing the withered plants. These operations are undertaken for 10 years, which is considered to be the establishment period as the plant starts bearing an average yield only after 10 years. Hence, the total establishment cost is spread out equally for 10 years. This apportioned cost on establishment of coffee accounted to 28.07 per cent of energy per acre per year. Since coping strategy constitutes a major share of 27.21 per cent of energy, water, which is an important input to *robusta* coffee plantation is no more the free gift of nature but has entered the economic scarcity because of investment on it.

This share of energy use has made way to use the rest of the energy, in terms of fertilizer and human labour. Because, if coping strategy is not adopted, the crop will fail due to lack of shower for blossom and backup. That leads to no further farm activities for the year and loss of income and employment is inevitable.

This analysis reflects that the energy requirement for the production of *robusta* coffee is 28646.55 MJ/acre/year with coping strategy and 14083.57 MJ/acre/year without coping strategy. 11630 extra units of energy (MJ) is used by the coping strategy to earn the extra sustainable gross income of Rs. 18882 (gross income with coping strategy Rs. 34097 minus Gross Income without coping strategy Rs. 15215). The increase in gross income is thus due to the additional energy used for coping strategy. The energy required to generate one rupee income (total energy/total income) was found to be 0.87 MJ.

According to the study, energy required to earn one rupee without adopting coping strategy was higher than with adopting coping strategy, i.e. 0.93 MJ against 0.84 MJ. This is because the gross income earned without coping strategy is less, to the tune of Rs. 15,215, compared with income earned by adopting coping strategy to the tune of Rs. 34,097 per acre per year. There is an additional consumption of energy in adopting coping strategy to the tune of 11630 MJ. Hence, the total energy consumption increases. What can be noticed here is energy units of human labour is almost half the proportion in *robusta* coffee plantation without adopting coping strategy when compared to adopting coping strategy. If there is adoption of coping strategy even when rainfall fails during critical growth period, employment is generated for application of fertilizers. Otherwise, the only minimum work for application of manure and harvesting the little quantity of coffee which the plantation yields will take place. Energy of water plays a significant role in the production of coffee. The quantum of energy to generate 1 rupee income is Rs. 0.84 under irrigated condition when compared to Rs. 0.93 without irrigated condition. Thus, the significance of water either by natural availability through rainfall or artificially by high investment, is reflected. Without this there cannot be employment and income to sustain the economy of Kodagu.

If the economy of Kodagu has to sustain itself, water resources have to be sustained. At present, more energy is used to earn one rupee without coping strategy, i.e., without the consumption of energy (investing) of water. Rupee is becoming costly in terms of energy (0.93 MJ to earn 1 rupee). By consuming an additional energy of water (11630 MJ) in *robusta* coffee plantation, it could earn a rupee with just 0.84 MJ. If water becomes costly in future, it is impossible to think of earning a rupee in Kodagu by *robusta* coffee plantation. Hence the study found the necessity of conserving this energy of water by preserving the total volume of rainfall.

Conclusion

Whatsoever is the topography of Kodagu, it makes it hard to adopt intensive rainwater harvesting due to lack of congenial storage area. Due to heavy rainfall, it becomes difficult to harvest this water and also store it when there is already heavy flooding during this period.

Hence, a painful choice needs to be made to harvest and conserve the rainwater by incurring high cost to convert drying yard into rainwater harvesting structure. This can be one of the options to solve the water problem. Planters who own estates beside rivers and streams should take steps to conserve water by digging adequate recharge pits in and around the rivers and streams (Yadav Anil, 2001). These pits should be properly covered by metal mesh to avoid dries twigs and leaves from clogging the flow of water. When the river recedes, these wells meet the water needs besides helping the process of recharging the groundwater and loss of water through excessive runoff. Desilting of the farm ponds has to be taken up to help ground water recharge. Solar pumping, which has a potentially widespread application in Ghana (Africa) and wind power need to be tested within pilot projects to be adopted as a standby for using pump set with diesel to lift water for sprinkler irrigation (UNDP, 1992).

Water scarcity is virtually a global phenomenon, manifesting itself even in regions which were considered least likely to be afflicted. Kodagu is one such (few) region. The district situated on the banks of the Cauvery and Lakshmanathirtha, and which receives more than 2700 mm of average annual rainfall having problems of inadequate water supply is too glaring a problem to be overlooked. Yet, this has been the fact of life for long. In the past few decades, water crisis has emerged in many places in Kodagu. Where water was once abundant, it is often now scarce. Hence, in many areas (very soon in the years to come), water rather than land availability will be the main constraint to agricultural production. In Kodagu, it is already constrained by competing planters' demand for water.

Consequently, water policy should be in the nature of a road map for the future, charting environmentally and socially desirable goals, purposes and directions. There is a pressing need to decide what is important, and for us to direct our science and technology policies for water accordingly. To fail is to jeopardize the future of our children; to succeed is to assure them a healthy environment and economic prosperity (Ministry of Supply and Services, 1988).

The term policy is used here to mean a general rule or guideline for decisions or actions in specific cases. As its availability decreases, its relative demand shifts higher. What is clear is that water and its problem that is already high on the list of public concerns, must move to the top of the people's agenda.

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Strong reasons make strong actions.

—William Shakespeare

Methodological Issues in the Development and Standardization of a Scale to Measure Farmer-Labourer Relationship

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This study is an attempt to develop and standardize a scale to measure the farmer-labourer relationship in the paddy production system, in which maximum labour is used for cultivation.

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The development of agrarian society in a country like India greatly relies on the progress made in the agricultural sector, achieved primarily through increased production. Land and labour are the two major components of the process of production and in every process of production, relations of production develop inevitably. Agricultural production being no exception to this phenomenon, the relationship between cultivators and agricultural labourers, the two prominent agrarian classes, assumes greater significance in accelerating the agricultural production. Hence, it is essential to establish and maintain a harmonious farmer-labourer relationship for maximizing the effectiveness of agricultural enterprise.

Studies on farmer-labourer relationship in the past focused mostly on the macro-level relationship, treating the farmers and the labourers as separate entities (Sen, 1962; Muthiah, 1970; Bergman, 1984 and Karanth, 1984). There is hardly any attempt to analyze the present day farmer-agricultural labourer relationship, particularly at the interpersonal level. In addition, use of a well constructed measuring tool to analyze the farmer-labourer relationship was found lacking in these studies. Under these circumstances, the present attempt was made to develop and standardize a scale to measure farmer-labourer relationship in paddy production system in which maximum labour is used for cultivation.

Methodology

Prior to going in for the development of a farmer-labourer relationship scale, it was found essential to take stock of the approaches in measuring interpersonal relationship. It was observed from the review of relevant literature in this field that broadly two types of approaches are being followed in the study of interpersonal relationship: they are unit or work group approach and dyadic approach.

Unit or work group approach

This is a popular and widely employed approach in measuring interpersonal relationships in industry, education, clinical psychology, domestic sector, etc., wherein the relationship between employer-employee is studied from either one or both parties involved, treating them as a unit or group. Here, it is assumed that the relationship between an employer and each of his/her employees is homogeneous and thus can be appropriately averaged. In the field of agriculture, Singh and Singh (1975); Agarwal (1975); and Parthasarathy and Prasad (1975) adopted this approach to analyze the changing agrarian relations. Alexander (1981) and Lukose (1982) attempted to study the interpersonal relationship existing between farmer and labourer. In spite of its common use the, unit approach was found inadequate to study interpersonal relationship, since leader-member/employer-employee agreement was seldom achieved with respect to their interdependence. To overcome the lacunae noticed in unit approach to a great extent, the use of a dyadic approach has been suggested to study interpersonal relationships.

Dyadic approach

A dyad is the smallest unit of interaction and in many ways it is a microcosm of all larger groups. It represents the interpersonal relationship between two individuals in an interacting situation. Each dyad is treated as a single unit for analyzing and interpreting the relationship between the members of the dyad. In the field of agriculture, there are hardly any studies wherein dyadic approach is employed to study interpersonal relationships. Considering the merit of dyadic approach over unit approach, it was decided to use the dyadic approach in the development of a scale to measure the farmer-labourer relationship.

For the convenience of the development of scale, the farmer-labourer relationship was considered as the extent and nature of dyadic agreement on day-to-day interactions, focusing on various parts of relationships taking place between a farmer and a hired agricultural labourer during work and non-work situations.

Item generation

By reviewing the literature in the areas of industrial relations, interpersonal relationships in business organizations and agriculture and in consultation with experts in these fields, all possible items of relationship were collected. The critical incident technique suggested by Flanagan (1954) was also employed to collect items from field situations. For this purpose five farmers and five agricultural labourers each from the districts of Alapuzha and Thiruvananthapuram, Kerala state were identified with the help of extension personnel. While Alapuzha represented intense labour union activities, Thiruvananthapuram had comparatively less intense union activity. The selected respondents were requested to describe their experiences in their relationship as both favourable and unfavourable. Altogether 148 items were generated and classified under seven dimensions namely economic, work, management, motivation, communication, human relations and social, and were subjected to further analysis.

Relevancy rating

The relevancy or otherwise of the 148 items generated was sent to 120 judges, experts in the field of extension, organizational management and field level extension functionaries, with a request to rate the degree of relevancy of each item in measuring the farmer-labourer relationship on a three continuum of 'most relevant', 'relevant' and 'least relevant' with corresponding score of 3, 2 and 1 respectively. Out of 120 judges, 71 (59.16%) responded. The mean relevancy score and coefficient of variation for each item were worked out and the items with mean relevancy score above grand mean relevancy score and coefficient of variation below grant coefficient of variation were selected for item analysis. By this procedure, 64 items were selected.

Item analysis

Item discrimination, dyadic agreement of items and item-total correlation were the indices used in the selection of items. A pilot survey was conducted with two dyadic groups of 30 farmers and labourers each from Alapuzha and Thiruvananthapuram districts employing known group techniques because of following reasons:

(i) Random selection of dyadic groups might result in the possibility of dyadic groups falling at either extremes of the best or worst or at the middle.

(ii) In addition, the chance of occurrence of dyads with erratic relationship could not be ruled out and this would not facilitate in performing the indices of item analysis.

The dyadic groups were formed by listing the names of farmers who in turn were asked to indicate the names of labourers with whom they had normal relationship. The quality of dyadic relationship was rechecked with the concerned labourers and also cross checked by obtaining the opinion of neighbouring farmers and labourers. From this list, two dyadic groups of 30 each were formed.

Response pattern of relationship items

Use of bipolar adjectives as in the case of semantic differential technique of Osgood (1952) was preferred over frequency rating for getting the response on items owing to:

(i) The farmer-labourer relationship concerns primarily with the behaviour of farmers and labourers at work situations and the nature of relationship is such that it can range from the best to worst.

By adopting this technique, the responses of the items were obtained on a 5 point scale as given below:

Items: Payment of wages.....Immediately-Delayed.

Response pattern	Score allotted
1. Very much immediately	5
2. Somewhat immediately	4
3. Neither immediately nor delayed	3
4. Somewhat delayed	2
5. Very much delayed	1

The items having significant difference in the response of best relationship dyadic group from that of normal relationship group, non-significant difference in the response of farmer respondents from that of labourer respondents within each dyadic group *i.e.* dyadic agreement or homogeneity in response and significant item-total correlation between the item score and total score indicating the internal consistency of the developed scale were selected for inclusion in the final scale. Person's product moment method was used to work out the item-total correlation of each of the items for farmers and labourers separately and the correlation was also found for the combined sample, wherein the average of the dyadic response was used for calculation. The results of the item analysis of the 64 items performed on the basis of item discrimination, dyadic agreement of items and item-total correlation is presented in Table 1. The final scale consisted of 33 items which had significant discrimination, insignificant class response (dyadic agreement of items) and significant item-total correlation.

Table 1: Item discrimination, dyadic agreement and item-total correlation of Farmer-Labourer relationship items

Sl. No.	Item	ANOVA F value		Item-total correlation		
		Between groups	Between classes	Farmers	Labourers	Combined
1	Time of work for the labourers	0.4173^{NS}	1.9161^{NS}	-0.1111^{NS}	-0.0113^{NS}	-0.0703^{NS}
2	Labourers coming for work in time	1.0396^{NS}	0.0211^{NS}	0.0458^{NS}	0.1292^{NS}	0.1074^{NS}
3#	Priority for the particular labourer while selecting for work	45.7693**	0.7664^{NS}	0.4901**	0.5534**	0.6779**
4#	Rapport with the labourers engaged in field work	102.2195**	0.3154^{NS}	0.6307**	0.7933**	0.8123**
5#	Timing of information to labourers on cultivation operations to be performed	72.3831**	0	0.6233**	0.6906**	0.7606**
6#	Propriety of instructions to labourers on scientific practices	52.6209**	0.9910^{NS}	0.5676**	0.5963**	0.6970**
7#	Clarity of instructions regarding work given to labourers	61.9280**	0.0237^{NS}	0.6432**	0.6007**	0.7415**
8#	Guidance to the labourers as and when required during work situation	67.4865**	0.1868^{NS}	0.6348**	0.5737**	0.7444**
9#	Nagging of labourers for doing work	36.8913**	1.5890^{NS}	0.3834**	0.7205**	0.6635**
10#	Wastage of working time by discussing unnecessary matters by labourers	15.4154**	0.3145^{NS}	0.3181**	0.3883**	0.4919**
11	Accord importance to completion of work irrespective of working hours	40.3829**	5.7410*	0.3599**	0.6605**	0.5946**
12#	Labourers doing the work as instructed even in the absence of farmers	61.8261**	0.4490^{NS}	0.4274**	0.7888**	0.7047**
13	Provision of drinking water at the place of work	0.3540^{NS}	2.6781^{NS}	0.0836^{NS}	0.1676^{NS}	0.0907^{NS}
14#	Team sprit amongst labourers	48.4310**	0.8448^{NS}	0.6116**	0.6319**	0.6831**

Sl. No.	Item	ANOVA F value		Item-total correlation		
		Between groups	Between classes	Farmers	Labourers	Combined
15#	Treatment of labourers during work situation	86.8699**	3.1844 NS	0.6284**	0.6587**	0.7814**
16	Care of indisposed labourers during work situation	36.6278**	4.0693*	0.4030**	0.6461**	0.6893**
17#	Address each other respectively	33.7425**	0.6159 NS	0.5407**	0.6430**	0.6883**
18	Supervising personally the labourers at work	1.3090 NS	0.5301 NS	0.1423 NS	0.0979 NS	0.1034 NS
19	Friendly relationship with each other during work situation	80.8894**	9.6921**	0.7255**	0.6753**	0.8118**
20#	Use of personal touch rather than authority in getting the work done by labourers	50.8651**	1.8652 NS	0.3511**	0.7703**	0.6540**
21#	Tactful and diplomatic way of getting the work done by the labourers	37.1073**	0.4579 NS	0.4159**	0.6488**	0.6215**
22	Emotional control in dealing with labourers during work situation	94.4990**	4.6664**	0.6257**	0.7977**	0.8063**
23	Open faith and trust in labourers	82.4445**	4.1872*	0.5068**	0.7429**	0.7103**
24#	Consideration of each others feeling before speaking or acting	46.8059**	0.2387 NS	0.4902**	0.7586**	0.7491**
25#	Differences of opinion with each other during work situation	24.9932**	1.8591 NS	0.3885**	0.6573**	0.5567**
26#	Minor comments by each other during work situation	44.2539**	0	0.5232**	0.6912**	0.6970**
27#	Response of farmers to labourers' faults	11.4643**	2.6222 NS	0.5438**	0.5388**	0.4987**
28	Expression of views about work by labourers	92.4513**	0.9043 NS	0.1723 NS	0.7689**	0.8021**
29#	Discussion of problems of work with labourers	71.0667**	2.0256 NS	0.5855**	0.6894**	0.7353**
30#	Solutions to the problems of work arrived at	80.2867**	0.2006 NS	0.5471**	0.7264**	0.7403**
31#	Labourers suggestions regarding work	42.9848**	0.4476 NS	0.5085**	0.6439**	0.6816**
32	Use of degrading words while talking to each other	75.3079**	6.6990**	0.4650**	0.8232**	0.7938**
33	Unpleasant arguments during work situation	81.9854**	5.7712**	0.5244**	0.8034**	0.7921**
34#	Ridicule labourers before others for not doing the work properly	60.7406**	2.2753 NS	0.5446**	0.7024**	0.6850**
35	Time given for rest and eating to labourers	46.9760**	7.7206**	0.4574**	0.6308**	0.7039**
36	Good work of labourers	77.5730**	5.6228*	0.6296**	0.6993**	0.7880**
37	Labourers suggestion on agricultural operations	43.7574**	23.7575**	0.3564**	0.6495**	0.6669**
38#	Heed to the problems of labourers	81.1497**	1.5092 NS	0.5429**	0.7796**	0.7430**
39	Consoling the labourers when feeling low	84.6916**	6.9136*	0.6225**	0.7211**	0.7917**
40#	Promptness in taking care of complaints of labourers	60.1560**	0.1788 NS	0.4772**	0.6576**	0.7168**
41	Deciding the wage rate	3.8461 NS	4.8041*	0.1668	0.2933*	0.2662*
42	Payment of wages	0.4101 NS	1.6466 NS	0.2170	0.1007	0.0973
43#	Payment of extra wages for extra work	4.9218*	2.6467 NS	0.2886*	0.2567*	0.2641*
44	Payment of wages in cash/kind or both as desired by labourers	56.2312**	6.7795*	0.6324**	0.5795**	0.6938**
45	Increasing the wage rate at appropriate occasions	2.0902 NS	5.4541*	0.1126 NS	0.2769*	0.2083 NS
46	Feeling of commitment to work by labourers	102.1011**	37.4042**	0.6193**	0.8548**	0.8292**

Sl. No.	Item	ANOVA F value		Item-total correlation		
		Between groups	Between classes	Farmers	Labourers	Combined
47	Farmers difficulties in cultivation empathized by labourers	80.5735**	34.4964**	0.5627**	0.7957**	0.7719**
48	Confidence of labourers in getting timely help from farmers	190.2681**	7.6105**	0.6489**	0.8812**	0.8562**
49	Gratefulness of labourers to farmers for the help rendered	85.1432**	8.5908**	0.5575**	0.8468**	0.7829**
50	Motivation of farmers to join Agricultural Labourers Welfare Schemes	13.4615**	5.8131*	0.4136**	0.1948 NS	0.4868**
51#	Labourers contribution towards high profits accrued in cultivation	76.3269**	2.3271 NS	0.5705**	0.7772**	0.7936**
52#	Oppurtunities for the progress of labourers	157.9900**	1.3059 NS	0.6466**	0.8457**	0.8124**
53#	OppOrtunities for labourers to get trained in skilled operations like planting, plant protection etc.	151.8020**	0.8455 NS	0.6494**	0.8548**	0.8208**
54	Encouragement to labourers in specialized works	0.2539 NS	0.0634 NS	0.0577 NS	0.0690 NS	0.0078 NS
55#	Facilitation of labourers in availing various beneficial schemes being operated by different departments	171.2964**	1.6650 NS	0.6885**	0.8666**	0.8475**
56#	Feeling of indispensability of labourers in cultivation	33.5600**	1.7860 NS	0.4534**	0.5879**	0.6205**
57	Confidence of farmers in the loyalty of labourers	125.8692**	17.8275**	0.5645**	0.8950**	0.8273**
58#	Enhancement of the morale of labourers	62.4809**	0.0194 NS	0.6223**	0.7044**	0.7715**
59	Help rendered during serious sickness to labourers	137.1436**	16.0847**	0.6572**	0.8166**	0.8096**
60	Support to labourers when they have genuine problem with others	104.6917**	5.2168*	0.4136**	0.7689**	0.7883**
61	Contact with each other	53.2435**	6.1432*	0.5476**	0.7612**	0.6871**
62#	Concern for each other when becoming seriously ill	42.6500**	2.9541 NS	0.4498**	0.6267**	0.6680**
63	Settling of misunderstandings with each other through mutual consensus	105.3488**	7.8358**	0.5749**	0.7402**	0.7253**
64#	Protection of labourers interests while mechanizing cultivation	17.9543**	1.4282 NS	0.2901*	0.6658**	0.5107**

NS Not significant
* Significant (P Ñ 0.05)
** Significant (P Ñ 0.01)
\# Items selected for inclusion in the scale

Classification of relationship items into dimensions

Cluster analysis suggested by Chat field and Collins (1980) which was hitherto used mostly in biometrics was employed to classify the 33 farmer-labourer relationship items selected through item analysis, considering its simplicity, effectiveness and novelty in the application in the field of agricultural extension. In order to carry out the cluster analysis, the similarity or dissimilarity of every pair of individuals is measured and of the various measures of similarity Euclidian distance (d) proposed by Hanson (1970), a most common measure of dissimilarity of unicriterion of items was employed here, as the items included in the farmer-labourer relationship scale represented the unicriterian nature of relationship. The Euclidian distance of every pair of items was calculated using the formula:

$$d^2ii' = q\Sigma_{j=1} (xij-xij')^2$$

where, d^2ii' = Euclidian distance between the items i and i'

$(xij-xij')$ = difference between the scores of items i and i' for j^{th} respondent.

