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Social Capital & Productivity Improvement in Japan

Yoji Inaba

This paper focuses on whether social factors can affect economic performance in the context of Japan's sluggish Total Factor Productivity (TFP).

Yoji Inaba is a faculty member of the College of Law, Nihon University.

The last decade, suggesting the period of low economic growth in the 1990's and early 2000s, has been frequently mentioned by Japan's mass media in the last five years. The annual average of real GDP growth rate in the 1990's remained at just one per cent, which is substantially below the four per cent growth rate achieved during the 1980's. The major portion of the decline in GDP growth in the 1990's can be attributed to the sluggishness of the Total Factor Productivity (TFP), defined as the portion of growth which cannot be explained either by changes in labour input or by those in capital stock. According to Inaba (2002a), TFP for Japan's economy registered a slight decline in the 1990's, while it was a major driving force for economic growth in the previous decades. What caused the drastic decline in TFP in Japan in the 1990's?

Since TFP based on the above mentioned definition includes all residual factors other than capital stock and labour input, it is affected by many factors including quality of human resources, changes in the level of technological competitiveness and external shocks such as oil price increases. It is also well known that the TFP is affected by business cycles. That is, once, the economy moves into a downturn, the contribution of TFP to economic growth decelerates, and during an upturn, an acceleration of TFP is observed.

However, as for the quality of Japan's labour force, it is unlikely that the quality of Japan's human capital or labour force deteriorated during the 1990's. The level of education received by Japan's labour force has been stable in the past twenty years.

The level of technological competitiveness is reflected by the amount of research and development (R&D) activities. R&D expenditure in Japan remained relatively high in comparison with those in other OECD countries. The country has kept the high level of the current account surplus, which is another illustration of Japan's international competitiveness. Judging from

this, it is again difficult to perceive how Japan's international competitiveness has drastically eroded in the past decade.

Importance on the productivity of social factors is often overlooked by economists. However, relationships among peers in firms have always drawn the attention of scholars in the field of business administration. Good relationships often enhance labour productivity. For instance, Carlos Ghosn, chief executive officer (CEO) of Nissan, created nine cross-functional teams (CFTs) consisting of managers from different divisions when he was creating Nissan's revival plan. One of these CFTs included designers, production engineers, procurement officers and marketing specialists. Thus it facilitated communication among peers of different backgrounds. Those CFTs eventually lead to better communication among different divisions. He also made it clear that he would take full responsibility for the operational results of the company by declaring his will to resign from the post of CEO in case of continued loss. These changes helped to create trust and a sense of cohesion among the workers of Nissan.

The case of Nissan seems to suggest the importance of social factors in the analysis of TFP. If some social factors such as trust, norms and networks, can enhance the performance of a firm, obviously, the deterioration or lack of them should cause a decline in performance. Can we apply this anecdote-based lesson to the entire economy? If we can, what are these social factors which affect economic performance? How can we measure them? What are the precise processes and to what degree do they affect the economy? Are they different from one country to another? The purpose of this paper is to provide a basis for discussions on these questions.

If some social factors such as trust, norms and networks, can enhance the performance of a firm, obviously, the deterioration or lack of them should cause a decline in performance.

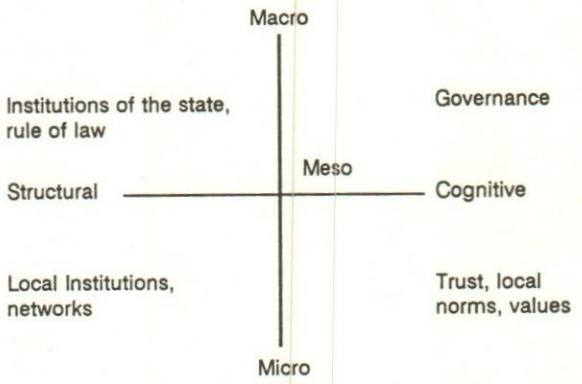
Definition

The best known definition of social capital is given by Putnam (1993a); "Social capital – refers to features of social organisation, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions". According to OECD (2001), social capital is defined as "networks together with shared norms, values and understandings that facilitate co-operation within or among groups". As for trust, which is treated as one of the most important elements of social capital, the OECD's paper views it as "both a source and an outcome of social capital as well as being a very close proxy for many of the norms, understandings and values which underpin social co-operation".