Having calculated the pair-wise Euclidian distance of items, grouping of items into clusters was carried out employing the methods suggested by Tochar and followed by Rao (1952). The steps involved in this method are:

The items were arranged in order of their relative distance from one another in ascending order in the form of a Euclidian matrix.

In the next step, the two items having smallest distance from each other were considered to form a cluster. To the above two items, a third item having smallest average Euclidian distance from the first two items was added.

Then the nearest fourth item was added and it was continued till there was a disrupt increase in the average Euclidian distance value. By this, the first cluster was formed.

The above steps were repeated to form second and subsequent clusters, till all the items were included in one or other cluster.

The clusters so formed were labelled suitably taking into consideration the common content of the items grouped under each cluster as followed by Nehru (1993).

Results

Farmer-labourer relationship scale

The final format of the farmer-labourer relationship scale developed with 33 selected items from the item analysis and grouped into nine clusters using the cluster analysis with their respective Euclidian distance and bipolar response pattern is given in Table 2. The nine clusters formed are facilitation (11 items), empathy (3 items), equity (2 items), tolerance (7 items), guidance (3 items), recognition (4 items), economic, social and priority with 1 item each. To find out the farmer-labourer relationship score, the score obtained by the farmer-respondent and the corresponding labourer-respondent of a dyad on each of the item is averaged which represented the item score of the farmer-labourer dyad. By simple addition of scores obtained by dyads on the items grouped under a particular

Table 2: Dimension wise items of Farmer-Labourer Relationship scale

Sl. No.	Item	Response pattern	Average Euclidean distance
DIMENSION 1. FACIKLITATION			
1	Opportunities for the progress of labourers	Facilitated - Blocked	0.50
2	Opportunities for labourers to get trained in skilled operations like planting, plant protection etc.	Facilitated - Blocked	
3	Facilitation of labourers in availing various beneficial schemes being operated by different departments.	Facilitated - Blocked	1.50
4	Timing of information to labourers on cultivation operations to be performed.	Well in advance - Very much delayed	16.00
5	Response of farmers to labourers' faults	Slighted - Magnified	17.63
6	Labourers suggestions regarding work	Encouraged - Discouraged	22.04
7	Team sprit amongst labourers	Encouraged - Discouraged	22.90
8	Labourers contribution towards high profits accrued in cultivation	Recognized - Ignored	23.00
9	Promptness in taking care of complaints of labourers	Prompt - Indifferent	23.94
10	Enhancement of the morale of labourers	Attempted - Avoided	24.59
11	Protection of labourers interests while mechanizing cultivation	Existent - Non-existent	32.15
DIMENSION 2. EMPATHY			
12	Use of personal touch rather than authority in getting the work done by labourers	Preponderant - Absent	4.25

Sl. No.	Item	Response pattern	Average Euclidean distance
13	Tactful and diplomatic way of getting the work done by the labourers	Preponderant - Absent	
14	Consideration of each others feeling before speaking or acting	Recognized - Ignored	37.75
DIMENSION 3. EQUITY			
15	Discussion of problems of work with labourers	Existent - Non-existent	5.00
16	Solutions to the problems of work arrived at	Jointly - Unilaterally	
DIMENSION 4. TOLERANCE			
17	Minor comments by each other during work situation	Slighted - Valued	9.00
18	Heed to the problems of labourers	Patient - Impatient	
19	Treatment of labourers during work situation	Impartial - Partial	17.75
20	Differences of opinion with each other during work situation	Tolerated - Precipitated	21.33
21	Clarity of instructions regarding work given to labourers	Clear - Hazy	21.38
22	Feeling of indispensability of labourers in cultivation	Existent - Non-existent	27.65
23	Labourers doing the work as instructed even in the absence of farmers	Ensured - Neglected	34.54
DIMENSION 5. GUIDANCE			
24	Guidance to the labourers as and when required during work situation	Adequate - Inadequate	34.25
25	Rapport with the labourers engaged in field work	Excellent - Worst	
26	Propriety of instructions to labourers on scientific practices	Proper - Improper	38.75
DIMENSION 6. RECOGNITION			
27	Address each other respectively	Existent - Non-existent	38.50
28	Ridicule labourers before others for not doing the work properly	Avoided - Attempted	
29	Nagging of labourers for doing work	Avoided - Attempted	39.36
30	Wastage of working time by discussing unnecessary matters by labourers	Avoided - Allowed	41.00
DIMENSION 7. ECONOMIC			
31	Payment of extra wages for extra work	Paid - Refused	41.50
DIMENSION 8. SOCIAL			
32	Concern for each other when becoming seriously ill	Prevalent - Absent	42.75
DIMENSION 9. PRIORITY			
33	Priority for the particular labourer while selecting for work	Heeded - Avoided	43.25

dimension, the dimension score can be derived. Then, the farmer-labourer relationship score is computed by summing the dimension-wise scores.

Standardization of the scale

The scale was standardized by establishing the reliability and validity of the scale. The reliability was determined by test-retest method, wherein the scale was administered to 30 farmer-labourer dyads of Thiruvananthapuram and Alapuzha districts twice at 15 days interval. The correlation coefficient (0.79) worked out between the two sets of relationship scores was highly significant indicating the reliability of the developed scale. The validity of the scale was measured using content validity, construct validity and known group validity. As utmost care was taken to include all the items of relationship to represent the universe of contents, the scale was assumed to possess content validity. The construct validity was tested by working out the correlation coefficient between the relationship scores of 30 farmer-labourer dyads using the developed scale and on the scores of the earlier developed cultivator-labourer relations scale by Alexander (1981). The highly significant (0.81) correlation coefficient between these two scores exhibited construct validity of the present scale. The known group validity was established by administering the scale to two known dyadic groups of 30 each, one having best relationship and the other having normal relationship. The critical ratio worked out between these two relationship scores was highly significant (7.26), thereby indicating the known group validity of the scale.

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The only medicine for suffering, crime and all the other woes of mankind, is wisdom.

—Thomas Huxley

Computers in Business Development and Management of Agro Industries in India

Prakash P Ambalkar

This paper highlights the various computer applications under different business heads, such as marketing, material management and handling, purchasing and inbound logistics, design and drafting (CAD/CAM), business planning, scheduling, control and total quality management, manufacturing, terotechnology and productive maintenance, automatic assemblies, distribution (outbound logistics) outsourcing. Computers are also vital in the globalization era for agro exports in the context of accessing of business data – in numeric, text, image, audio and video form for information requirement for the growth and progress of the concern agro industrial unit.

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The development of agro-based industries started during pre-independence days. It is ironic that while India is an agricultural based country, the value added by the processing industry is merely 8 per cent of the total food production. Therefore, vast untapped potential of processing of crop produce remains unutilized for the development and management of agri-business in the country. The roles of agro industries are vast and vary from value addition and loss prevention of raw produce, income and employment generation, development of purchasing power to improvement in quality of life of the rural populace.

Since the processing industry creates jobs, demand for agricultural raw materials lead to diversification and also commercialization of agriculture, enhancing the income of farmers and creating surpluses for export of agro foods. The broad-based development of the food processing industries will improve both the social and physical infrastructure of rural India. The development of agro industries can help stabilize and make agriculture more remunerative and essential for the elimination of poverty and distress in rural inhabitation.

The agro industry is broadly categorized as three types:

(i) Village industries owned and run by rural households with very little capital investment and a high level of manual labour,

(ii) Small-scale industries characterized by medium investment and semi-automation, and

(iii) Large-scale industries involving large investment and a high level of automation. Pickles, papad, fryms, biscuits/namkeen, brooms/basket fall in the first group and edible oil and rice mills in the small industry segment. Sugar, jute and cotton mills are in the large-scale sector. The three segments are

mainly based on ability to bring in capital and capacity to market products.

Computers - An Aid to Decision Making

Decision-making for formation of strategies for institutionalizing agro-processing in production catchments, is an essential link in the production to consumption value chain under agro industrial development and management programme. Decision-making has been an essential part of the management. Managers are decision makers and problem solvers. The process of deciding is intimately related to the whole process of knowing (or cognition). Knowing "what the problem is" will assist in deciding "what to do about it," that is finding the best solution. This is a basic truth for each individual and also for a professional manager, whose main orientation is towards decision making.

There is always an implicit opportunity loss associated with poor decisions. They are the foregone gains, profits or cost savings, which could have been realized had a better decision been made. A progressive increase in agricultural productivity and incomes is essential both for the removal of mass poverty and for creating an expanding market for agro industrial products. Computers (internet/intranet) are an inherent part of industrial life. Now, virtually anything industry expects to decide upon can be provided by internet/intranet today.

Computers and the world wide web can provide relevent information for carrying out the basic management functions such as planning, organizing, coordinating, communication and control. The success of every kind of business is determined by how well production and operation managers perform business activities by accessing information needs. Since uncertainties and risks form a part and parcel of the business, every decision has to be based to a large extent on analysis and evaluation of facts to deal with critical situations in careful way.

Computers in marketing

Now-a-days marketing is one of the very important managerial concepts. In order to market a product efficiently and effectively an agri business firm needs to develop various elements such as branding, segmentation, positioning and differentiation, new product development, advertising, competitive price and sales management. Marketing research data and information needs may be identified, analyzed and utilized. Here computer may be used to design brochures, leaflets, advertisements, monograms. It is also useful for accessing market information such as on competitor's strategy to market products etc.

It has been observed that many industries have collapsed since the marketing role was not properly and timely understood and practiced in the right manner. If the needs and wants of the customer are analyzed and identified in a systematic manner, then modern management philosophy can be executed in ways sustainable to the organization, which justifies the production of agro/food items.

Computers in material management and handling

Inventory includes all stocks of articles and materials which an industry owns and uses in the process of manufacturer or providing a service. It consists of the following items:

i) Raw materials
ii) Components and parts
iii) Work in progress
iv) Finished goods
v) Maintenance and repair supplies
vi) Other operating supplies such as trolleys, lifters etc.

Inventory tends to fluctuate when supplies are regulated for the furtherance of production, which means that capital is tied up, and while it may be a necessary evil, every effort should be made to control and reduce the blockage of capital due to the carrying cost of the inventory. Computers have been used extensively in operating inventory control systems in warehouses for raw materials, for packaging and forwarding material (stationery), fuel and lubricants, maintenance parts and spares, chemicals and consumables, laboratory and safety equipments etc. Usually fixed order quantity review system comprising of minimum stock, ordering level and economic order is operated. The moment the stock of an item depletes to the ordering level (OL), the computerized schedule sets off an alarm for the indenter to order the next desired quantity of stocks without waiting. Here a buffer of minimum stock is maintained for fluctuations control of mean rate of consumptions and/or a mean lead-time of the supplier.

Computers for purchasing and inbound logistics

Computers are used for preparing purchase and dispatching orders electronically for time and cost effective

supply through inbound logistics. Computer systems are used to support progressing and inspection at vendors works, tracking materials in transit from different locations, reporting arrival, arranging acceptance with quality and quantity inspection, binning etc. Similarly in the event of any rejection of consignment the same can be asked for by the vendors electronically through e mail to collect it back. Next to this computers keep a tab on the movement of food materials etc. until these have been physically put into the designated location and taken into computerized inventory control system after all checks/stock verification as per the supply order. Since crop produce, food items etc. are perishable in nature, therefore timely information exchange may save significant commodities losses.

Computers in design and drafting (CAD/CAM)

The goal of applying computerized automation to the manufacturing environment is improved efficiency and lowered costs, both direct and indirect especially required for cost effective agricultural machinery/equipments/tools, production etc. There are several different computer software applications that are designed for various stages of product life cycle, from computer-aided design (CAD) to computer-assisted production on the plant floor. CAD refers to the integration of the computers and graphics-oriented software for the purpose of automating the design and drafting the process for jobs of even 3-dimensional view. CAM highlights the use of computers in the production process for manufacturing of farm/process machinery, farm implements, structures and facilities etc.

Computers in operations planning, scheduling, control and total quality management

Within the purview of enterprise resource planning (ERP) operation planning, scheduling and control in manufacturing systems is rather complex and cannot be done within the constraints of time available, and without the imaginative use of computers in material requirement planning (MRP). Computers help in identifying the variables, which come into play and can influence the planning and scheduling of unit operation farm/agricultural process machinery, processed food products. It is through shortening the time involved with numerically process controlled database storage, industrial electronics, that a greater role will be played in measuring process variables on a continuous basis, monitoring and managing the process conditions and keeping them within the desirable limits from computerized control rooms for the resultant production under total quality management for utmost consumer satisfaction. Computers help in making a holistic decision by considering all the contingent factors.

Computers in manufacturing

A manufacturing system comprises of man, materials, machine and processes working together as a whole, guided by set of ideas, theories and principles. The basic functions of this generic manufacturing system are product and process design, planning & control and the manufacturing process. Modern concepts are aimed at integrating these functions to form a sensitive system, which is responsive to the ever-changing customer needs and wants. It was when computerized numerically controlled machine (CNC) tools originated in year 1970 since then it was thought that it would be difficult to economize on unit cost of production. However, now technology has developed so rapidly that a manufacturing unit is able to integrate computers into not only the process of manufacturing, but also in shortening the time involved in setting up and changeover. This meant that CNC machining centers could be set up very quickly for new jobs of agricultural machinery production/ workshops.

Computer integrated manufacturing (CIM) provide an integrated approach to production process through efficient information handling for overall improvements in product quality and productivity through fully automated process integration. CIM system can be used for integrating data or information either horizontally or vertically within an enterprise, applications in different areas like design, manufacturing, management and planning. The various components of CIM systems are: computer aided drafting, computer aided design (CAD and engineering (CAE), computer aided production planning (CAPP), computer aided manufacturing (CAM), computer aided quality control (CAQC), numerically controlled (NC/CNC/DNC) machine tools, Robots, transfer lines and flexible manufacturing systems (FMS). In addition, to be effective they also use systems management concepts, which include Just in time manufacturing (JIT), total quality management (TQM) and MRP (Material requirements planning) for manufacturing improved machinery/implements.

Computer in terotechnology and productive maintenance

Maintaining the history card of each machine/ equipment has been a herculean task when it is performed manually. Terotechnology relating to the total information on machines and equipment was a good concept but could not be successfully organized owing to a large variety of

information and data needed to be captured, recorded and analyzed manually can now be computerized. Similarly advancing agricultural technology and availability of good, reliable and fast diagnostic tools and kits are helping to monitor the conditions of equipment and work in progress inventories at regular intervals with parameters such as – temperature, pressure, vibrations, noise levels etc. and prediction of useful life of machine in operation. Supported by advances in electronic diagnosis tool kits and computer-aided terotechnology, it is now much easier to install total productive maintenance (TPM), which is a happy mix of preventive maintenance (on-line maintenance), predictive maintenance (scheduled maintenance) and breakdown maintenance of farm/ process machinery/implements.

Computers in automatic assemblies

It is in fully automated industries that computers are increasingly being used in organizing assemblies of components – automatic movement of raw materials, work in progress inventory and finished goods movements of materials through robots, positioning of components in the correct place for assembling, screwing and fastening sub assemblies to main frame of equipment, testing and packaging them for transport with the help of suitably programmed computers, which without fatigue or manual errors, operate continuously and faultlessly like in sophisticated tractor workshop/agricultural machinery fabrication unit.

Computers in distribution (outbound logistics)

In the past, inter-city transportation of small lots or partial truckloads was very tricky and painstaking. The carriers could not inform the status of movement of the consignment to their customers and could take weeks together for proper delivery. Now with the introduction of internet trucking and transportation with consignee and consigner both get time to time updated status of transshipment through e-mail and cell phone use for efficient and cost and time effective outbound logistics for transport of tractors/earth moving machinery or highly perishable food items such as fishes, vegetables and flowers etc.

Computers in outsourcing

Owing to greater emphasis on core competence, companies are going virtual by outsourcing a large number of sophisticated agricultural products and services such as rotavator, light weight power tillers and mechanized paddy transplanter or genetically improved hybrid seeds etc. Computers have made it possible by improving the access, reach and spread of the purchaser company. It is because of computerized systems purchasers have no longer to wait for invoices to be received and advice preparation and dispatch of cheques etc. as per the terms and conditions of the payment and no sooner are quantities received matched with quantities in purchase order given that they can be cross checked with the database of inventory evaluation.

Computers in globalization era for agro exports

Export enhances the competitive abilities of small-scale entrepreneurs. The entrepreneur may increase the production target for meeting the economics of his business unit. Optimum production with minimum cost incurred makes the entrepreneur more competitive in the international as well as domestic markets. Here he may overcome the risk of recession and low level of demand in the domestic market. Often products and product brands reach a stage of decline in the product market. At this instance, the same brands may attract foreign buyers and may accrue larger profits for an entrepreneur. It also compels the entrepreneur to improve or maintain the quality of product by holding the nerve of international market.

Here agro industries like Indian handicrafts, handlooms, leather goods, sweets, jams, jellies, pickles and papad etc. along with cost effective improved agricultural implements/ machinery may have enormous potential to grab the international market share and computerization will provide the know how to augment the scope of export if an entrepreneur may exercise the process of identifying the customers needs and expectations by taking into account area and climatewise cropping pattern at the international level.

The raw crop produce and processed agro commodities marketed in India are of a wide range such as paddy, wheat, rice, maize sugarcane, potato, cotton, fruits, vegetables, flowers, spices, fish, poultry, tea, coffee, medicinal plant and honey. All these commodities are processed in one form or the other and consumed in huge quantities within the country and also exported. However, the private sector is yet to fully realize the huge potential of agro industries. The global market is enormous for sugar, coffee, tea and processed foods such as sauce, jelly and honey. The market for processed meat, spices and fruits are equally large. Only with mass production aided by modern computer technology it may help exploitation of domestic as well as export market to the fullest extent.

Results and discussions

When businesses are small and have limited operational goals it is possible to manually process data and run the business reasonably well. In fact even today many small businesses with a single owner who manages the grocery shop/sweet shop or shop of handicrafts and jewelry, dairy farm establishment of oil expeller unit, pulse/ rice mill or feed mill etc. do not use computers at all. However, with the reduction of the cost of computers and time-bound activities to perform for encashing the modern business opportunities, the use of computer has become very vital and productive, due to the following reasons:

- As an organization grows the volume of data which an organisation has to process becomes too large and cumbersome to process manually. Computer assistance is required for accessing information and taking a prompt decision for an appropriate action based on readily displayable information on the computer screen.
- Computer based processing enables the same data to be processed in various ways for understanding different tactical aspects of the business for improvement of operation and to increase profit percentage for growth and progress of the agro industrial unit from time to time. Computers may also assist in keeping the record of all customer complaints for upgradation of product quality/ service delivery etc.
- International/national and local markets are increasingly becoming competitive due to the upcoming trend of globalization. It is thus felt essential to produce and market quality food products at a minimum incurred cost to achieve targeted sale with the help of computers aid.

Conclusion

Computer technology is now very powerful and is integrated into the daily life of the common man. Computer and related information technologies blend data, information, figures and images etc. with the use of multimedia, by receiving/sending them through vast computer networks. The practicing general manager should have: (i) Adequate knowledge of his information needs and expectations and (ii) To understand/get trained on the computer software/hardware usages and skills to access the timely business data – numeric, text, image, audio and video for actual growth and progress of the agro industrial unit.

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If we do not plant knowledge when young, it will give us no shade when we are old.

—Lord Chesterfield

Feature

Inter-District Disparities in Socio-Economic Development in Nagaland

Amod Sharma, S D Dhakre & Rajat Sharma

The level of development of Nagaland has been estimated with the help of a composite index based on optimum combination of socio-economic indicators. The district-wise data for the year 2006 based on twenty indicators were used for eight districts of the state.

In the context of overall socio-economic development, Kohima has been ranked first and Zunheboto is ranked last. Wide disparities were obtained in the level of development among different districts.

For bringing about a uniform regional development, potential targets for various indicators have been estimated for low developed states.

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Development has been appropriately conceptualized as a process which improves the quality of life. The programmers of development have been taken up in the country in a planned way through various Five Year Plans. The main objective of this program is to enhance the quality of life of people as well as effecting improvement in their social and economic well-being. Economic growth and uniform regional development are the basic aims of the programme.

The Green Revolution in the agricultural sector and commendable progress on the industrial front have certainly increased the overall total production in the country, but there is no indication that these achievements have been able to substantially reduce the regional inequality in the area of development. It is found that all areas of the low developed districts are not backward, but that some parts are middle level or high level developed.

This paper is a study on the evaluation of economic development of Nagaland. The data for the years 1991-2006 in respect to eight districts had been critically analysed and wide disparities in the level of development were found in different stages. It was, therefore, felt necessary to conduct a deeper analysis using the district level data for socio-economic indicators for evaluating the imbalances of development in the state. The district level data had for Nagaland has been analyzed in this paper.

Nagaland, the 16th state of the Indian union, was inaugurated on the 1st December 1963.The people of Nagaland are mostly tribal and the land is agrarian. There are several tribes and sub-tribes amongst the Nagas, each of which have their own distinctive language and cultural features. About 82.26 per cent population of the state live in rural areas. As per the 2001 population census, the total population of the state was 1,988,636, which was about 0.19 per cent of the total All India population. The

percentage of workers to total population was about 42.74 per cent. The population density of population is 120 per square kilometer and the annual growth of the population is the about 64.41 per cent. The literacy rate in the state is about 67.11 per cent, which is higher than the All India rate of 65.18 per cent. Agriculture is an important primary sector. It provides food to the growing population, raw materials to the agro-based industries and various other products to fulfil the basic needs. The state's economy largely depends upon the agricultural sector. Major food crops are rice, jowar, wheat, bajra, barely, maize and pulses. Important commercial crops grown in the state are sugarcane, cotton, jute, potato, coffee, tea, cardamom etc. The total forest area in the state is about 11.68 per cent and the major forest products are teak, oak, bamboo, pulpwood and fuelwood.

Knowledge of the level of the development will help in identifying where a given state stands in relation to the other. The study also throws light on the relationships of socio-economic development with the agricultural development and infrastructural facilities. Improvements required in the development indicators of the low developed states have been suggested. The regions and the populations under different stages of development have been evaluate and the model districts have been identified for fixing up the potential targets of different indicators for low developed districts so that these districts may make improvement in the present level of development.

Research Methodology

Development is a multidimensional, continuous process. Its impact cannot be evaluated fully by any single indicator. Moreover, a number of indicators when analyzed individually do not provide an integrated and easily comprehensible picture of reality. Hence, there is a need for building up a composite index of development-based on various indicators combined in a optimum manner. For this study, the district has been taken as the unit of analysis. Eight districts of the state are included in the study. The data on twenty development indicators for the year (1991-2006) are utilized in the analysis.

Developmental Indicators

Each district faces situational factors of development unique to it as well as common administrative and financial factors. Indicators which are common to all the states have been included in the analysis for evaluating the level of development. The composite indices of development have been calculated for different districts by using the data on the following indicators:

Agricultural Sector

1. Productivity of total cereals,
2. Productivity of pulses,
3. Productivity of oil seeds,
4. Productivity of commercial crops,
5. Per capita cereal production,
6. Number of farms,
7. Number of Beneficiaries under IRDP,
8. Percentage net area irrigated &
9. Number of veterinary hospitals and dispensaries.

Infrastructural Facilities

1. Number of banks per lakh population,
2. Credit / Deposit ratio,
3. Decadal growth rate of population,
4. Population density,
5. Sex ratio,
6. Literacy rate (male),
7. Literacy rate (female),
8. Total literacy rate,
9. Birth rate,
10. Death rate and
11. Infant mortality rate.

These indicators may not form an all inclusive list but these are the major interacting components of development in the state. Out of these indicators, nine indicators are depicting the progress of agricultural development and the eleven are concerned with the infrastructural facilities.

Estimation of Composite Index of Level of Development

Variables in respect of different indicators are taken from various population distributions and these are recorded in different levels of measurement. The values of these development indicators are not quite suitable for simple addition in combined analysis. For obtaining the composite index of development, the values of indicators

are transformed as follows.

Let X_{ij} be the value of jth indicator for ith unit, i = 1,2, - - -, n and j = 1,2, - - - , k. X_{ij} is transformed to Z_{ij} as follows

$$Z_{ij} = \left(X_{ij} - \bar{X}_j \right) / S_j$$

Where $\bar{X}_j$ = mean of the jth indicator; S_j = S.D. of jth indicator

The best value of the transformed variables for different indicators (with maximum value depending upon the direction of the impact of indicator on development) is identified and the square of the deviations of the transformed variables from best values are obtained. The inverse of the coefficient of variation of the original variables is used as weight for obtaining the pattern of development. The statistical technique given by Narain *et al.* (2000, 2002, 2003, 2004) is applied to construct the composite index of development for different district. The composite indices have been worked out separately for agricultural, infrastructural and overall socio-economic fields. The value of the composite index lies between 0 and 1. A value close to 0 indicates a high level of development and a value near to one indicates a poor level of development. The association between the levels of development of different sectors of economy has been worked out. For low districts, improvements needed in various indicators are also presented.

Table 1: Composite Index of Development

S. No.	Districts	Agriculture		Infrastructure		Socio-economic	
		C.I.	Rank	C.I.	Rank	C.I.	Rank
1.	Kohima	0.44	1	0.50	2	0.40	1
2.	Dimapur	0.71	6	0.21	1	0.69	6
3.	Phek	0.67	4	0.55	5	0.59	4
4.	Mokokchung	0.67	5	0.54	4	0.63	5
5.	Zunheboto	0.80	8	0.56	6	0.81	8
6.	Wokha	0.73	7	0.53	3	0.71	7
7.	Tuensang	0.61	2	0.68	7	0.55	2
8.	Mon	0.63	3	0.79	8	0.57	3

It can be seen from the table that in case of agricultural development, district Kohima is ranked first and district Zunheboto is ranked last. The composite indices of development vary from 0.44 to 0.80 in the case of infrastructure facilities. District Dimapur is found to be on the first position and the district Mon is ranked last. The composite index varies from 0.21 to 0.79. In the overall socio-economic development, the district of Kohima is ranked first and district Zunheboto is ranked last. The composite indices of development vary from 0.40 to 0.81.

Different Stages of Development

For relative comparisons among the districts with regard to the level of development, it appears appropriate to assume that the districts having the composite indices less than or equal to (Mean - SD) are highly developed, whereas the district having the composite indices greater than or equal to (Mean + SD) are low developed. Districts with composite index lying between (Mean - SD) and Mean are medium level developed and the district having the composite index between lying (Mean) and (Mean + SD) are at developing district. On the basis of this classification, districts are put into the four categories of development, high, medium, low and developing. Table 2 presents the classification of districts lying in different levels of development along with data on percentage area and population.

In case of agricultural development, the district Kohima is found to be better developed when compared to other Nagaland districts. This district occupies 12.49 per cent area and 15.81 per cent population of Nagaland districts covered under the study. The districts Tuensang and Mon are middle level developed covering 24.13 per cent area and 33.90 per cent population. The districts Phek,

Results and Discussions

The composite indices of development have been worked out separately for the agricultural sector, infrastructure sector and overall socio-economic sector for different district (See table 1). The sectors have also been ranked on the basis of level of development.

Table 2: Area and production in different levels of development

AGRICULTURE

Level of Development	Name of Districts	Area %	Population %
High	Kohima	12.49	15.81
Middle	Tuensang & Mon	24.13	33.90
Developing	Phek, Mokokchung, Dimapur & Wokha	58.34	42.50
Low	Zunheboto	5.04	7.79

INFRASTRUCTURE

Level of Development	Name of Districts	Area %	Population %
High	Dimapur	37.19	15.51
Middle	Kohima, Wokha & Mokokchung	25.51	35.34
Developing	Phek, Zunebotho & Tuensang	30.13	36.10
Low	Mon	7.17	13.05

SOCIO-ECONOMIC

Level of Development	Name of Districts	Area %	Population %
High	Kohima	12.49	15.81
Middle	Tuensang & Mon	32.27	41.35
Developing	Mokokchung, Wokha, Phek & Dimapur	50.20	35.05
Low	Zunebotho	5.04	7.79

Mokokchung, Dimapur and Wokha are in the developing stage. These districts covered 58.34 per cent area and 42.50 per cent population. The district Zunheboto is observed to be in the low developed category. This district covers 5.04 per cent area and 7.79 per cent population.

Infrastructure facilities include medical, banking and overall economic enterprises available to the people in Nagaland districts. The position of various districts regarding the availability and use of the above facilities for the people is assessed by the composite index. It may be seen from the table that the district Dimapur is found to be better developed as compared to the rest of the Nagaland districts. This better developed district occupies 37.19 per cent area and 15.51 per cent population of Nagaland. The districts Kohima, Wokha and Mokokchung are middle level developed covering 25.51 per cent area and 35.34 per cent population. The districts Phek, Zunebotho and Tuensang are in the developing stage. These districts cover 30.13 per cent area and 36.10 per cent population. The district Mon is observed to be in the low developed category. This district covers about 7.17 per cent area and 13.05 per cent population.

Regarding overall socio-economic development, the district Kohima is found to be better developed as compared to the rest of the Nagaland districts. This better developed district occupies 12.49 per cent area and 15.81 per cent population of Nagaland. The districts Tuensang and Mon are middle level developed covering 32.27 per cent area and 41.35 per cent population. The districts Mokokchung, Wokha, Phek and Dimapur are in the developing stage. These districts cover 50.20 per cent area and 35.05 per cent population. The district Zunebotho is observed to be in the low developed category. This district covers 5.04 per cent area and 7.79 per cent population.

Inter-relationships among different sectors

To examine the relationship among development of agricultural, infrastructure, overall socio-economic sectors and total literacy, pairwise correlations have been worked out and presented in table 3.

The correlation coefficient between the developments in agriculture and socio-economic sectors is found to be significantly at the 0.01 probability level. However, the correlation coefficient between the development in agriculture and infrastructural facilities is not significant. The correlation coefficient between the development in infrastructural facilities and socio-economic sectors is also not significant. Infrastructural facilities with respect to banking, medical and other economic enterprises are also not found to be associated with the agricultural development.

Table 3: Pairwise Correlation Coefficient

S.No.	Pair of Sectors	Correlation Coefficient
1.	Agriculture and Infrastructure	– 0.16
2.	Agriculture and Socio-economic	0.98**
3.	Agriculture and Total literacy	– 0.24
4.	Infrastructure and Socio-economic	0.19
5.	Infrastructure and Total literacy	– 0.73
6.	Socio-economic and Total literacy	0.27

** Significant at 1 per cent level

Literacy rate is also not associated with the agricultural, infrastructure and socio-economy development.

Potential Targets for Low Developed districts

For bringing out uniform regional development among the Nagaland districts, it is important to examine the nature of improvement required in different indicators of low developed districts for enhancing the level of development. This information is useful for readjusting the resources in reducing inequalities in levels of disparities in development among different districts. It would also provided avenues to bring about uniform regional development in the state. Potential targets of various development indicators for the low developed districts have been determine by taking the best value among the Nagaland districts. Table 4 gives the value of various important developmental indicators along with the potential targets in respect to these two districts.

The district Zunebotho is found to be low developed in agricultural and overall socio-economic sectors. The district Mon is found to be low developed in infrastructure facilities.

Table 4: Potential targets of low developed districts

Development Indicators	Zunebotho	Mon	Potential target
1. Productivity of total cereals	8.14	8.11	21.94
2. Productivity of pulses	12.02	10.95	14.20
3. Productivity of oilseeds	13.65	12.09	15.15
4. Per capita cereal production	0.20	0.12	0.37
5. Productivity of commercial crops	4.93	43.03	43.03
6. No. of farms	2	2	7
7. Percentage net area irrigated	5.17	7.67	24.20
8. No. of bankslakh population	5.16	1.93	8.11
9. Decadal growth rate	61	73.42	95.01
10. Total literacy	69.73	42.25	84.27
11. Birth rate	21.42	14	35.31
12. Death rate	2.75	1.86	4.23
13. Infant mortality rate	1.24	1.35	2.77

It may be seen from table 4 that the values of such developmental indicators are very low as compared to the potential targets. In case of those indicators which are related to agriculture development like productivity of total cereals, pulses, oil seeds, farms, net irrigated area and per capita cereal production are very low in comparison to the corresponding potential targets. In Mon district the total literacy rate is very poor. Improvements needed in the level of development in these two districts are as follows.

Zunebotho

Zunebotho district is the home of the *Sema* tribe. This district is low developed in agricultural and socio-economic fields. Improvement in forest production should be made. Road transport is not very satisfactory and needs to be improved to further agriculture development. For ensuring per capita food production, measure improvements are required in creating more irrigation facilities.

Mon

Mon district is the home of the *Konyak* Tribe. These people also chiefly practice jhum cultivation. An adoption of the terraced cultivation is now encouraged in these areas also by the state government. This district is low developed

in infrastructure and education field, and could benefit from welfare developmental programs.

Conclusion

The broad conclusions emerging from the study are as follows:

1. With respect to the overall socio-economic development, the districts Kohima is found to be highly developed. The districts Tuensang and Mon are middle level developed. The districts Mokokchung, Wokha, Phek and Dimapur are at the developing stages. These districts are making fast improvement in their level of development. The district Zunebotho is found to be low developed. This district requires care in implementation of developmental programs.

2. In the agricultural field, district Kohima is found to be better developed and district Zunebotho is low developed.

3. Agriculture development is closely associated with socio-economic development.

4. Wide disparities in the level of development have been observed between different districts.

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The happiest life is that which constantly exercises and educates what is best in us.

—Hamerton

Feature

Is the Present Technology Mix enough for Indian Micro Small and Medium Enterprises (MSMEs) to Cope with Globalization?

Indranil Biswas & Milindo Chakrabarti

The significance of technology in a production process cannot be overemphasized. Using enterprise level data from the third MSME Census, this paper looks at the variations in performance of MSMEs depending on their sources of technological know-how and estimates separate Cobb-Douglas production functions according to different sources of technology: foreign, domestic collaborating company/unit and domestic R&D institutions/specialized agency/organization. Estimates have also been made separately for registered and unregistered units. This study underscores the need for supplying better and effective technology to the MSMEs to help them tide over global competition.

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The significance of technology in a production process cannot be overemphasized. A common reason cited to explain the North-South divide has been in terms of technology-differentials. Needless to say, a generation of new technology demands considerable capital investments. Rich countries are capable of generating superior technologies, which poorer countries, given their slender capital base, are not. Even within an economy, enterprises operating on a larger scale can afford to generate and adopt more efficient and sophisticated technologies. Traditionally, technology has been treated as an asset good that can be traded off-the-shelf, implying that rich countries would invent superior techniques of production and use them, while enterprises in the poorer countries would import them and adapt them for local use (Bardhan and Udry 1999, P 152). Flow of technologies within a domestic economy is also expected to follow the same pattern.

Industrial Policy in India till the early 1990s was characterized by a major share of production activities remaining in the hands of the State, through the public sector undertakings (PSUs). The PSUs were engaged in heavy industries of national importance. Production of consumer goods and services were left in the hands of the private sector. The space for the private sector was also bifurcated with a significant part reserved for small scale industries (SSI). With the onset of globalization, a process of dereservation has set in where larger private sector enterprises have been allowed to enter the sectors so far reserved for the SSIs. Needless to say, sectors requiring larger capital investment, so far reserved as a domain of the PSUs, have also been opened up to the big players operating in the private sector.

Against this backdrop, the present paper analyses the data available from the 3rd Census of Micro, Small and Medium Enterprises (MSMEs) carried out in 2001-02, to

identify some characteristic features of the registered and unregistered MSME units in terms of source of technology adopted by them.