Although there is no consensus on the definition of social capital, in many cases social capital takes two forms: Structural and cognitive (Groetaert and van Bastelaert, 2002). Networks such as associations, casual ties with neighbours and peers are structural social capital, while norms, trust, values and understandings are cognitive social capital. In other words, the former is objective, while the latter is subjective.

Social capital is found at various levels of daily activities; macro, micro and in-between. At the micro level social capital is found among individuals and households at various settings such as work places and in their communities. On the other hand, social capital based on the World Values Survey mainly reflects its aspects at the macro level. It does not imply relationships with specific individuals or groups.

Two Dimensions of Social Capital



Source: Grootaert and von Bastelaert (2002)

In many papers, trust is treated as one of the key elements of social capital. Uslaner (2002) divides trust into two categories: Moralistic and strategic. "Putting faith in strangers in moralistic trust. Having confidence in people you know is strategic trust" (p.4). He also makes a difference between particularized trust and generalized trust.

> "We might learn to trust our fellow club members more, but we are merely reinforcing particularized trust (in our own kind) rather than generalized trust, the idea that "most people can be trusted". (p.5)

In this paper, a rather broad concept for social capital is used by defining it as intangible resources contained

in both individuals and in the community, which enhance cooperative actions among individuals. These resources are networks, norms, trust and so on.

How Does Social Capital Affect Economic Activities?

Carlos Ghosn revitalized Nissan by mobilizing intra-company social capital through cross functional teams (CFTs). CFTs reduced intra-company frictions through better communication networks. It also enhanced the motivation among workers below middle-class management level because CFTs consisted of relatively young people. It helped to alleviate mistrust among workers towards the top management, and thus, created trust towards the new management team. Although social capital is not the only factor contributing to the revitalization of Nissan, it seems to be of vital importance in improving the performance of the workers. Nissan's case suggests possible paths through which social capital functions.

In the first place, social capital may reduce transaction costs among both economic entities and individuals. Communication among different divisions in large organisations like Nissan is always time-consuming and costly. Quite frequently, each division behaves like an independent company, and thus creates information barriers around it. The same situation can be applied to the transactions between various economic entities including firms, households, governments and even NPOs (non-profit organisations). These transaction costs, particularly those for contracts and legal checks can be lower in a society with abundant social capital.

Secondly, social capital may improve a sense of cohesion which, in turn, promotes co-operation among workers or members of communities. It seems to create synergy effects or some positive externalities in the operations of organisations. Carlos Ghosn's success can be, at least partly, attributed to the fact that he made his colleagues understand how they are interrelated with each other. It is a creation of new social capital in the form of new networks among workers.

Thirdly, these improvements lead to more optimistic views on strategic trust, since the probability of reciprocity, that is your favour will be returned in the future, is higher than it used to be. Workers who used to be ignorant of or indifferent to activities of other sections, did not mind if they carried out activities which were contradictory to those of other divisions. In such a situation, one can not expect a virtuous cycle of reciprocity. Once they have a better understanding of what others are doing, the situation could be completely different. In other words, as mentioned above, people now fully understand how everyone is interconnected with each other. They have more coordinated behaviours in which norms of reciprocity can exert a positive impact on the performance of the firm.

Fourthly, a clear stance on corporate governance shown by the COO-enhanced norms of the company, may have reduced sabotage and corruption. Importance of social capital on organisational governance is of vital importance in the public sector as well. Putnam (1993b) pointed out that abundance of social capital is attributable to the efficiencies of local government in the northern part of Italy.

There are many instances in which social capital may have an impact on economic activities. A most exhaustive list is found in Omori (2003). He pointed out the following as possible microeconomic channels through which social capital functions:

- Social capital, especially trust, reduces costs of contracts and legal action.
- Social capital especially trust, shared values and understanding, makes negotiations more fruitful.
- Social capital can facilitate information exchange that would make dynamic resource allocation more efficient.
- Social capital can enable an economy to take advantage of network externality.
- Social capital may play an important role for governance of firms.
- Social capital can create business chance by facilitating exchanging semi-confidential information and mutual encouragement.
- Social capital can enable local communities to differentiate themselves from others, and this may provide new business opportunities and new local culture.
- Social capital can give an important reason for the difference between the going concern value and liquidation value of firms.
- Social capital, especially security level of the society, makes some businesses profitable but others non-profitable.

Social capital, especially trust, reduces costs of contracts and legal action.

- Social capital can influence the saving ratio, through its risk-sharing function.
- Social capital can encourage collective consumption.
- Social capital can encourage investment in human capital and promote challenges.
- Social capital can play a role in the management of public facilities and services.
- Good social capital can make government activity more efficient.
- Non-economic benefits of social capital may have important implication on fiscal balance.
- Social capital may influence land value.
- Social capital may increase economic self-dependence of regions, leading to higher income level.

Although some of channels should be subjects of closer examination, Omori's list covers most of the economic impact channels of social capital.

How Is Social Capital Measured?

Most people agree on the importance of social capital in economic activities. However, when it comes to measurement, the current situation in Japan leaves much to be desired. As far as Uslaner's generalized trust is concerned, the Institute of Statistical Mathematics carries out a "Study of the Japanese National Character" every five years. The study contains three questions relating to interpersonal trust:

1. Would you say that most of the time, people try to be helpful, or that they are mostly just looking out for themselves?
2. Do you think that most people would try to take advantage of you if they got the chance, or would they try to be fair?
3. Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?

The most recent study was conducted in 1998. Data on generalized trust is available for 1978, 1983, 1993 and 1998. As for the third question, the ratio of affirmative answer increased rapidly between 1978 and 1993 from 26% to 38%, and then declined to 33% in 1998, though, according to Yoshino (2002), interpersonal trust measured by the above three questions combined had been relatively stable over the last two decades from 1978 to 1998.

As a measure to get a general idea on social capital-related activities, Yamauchi (2003) created a civic activity index based on three indices, namely, activities relating to non-profit organisations, donations and volunteers. Each part consists of three series of data. All of these data are cross-sectional based on 47 prefectures in Japan.

The NPO index consists of: (1) the share of NPOs in the total number of firms and NPOs in each prefecture, (2) the share of non-firm organisations in the field of social services, and (3) the share of NPO in total employment.

Index on donation is calculated based on (4) household propensity to donation, (5) the ratio between cooperative donation and prefecture income, and (6) the share of people who donated blood in the total population.

Volunteer index includes (7) share of those who conducted volunteer activities in the total population, (8) the annual average number of days dedicated to volunteer works per volunteer, (9) share of volunteers out of the total population worked for prefecture's social welfare council.

In any case, it is always difficult to measure the degree and nature of trust. One way to deal with this measurement difficulty is to use data on security or distrust including crime rate, frequency of arson, divorce rate and unemployment rate. As for measures for individuals' networks, interviews can be carried out to find out the density and nature of networks among the members of certain social groups.

A Tentative Analysis

Inaba (2002 b) conducted a tentative OLS analysis on the correlation between Japan's TFP and two factors related to social capital, namely the number of heavy crimes and the amount of value added of private non-profit institutions serving households; the former as a proxy for trust, the latter for civic activities and norms. TFP is calculated as residuals in growth accounting. That is the portion of changes in GDP unaccountable by changes in capital stock and in labour input. The regression covers a period between 1985 and 1999. The result is shown in table one.

Needless to say, the result of the analysis should be dealt with caution. Causality is not clear. Heavy crime reflects only a small portion of trust or even being contradictory. Picking up the value added of private non-profit institutions serving households as a proxy for norms could be even misleading. In fact, these proxies are far

from a comprehensive description of social capital. The measurement of TFP could be inaccurate. A robustness test was not carried out. It should be understood just as a starting point for further detailed analysis.

Table 1: Social Aspects of TFP

Exogenous Variable	TFP Index Coefficient	N = 16 (t-statistics)
• Heavy Crime Index	–0.1204	(–2.7426)
• Index of value added of private non-profit institutions serving households	0.1325	(2.2942)
• Intercept	95.4935	(20.0472)
• Adj. R^2	0.2816	

Concluding Remarks—A Search For The Missing 20 Per Cent

As Fukuyama (1995), described, neoclassical economics provides a powerful tool to reveal the basic nature of free market systems. However, it is not perfect.