Indian economy and MSME

Micro, Small and Medium Enterprises have a significant role in the Indian economy in terms of output, employment generation, export etc. A recent concept note prepared by UNDP observes that MSMEs in the Indian economy contribute

- 40% in terms of volume;
- 80% in terms of employment;
- 60% in terms of export and
- 92% in terms of number of enterprises.

(http://www.weplayfair.com/UserFiles/File/ESR%20Inducing%20Factors/UNIDO_Concept%20Note_Business%20schools.pdf as on 20-06-08]

As per the third MSME Census document, employment-investment ratio is about seven times for MSMEs compared to that found in big industries. Investment-output ratio also appears to be a shade better for the MSMEs. Consumption of energy by MSMEs also appears to be considerably lower than that of their large-scale counterparts (Table 1). Thus one may argue that MSMEs play a very important role in creating employment opportunities in an economy that has been witnessing a bout of jobless growth for quite some time, ensuring judicious use of scarce capital resources and facilitating efficient management of energy utilization against the threat of global warming and consequent climate change.

Table 1: Comparative Characteristics of Large Scale Industries and MSMEs in India

S. No.	Characteristic	Annual Survey of Industries (ASI)	Third Census of SSIs (2001-02)
1.	Per unit employment	61	3
2.	Per unit output (Rs. lakhs)	730	4.22
3.	Per unit investment (Rs. lakhs) as per ASI 2000-01	304	2.04
4.	Employment per Rs. one lakh investment as per ASI 2000-01	0.2	1.39
5.	Output per employee as per ASI 2001-02	11.88	1.49
6.	Investment to Output as per ASI 2000-01	0.43	0.48

MSMEs are broadly classified in two categories (MSME 2007): one category consists of manufacturing enterprises and the other category is composed of service-based MSMEs. These two categories of MSME are further divided into micro, small and medium enterprises depending on the investment ceiling for plant machinery and equipments used therein. According to the present definition (effective from 2 October, 2006), the MSMEs are classified in the manner explained in Table 2.

Table 2: Classification of Enterprises into Different Categories (New Definitions)

Classification	Investment Ceiling (excluding land and building)	
	Manufacturing	Service
Micro	Up to Rs 25 lakh ($US62,500)	Up to Rs 10 lakh ($US25,000)
Small	Between 25 lakh to Rs 5 crores ($US62,500 & $US1.25 mn)	Between Rs 10 lakh to Rs 2 crores ($US25,000 & $US0.5 mn)
Medium	Between Rs 5 crores to 10 crores ($US1.25mn & $US2.50 mn)	Between Rs 2 crores to Rs 5 crores ($US0.5mn & $US1.25 mn)

(*Source*: http://dcmsme.gov.in/ssiindia/MSME_OVERVIEW.pdf.)

Table 3: Classification of Enterprises into Different Categories (Old Definitions)

Classification	Investment Ceiling (excluding land and building)	
	Manufacturing	Service
Micro	Up to Rs 25 lakh ($62500)	Up to Rs 10 lakh ($25000)
Small	Between 25 lakh to 1 crore ($62,500 & $0.25 mn)	
Medium	Not defined	Not Defined

(*Source*: http://dcmsme.gov.in/ssiindia/MSME_OVERVIEW.pdf.)

*1US$=Rs 40.00 (October 2007), 1 mn = 10 lakh

Table 4: Present Profile of the MSME Sector (as in September 2007)

	Under Old Definition	Under New Definition
Number of micro and small enterprises	12.8 million	13 million
Employment	31.0 million	41.0 million
Production(at current price)	$140 billion	NA
Export $	33 billion	NA
Shares in GDP	6%	8-9%
Share in manufacturing output	39%	45%
Share in Exports	33%	40%

(*Source:* http://dcmsme.gov.in/ssiindia/MSME_OVERVIEW.pdf.)

However, the 3rd MSME census was carried out using older definitions that was prevailing during 2001-02 (Table 3).

Table 4 captures the present profile of the MSME sector, using both the present and earlier classification of the enterprises. It amply captures the importance of MSMEs in India. The number of MSMEs according to the new definition reached to 13 million approximately. Out of a total labour force of 509 million, 30 million are employed in this sector (Sircar 2006) and the sector generates 40% of India's total export. Its share in GDP stands at 8-9%. The total annual credit flow to the Indian MSMEs adds up to $12.0 billion (MSME 2007 P: 3).

Since the 1990s Indian MSMEs have been facing robust competition due to globalization and subsequent policy actions that dereserved many sectors earlier closed to big industries. A moot question often raised is as to whether the sector till recently reserved for the small sector should be opened to big players. Debroy et al (2006) while studying the effect of dereseravation for small scale industries found that:-

1. "The Reserved SSI sector is a minor component of the SSI sector.
2. The reserved sector from all available evidence continues to be less efficient than the un-reserved sector.
3. A few industry classifications account for the bulk of the reserved output and units producing reserved items.
4. Dereservation has not been followed by any significant SSI output fall in most dereserved product segments—in other words past dereservation has not harmed the sector.
5. De-reservation is followed by a fall in the growth rate of imports of the dereserved items.
6. Some large units have professed an interest (as reflected in LOI) in entering the reserved sector but not to a large extent." [Pp: 3-4]

These findings clearly advocate the dereservation of the small scale sector to facilitate entry by larger players generally assumed to have access to a larger capital base, better managerial skills and an updated information base.

Some scholars also found post-globalization performance of Indian MSMEs to be encouraging because it created new opportunities for MSMEs (Subrahmanya et al 2005). It has been pointed out that "SME has many other benefits: it can be started with relatively less capital; it facilitates nurturing of entrepreneurship, which could emerge from within; it can be used as an instrument for alleviating regional disparities in development etc. Further, a SME is flexible in production, has the potential to be a training ground for managerial skills, promotes individual initiatives, and encourages rich personal relations. Therefore, it is often promoted as a source of technological innovations in industrialized economies" (ibid p. 471).

However, Indian MSME sector has still been suffering from a host of problems which keeps them lagging behind. Sadana & Daskanya (2007) list the following problems of SMEs:-

1. *Finance problems*: Non-availability of finance on soft terms, problems related to equity, bank loans, high cost of borrowings, management finance.
2. *Market-related problems*: Lack of information, networking and cooperation among SMEs.
3. *Technological constraints*: Product design, innovation, product development, processing technology, preservation, distribution etc.
4. Infrastructure constraints.
5. Govt. apathy.
6. *Management constrains*: There is a lack of qualified workers, of innovations, of efficiency, and of transportation infrastructure.

These problems need to be taken care of for a sustainable growth of MSMEs. The main concerns to keep the business on the right track are quality of the service, customer loyalty and quality employers. According to a survey published in Business Standard (April 11, 2007) on the constraints faced by Indian SMEs in financing their businesses:-

- 57% identified state bureaucracy and red tape in processing applications;
- 40% mentioned state insufficient collaterals; and
- 34% rued the lack of institutions willing to lend to small businesses.

According to the survey, Indian SMEs also face problems in supply chain management and 42% of SMEs in India experienced difficulty in forecasting demand, which directly affects the efficiency of their supply chain. As per the survey "SME leaders in India cite a lack of supply chain efficiency and transportation infrastructure as the biggest obstacles to their competitiveness, factors considered both important and lacking. These obstacles need to be addressed to ensure their sustainable growth and competitive position in the global marketplace."

(http://www.business-standard.com/general/storypage.php?&autono=280816)

Source of Technological Know-how

However, it will be interesting to note whether the MSMEs that have access to better technological options actually improve their efficiency *vis-à-vis* those operating in the large scale sector. A thorough review of the literature on MSME reveals that not much is known about the issue of availability of technology to the MSME sector. Roy and Banerjee (2007) is an interesting study that looks into the role of national laboratories in developing regional MSME clusters. However, the study, using a few case studies, arrives at some qualitative conclusions *vis-à-vis* the nature and characteristics of technology adoption in some selected clusters. It does not, however, compare the different broad sources of technology. The present study is an attempt to capture the quantitative perspectives of technology adoption in Indian MSME using enterprise level data from 3rd MSME census. It should, however, be clarified that owing to non-availability of data on source of technology for large-scale industries – a typical source of enterprise level information for them being the Annual Survey of Industries carried out by National Sample Survey Organization (NSSO) – it is not possible to compare the status of MSMEs in this regard *vis-à-vis* their large sector counterparts.

As per the census, there were 1374974 registered units in 2001-02. The dataset captures information about 1348447 such units. The estimated number of unregistered units stands at 9146216. Out of them a sample of 168654 units were identified and relevant information was recorded about them during the Census operations. Our analysis is based on the information available for these units.

Census data identifies four sources of technology for the MSME sector:-

- From abroad
- From domestic collaborating company/unit
- From domestic R&D institutions/specialized agency/organization
- From none [MSME Census identifies them as traditional]

Table 5: Key Statistics for Registered MSMEs in Terms of Source of Technology

REGISTERED UNITS				
	Abroad	Domestic Collaborating company/unit	Domestic R&D inst./specialized agency/organization	None
Per unit original purchase value of plant and machinery installed as on 31.03.2002 (in Rs)	618894	387440	433305	168691
Per unit market value of fixed asset as on 31.03.2002 (in Rs.)	2088471	1263580	1344581	520437
Employment/unit	8.76	6.10	6.37	4.10
Market value of fixed asset as on 31.03.2002 per unit of employment (Rs.)	172848	130160	151561	88504
Original purchase value of plant and machinery installed as on 31.03.2002 per unit of employment (Rs.)	54080	43052	49283	28167

Source: Authors' estimates from MSME census 2001-02 data

Table 6: Key Statistics for Unregistered MSMEs in terms of Source of Technology

UNREGISTERED UNITS				
	Abroad	Domestic Collaborating company/unit	Domestic R&D inst./specialized agency/organization	None
Per unit original purchase value of plant and machinery installed as on 31.03.2002 (in Rs)	39919	40501	50148	32151
Per unit market value of fixed asset as on 31.03.2002 (in Rs.)	130430	106110	125773	92060
Employment/unit	2.20	2.33	2.42	2.17
Market value of fixed asset as on 31.03.2002 per unit of employment (Rs.)	50097	40337	50032	42406
Original purchase value of plant and machinery installed as on 31.03.2002 per unit of employment (Rs.)	13740	17449	17898	14413

Source: Authors' estimates from MSME census 2001-02 data

Tables 5 and 6 reveal the variations among the registered and unregistered MSMEs across the differences in source of technology. For the registered units:

- Average original purchase value of plant and machinery appears to be the highest for technologies procured from abroad, followed by those procured from domestic R&D institutions. As expected, it is the lowest for "traditional" technologies.
- The same trends are observed in respect to average market value of fixed assets and average employment per unit. Investment required to create one unit of employment potential is found to be the lowest for "traditional" technology at Rs 28167.

The same trends are observed in respect to the unregistered units as well. However, the scope of employment per unit is considerably lower for the unregistered units. Investment required to procure plants and machineries to create one unit of employment opportunity is also substantially lower.

Incidentally the shares of technology procured from different sources are not identical across different sectors. Appendix Tables A-1 up to A-3 capture the sector-wise variations. While Table A-1 records the number of registered and unregistered units in terms of their source of technology according to 2-digit NIC classification, Table A-2 looks into distribution of technology from different sources in a particular sector. Table A-3 considers distribution of technologies from a particular source across different sectors. All the tables A-1 through A-3 provide results separately for the registered and unregistered units.

Salient features of sector specific distribution of technologies according to source (Table A-2) are:

- Most of the technologies used in any sector by both registered and unregistered units are traditional – not procured from any of the other three sources.
- The least number of the technologies is procured from abroad for all the sectors.
- Units across an industry group procured more technologies from domestic collaborating companies or units than what they obtained from domestic R&D institutions/specialized agencies and organization, barring a few exceptions.
- Notable exceptions where Domestic R&D institutions/specialized agencies and organization provided a larger share of technologies to MSME sector are:

1. Manufacture of paper and paper products (Unregistered units)
2. Publishing, printing and reproduction of recorded media (Unregistered units)
3. Manufacture of chemicals and chemical products (Registered units)
4. Manufacture of basic metals (Unregistered units)
5. Manufacture of office, accounting and computing machinery (both Registered and Unregistered units)
6. Manufacture of radio, television and communication equipment and apparatus (Registered units)
7. Manufacture of medical, precision and optical instruments, watches and clocks (both Registered and Unregistered units)
8. Electricity, gas, steam and hot water supply (Registered units)
9. Computer and related activities (both Registered and Unregistered units)
10. Health and social work (both Registered and Unregistered units)

- Interestingly, technologies from the three identified sources were not procured by units engaged in (i) Collection, purification and distribution of water (unregistered units) and (ii) Land transport; transport via pipelines (both registered and unregistered units).

As we look into the spread of technology from a particular source into different industrial sectors (source specific variations), it is observed that [Table A-3]

- Among registered units, technologies from abroad dominate in sectors engaged in. (i) manufacture of food products and beverages; (ii) Manufacture of fabricated metal products, except machinery and equipments and (iii) Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods.
- Technologies from the other two identified sources also compete vigorously for their shares with those from abroad in these three sectors.
- Technologies from domestic R&D institutions/ specialized agencies and organization are considerably concentrated in units engaged in manufacture of wearing apparel; dressing and dyeing of fur.
- Same trends are observed among the unregistered units.

Estimated Production Functions with MSME Census Data

Even though information about source of technology across 2-digit industry classification level is available at an aggregated level, with not much detailed specification available about characteristic features of the technology – input-output mix to be specific – it will be interesting to carry out a quantitative exercise to estimate the productions functions for units aggregated in terms of their source of technology with some restricted assumption about the quality of labour and capital. Such an exercise may provide us with some insight into the implications of source of technology for the productivity of an MSME – a vital issue for them to be competitive in a globalized world.

For the measurement of productivity and returns to scale among the MSMEs, we use a simple Cobb-Douglas production function of the following form.

$$Q = A.K^{\alpha}L^{\beta}$$

$$\text{Log}_e Q = \text{Log}_e A + \alpha \log_e K + \beta \log_e L$$

where the symbols have their usual meanings. If á + â exceeds 1, it is a case of increasing returns to scale (IRS). It is constant returns to scale (CRS) if the sum is equal to 1 and diminishing return to scale (DRS) if less than 1. To render the dataset compatible to estimation, we assume that the labour units and machineries used in production across different industrial groups are homogenous in quality. Data on market value of fixed assets as on 31.03.2002 expressed in monetary terms has been utilized as K, whereas L captures total employment in the units. Q captures the gross output of 2001-02 expressed in monetary values.

The estimates of α and β and as a consequence those of $\alpha + \beta$ are statistically significant at 1% level. As per the estimates the technologies irrespective of their sources are exhibiting increasing returns to scale in case of registered units, even though the difference in returns to scale are not found to be varying much across the known sources of technology, the coefficients of labour and capital – output elasticities of input– vary considerably with change in sources. Returns to scale in units using technologies not procured from any of the known sources are, however, lower. Existence of increasing returns to scale calls for a scope of increased scale of operation for the registered MSME units irrespective of their source of technology.

Table 7: Parameter Estimates of Regression Analysis for Registered Units

Coefficients	Abroad	Domestic Collaborating company/unit	Domestic R&D inst./specialized agency/organization	None
Constant	4.7000(59.88)	5.4153(209.16)	4.6762(152.59)	5.6744(774.77)
Labour	0.7586(50.50)	0.8867(167.31)	0.8171(133.86)	0.8403(536.50)
Capital	0.5446(72.55)	0.4686(186.34)	0.5344(183.24)	0.4451(623.56)
Returns to scale	1.3032	1.3553	1.3515	1.2854
Adj. R-Squared	0.6773	0.6770	0.6710	0.6058

Source: Authors' estimates from MSME census 2001-02 data. Figures in parentheses indicate t-value

Table 8: Parameter Estimates of Regression Analysis for Unregistered Units

Coefficients	Abroad	Domestic Collaborating company/uni	Domestic R&D inst./specialized agency/organization	None
Constant	6.6201(29.94)	7.125(113.33)	7.246(96.56)	7.2436(485.23)
Labour	0.7911(15.14)	0.6469(42.69)	0.7048(41.15)	0.6326(161.01)
Capital	0.3455(15.91)	0.3132(50.32)	0.3025(40.94)	0.2955(198.25)
Returns to scale	1.1366	0.9601	1.0073	0.9281
Adj. R-Squared	0.4159	0.4241	0.4319	0.3813

Source: Authors' estimates from MSME census 2001-02 data. Figures in parentheses indicate t-value

Estimates of output elasticity of capital (á) and labour (â), indicate that for registered units

1. Technologies procured from domestic collaborating units have the highest output elasticity of labour, implying one percent increase in labour input leads to 0.89% increase in output and the estimates are the lowest for those procured from abroad.

2. Output elasticity of capital is on the higher side for technologies procured from abroad. The estimated elasticity for technology procured from domestic R&D units also appears to be close to that obtained for the former.

For unregistered units the returns to scale are not uniform across the sources of technology

1. Betraying *a priori* expectations, output elasticity of labour appears to be the highest for technologies procured from abroad.
2. It is rather low for technologies supplied by domestic collaborating units than for those procured from domestic R&D inst./specialized agency/ organization.
3. Output elasticity of capital is also expectedly highest for technologies brought from abroad.
4. Units using "traditional" technology and procuring technology from domestic collaborating units exhibit decreasing returns to scale.

The estimated constant captures the contribution of residual inputs including technology and other complementary, including institutional factors. A look at the estimates of the constants suggest that the contribution of residual factors:

1. Is the highest for technologies supplied by domestic collaborating units and the least in case of technologies procured from domestic R&D inst./ specialized agency/organization in case of registered units.
2. Is the least for technologies imported from abroad and the highest in case of technologies procured from domestic R&D inst./specialized agency/ organization for unregistered units.

Conclusion

To conclude we may argue that technology plays a major role in the capacity of MSMEs to withstand the onslaught of completion from global players. Even though dereservation is cited as an important step in infusing efficiency in the MSME sector, it is equally important to look into the technology-mix available with the units in this sector. It will be difficult for a small unit to compete with the global competitors if the technologies available with them are not effective enough to make their production efficient. The large incidence of technology not being procured from any of the three identified sources may imply that

- There is a significant diffusion, imitation (to be specific, of technology procured by others from the identified sources, or;
- There may be technological innovations within units not relying on the identified sources for supply of technology, or;
- There may be no infusion of new and efficient technology in the bulk of the MSMEs who are happy to carry on with traditional technologies which may not be effective in making them globally competitive, or;
- A combination of these alternatives.

MSME Census data does not help throw much light on the possible reasons behind the units mostly sticking to technologies that are not directly procured from either of these sources. However, given the plethora of problems in access to market, credit and technology faced by MSME units as reflected in the literature, it will perhaps not be out of place to argue that the phenomenon is more supply-driven and warrants a well thought out intervention from the powers-that-be in helping the small scale units adopt efficient technology. Further research on these issues at the sectoral level may help identify the reasons dominating the pattern of technology adoption in Indian MSMEs today.