> "Its fundamental model based upon rational, self-interested human behaviour is correct about 80 per cent of the time. But, there is a missing 20 per cent of human behaviour about which neoclassical economics can give only a poor account. As Adam Smith well understood, economic life is deeply embedded in social life, and it cannot be understood apart from the customs, morals, and habits of the society in which it occurs. In short, it cannot be divorced from culture".

Social capital always reflects some aspects of culture. In that sense, it is a concept beyond economics. Any study about the economic impact of social capital should be carried out in the context of cultural backgrounds and should reflect values inherent in that culture.

It was prepared for the First Coordination Meeting of Basic Research XII on Social Capital and its Impact on Productivity, held by the Asian Productivity Organisation, in Seoul on 11 and 12 December 2003.

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Size works against excellence.

— Bill Gates

Impact of Social Capital on Productivity: Indications from Singapore

Wee-Liang Tan

This Singapore-based study examines export small and medium enterprises (SMEs) to find out to what extent family, social and informal networks prove useful to entrepreneurs, in comparison to industry and professional networks.

Wee-Liang Tan is a faculty member of Singapore Management University.

The importance of social capital in Asia seems obvious, with literature about doing business in Asia being replete with references to business networks being the foundation of business. This conclusion is reached if one were to conceptualize social capital as the nature of the resources embedded within a network (Tsai & Ghoshal, 1998). In Asia, the accepted wisdom is that there are informal Chinese business networks (Redding, 1995; Kao, 1993) and that in order to operate in Asia one has to be plugged into these networks (Vanhonacker, 1997). The Chinese, as with most other Asian cultures, place great importance on a person's place in social hierarchy. The family business enterprise is the central business organisation in Chinese societies (Weidenbaum and Hughes, 1996; Redding, 1990; Fukuyama, 1995). In such situations reputation capital becomes important. Face is an individual's public image and is hence contextually an important concept in Confucian societies (Chen, 1995; Begley & Tan, 2001).

Another feature that links the Confucian societies in Asia is *guanxi* (Yeung & Tung, 1996). The word *guanxi* has been defined as "connections" and is identified as being crucial in business dealings in China (Swanz, 1995). However, *guanxi* is more than just connections: it is "friendship with implications of continued exchange of favours" (Tsang, 1998). It implies reciprocal obligations and in the context of conflicts it implies mutual accommodation keeping long-term relationships in view. The difference, between *guanxi* and the old boy's network, is

The word guanxi has been defined as "connections" and is identified as being crucial in business dealings in China.

in the reciprocity required in the relationship, the long-term perspective adopted by the parties, and the underlying ethical notion that a party to a *guanxi* relationship should behave uprightly (Yueng & Tung, 1996b).

Business relationships with those outside the family would depend on, whether there is a "connection" (*guanxi*) between the outsider and a member of the family or someone with whom the family has *guanxi*. It is through the networks that a person from the lower of rung of the ladder can approach another higher on the ladder for a favour or assistance. Given the Confucian tradition (Volery & Mensik, 1997; Yeung & Tung, 1996c) those outside the Chinese cultures, such as a prospective foreign joint venture partner, would not fit into the hierarchy and as such would find it difficult to become a part of the network.

Yet while the importance of social capital in Asia has become accepted, there are indications from anecdotal evidence that the social capital associated with these networks may change with each succeeding generation. The social capital of the founding fathers of businesses may not be available to the successors either because of changes in conditions or weakening of ties. Further, there has not been sufficient interest in the region on the role of social capital in community development.

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In Singapore there has been little research on social capital and productivity. There has been little research on social capital except for work on the state-citizen and community development by Tay (2002). The proposal for research into social capital and its impact in Singapore is most welcome. In the following sections, suggestions are made on how the research project can be conducted, from the findings of a study conducted by the author in the context of Singapore.

Preliminary Findings on Singapore

The preliminary findings on Singapore are drawn from two prior studies that I have conducted. The first is on the usefulness of networks to small and medium enterprises (SMEs) that engage in export activities. The second is on the role of trust in domestic alliances. The findings of the first study were presented at the USABE conference in 2002. The second is a study completed in 2003, the data for which has just been coded.

The usefulness of networks to export SMEs in Singapore

This is a simple study to examine the much-asserted importance of networks to entrepreneurs and enterprises in Asia, by examining a sample in Singapore. The study explores two research propositions suggested by the literature on Chinese business networks. What the literature has discussed on Chinese business networks is relevant to Singapore as the majority of the businesses in Singapore are owned and managed by the Chinese. The population of Singapore comprises 76.5% Chinese, which explains the predominance of Chinese businessmen. The Chinese in Singapore are part of the Chinese diaspora that has seen the Chinese culture and Confucianism spread among the South-east Asian countries.

The literature on Chinese business networks suggests that family, social and informal networks involving *guanxi* would feature greatly and prove to be useful to the respondents. In contrast, industry and professional networks would prove to be less useful. At the same time, the literature suggests that these networks would be used by entrepreneurs to leverage on the resources of others for the purposes of export activities. Hence, the study examined two propositions:

Proposition 1: The respondents would find extended family, social and informal networks more useful than industry and professional networks.

Proposition 2: The respondents would use family, social and informal networks in obtaining the assistance they need for their export activities rather than other networks.

Methodology

As there is no directory of SMEs engaged in exports, the researchers relied upon data on SMEs compiled by the government agency responsible for SMEs in Singapore. The research instrument was sent to a sample of 354 SMEs. SMEs included in the sample followed the definition used by the government agency for the purposes of statistics and assistance; namely, an enterprise with at least 30 per cent local equity and less than $ 15 million fixed asset investment; in the case of enterprises in services they must be no more than fifty employees. A total of 66 completed and usable questionnaires were received. The effective response rate is

thus 18.64 per cent, which is a reasonable response rate in Singapore, where there has traditionally been a low response rate to questionnaire surveys. The data was collected in 2001.

The research instrument comprised of two sections: The first section sought information on the respondents and their export sales and markets; the second section focused on the information sought on the research questions. This section comprised two questions: The usefulness of the listed networks for the respondent's export business and the ways in which the networks were useful. Usefulness of the networks was measured using a Likert-like scale of 1 (being most useful) to 5 (being least useful). The networks enumerated were extended family networks, social networks, industry networks, professional networks/associations and informal networks. The functions of the networks that formed the basis of the second question were drawn from the literature that suggested that networks could help SMEs in raising capital for export ventures, meeting production targets, sharing marketing costs, obtaining special knowledge of export markets, sharing customer bases and overcoming barriers to market entry.

Findings

The respondents were in the industries shown in Figure 1 below. A majority of them (40.3 per cent) are in the retail or wholesale trade sector, followed by the manufacturing (26.87 per cent). The SMEs in the commerce sector (which incorporates retail and wholesale trade) comprise 53.7 per cent of the total number of SMEs in 1997 (PSB, 2000) and the SMEs in manufacturing only represent 3.84 per cent of the SME population. As such, the respondents cannot be said to be representative of the SMEs in Singapore.

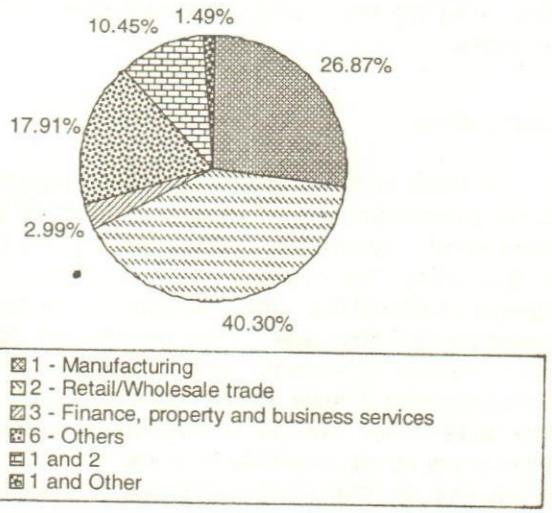

Fig. 1. Type of Business

The export sales in relation to the respondents' total sales are shown in Figure 2 below.