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Table A-1: Sources of Technological Know-how

NIC Code (2 digit)	Source of Technological Know-How									
	Number of Registered Units					Number of Registered Units				
	1	2	3	4	Total	1	2	3	4	Total
15	1429	13722	7715	173662	196528	143	1,093	515	17,792	19,543
16	16	161	90	2386	2653	35	140	29	3,970	4,174
17	1092	3876	3286	55921	64175	14	339	206	5,156	5,715
18	877	8620	8192	130921	148610	163	1,745	1,664	28,339	31,911
19	281	2877	1363	30872	35393	10	94	64	1,564	1,732
20	449	4096	2694	52202	59441	27	307	175	6,121	6,630
21	154	1069	975	8664	10862	3	25	32	342	402
22	541	4130	3878	39356	47905	23	158	185	2,128	2,494
23	34	321	255	2833	3443	1	6	2	100	109
24	572	4167	4222	31954	40915	7	56	56	1,049	1,168
25	490	4029	3605	34226	42350	8	108	94	1,423	1,633
26	524	4998	3454	54909	63885	39	232	88	3,418	3,777
27	350	2362	1864	19479	24055	5	54	75	1,115	1,249
28	1663	12287	10622	123294	147866	82	527	387	6,472	7,468
29	534	4177	3075	41663	49449	11	92	61	1,487	1,651
30	23	135	187	916	1261	0	3	6	41	50
31	299	2246	2049	19207	23801	4	80	74	1,021	1,179
32	57	467	508	3067	4099	2	73	50	916	1,041
33	77	415	539	3216	4247	1	10	16	153	180
34	105	881	638	5992	7616	0	19	16	198	233
35	99	475	250	4012	4836	1	17	9	196	223
36	825	7238	4354	84375	96792	63	623	359	8,427	9,472
37	5	46	39	461	551	0	1	0	13	14
40	6	43	81	387	517	0	8	5	58	71
41	1	14	10	123	148	0	0	0	6	6
50	547	4805	3646	53758	62756	58	550	525	8,383	9,516
52	1196	9454	7472	130054	148176	154	1,348	1,323	21,666	24,491
60	0	0	0	2	2	0	0	0	2	2
63	17	180	156	1542	1895	0	5	5	88	98
64	173	511	545	10132	11361	57	613	470	10,997	12,137
71	14	84	66	902	1066	0	24	23	562	609
72	186	1080	2399	9577	13242	15	66	161	745	987
74	314	1623	1755	18588	22280	34	304	340	4,468	5,146
85	32	102	268	813	1215	2	34	68	293	397
92	8	56	52	393	509	3	20	17	158	198
93	33	224	350	3735	4342	49	443	467	8,342	9,301
Total	**13023**	**100971**	**80654**	**1153594**	**1348242**	**1015**	**9219**	**7570**	**147213**	**165007**

Table A-2: Distribution of Technology from Different Sources within a Sector

NIC Code (2 digit)	Distribution of technology (with in Sector) in Registered Unit Source of Technology					Distribution of technology (with in Sector) in Unregistered Unit Source of Technology				
	1	2	3	4	Total	1	2	3	4	Total
15	0.73	6.98	3.93	88.37	100.00	0.73	5.59	2.64	91.04	100.00
16	0.60	6.07	3.39	89.94	100.00	0.84	3.35	0.69	95.11	100.00
17	1.70	6.04	5.12	87.14	100.00	0.24	5.93	3.60	90.22	100.00
18	0.59	5.80	5.51	88.10	100.00	0.51	5.47	5.21	88.81	100.00
19	0.79	8.13	3.85	87.23	100.00	0.58	5.43	3.70	90.30	100.00
20	0.76	6.89	4.53	87.82	100.00	0.41	4.63	2.64	92.32	100.00
21	1.42	9.84	8.98	79.76	100.00	0.75	6.22	7.96	85.07	100.00
22	1.13	8.62	8.10	82.15	100.00	0.92	6.34	7.42	85.32	100.00
23	0.99	9.32	7.41	82.28	100.00	0.92	5.50	1.83	91.74	100.00
24	1.40	10.18	10.32	78.10	100.00	0.60	4.79	4.79	89.81	100.00
25	1.16	9.51	8.51	80.82	100.00	0.49	6.61	5.76	87.14	100.00
26	0.82	7.82	5.41	85.95	100.00	1.03	6.14	2.33	90.50	100.00
27	1.45	9.82	7.75	80.98	100.00	0.40	4.32	6.00	89.27	100.00
28	1.12	8.31	7.18	83.38	100.00	1.10	7.06	5.18	86.66	100.00
29	1.08	8.45	6.22	84.25	100.00	0.67	5.57	3.69	90.07	100.00
30	1.82	10.71	14.83	72.64	100.00	0.00	6.00	12.00	82.00	100.00
31	1.26	9.44	8.61	80.70	100.00	0.34	6.79	6.28	86.60	100.00
32	1.39	11.39	12.39	74.82	100.00	0.19	7.01	4.80	87.99	100.00
33	1.81	9.77	12.69	75.72	100.00	0.56	5.56	8.89	85.00	100.00
34	1.38	11.57	8.38	78.68	100.00	0.00	8.15	6.87	84.98	100.00
35	2.05	9.82	5.17	82.96	100.00	0.45	7.62	4.04	87.89	100.00
36	0.85	7.48	4.50	87.17	100.00	0.67	6.58	3.79	88.97	100.00
37	0.91	8.35	7.08	83.67	100.00	0.00	7.14	0.00	92.86	100.00
40	1.16	8.32	15.67	74.85	100.00	0.00	11.27	7.04	81.69	100.00
41	0.68	9.46	6.76	83.11	100.00	0.00	0.00	0.00	100.00	100.00
50	0.87	7.66	5.81	85.66	100.00	0.61	5.78	5.52	88.09	100.00
52	0.81	6.38	5.04	87.77	100.00	0.63	5.50	5.40	88.47	100.00
60	0.00	0.00	0.00	100.00	100.00	0.00	0.00	0.00	100.00	100.00
63	0.90	9.50	8.23	81.37	100.00	0.00	5.10	5.10	89.80	100.00
64	1.52	4.50	4.80	89.18	100.00	0.47	5.05	3.87	90.61	100.00
71	1.31	7.88	6.19	84.62	100.00	0.00	3.94	3.78	92.28	100.00
72	1.40	8.16	18.12	72.32	100.00	1.52	6.69	16.31	75.48	100.00
74	1.41	7.28	7.88	83.43	100.00	0.66	5.91	6.61	86.82	100.00
85	2.63	8.40	22.06	66.91	100.00	0.50	8.56	17.13	73.80	100.00
92	1.57	11.00	10.22	77.21	100.00	1.52	10.10	8.59	79.80	100.00
93	0.76	5.16	8.06	86.02	100.00	0.53	4.76	5.02	89.69	100.00
Total	**0.97**	**7.49**	**5.98**	**85.56**	**100.00**	**0.62**	**5.59**	**4.59**	**89.22**	**100.00**

Table A-3: Distribution of Technology from Different Sources across Sectors

NIC Code (2 digit)	Distribution of technology (with in Sector) in Registered Unit					Distribution of technology (with in Sector) in Unregistered Unit				
	Source of Technology					Source of Technology				
	1	2	3	4	Total	1	2	3	4	Total
15	10.97	13.59	9.57	15.05	14.58	14.09	11.86	6.80	12.09	11.84
16	0.12	0.16	0.11	0.21	0.20	3.45	1.52	0.38	2.70	2.53
17	8.39	3.84	4.07	4.85	4.76	1.38	3.68	2.72	3.50	3.46
18	6.73	8.54	10.16	11.35	11.02	16.06	18.93	21.98	19.25	19.34
19	2.16	2.85	1.69	2.68	2.63	0.99	1.02	0.85	1.06	1.05
20	3.45	4.06	3.34	4.53	4.41	2.66	3.33	2.31	4.16	4.02
21	1.18	1.06	1.21	0.75	0.81	0.30	0.27	0.42	0.23	0.24
22	4.15	4.09	4.81	3.41	3.55	2.27	1.71	2.44	1.45	1.51
23	0.26	0.32	0.32	0.25	0.26	0.10	0.07	0.03	0.07	0.07
24	4.39	4.13	5.23	2.77	3.03	0.69	0.61	0.74	0.71	0.71
25	3.76	3.99	4.47	2.97	3.14	0.79	1.17	1.24	0.97	0.99
26	4.02	4.95	4.28	4.76	4.74	3.84	2.52	1.16	2.32	2.29
27	2.69	2.34	2.31	1.69	1.78	0.49	0.59	0.99	0.76	0.76
28	12.77	12.17	13.17	10.69	10.97	8.08	5.72	5.11	4.40	4.53
29	4.10	4.14	3.81	3.61	3.67	1.08	1.00	0.81	1.01	1.00
30	0.18	0.13	0.23	0.08	0.09	0.00	0.03	0.08	0.03	0.03
31	2.30	2.22	2.54	1.66	1.77	0.39	0.87	0.98	0.69	0.71
32	0.44	0.46	0.63	0.27	0.30	0.20	0.79	0.66	0.62	0.63
33	0.59	0.41	0.67	0.28	0.32	0.10	0.11	0.21	0.10	0.11
34	0.81	0.87	0.79	0.52	0.56	0.00	0.21	0.21	0.13	0.14
35	0.76	0.47	0.31	0.35	0.36	0.10	0.18	0.12	0.13	0.14
36	6.33	7.17	5.40	7.31	7.18	6.21	6.76	4.74	5.72	5.74
37	0.04	0.05	0.05	0.04	0.04	0.00	0.01	0.00	0.01	0.01
40	0.05	0.04	0.10	0.03	0.04	0.00	0.09	0.07	0.04	0.04
41	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
50	4.20	4.76	4.52	4.66	4.65	5.71	5.97	6.94	5.69	5.77
52	9.18	9.36	9.26	11.27	10.99	15.17	14.62	17.48	14.72	14.84
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	0.13	0.18	0.19	0.13	0.14	0.00	0.05	0.07	0.06	0.06
64	1.33	0.51	0.68	0.88	0.84	5.62	6.65	6.21	7.47	7.36
71	0.11	0.08	0.08	0.08	0.08	0.00	0.26	0.30	0.38	0.37
72	1.43	1.07	2.97	0.83	0.98	1.48	0.72	2.13	0.51	0.60
74	2.41	1.61	2.18	1.61	1.65	3.35	3.30	4.49	3.04	3.12
85	0.25	0.10	0.33	0.07	0.09	0.20	0.37	0.90	0.20	0.24
92	0.06	0.06	0.06	0.03	0.04	0.30	0.22	0.22	0.11	0.12
93	0.25	0.22	0.43	0.32	0.32	4.83	4.81	6.17	5.67	5.64
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table A-4: Activity wise Code Sheet at NIC 2-Digit Level

NIC Code (2-Digit)	Nature of activity
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags saddlery, harness and footwear
20	Manufacture of wood and of products of wood and cork, except Furniture; manufacture of articles of straw and plating Materials
21	Manufacture of paper and paper products
22	Publishing, printing and reproduction of recorded media
23	Manufacture of coke, refined petroleum products and nuclear Fuel
24	Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastic products
26	Manufacture of other non-metallic mineral products
27	Manufacture of basic metals
28	Manufacture of fabricated metal products, except machinery and Equipments
29	Manufacture of machinery and equipment n.e.c.
30	Manufacture of office, accounting and computing machinery
31	Manufacture of electrical machinery and apparatus n.e.c.
32	Manufacture of radio, television and communication Equipment and apparatus
33	Manufacture of medical, precision and optical instruments, Watches and clocks
34	Manufacture of motor vehicles, trailers and semi-trailers
35	Manufacture of other transport equipment
36	Manufacture of furniture; manufacturing n.e.c.
37	Recycling
40	Electricity, gas, steam and hot water supply
41	Collection, purification and distribution of water
50	Sale, maintenance and repair of motor vehicles and Motorcycles; retail sale of automotive fuel
52	Retail trade, except of motor vehicles and motorcycles; Repair of personal and household goods
60	Land transport; transport via pipelines
63	Supporting and auxiliary transport activities; activities ofTravel agencies
64	Post and telecommunications
71	Renting of machinery and equipment without operator and of personal and household goods
72	Computer and related activities
74	Other business activities
85	Health and social work
92	Recreational, cultural and sporting activities
93	Other service activities

Feature

Working of Cooperative Marketing Societies in India: Some Emerging Issues

Deepak Shah

Since the post-WTO world trade order will put increasing pressure on the agricultural marketing system and trade practices of various agricultural commodities, cooperatives have to play a vital role in strengthening marketing of agricultural goods. At present, the losses incurred by primary cooperative marketing societies (PCMS) are more than two-fold than the profit earned by them. The emergence of certain factors like erosion of values, tendency to depend too much on government help, absence of knowledge-based market orientation, etc. have adversely affected the functioning of PCMS in India. This has resulted in a weak cooperative marketing structure in India which can only be improved by better transport and storage facilities.

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Although the National Agricultural Policy (NAP) document of India released in July 2000 envisage an agricultural growth rate in excess of 4 per cent per year over the next two decades, the achievement of this growth to a great extent depends on raising the productivity of various crops as well as the improvement of the marketing mechanism encompassing agricultural commodities. The NAP recognizes the crucial role of agricultural marketing when it proclaims to promote "growth that is demand driven and caters to domestic markets and maximizes gains from exports of agricultural products in the face of the challenges arising from economic liberalization and globalization".

In the current context of globalization, liberalization and privatization, the present marketing system which was essentially evolved earlier to cater to the need of a growing population and for the planned development of the country, needs to be reviewed. The Government of India, recognizing the need for evolving an efficient marketing system, which forms the core of agricultural growth, recently constituted an Expert Committee on "Strengthening and Developing of Agricultural Marketing (June, 2001)". This expert committee has categorically emphasized upon the need to formulate strategies that are required to handle the increased quantities of marketed surplus, which expected to be large in view of available projections of production and marketed surplus as well as marketed surplus-output ratios of various commodities. It is also expected that the post-WTO world trade order will further put increasing pressure on the agricultural marketing system and trade practices of various agricultural commodities. In this veritable scenario, cooperatives have to play a pivotal role in strengthening systematic marketing of agricultural goods with due emphasis on horizontal and vertical integration of markets, with a further thrust on ensuring reasonable prices to producer farmers for better quality produce and reducing chain of intermediaries in marketing function that always reduced the producers' share in consumer rupee.

There are several studies that have dealt with the issue of viability and performance of cooperatives. While some of the studies have pinned their attention towards a

framework to quantify and measure viability, the others have tried to empirically measure viability or related issues like profitability, efficiency, performance, etc. of various categories or types of cooperative societies. As for the conceptual framework for evaluating the performance of cooperatives is concerned, the notable contributions in this respect are from Seetharaman and Mohanan (1986), Gupta (1989), Shah (1992), Baviskar and Attwood (1990) and Datta and Kapoor (1996). Apart from these studies, some other studies have dealt with the success and failure of agricultural non-credit cooperatives, particularly marketing societies (Attwood and Baviskar, 1987; Deshpande and Reddy, 1990; Kumar, 1990; Singh 1990).

The studies conducted in the past on agricultural marketing cooperatives provide us with an insight into the weaknesses, prospects, opportunities and strengths of these cooperatives. Besides, these studies also provide us with a framework for carrying out similar kind of studies with varying spectrum of issues awaiting to be laid bare open to understand the problems uniquely faced by such cooperatives in different agro-climatic are regions of the country. Elucidation of such problems will surely help us in understanding and streamlining their functioning under different conditions, particularly those that deal with the marketing of produce at the grassroot or primary level.

Progress of PCMS

Though the decades of the 1950s, 1960s and 1970s witnessed very insignificant growth in the numerical strength of Primary Cooperative Marketing Societies

Table 1: Number and Membership of Primary Cooperative Marketing Societies (PCMS) in India

Sr. No.	State	Number of Societies				Membership			
		1984-85	1994-95	1997-98	2000-01	1984-85	1194-95	1997-98	2000-01
1	Andhra Pradesh	386	98	383	383	344420	32459	356730	356730
2	Assam	-	-	51	51	-	-	19506	19506
3	Bihar	492	475	526	475	76421	133140	140429	148850
4	Gujarat	1459	2098	2346	2160	302409	379432	355195	395521
5	Haryana	78	88	91	101	96327	135504	95281	158274
6	Himachal Pradesh	58	78	138	153	8762	12596	16730	17354
7	Jammu & Kashmir	46	-	85	85	14574	-	20530	20530
8	Karnataka	384	634	639	447	392300	521247	516746	414695
9	Kerala	104	365	467	524	171822	254569	283039	352492
10	Madhya Pradesh	755	-	3849	227	181048	-	386061	143749
11	Maharashtra	556	1034	989	1088	492358	794209	757166	785920
12	Manipur	-	-	19	22	-	-	2185	3711
13	Meghalaya	35	23	27	16	1779	5019	2959	974
14	Nagaland	-	12	32	32	-	12	1280	1280
15	Orissa	100	104	117	257	37573	63225	106919	131688
16	Punjab	109	98	121	116	101579	95643	143697	104550
17	Rajasthan	159	196	195	204	80810	137486	156191	169075
18	Tamil Nadu	523	305	132	143	1054487	882508	833803	882780
19	Tripura	14	14	14	14	2233	2611	2759	2853
20	Uttar Pradesh	314	-	199	1	913047	-	3020794	177
21	W.Bengal	292	269	274	274	112331	70918	76365	76365
22	Andaman & Nicobar	32	32	32	-	3524	3111	3111	-
23	Arunachal Pradesh	3	5	5	5	510	603	594	594
24	Chandigarh	-	-	1	1	-	-	917	917
25	Delhi	57	-	14	-	3198	-	1317	-
26	Goa, Daman & Diu	3	-	10	8	4199	-	8634	8571
27	Lakshadweep	10	-	10	10	19194	-	20008	20008
28	Puduchery	-	-	2	2	-	-	1274	1282
29	Mizoram	-	-	10	8	-	-	272	427
30	Sikkim	-	-	26	26	-	-	385	385
31	Dadra Nagar Haveli	-	-	3	3	-	-	277	277
32	All India	5969	5928	10807	6836	4414905	3524292	7331154	4219541

Source: Statistical Statements relating to Co-operative Movement in India, Part-II, Non Credit Societies 1984-85, 1994-95, 1997-98, 2004-05, NABARD, Mumbai

(PCMS) in India, the progress in cooperative marketing societies was remarkable after the 1980s period with the period between 1984-85 and 1997-98 showing a two-fold rise in the same as against hardly 20 per cent increase in the strength of these marketing societies between 1950-51 and 1980-81. However, the numerical strength of PCMS in India declined dramatically in 2000-01 (see Table 1). A sharp decline in numerical strength of PCMS in Uttar Pradesh, Tamil Nadu and Madhya Pradesh during the period between 1997-98 and 2000-01 mainly contributed to this decline in the numerical strength of PCMS in India. Even the membership of these PCMS in India that increased from 44 lakhs in 1984-85 to 73 lakhs in 1997-98 declined sharply to 42 lakhs in 2000-01 (Table 1). Perhaps the membership of PCMS in India in 2000-01 was even lower than the membership of PCMS in India in 1984-85. Due to the all in numerical strength of PCMS in Uttar Pradesh, Tamil Nadu and Madhya Pradesh, their membership in these states also declined steadily between 1997-98 and 2000-01 and as a result overall membership of these PCMS in India declined sharply during this period. The figures clearly underscore the fact that majority of PCMS in Tamil Nadu and Madhya Pradesh almost all the PCMS operating in Uttar Pradesh were closed down between 1997-98 and 2000-01 mainly due to their inefficient functioning.