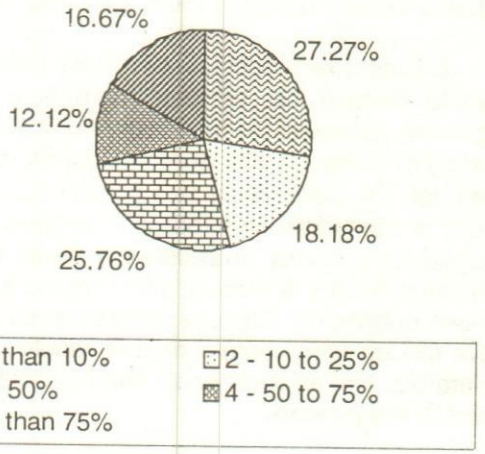

Fig. 2. Export Sales of the Respondents (percentages of sample)

Usefulness of networks to export activities

The respondents rated the usefulness of the networks to the export business on a scale of 1 to 5 where 1 means "very useful" and 5 means "least useful". The findings are shown in Table 1 below. Contrary to expectations, the family networks (mean = 3.85) are rated the lowest in usefulness to export business (proposition 1). Instead, industry (mean = 2.09) and professional networks (mean = 2.54) were the two networks that proved to be more useful to the SMEs. When the respondents were split into two groups, one with more than 51 per cent of their total sales in exports and the other group with exports representing 50 per cent or less, statistical analysis of the differences in the mean scores for the various networks found that the differences were not statistically significant. This analysis was conducted to check if there might be some difference between the SMEs that were more highly export-oriented than those who had less export sales.

Table 1: Usefulness of networks to respondents

Type of networks	N	Mean	Std. Deviation
Extended Family	66	3.85	1.42
Social	66	3.462	1.410
Industry	66	2.09	1.33
Professional	65	2.54	1.55
Informal	64	3.17	1.48

Role of the networks

The role of the networks was another aspect the questionnaire explored with the respondents. The respondents were requested to indicate which of the networks were used for various purposes. The findings based on

Table 2: Role of the Networks

Frequency Role	Extended Family	Social	Industry	Professional Networks/ associations	Others	None Applicable
Help in raising export finance	9	7	19	7	3	27
Help in meeting production targets	2	7	29	14	0	25
Help in sharing costs in marketing strategy	1	5	27	18	1	27
Help in obtaining special knowledge of export market	5	13	36	27	2	12
Share customer base	5	14	36	9	3	17
Help overcome barriers (legal political etc.) to market entry	0	9	25	28	1	18

the number of times each of the networks was selected by the respondents are shown in table 2. As the respondents were permitted to indicate more than one network for each purpose, the frequencies may exceed the sample size. The frequencies support the earlier finding on the usefulness of the networks. The frequencies shown in table 2 indicate that the respondents who found the networks useful indicated that industry and professional networks were of greater use for the purposes indicated. The second proposition is not supported.

Discussions

The findings are most interesting in that the two propositions based on the accepted notion that Chinese business networks and *guanxi* are the bases of doing business in Asia were not supported. These findings give rise to the need to consider possible reasons why extended family, social and informal networks did not feature as being as useful. One possible reason lies in access to the Chinese business networks that the literature refers to. The literature, while referring to the Chinese business networks, usually refers to established businesses. The networks referred to are long-established with linkages to other established businesses and opportunities. Our focus in this study has been on SMEs. They may not be able to access the established Chinese business networks. More pertinently, their extended family networks would not be useful as they are not as established. This distinction is important as there has been little attempt to distinguish between the networks of established larger firms and the smaller enterprises. This generalization can lead to ill-conceived advice being provided to enterprises seeking to establish businesses in Asia.

The usefulness of industry networks and professional networks/associations is also telling, as it cannot be simply assumed that all networks are pertinent for all activities and the full spectrum of functions. The study shows that different networks are more pertinent than others for different activities. It appears that the SMEs found that extended family, social and informal networks less useful than professional networks and associations. The professional networks and associations would include chambers of commerce, trade associations and SME interest groups. It appears that these networks offer greater assistance to export, which is plausible as they would be individuals in these networks who would have either expertise or prior experience in the export markets. The experiences, information and contacts that these networks offer may be more directly relevant than those offered by the other less useful networks.

The findings in this study in no way detract from the relevance of prior studies on *guanxi* and relationships. It points out that the relationships, extended family and social and informal networks may be more pertinent to other functions and roles than those specified in this study. One example of this is the identification of suitable business partners, which was not a part of this study. Another example would be the use of these networks for the assessment of trustworthiness and creditworthiness. Even so, in the preceding example, it might appear that the industry and professional networks may prove to be more useful, although this is conjecture.

This preliminary study shows that there is a need for a better understanding of social capital in Singapore as it relates to business.One cannot assume that the social capital represented by the networks associated with Chinese businesses – extended family, social and informal networks – are the keys to productivity. Granted that the study has limitations in that it is not a representative study and the sample size is small, but it does provide the impetus for further research on social capital. There is need for a better understanding of social capital available to SMEs.

Reliance on Networks In The Choice of International Strategic Partners

The second preliminary study involved the use of

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social capital in the selection of partners in international strategic alliances. The research questions were: –

- What motivated the SMEs to enter international strategic alliances?
- How did the SMEs select their partners?
- Whether they employed networks that literature (Hamilton, 1996; Redding, 1995) suggested was the main way in which business is done in Asia;
- How they overcame the distrust that exists in the regional countries as the literature suggested – that the Asian countries are low-trust communities (Fukuyama, 1995b)?

International growth and foreign direct investments are no longer the sole purview of the multinational corporations from developed countries. Small and medium-sized enterprises from the developing countries are engaging in international strategic alliances. Interviews were conducted with six firms whose identities were disguised.

Findings

The six firms and the countries in which they have strategic alliances, are shown in table 1 below.

Respondent	Location/s
Pneumatic	China, Australia, New Zealand, Thailand (failed)
All Metal	China (failed), Hong Kong, Brunei, Indonesia
Logistics	China
Manufacturing	China, Thailand, Germany
Leisure	Indonesia, Malaysia
Stationery	Indonesia, Malaysia (both successful & ended)

All the SME owners are Chinese. Their overseas partners are Asian except for two interviewees: Manufacturing and its German joint ventures with a German manufacturer. Pneumatic's overseas alliances in Australia and New Zealand were with a Chinese partner who had immigrated to Australia from Singapore.

Of the interviewees, there are two instances where the alliances failed (Pneumatic and All Metal) and one instance where the interviewee parted company amicably with his partner (Stationery). All Metal's joint venture failed because of lack of control over the venture because of the distance between Singapore and Shandong and the lack of progress after three years. Pneumatic's explanation for the failure of its Thailand joint venture was a lack of understanding of the Thai culture. Stationery withdrew from its two joint ventures with its German partner amicably after many years of success because of Stationery's then impending joint venture with a competitor from Sweden.

The findings pertinent to our social capital research are mentioned below.

Partner selection & network

One key aspect of the study revolved around how the SMEs identified and selected their respective alliance partners. In most of the cases, the partner identification and selection were based on prior relationships. Four companies interviewed reported having had prior relationships with their current foreign partners. These prior relationships took the form of either personal or business relationships. Logistics and Leisure stated that they were friends with their partners, way before they decided to pool their resources in China and Malaysia. Stationery was the agent for their partners, with the initial contact established through word of mouth. The business relationship in the case of one of its alliances had spanned 27 years. Manufacturing reported that their partner was initially their supplier. Pneumatic's partner in Australia was a person in whom there was trust, gained through the experience and rapport established over time when the partner started working for them a few years ago. In all the cases except for Stationery, the period of prior relationship was between three to five years. Logistics said: "By being friends for so many years one can roughly study his character. I have known him for three to five years before we started the joint venture. That is why I can trust him."

Of the remaining two SMEs, All Metal relied upon the introduction of a person who wrote to All Metal after having noticed all Metal in a newspaper account. Manufacturing's partner in Germany was by way of an introduction of a German supplier with whom they had business dealings.

Trust and Distrust

The interviewees were also asked to comment on their perceptions on the importance of trust in their alliances and how they overcame the element of distrust. All the interviewees felt that personal trust was an impor-

tant factor in their selection of their business partners. However, trust was one of the factors and there were other factors that were also important. Pneumatic reported that its venture with the Malaysian counterpart was not based so much on trust, as it was on competence. There is a need for other factors as distrust was present. All Metal, for instance, cautioned that people could not be trusted at first sight. He believed that he could trust a person only after working with him for a long time. All Metal and Manufacturing echoed that trust is not so important, but rather, one's own judgment and experience. The owner of All Metal felt that the element of trust was not essential since even a trusted person could change at any point in time.

A recurring remark from the interviews concerned the character of the overseas partner. It is best captured in the remarks of the logistics CEO, who said "First the personal character is very important, on which depends whether he will contribute money or not. Secondly, one has to see whether he is efficient and honest".