Among various states of India, the numerical strength of PCMS during the year 2000-01 was noticed to be highest in Gujarat, followed by Maharashtra, Kerala and Bihar. These four states put together accounted for 62 per cent share in total numerical strength of PCMS in India during 2000-01. Interestingly, despite showing very low numerical strength of PCMS, Tamil Nadu showed as much as 20.92 per cent share in total membership of PCMS in India during 2000-01. The other states like Maharashtra, Karnataka, Gujarat, Andhra Pradesh and Kerala showed a share of 18.63 per cent, 9.83 per cent, 9.37 per cent, 8.45 per cent, and 8.35 per cent, respectively, in total membership of PCMS in India during 2000-01. This implied that 76 per cent share in total membership of PCMS in India was accounted for by states like Tamil Nadu, Maharashtra, Karnataka, Gujarat, Andhra Pradesh and Kerala.

The observations emerging from Table 1, by and large, are concomitant of an inverse relationship between numerical strength and membership of PCMS across various states in India, though no conclusion can be assigned to this phenomenon. It is quite possible that the PCMS in some of the states are quite large and that they have a large membership. However, the point which merits attention is that during 2000-01 the state of Maharashtra ranked second in terms of both numerical strength and membership of PCMS in India. On the other hand, during 2000-01 the state like Tamil Nadu ranked first in terms of membership of PCMS in India with very low rank in terms of total numerical strength of PCMS in India.

Agricultural Produce Marketing

Marketing cooperatives in India have multifarious goals that include helping the producers for higher returns on farm produce, creation of market infrastructure facilities such as go down and warehouses, transport vehicles and graders, etc. supply of inputs such as seeds, fertilizers, pesticides, implements, etc. to farmers at reasonable price, providing consumer goods needed by the farmers like cloth, matches, kerosene, etc., and also undertaking processing activities like crushing oilseeds, ginning and pressing of cotton, etc. Among various activities undertaken by PCMS, marketing of agricultural produce assumes greater

Table 2: Number of Primary Cooperative Marketing Societies in India as per undertaking marketing of agricultural produce

Sr. No.	Product	1984-85	1994-95	1997-98	2000-01
1	Cotton	128 (2.1)	99 (1.7)	131 (1.2)	94 (1.4)
2	Fruits & Vegetables	1016 (17.0)	959 (16.2)	1173 (10.9)	1304 (19.1)
3	Arecanut	13 (0.2)	14 (0.2)	16 (0.1)	15 (0.2)
4	Tobacco	216 (3.6)	237 (4.0)	248 (2.3)	241 (3.5)
5	Coconut	27(0.5)	31 (0.5)	48 (0.4)	41 (0.6)
6	Sugarcane supply	32 (0.5)	27 (0.5)	43 (0.4)	18 (0.3)
7	Other specialized commodities	1720 (28.8)	2270 (38.3)	4168 (38.6)	2222 (32.5)
8	General purpose	2817 (47.2)	2291 (38.6)	4980 (46.1)	2901 (42.4)
9	All marketing societies	5969 (100.0)	5928 (100.0)	10807 (100.0)	6836 (100.0)

Source: Statistical statements to Co-operative Movement in India, Part II, Non Credit Societies 1984-85, 1994-95, 1997-98, 2004-05, NABARD, Mumbai

significance due to the involvement of both forward and backward linkages. As for agricultural goods marketing, PCMS in India are seen to deal with several activities, which not only encompass activities relating to general purpose and other specialized commodities, but also activities relating to marketing of cotton, fruits and vegetables, arecanut, tobacco, coconut and sugarcane supply (Table 2).

During 2000-01, out of 6,836 PCMS operating in India, 42.4 per cent societies were seen to be engaged in the activities relating to general purpose, 32.5 per cent with other specialized commodities, and 19.1 per cent in the marketing of fruits and vegetables (F & Vs). The societies dealing with other activities like marketing of cotton, areca-nut, tobacco, coconut, and sugarcane were seen to account for marginal share in total numerical strength of PCMS in India during 2000-01. These estimates establish the fact that marketing of F&Vs is the third major activity undertaken by PCMS in India.

Achievements of PCMS

The achievements of PCMS in India in terms of broad quantitative parameters such as their working capital, paid-up capital, borrowings, sales of agricultural produce, requisites and consumer goods encompassing the period between 1984-85 and 2000-01 are shown in Table 3.

The estimates shown in Table 3 clearly underscore the fact that there has been substantial increase in all the quantitative parameters undertaken during the given period of time. The sales of agricultural produce and paid-up capital of PCMS, in particular, have grown by more than 4-5 times during the period between 1984-85 and 2000-01. Even the sales of agricultural requisites, borrowings, and working capital of PCMS in Indian have grown by 3 to 4 times during the same period. However, as for the sales of consumer goods of PCMS at all India level is concerned, there has been slower growth during the given

Table 3 : Primary Cooperative Marketing Societies in India

Sr. No.	Product	1984-85	1994-95	1997-98	2000-01
1	Working capital	6199698 (100.0)	11165097 (180.1)	21800672 (351.6)	16940654 (273.2)
2	Paid-up capital	767930 (100.0)	1450114 (188.78)	4441232 (578.7)	3383323 (440.6)
3	Total borrowings	1452188 (100.0)	1991061 (137.1)	5111686 (352.0)	4139334 (285.0)
4	Sales of Agriculture produce	7292777 (100.0)	22080707 (302.8)	37750382 (517.6)	41636046 (570.9)
5	Sales of agricultural requisites	4912214 (100.0)	12975445 (264.1)	18980186 (319.1)	18610053 (378.9)
6	Sales of consumer goods	5558932 (100.0)	12336331 (221.9)	14056375 (252.9)	16416888 (295.3)

Source: Statistical statements relating to Cooperative Movement in India, Part-II, Non-credit Societies, 1984-85, 1994-95, 1997-98, 2000-05, NABARD Mumbai.

period of time, though registering nearly a three-fold rise in consumer goods sale between 1984-85 and 2000-01. Interestingly, though there has been decline in working and paid–up capital of PCMS in India between 1997-98 and 2000-01, the estimates also show lower dependency of PCMS on borrowings in 2000-01 as compared to borrowings noticed in 1997-98. This is a point that needs appreciation.

Profit and Loss Account of PCMS

The profit and loss accounts of PCMS operating at an all–India level for different points of time viz, 1984-85, 1994-95, 1997-98, and also for 2000-01 are shown in Table 4. The estimates presented in Table 4 not only include number of societies making profit or loss but also amount of profit and loss of PCMS at an all-India level during the period between 1984-85 and 2000-01. As

Table 4: Number of Primary Marketing Societies Making Profit or Loss and Amount of Profit and Loss in India

Sr. No.	Product	1984-85	1994-95	1997-98	2000-01
1	No. of societies making profit (%)	2938 (49.24)	2323 (39.19)	4531 (41.93)	2447 (35.80)
2	No. of societies making loss(%)	1631 (27.33)	2127 (35.88)	2932 (27.13)	2374 (34.73)
3	No. of societies without profit or loss (%)	1398 (23.43)	1478 (24.93)	3344 (30.94)	2015 (29.48)
4.	Total no. of societies	5967 (100.00)	5928 (100.00)	10807 (100.00)	6836 (100.00)
5.	Amount of profit	135880	583615	493801	397805
6	Amount of loss	111869	297072	1019313	993897

Source: Statistical Statements relating to co-operative Movement in India, Part-II, Non-Credit societies 1984-85, 1994-95, 1997-98,2004-05, NABARD, Mumbai

regards amount of Profit earned by PCMS at an all – India level, though the period between 1984-85 and 1994-95 witnessed nearly a four-fold rise in the same, the amount of profit earned by PCMS in India declined consistently after 1994-95, so much so that there was 32 per cent declined in profit earned by them between 1994-95 and 2000-01 (Table 4).

The amount of profit made by the PCMS operating at an all-India level was substantially high during 1994-95 and moderately high during 1984-85 as compared to losses incurred by them during these two reference years. On the other hand, these PCMS operating at all-India level showed substantially high amount of losses not only during 1997-98 but also during 2000-01, as compared to profit earned by them during these two reference years. The losses incurred by PCMS were noticed to be more than two-fold the profit earned by them during 1997-98 and 2000-01. Not only this, there has been a growing trend in a number of societies incurring losses as compared to societies making profit. These are certainly some of the disquieting features emerging from Table 4 as PCMS in India show a much higher amount of losses as compared to profit earned by them.

As a matter of fact, the emergence of certain negative factors like erosion of values, decline in service-oriented leadership, absence of professional management, tendency to depend too much on government help and financial support, adverse impact of rigid bureaucratic response, outdated legal framework, absence of knowledge-based market orientation, etc. have adversely affected the functioning of PCMS in India.

Weaknesses of PCMS

One of the major factors contributing to the weakness of primary units is related to service function of the cooperatives (Suryanarayana, 1995). The nature and viability of these service functions are also examined by Puhazhendi (1996) taking into consideration the performance of the Public Distribution System (PDS) of essential commodities in five different agro-climatic regions of the country. This study selected one state from each of the regions that had high volume of business under PDS and PACS. The study revealed that the PDS function of the cooperatives had become non-viable. The low volume of business as a result of a low number of cards being serviced, low margin high transaction costs, supply of poor quality of food grains, inefficient management of funds thin margin of price differentials between PDS and open market commodities, etc, were found to be the major contributing factors for the non-viability of PDS function. Pubhazhendi (1996) in this study recommended that the margin on the commodities being distributed through the PDS should be increased commensurate with the transaction costs of this function by the PACS. A recent study conducted by Das et al. (2006) found several causes for the slow progress of cooperative marketing, which mainly revolved around government interference, lack of awareness, restricted coverage, and functional weaknesses.

Conclusions

Though one can envisage several advantages in cooperative marketing, the structure remains weak as compared to credit cooperatives. The weaknesses arise due to the complex nature of marketing of agricultural produce, particularly fruits and vegetables. An efficient marketing system requires quick transport and storage facilities to avoid losses of produce, aside from keeping a watch on demand-supply forces to ensure remunerative prices to member farmers. Studies in the past have categorically emphasized on the fact that marketing of

produce, aside from keeping a watch on demand supply forces to ensure remunerative prices to member farmers. Studies in the past have categorically emphasized on the fact that marketing of produce through cooperatives offers much larger share to the producer in consumer rupee as against any other marketing channel (Shah, 1999 and 2000). However, despite inherent advantages in cooperative marketing, India is yet to have/achieve desired number of societies dealing with the marketing of agricultural produce. Though during the few decades after their inception, marketing cooperatives could not show very significant progress, their performance was remarkable after the period of eighties. But, in more recent times coinciding with the period of liberalization, these marketing cooperatives are again seen to be marked with very slow progress in their various functional activities, with several cooperatives associated with marketing of agricultural produce showing varied deficiencies and discouraging results insofar as their performance is concerned.

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Exert your talents, and distinguish yourself, and don't think of retiring from the world, until the world will be sorry that you retire.

—Samuel Johnson

Feature

Risk Coping Mechanism in the Flood Prone Areas of Majuli Sub-division of Assam

D C Kalita, B C Bhowmick, C Hazarika and R S Saikia

The present study aims to study the risk coping mechanism in the flood prone areas of Majuli sub-division of Assam, covering a total sample of 120 farmers using the multistage random sampling procedure and data collected by the personal interview method for the year 2000-01. The results showed that the large farms adopted crop diversification as a risk coping mechanism. The proportion of sample farmers engaged in varietal diversification was 72.06 per cent in the area. Among the ex-post mechanisms adopted by the sample farmers, selling of animals, implements, and other assets like land, was common amongst the sample farmers in the area.

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Risk is inherent in every form of enterprise, but its intensity in input-output relation in agricultural production is comparatively high. Flood is considered to be one of the major natural calamities having a profound impact on agriculture *vis-à-vis* the entire economy. Agricultural production in Assam suffers mostly due to recurrent flood. Assam is a riverine state, where riverine area covers more than one fourth of the total geographical area (Anonymous, 1997). The Brahmaputra, with more than 20 tributaries and sub-tributaries and the Barak with 9 tributaries, constitute the two–river system of the state. No district in the plains of Assam is immune from flood, though the periodicity of occurrence, intensity and duration of flood varies over time and coverage.

In Assam, the occurrence of floods starts from the onset of monsoon in May until October every year and brings untold misery to lakhs of people by destroying assets. The crop damage in Assam due to flood accounted for 75 per cent of the total flood loss (Goswami, 1988). Assam has a total flood prone area of 3.39 lakh hectares (Anonymous, 1980).

Majuli is the biggest River Island in the world. Majuli sub-division has an area of 924.60 square kilometres. Agriculture is the main source of earnings in the sub-division. Flood occurs in this river island almost every year with several waves, which causes severe land erosion, making the land unproductive and infertile besides damaging standing crops. The land erosion in Majuli in 1998-99 was 322.78 ha. The number of families affected by floods in 1998-99 was 286, which registered a growth rate of –3.70 per cent during 1970-1999. The crop affected by flood has increased from 1276.00 ha in 1969-70 to 3225.00 ha in 1998-99 (Anonymous, 2000).

The detrimental affect of floods compels the farmers to adopt some risk-coping mechanisms to reduce losses due to recurrence of floods. Farmer's risk coping mechanisms are of two type's *viz., ex ante* and *ex post*

mechanism. *Ex ante* coping mechanisms are designed to exploit low correlation among activity returns for stabilization of total income (Pandey, *et al*, 2000). The *ex ante* mechanisms are adopted by farmers are crop diversification parietal diversification, income diversification; temporal adjustments etc. Farmers also adopt some mechanisms to reduce loss after occurrence of flood, which is termed as *ex post* mechanism.

The present study, hence, is an attempt to examine the risk coping mechanisms adopted by farmers in the flood prone areas of Majuli sub-division of Assam.

Methodology

The present study was conducted in the Majuli sub-division of Jorhat district of Assam, covering a total sample farmers of 120. The sample farmers were selected by using multi-stage random sampling procedure and selected sample farmers were stratified into four size groups viz., marginal (less than 1.00 ha), small (1.01-2.00 ha), medium (2.01-3.00 ha) and large (above 3.01 ha) based on size of holding. Thus, 30 marginal, 33 small, 35 medium and 22 large farmers were finally selected for the study and primary data for the year 2000-01 was collected with the help of pre-tested structured schedules by the personal interview method. Simple tabular and percentage analysis were done to meet the specific objective of the study. Besides, diversification index like Herfindahl and Entropy Index were constructed to see the diversification of crops as an *ex ante* mechanism of risk which are given below:

Herfindahl Index:

$$H.I. = \Sigma P_i^2$$

Herfindahl Index defined, as the sum of square of all n proportions, is a measure of concentration. This measure can be applied both for acreage and income proportion of crops. In this study, this measure has been applied for acreage of crop enterprises. The value of Herfindahl Index varies between O and 1. Lower value of index indicates diversification and higher value indicates specialization.

Entropy Index:

$$E.I. = \Sigma P_i \text{ Log } 1/P_i$$

Entropy Index is regarded as an inverse measure of concentration having logarithmic character. This measure was taken both for acreage proportions of crops. Higher the value of this index, higher is the diversification and vice-versa. It also ranges between O and 1.

Results and Discussion

The *Ex ante* mechanisms adopted by sample farmers are:-

Crop Diversification

Growing several crops with poorly or negatively correlated yields can stabilize farm output. Other benefits include better exploitation of environmental niches, staggering of labour demand and meeting the demand for a range of outputs. Crop diversification was more in large farms as compared to marginal farms (Table 1). The lower the index value of Herfindahl index, the lower the crop diversification. The large farms adopted crop diversification as a risk coping mechanism.

Seasonal Crop Diversification

Herfindahl and Entropy index was also calculated season wise. The crop diversification was more in the *rabi* season than the *kharif* and summer season. For small farmers, diversification was more in the *Kharif* season. Amongst the different size groups of farms, diversification was more in large farms during summer season and lower in the case of medium farms. In *kharif* season,

Table 1: Crop Diversification Index of various size groups of farm.

Size groups	Herfindahl Index	Entropy Index
Marginal	0.14	0.19
Small	0.12	0.38
Medium	0.13	0.99
Large	0.11	0.99
Average	0.13	0.64

Table 2: Crop Diversification Index of various size groups of farm according to seasons

Size groups	Summer season		Kharif season		Rabi season	
	Herfindahl Index	Entropy Index	Herfindahl Index	Entropy Index	Herfindahl Index	Entropy Index
Marginal	0.26	0.59	0.38	0.45	0.43	0.44
Small	0.40	0.50	0.35	0.47	0.27	0.62
Medium	0.40	0.53	0.37	0.45	0.31	0.57
Large	0.24	0.64	0.47	0.37	0.23	0.67
Average	0.33	0.57	0.39	0.44	0.31	0.58

diversification was more in small farms and lower in large farms but the results were reverse in case of the *rabi* season (Table 2).

Varietal Diversification

Diversification through a growing of number of varieties of a crop usually stabilizes the total output of the crop if yields of different varieties are poorly correlated. Varieties with different duration can reduce risk by avoiding periodic risk. Similarly, varieties with different tolerance degree for pest and diseases and submergence also reduce risk.

The proportion of sample farmers engaged in varietal diversification was 72.06 per cent. Amongst the size groups of farm, the proportion of varietal diversification was found to be more in small farms (75.76 per cent) and lowest in large farms (72.06) per cent) (Table 3).

Temporal Adjustments

Temporal adjustments are the mechanism adopted by the farmer for reducing losses in poorer years and increasing gains in years that are more favourable. The proportions of farmers who adopted temporal adjustment mechanisms is presented in Table 3. On an average, about 31 per cent of the sample farmers adopted temporal adjustment mechanisms to reduce the loss in adverse years. Amongst the size groups of farms, the proportion was highest (42.29 per cent) in medium farms and lowest (24.24) in small farms.

Income Diversification

Diversification of income from farm to non-farm source is another mechanism of reducing loss. The source of income diversification governed by the factors such as education, infrastructure facilities available in the locality, access to credit facilities and availability of local resources. The percentage of respondents who adopted different income diversification measures across size of farms is shown in Table 3. The proportion of income diversification was about 50 per cent in the average farm situation. Amongst the size groups, the proportion of income diversification showed a decreasing trend with the increase

Table 3: Percentage of households engaged in varietal diversification, temporal adjustments and income diversification in various size groups of farm.

Size groups	Percentage of farmers		
	Varietal Diversification	Temporal Adjustments	Income Diversification
Marginal	70.00	30.30	53.33
Small	75.76	24.24	51.15
Medium	74.29	42.29	51.43
Large	68.18	27.27	45.45
Average	72.60	31.03	50.34

in farm size. This was might be due smaller size of operational holding in smaller size groups, which compel them to take other income generating activities other than agriculture.

Ex post mechanism adopted by sample farmers

Table 4 shows the sample farmers who resorted to selling of animals, implements, and other assets to cope with losses after floods. The major asset sold at different farm size groups were animals, land, and trees. Amongst the sample farmers surveyed, nearly 23 per cent had reported that they had sold goat, 20 per cent duck and poultry. In addition to sale of those animals, some farmers sold trees and land to meet the consumption needs, which were 10 and 8 per cent respectively.

Amongst the size groups who resorted to selling of animals, javellery, trees and mortgaged farm assets, marginal and small farms were more as compared to medium and large farms. Besides selling of assets, farms also adopted some other adjustment measures after flood.

The other adjustment measures taken by the sample farmers after occurrence of floods include about 57 per cent farmers having to postpone medical treatment (Table 5). Almost 47 per cent sample farmers had reduced expenditure on social obligations, 12 per cent sample farmers had migrated to other places and engaged themselves in non-farm activities. Besides these, 56 per cent farmers had curtailed expenditure on household's activities. Even expenditure for children for education was curtailed by about 56 percent of the sample farmers. Some farmers reported their inability to thatch the roof of their houses because of their inability to purchase thatch. About 23 to 26 per cent of the sample farmers resorted to borrowing to meet their domestic needs and fulfilling previous commitments.

Table 4: *Ex post* measures adopted by the sample farmers to sustain after floods (in percentage).

Measures	Marginal	Small	Medium	Large	Average
1. Selling of animals					
a. Duck	23.33	21.12	14.29	22..73	20.37
b. Bullock	13.33	15.15	5.71	–	8.55
c. Calf	10.00	27.73	–	22.73	9.43
d. Poultry	23.33	18.18	14.29	–	19.63
e. Cow	13.33	–	–	–	3.33
f. Goat	16.67	30.30	14.29	31.82	23.27
g. Pig	10.00	3.03	–	–	3.26
h. Pigeon	16.67	–	–	–	4.17
2. Selling of asset					
a. Jewellry	10.00	9.09	–	–	2.50
b. Land	–	6.06	8.57	13.64	7.83
c. Trees	10.00	–	8.57	13.64	9.57
d. Utensils	–	–	–	–	–
3. Mortgaging of asset					
a. Jewellry	6.67	18.18	5.71	–	7.64
b. Land	16.67	12.12	–	9.09	9.47

Table 5: Other households' adjustments in response to occurrence of floods by the sample farmers (in percentage)

Measures	Marginal	Small	Medium	Large	Average
1. Medical treatment postponed	50.00	51.52	71.43	54.55	56.88
2. Social obligation curtailed	43.33	45.45	34.29	63.64	46.68
3. Households expenditure curtailed	56.67	60.61	62.86	45.45	56.60
4. Land sold/lease out	—	9.09	8.57	13.64	7.83
5. Non maintenance of house	23.33	30.30	42.86	31.82	32.08
6. Children education curtailed	60.00	69.70	77.14	68.18	68.76
7. Borrowing	26.67	36.36	28.57	22.73	28.58
8. Permanent migration	6.67	15.15	17.14	9.09	12.01
9. Migration to non-farm activities	60.00	45.45	51.43	31.82	47.18

Conclusion

This discussion has highlighted the fact that crop diversification along with seasonal, varietal and temporal adjustment were some of the *ex ante* risk coping mechanisms that adopted by the sample farmers in the study area. The sample farmers also adopted the income diversification as risk coping mechanism and mostly small and marginal farmers took this risk coping mechanism. Amongst the *ex post* risk mechanisms, selling of animals, implements, and other assets like land, trees, and jewellry were taken by the sample farmers in the area. Besides these mechanisms, sample farmers had curtailed their expenditure on education, medical treatments and social obligations. Some farmers had resorted to borrowing to meet their domestic needs and fulfilling previous commitments.

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If we all did the things we are capable of, we would astound ourselves.

—Thomas Edison

Feature

An Empirical Analysis of Corporate Social Responsibility Practices of Selected Companies

Suresh K. Chadha, Paramjit Kaur & Deeksha

This study focuses on the corporate social responsibility practices of various companies associated with Birla Sun Life Insurance during 2006-2007. This study sought to formulate corporate social index parameters and apply this index for ranking to see whether Birla Sun Life Insurance had invested in high score corporate social responsibility index companies. The study established a cause and effect relationship between corporate social responsibility scores and company attributes i.e. sales, total assets etc., while acknowledging that Birla Sun Life Insurance had been mainly investing in high corporate social responsibility scores companies.

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In today's environment, business for its existence, sustenance and encouragement, has to take action which protects and improves the welfare of society. The notion of companies looking beyond profits to their role in the development of society is known as corporate social responsibility (CSR). The dynamics of CSR include how companies interact with their employees, suppliers, customers, and communities in which they operate and how they protect the environment (The Institute of Directors, UK, 2002). Corporate social responsibility encompasses the economic, legal, ethical, and discretionary expectations that society has from the companies at a given point time (Archie B. Carroll: 1979).

It is imperative for companies to make corporate social responsibility practices an integral part of strategy, and link these to delivering products or services to society. Thus, a firm should not think of the company's responsibilities only in terms of narrow financial interests, but should also link itself with ethical values, transparency, bettering employee relations, compliance with legal requirements and overall respect for the communities in which they operate. A trade-off must be maintained between these competing interests for the firm's overall benefit. Moreover, corporate social responsibility has to be a corporate philosophy that drives strategic decision-making, partner selection, hiring practices and, ultimately, brand development of companies (South China Morning Post, 2002). The success of a firm's corporate social responsibility reflects how well it has been able to navigate stakeholders concerns while implementing its business model. Thus, corporate social responsibility essentially means a more integrated and pro-active approach towards all the stakeholders to maximize the probability of its long-term survival and sustained growth.

Corporate social responsibility is then not only a way of 'doing business,' rather it may have to be enforced through public pressure. The term 'responsibility' implies

an internal work ethic as well as a sound practice in the every day working of a business. It has been seen that various Indian companies have been implementing corporate social responsibility practices from time to time by claiming to be model employers, by doing development work in villages or giving donations for good causes. Also, Indian companies have starting realizing the significance of CSR and are incorporating this into their corporate strategy for their survival in the long run. Clearly, corporate social responsibility will be the way to go in the future and some of the Indian companies are showing the way (see annexure I).

Review of literature

A number of studies have been conducted over a period of time with respect to the various aspects of corporate social responsibility. Apart from empirical evidence on CSR practices, some researchers have also investigated the benefits to companies of implementing CSR practices.

Agarwal (2003) attempted to evaluate the divergent social responsibility disclosure practices in the private and public sectors. The author constructed a social information disclosure index containing 26 items. The disclosure of social information is more popular or prevalent in the public sector companies. He has strongly supported the opinion of the Sachar Committee that a provision should be incorporated in the Companies Act wherein the Director's Report should include the social report, which would indicate and quantify the activities relating to social responsibility.

Williams, Siegel and Wright (2004) in their article diagnosed special issues related to corporate social responsibility and difficulties in globalizing the existing corporate social responsibility concepts. Cramer, Heijden and Jonker (2004) in their research paper studied 18 companies and the results showed that in corporate social responsibility general patterns were recognized. The paper mainly stated the practical results and detailed eight general rules on how to implement corporate responsibility, while pointing out the difficulties in globalizing the existing corporate social responsibility concepts.

Heal (2005) emphasized the impact of corporate social responsibility on the financial markets. The analysis suggested that there was resource-allocation role for corporate social responsibility programs in case of market failures through private-social cost differentials, and also in cases where distributional disagreements were strong. Morimoto, Ash and Hope (2005) focused on the possibility of developing a new corporate social responsibility auditing systems based on the analysis of literature and interviews conducted with a number of interested and knowledgeable stakeholders.

Mackey and Barney (2005) indicated in their study that managers should maximize the present value of their firm's cash flows in making strategic choices and the wealth maximizing interests of a firm's equity holders should be abandoned for the good of a firm's other stakeholders. Siegel and Vitaliano (2006) explained the role of information asymmetry and how corporate social responsibility has to be matrixed into a firm's product differentiation strategy. The analysis suggested that the firms' selling experience of goods and services are more likely to be socially responsible than firms selling search goods. Davis, Whitman and Zald (2006) investigated the impact of multinational firms' due to increased geographical and institutional boundaries on corporate social responsibility. It also explained the history of CSR practices changes in the global corporation and the pressures over the past 25 years, and analyzed the resulting mismatch between the contemporary corporation and traditional concepts of CSR.

Gupta and Saxena (2006) in their paper concluded that corporate social responsibility activities led to better business. They ensured future development with end results of reduction in cost and time, exploration of new destinations, and higher level of sensitivity of organizations towards society being served for aviation industry in India. Neetu Parkash (2006) probed the corporate social responsibility reports of various Indian companies on the basis of six broad elements. It was found that only 38.82% of companies were making such disclosures, with oil and petroleum sector, steel and engineering sector ranked the highest in making such disclosures. Sengupta (2007) emphasized the changing face of corporate social responsibility. He developed "The Emerging CSR Model" and showed the wider concept of CSR practices. Lyon and Maxwell (2007) explained the motives for and welfare effects of corporate greening. They showed how both market and political forces made environmental corporate social responsibility profitable for the companies. Lumsden & Fridman (2007) focused on the duties of directors and the wider role in the implementation of corporate social responsibility practices in the companies. Becchetti, Ciciretti and Hasan (2007) elaborated that corporate social responsibility was a core component of corporate strategy in the global economy. In recent years its importance had

become even greater, due to the financial scandals, investors' losses, and reputation damage to listed companies. The paper investigated the issue by tracing the market reaction to corporate entry and exit from the Domini 400 social index, recognized as a corporate social responsibility benchmark, between 1990 and 2004.

Dutta and Durgamohan (2007) in their study focused on corporate social responsibility as a strategic move that organizations can incorporate in their overall business strategy, for the purpose of achieving better all-round performance. Chatterji, Levine and Toffel (2008) explained that ratings of corporations' environmental activities and capabilities influenced billions dollars of "socially responsible" investments as well as some consumers, activists, and potential employees. In the study these ratings were accessed and it was examined as to how well the most widely used ratings— those of Kinder, Lydenberg, and Domini Research & Analytics (KLD)— provided transparency about past and likely future environmental performance and its impact on financial performance.

Need of the study

In the light of the studies discussed and literature reviewed on the subject, it can be inferred that most of the research work done has been on various challenges focusing on one or more elements of corporate social responsibility, such as environmental protection, health and safety, corporate governance, human resource management practices, human rights, community development and consumer protection. The challenges often call for voluntary actions by companies to demonstrate responsible behaviour and effective responses to social and environmental problems—both in the domestic and international contexts.

Corporate social responsibility practices are important because they influence all aspects of a company's operations. Increasingly, consumers want to buy products from companies they trust; suppliers want to have business partnerships with a company they can rely on; employees want to work for companies they respect; large investment funds want to support firms they see as socially responsible; and non-profits and NGOs want to work together with companies to seek practical solutions to common goals. Moreover, satisfying each of these stakeholder groups (and others) allows companies to maximize their commitments to their owners (their ultimate stakeholders), who benefit most when all of these groups needs are being met. Increasingly, shareholders, customers, partners and employees are going to vote with their feet, rewarding those companies that fuel social change through business. This is simply the new reality of business and one that we should and must embrace.

The relevance of corporate social responsibility is increasingly crucial to success because it gives companies a mission and strategy around which multiple constituents can rely. The businesses most likely to succeed in today's rapidly evolving global environment will be those best able to balance the often conflicting interests of their multiple stakeholders.

Research Objectives

The main objectives of the study are to formulate corporate social index parameters and apply this index for ranking and to see whether Birla Sun Life Insurance has invested in high score corporate social responsibility index companies. The aim is also to study the relationship of corporate social responsibility score of these companies with selected parameters affecting financial performance.

The present study focuses on the corporate social responsibility practices of various companies mainly associated with Birla Sun Life Insurance during 2006-2007.

The stratified sample had been taken on the basis of companies in which Birla Sun Life Insurance has invested in 2006-07. There were 64 companies in which Birla Sun life Insurance had invested in the equity market. After finding various companies in which Birla Sun Life Insurance invests, the next step was to rank these companies on the basis of their market capitalization as per the National Stock Exchange Sensex during 2006-07. For the study the market capitalization values of all these companies as on 31st March, 2007, was taken and the companies were ranked in ascending order.

On analysis, it was observed that among these 64 companies there were 30 companies, which were ranked among the top 100 companies at the National Stock Exchange, but due to non-availability of data only 26 companies were taken (see annexure II).

The data collected was mainly secondary in nature. The important sources were published annual reports, Directors' reports, brochures published by the companies, articles published about the selected companies in reputed journals, and respective companies' websites. The period of study is from April 2006 to March 2007.

In order to achieve the objectives the corporate social responsibility index had to be formulated. It was done thorough analysis of research studies, articles of company's practices of corporate social responsibility and also the initiatives of the Confederation of Indian Industry were used in the identification of corporate social responsibility key areas and sub-elements of corporate social responsibility index (see annexure III).

The corporate social responsibility index was formulated for 25 companies which were selected for the study. This index was used for ranking the companies and analysing whether Birla Sun Life Insurance had invested in high corporate social responsibility score companies on the corporate social responsibility index. For this purpose scores were decided as "1" for each factor that the company discloses in its annual report and "0" for each undisclosed factor (see annexure IV).

Further, to study the relationship of corporate social responsibility scores of each company with selected performance attributes were analyzed. The selected parameters were:

(i) The value of Return on Equity (ROE) and Return on Capital Employed or Return on Investment (ROI) is calculated. ROE is a relative measure of profitability for the owners and is calculated using the following formula:

$$ROE = \frac{\text{Profits After Taxes}}{\text{Net Worth (Equity)}} = \frac{PAT}{NW}$$

(ii) Return on Capital Employed (ROE) means the funds employed in net assets of a firm and is calculated using the following formula:

$$ROI = \frac{\text{Earnings Before Interests and Taxes}}{\text{Total Assets}} = \frac{EBIT}{NA}$$

(iii) Growth in sales refers to the net increase in the volume of sales with respect to previous year's sales. Growth in sales is calculated using the following formula:

$$\text{Growth in Sales} = \frac{\text{Current year sales} - \text{Previous year sales}}{\text{Previous year's sales}} \times 100$$

(iv) Net assets (also known as owner's equity, shareholders equity or net worth) are the total assets minus the total liabilities of a company or individual. On the balance sheet, net assets comprises both capital stock and additional paid in capital, which represent amount paid into the companies for its shares.

(v) Shareholders funds are the balance sheet value of shareholders interest in a company.

(vi) Market Capitalization is defined as that proportion of total shares issued by the company, which are readily available for trading in the market. It generally excludes promoter's' holdings, government holdings, strategic holdings and other locked-in shares, which will not come to the market for trading in normal course.

(vii) Net Profit after tax is one of the most important components. It refers to the net income as a result of the impact of all the factors on the firm's earning.

Various appropriate statistical tools like mean, standard deviation, coefficient of variation were applied to draw conclusions.

Data Analysis and Main Findings of the Study

The quality of social responsibility is very crucial for the continued existence of a corporate entity. In order to identify companies with high and low social responsibility score, the corporate social responsibility index was developed. The social responsibility scores of respective companies for the year 2006-07 have been shown in the tables (see Annexure V).

This reveals that the maximum score of 57 was attained by ITC Ltd and the second one was by Reliance Industries Ltd. with a score of 52. Infosys, ONGC and NTPC were ranked third with the corporate social responsibility score as 51. NTPC and ONGC were also recipients of the Business World FICCI-SEDF corporate social responsibility Award, 2007. Mahindra and Mahindra Ltd. was also rewarded the same award and attained an aggregate score 49. The lowest score of 24 was attained by Larsen & Tuobro Ltd.

In case of social responsibility towards employees the highest score of 14 was attained by ITC Ltd, Sterlite Ind. Ltd. and Sun Pharmaceuticals Industries Ltd., whereas ONGC, NTPC and Mahindra and Mahindra Ltd. scored the second highest score of 13. The lowest score of 5 was attained by Larsen and Tuobro Ltd, Maruti Suzuki Ltd and Glenmark Pharmaceuticals Ltd. Factors like human resource management, employee's welfare, employee productivity, and the consideration of employees as a resource were disclosed by every company. It was also found that human resource audit, voluntary retirement schemes, employee pension schemes, etc. were not disclosed by most of the companies.

In case of social responsibility towards customers, the highest score of four was attained by ten companies and the lowest one by only two companies. Moreover, the factors like better service/product quality – ISO Certified and disclosures about intangibles were also disclosed by almost all the companies in their annual reports.

In case of social responsibility towards society, the highest score of 16 was attained by ITC Ltd. and lowest of three by BHEL, RIL and Tata Motors Ltd. Other factors such as promoting entrepreneurship, rewards and scholarship, health risk audit, charitable contributions were disclosed by few companies. It was further observed that common factors like creating and maintaining infrastructure, protection of human rights, local community's welfare, energy conservation, water management, and women empowerment were disclosed by almost all the companies.

In case of social responsibility towards the shareholders highest score of six was attained by RIL, Infosys, NTPC, ITC Ltd, Sun Pharmaceuticals Industries Ltd and the lowest score of three was by Sesa Goa Ltd, Tata Chemicals Ltd. and Ultra Tech Cement Ltd.

In case of social responsibility towards vendors the maximum score of four was attained by Infosys, and HUL and zero score by 14 companies, like L&T, BHEL, Tata Steel Ltd, Sun Pharmaceuticals Ltd., Tata Power Ltd, Maruti Suzuki Ltd, Ranbaxy Laboratories Ltd, Tata Motors Ltd, Glenmark Pharmaceuticals Ltd, Sesa Goa Ltd, Power Finance Corporation Ltd, Crompton Greaves Ltd and Ultra Tech Cement Ltd, did not disclose any CSR practices towards vendors in their annual reports.

In case of social responsibility towards the Government a maximum score of two was attained by almost all of the companies and in case of responsibility towards other parties a maximum score of 15 was attained by RIL and lowest score of six by six companies. Also, Capital Integrity Audit was one of the parameter undertaken by only two of the companies, i.e. RIL and ONGC. Almost all of the companies disclosed the preparation of sustainability reports and it had been observed that more than 50% of the companies had a corporate responsibility score above 30 (i.e. approx 50% of total score). Therefore, we may conclude that Birla Sun Life Insurance had been mainly investing in high corporate social responsibility scores companies.

Relationship of Corporate Social Responsibility Score to Company Attributes

The study established a cause and effect relationship between corporate social responsibility scores and company attributes i.e. sales, total assets, net worth/ shareholders funds, profit after taxes, return on net worth, return on investment/capital employed and market capitalization etc. Thus, mean, standard deviation and coefficient of variation have been applied for each attribute.

Table 1 reveals that the companies in the range of Return on Equity of more than 50% have the highest mean corporate social responsibility score of 116.89 and a minimum of 15.51 for companies less than 25%. It can be observed that that the mean corporate social responsibility score has increased with the highest level of Return on Equity. Also, the variation in corporate social responsibility was maximum in the case of 10 companies having ROE in the range of below 25% and was minimum in the case of two companies in the range of 50% and above.

Table 1: Relation of CSR Scores and Return on Equity (Rs. in Crores)

Range	No. of Companies	Mean CSR Score	Standard Deviation	Coeff of Variation
Upto 25%	10	15.5080	7.67414	49.48504
25%-50%	14	32.8936	7.58578	23.06157
Above 50%	2	116.8900	23.88607	20.43466

Source: Annual reports of companies

The relationship with corporate social responsibility scores and return on capital employed as indicated in Table 2 is that companies in the range of Return on Investment more than 50% have the highest mean corporate social responsibility score of 107.16 and a minimum of 14.29 for companies less than 25%. It can be observed that that the mean corporate social responsibility score has increased, with the highest level of Return on Equity. Also, the variation in corporate social responsibility was maximum in case of 12 companies having a Return on Investment in the range of below 25% and was minimum in the case of 11 companies ranging between 25% and 50%.

Table 2: Relation of CSR Scores and Return on Capital Employed (Rs. in Crores)

Range	No. of Companies	Mean CSR Score	Standard Deviation	Coeff. of Variation
Upto 25%	12	14.2858	6.85347	47.974
25%—50%	11	31.7300	4.96220	15.63883
Above 50%	3	107.1633	44.25003	41.29215

Source: Annual reports of companies

Table 3 depicts the relationship between corporate social responsibility scores and growth in sales. Growth in sales refers to the net increase in the volume of sales with respect to previous year's sales. The highest mean corporate social responsibility score is 75.75 in case of companies with a growth in sales of 50% and above, and the minimum is 13.21 in case of companies having a growth in sales of 25% and below. Also, the variation in corporate social responsibility was maximum in case of 13 companies having growth in sales in the range of below 25% and was minimum in case of two companies in the range of 25%—50%.

Table 3: Relation of CSR Scores and Growth in Sales (Rs. in Crores)

Range	No. of Companies	Mean CSR Score	Standard Deviation	Coeff of Variation
Upto 25%	13	13.2062	7.15600	54.18667
25%—50%	9	34.2689	7.60502	22.19219
Above 50%	4	75.7550	28.89489	38.14255

Source: Annual reports of companies

Net assets (also known as owner's equity, shareholders equity or net worth) are the total assets minus the total liabilities of a company or individual. In the balance sheet, net assets comprise both capital stock and additional paid in capital, which represent cash paid into the companies for its shares. Table 4 establishes the relationship with corporate social responsibility scores and net assets and it reveals that the companies in the range of net assets above 15000 have the highest mean corporate social responsibility score of 46353.66 and a minimum of 27.23.31 for companies less than 10000. It can also be observed that that the mean corporate social responsibility score had increased with the increase in net assets. Moreover, the variation in corporate social responsibility was maximum in the case of 19 companies having net assets up to 10000 and was minimum in the case of four companies in range of net assets 15000 and above.

Table 4: Relation of CSR Scores and Net Assets (Rs. in Crores)

Range	No. of Companies	Mean CSR Score	Standard Deviation	Coeff of Variation
Upto 10000	19	2723.3062	3242.67886	119.0714
10000-15000	3	7979.5100	7953.79822	99.67778
Above 15000	4	46353.66	36850.34715	79.49825

Source: Annual reports of companies

Shareholder funds are the balance sheet value of shareholders interest in a company. Table 5 indicates the relation of corporate social responsibility scores and shareholder funds and it is found that mean corporate social responsibility score is highest as 14660.34, in case of companies having range above 5000 and is least as 321.05 in case of companies ranging up to 1000. Also, the variation in corporate social responsibility was maximum in case of 11 companies having shareholders funds above 5000 and was minimum in case of 5 companies in range of 1000—5000.

Table 5: Relation of CSR Scores and Shareholders Funds (Rs. in Crores)

Range	No. of Companies	Mean CSR Score	Standard Deviation	Coeff of Variation
Upto 1000	11	321.0545	314.79706	98.05097
1000-5000	5	2216.7860	822.39554	37.09855
Above 5000	11	14660.34	17534.97246	119.6082

Source: Annual reports of companies

Market capitalization is defined as that proportion of total shares issued by the company, which are readily available for trading in the market. It generally excludes promoter's holdings, government holdings, strategic holdings and other locked-in shares, which will not come to the market for trading in normal course. Table 6 indicates the relationship with corporate social responsibility scores and market capitalization reveals that the companies in the range of market cap above 100000 have highest mean corporate social responsibility score of 148776.6 and minimum of 19378.74 for companies less than 50000. It can be observed that that the mean corporate social responsibility score have increased with the rise in value of market capitalization. Also, the variation in corporate social responsibility was maximum in case of 5 companies having market cap above 100000 and was minimum in case of 5 companies having market cap ranging 50000—100000.

Table 6: Relation of CSR Scores and Market Capitalization (Rs. in Crores)

Range	No. of Companies	Mean CSR Score	Standard Deviation	Coeff of Variation
Upto 50000	16	19378.74	11032.98585	56.93345
50000-100000	5	65942.74	9799.47763	14.86059
Above 100000	5	148776.6	107298.27310	72.1204

Source: Annual reports of companies

Net Profit after taxes is one of the most important items in the balance sheet. It refers to the net income as a result of the impact of all the factors on the firm's earning. Table 7 reflects the relation of corporate social responsibility score and Net Profit after taxes reveals that the companies in the range of more than 5000 have highest mean corporate social responsibility score of 11943.40 and minimum of 291.14 for companies less than 1000. It could be observed that that the mean corporate social responsibility score have increased with the highest level of profit after taxes. Also, the variation in corporate social responsibility was maximum in case of 16 companies having PAT below 1000 and was minimum in the case of nine companies having profit after taxes ranging from 1000—5000. For the range above 5000, the coefficient of variation cannot be determined as there was only one company in this category.

Table 7: Relation of CSR Scores and Profit after Taxes (Rs. in Crores)

Range	No. of Companies	Mean CSR Score	Standard Deviation	Coeff. of Variation
Upto 1000	16	291.14	349.50876	120.05
1000—5000	9	2610.7544	1157.18769	44.32
Above 5000	1	11943.40	-	-

Source: Annual reports of companies

The attempt provided interesting insights on the impact of CSR on various performance attributes of a company. The companies whose CSR score were high were the only ones with high performance attributes of companies. The companies having higher range of return on equity and return on capital employed have attained maximum CSR scores. The companies having higher growth in sales, maximum value in net assets, higher shareholders funds and higher market capitalization were the only ones having higher CSR mean scores with comparison to other companies.

Conclusion and Suggestions

In recent times, companies are increasingly realizing that CSR is no longer a collection of discreet practices or occasional gestures motivated by marketing or public relations. It is rather a comprehensive set of practices and policies that should be integrated into the organizations operations and activities.

It had been observed that companies are increasingly getting more involved in CSR activities, with a few notable exceptions. The companies were analyzed as per the list key areas and sub-elements of corporate social responsibility which included responsibility towards employees, customers, society, shareholders, vendors, government and other parties. It was found that companies like ITC Ltd, ONGC, NTPC, Reliance Industries Ltd, Mahindra and Mahindra Ltd, were some of the top rankers with a high CSR scores. Moreover, these were the companies who had bagged various corporate social responsibility awards for the year ending 2006-07. The companies like Larsen & Tuobro Ltd, BHEL, Tata Power Ltd, Glenmark Pharmaceuticals Ltd, Sesa Goa Ltd and Zee Entertainments Ltd have attained the least CSR scores. These companies were suggested to improve their corporate social responsibility practices to be competitive in the globalized environment.

The same holds good for the Indian companies studied here like ITC Ltd, ONGC, NTPC, HUL, RIL, etc. Further, Tata group companies like Tata Steel Ltd, which is of the opinion that the wealth created out of business operations should be given back to the society, which is just not philanthropic, but goes beyond it. Thus, it has been observed that CSR impacts not only the environment and the general public at large but is also profitable for the organization. Also, by being socially responsible 'firms can proactively anticipate and handle government regulations, exploit opportunities arising from increasing levels of cultural, environmental and sexual awareness and differentiate their products from their less socially responsible competitors'.

In India, although corporate social responsibility practices in companies still have a long way to go, but definitely various institutions and companies have shown a positive approach towards CSR practices and initiatives are satisfying.

Based on the above-mentioned observations some general "rules" can be derived that can be applied to all the companies for successful application of CSR practices:-

1. To start the implementation process of CSR in a pragmatic, step-by-step way;
2. To adopt an approach that is closely attuned to the company's culture and the way of working and communicating;
3. To make sure that the Board is committed and assumes a leading role over a long period of time;
4. To consider CSR as a cyclic, continuous improvement process in which monitoring and reporting plays a key role;
5. To keep corporate social responsibility practices simple.
6. To ensure various actions are well coordinated and show coherence;
7. To strengthened the corporate identity and values of the organization by actively communicating internally and externally the mission, strategy and results gained in implementing CSR.

We may conclude that CSR initiatives should form part of the overall business strategy so that they are taken in the right earnest by firms and successfully implemented. Further, CSR is increasingly becoming a driver of business growth and is seminal in the success of the organization in the years to come. It can be concluded that the HUL's CSR strategy can be viewed as a twin-pronged strategy wherein they are empowering the women and working for a social cause and along with they are also creating enhanced sales through their women representatives and reaching areas which were till now inaccessible to them. Hence it can be considered as a revenue generating model within the CSR initiatives.

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Annexure I

Corporate Social Responsibility Practices of Selected Companies

COMPANY	HIGHLIGHTS OF CORPORATE SOCIAL RESPONSIBILITY ACTIVITIES
CII	• Assists in identifying social issues and activating partnerships of members with NGOs for adding to human development. • Community efforts for corporate are stressed in many fields such as health, education, regional development, and others. • Helps large companies in developing health programs for workers, raising awareness about HIV/AIDS, tuberculosis and public health. • Set out best practices in community work, and the benefit that can be derived from it to enable companies to develop their own programs.
Birla Group	• Imparts adult education. • Runs 15 hospitals and 78 schools all over the India. • Rehabilitates handicapped persons and have reached to more than 5,000 physically challenged individuals. • More than 100,000 patients have been examined under the group's medical programmes. • Over 15,000 children along with 2,000 pregnant women have been immunized and over 500 cataract patients operated.
TATA Group	• About 7000 villages around Jamshedpur and Orissa benefit from development programmes run by the Tata Steel Rural Development Society (TSRDS). • The Company Development and Society Welfare Development (CDSW) at TATA Steel carries out medical and health programmes, blood donation camps, mass screening of tuberculosis patients, immunization and drug rehabilitation camps. • Developed a model (TBEM—Tata Business Excellence Model) to serve the varying interest of its multiple stakeholders. This model encompasses the interests of customers, shareholders, employees, Government and society.
ITC Ltd.	• Pioneered Triple Bottom Line Reporting in India. • Creation of E-Choupal, Choupal Sagar and ITC Social Farm Forestry Program serving 1,00,000 villages representing one-sixth of rural India. • Managing natural resources through 'Sunahra Kal' project.
Grasim India Ltd.	• Medical camps were conducted across your Company's Units, wherein the villagers were examined and provided the necessary treatment. • AIDS awareness camps were conducted to build greater awareness amongst students and the people amidst whom we work. • Nurturing the child through preschool education in the form of Balwadis, Bal Sanskar Kendras. • Agriculture – farmers benefit through farm-based programmes, training, nursery raising, seed multiplication and intercropping. • Infrastructure development through the construction and repair of roads, setting up troughs and drinking water structures.
Infosys	• Initiatives in the areas of Research and Education. • Community Service. • Rural Reach Programmes. • Welfare activities undertaken by the Infosys Foundation.
Mahindra &.	• K. C. Mahindra Education Trust was established in 1953 to promote education.

COMPANY	HIGHLIGHTS OF CORPORATE SOCIAL RESPONSIBILITY ACTIVITIES
Mahindra Ltd	• The Trust has provided more than Rs 7.5 crore in the form of grants, scholarships and loans. • The Nanhi Kali project has over 3,300 children with an aim to increase the number of Nanhi Kalis (children) to 10,000 in the next 2 years, by reaching out to the underprivileged children especially in rural areas.
Larsen & Toubro Ltd.	• Regulate and promote Construction Vocational Training (CVT) in India by establishing a Construction Skills Training Institute (CSTI).

Source: Annual Reports and Websites of Companies

Annexure II

List of Sample Companies

Reliance Industries Ltd.	ONGC	Sun Pharmaceutical Industries Ltd
Bharti Airtel Ltd	Infosys	Maruti Suzuki India Ltd
NTPC Ltd.	Larsen & Toubro Ltd.	Grasim Industries Ltd.
ITC Ltd	Bharat Heavy Electricals Ltd	Glenmark Pharmaceuticals Ltd.
Tata Steel Ltd.	Sterlite Industries Ltd	Sesa Goa Ltd.
Hindustan Unilever Ltd (HUL)		Zee Entertainments Ltd.
Tata Power Co. Ltd.	Power Finance Corporation Ltd	Tata Chemicals Ltd
Ranbaxy Laboratories Ltd.	Crompton Greaves Ltd	Mahindra and Mahindra Ltd.
Tata Motors Ltd.	Ultra Tech Cement Ltd.	

Source: Annual Reports of Birla Life Insurance

Annexure III

Elements of Corporate Social Responsibility Index

Responsibility towards Employees	**Responsibility towards Shareholders**
Human Resource Management	Better Financial Disclosures
Employees Welfare	Protection of Shareholders Interests
Employee Productivity	Providing Adequate Information – Through Websites
Treatment of Employees as Resources.	Check Future Forecasting
Life and Career Planning	Investor's Grievance Committee
Employee Volunteer Programmes	Assured Returns
Better Job Design	**Responsibility towards Vendors**
Creating Employment Opportunities	Sharing the Risk
Work Safety	Supply Chain Management
Health Measures	Providing Support and Facilitation
Human Resource Audit	Business Partners
Voluntary Retirement Scheme	**Responsibility towards Government**
Employee Pension Scheme	Tax Assessment
Grievance Management System	Legal Compliances
Employee Stock Option Plans	**Responsibility towards Other Parties**
Training Programmes	Rise in Competition
Responsibility towards Customers	Globalization
Better Service / Product Quality – ISO Certified	Exports Involvement
Disclosures About Intangibles	CEO/CFO Certification
Create Awareness – Through Market Surveys	SEBI Compliances
Not Involving In Monopolistic Activities - Charging Fair Prices	Secretarial Audit
Responsibility towards Society	Preparation of sustainability reports
Protection of Environment	Research and Development
Promoting Entrepreneurship	Disaster management
Rewards and Scholarship	Cost Audit
Contribution to NGO's	Qualified Audit /report
Corporate Involvement in Community Education	Value Creation

Responsibility towards Employees	Responsibility towards Shareholders
Medical Facilities	Working in SEZ's
Health Risk Audit	Forward Looking Statements
Management Of Environmental Impacts	Adoption of Mandatory and Non Mandatory Requirement of Clause 49
Create and Maintain Infrastructure	Capital Integrity Audit
Protection of Human Rights	Balanced Score Card
Local Communities Welfare	
Charitable Contributions	
Energy Conservation	
Social Audit	
Water Management	
Women Empowerment	
Environmental Audit	

Source: Analysis O of Annual Reports of Companies & Research Articles on CSR

Annexure IV

Corporate Social Responsibility Index – Information Used

No.	Broad Parameters	No. of Information Items	Maximum Score Assigned
1.	Responsibility towards employees	16	16
2.	Responsibility towards customers	4	4
3.	Responsibility towards society	17	17
4.	Responsibility towards shareholders	6	6
5.	Responsibility towards vendors	4	4
6.	Responsibility towards government	2	2
7.	Responsibility towards other parties	17	17
	Total	**62**	**62**

Source: Analysis of Annual Reports & Research Articles on CSR

Annexure V

Corporate Social Responsibility Score of Companies

	Reliance Industries Ltd	ONGC	Bharti Airtel Ltd	Infosys	NTPC Ltd
Employees	10	13	11	12	13
Customers	4	4	3	4	3
Society	13	11	11	12	11
Shareholders	6	5	5	6	6
Vendors	2	2	3	4	3
Government	2	2	2	2	2
Other Parties	15	14	6	11	13
Total	**52**	**51**	**41**	**51**	**51**

	Larsen & Tuobro Ltd	ITC Ltd	BHEL	Tata Steel Ltd
Employees	5	14	8	10
Customers	3	4	3	2
Society	5	16	3	11
Shareholders	4	6	4	5
Vendors	0	3	0	0
Government	0	2	2	1
Other Parties	7	12	6	7
Total	**24**	**57**	**26**	**36**

	Sterlite Ind. Ltd	HUL	Sun PharmaceuticalsLtd	Tata Power Ltd
Employees	14	7	14	6
Customers	3	4	2	3
Society	8	9	5	8
Shareholders	5	4	6	4
Vendors	1	4	0	0
Government	1	0	1	1
Other Parties	8	6	10	6
Total	**40**	**34**	**38**	**28**

	Maruti Suzuki Ltd.	Ranbaxy Laboratories Ltd	Grasim India Ltd	Tata Motors Ltd	Glenmark Pharmaceuticals Ltd	Mahindra & & Mahindra Ltd
Employees	5	12	8	6	5	13
Customers	3	2	3	4	2	4
Society	7	6	10	3	4	12
Shareholders	4	5	5	5	5	5
Vendors	0	0	0	0	0	3
Government	1	1	1	2	2	2
Other Parties	10	9	9	9	8	10
Total	**30**	**35**	**36**	**29**	**26**	**49**

	Sesa Goa Ltd	Power Finance Corporation Ltd	Zee Entertainments Ltd	Crompton Greaves Ltd	Tata Chemicals Ltd	Ultra Tech Cement Ltd
Employees	6	8	6	7	7	12
Customers	2	4	3	4	1	1
Society	6	6	4	8	9	9
Shareholders	3	5	5	4	3	3
Vendors	0	0	1	0	2	0
Government	2	1	1	2	0	1
Other Parties	10	6	7	8	8	8
Total	**29**	**30**	**27**	**33**	**30**	**34**

Source: Annual Reports & Websites of Companies

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