When asked how they overcame the distrust that the authors anticipated would exist when SMEs ventured into new markets, the interviewees did not express difficulty in this area with respect to their partners. The distrust was removed because they (except All Metal) had previous dealings with their partner. The managing director of Pneumatic noted, "Don't trust at the start unless you have a past dealing; if not there is no basis for trust". Stationery spoke of a long courtship from, being an agent for its German principal before becoming a partner in Malaysia; "It's because 27 years is long enough, that's why we know we can trust him".

Although All Metal did not have any prior business dealings with the contact who introduced it to its ultimate partner in China, the entrepreneur said they became good friends. Hence, when his new friend brought him to China, he was open to the idea. However, he made his own assessment of the situation in China when deciding on the joint venture.

Social Processes: Whilst the respondents did not refer to their approach to locating suitable partners in terms of strategy, they did refer to activities and social processes. The respondents were asked to provide details on the activities that they engaged in with the prospective alliance partners prior to and during the alliance-formation negotiations. The importance of social processes extended across all the various countries where the SMEs had foreign partners.

The importance of social processes extended across all the various countries where the SMEs had foreign partners.

Pneumatic, Logistics and All Metal voiced the same sentiments that to build up a closer relationship with their Chinese partners, it was important to carry out social activities like going out to dinner, going to lounges and presenting gifts. All Metal revealed that they brought with them cigarettes and wine as gifts whenever they visited China and occasionally even bought $100-$200 worth of jewelry for their partners' sons and grandsons so as to develop *guanxi* (relationships). Pneumatic also felt that engaging in these social activities was necessary to develop closer ties. The interviewee often instructed his managers and subordinates, "If you are a staunch Christian and you don't want to betray your values, you are not suitable for business there".

Both Leisure and All Metal reported that engaging in social activities like having dinners and sending gifts are a part and parcel of doing business in Indonesia. Hosting government officials at a fine dinner party and presenting them with gifts such as a full golf set worth $17,000 were normal social activities, Leisure reported. The Leisure representative proffered the following explanation for developing closer business ties: "This relationship has to start with friendship, then it will be proceeded by giving little gifts here and there, followed by an unspoken kind of 'under table' process". Leisure also engaged in meeting and social events including staying over at their partners' place. The interviewee said they learned to trust their partners through a lot of communication.

Pneumatic noted that in Malaysia the social processes were not similar to China. They were similar in context but not in the extent. According to Leisure, the usual activities involved dinners and some gifts as a courtesy. In their dealings in Australia and New Zealand, Pneumatic discovered that social meetings are few in Australia compared to China. In the New Zealand venture, the only social activity was to bring each other home for a simple dinner. He thinks that in the Western context, "you have dinner because you need to eat rather than because you need to socialize". Stationery's dealings with its German partner included food and golf. For the managers and more junior employees, there may be some karaoke, some drinking and dancing in the nightclubs.

Discussion and Implications

The findings are insightful as most of the SMEs reported employing a strategy involving their contacts with whom they had prior relationships. Contrary to the literature, all but one of the cases made reference to the

word "networks". The exception was Pneumatic where the word "networks" only appeared in the context of the joint venture in Japan. The use of networks in Japan is consistent with the developed status and culture of that country. The joint venture in Japan is to be contrasted with the other regional alliances reported on in this study between Singapore (a more developed developing nation) and the other countries in Asia, who are in a continuum of development equal to (e.g. Taiwan) and a little behind Singapore (e.g. Thailand and Indonesia). By networks, the managing director of Pneumatic was referring to business networks that are more akin to the western-style business networks rather than the Asian business networks that have been the subject of some discussion. The latter group of networks is family and kinship networks associated with the Chinese (Tong, 1996; Redding 1995). It is apparent that growing SMEs, unlike the established family firms that exist in Asia, do not have the kinship networks that the literature refer to as the bamboo network (Weidenbaum, 1996b). The interviews highlighted the role of social processes in overcoming the cultural and organisational differences that confront both parties (the SMEs and their respective overseas partners). The social relations and processes appear to have a function in reducing the distrust that would exist in the situation when two enterprises from different cultures, markets and environments seek to cooperate.

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The findings are interesting in terms of the mechanism picked by the SMEs in their choice of overseas partners. They did not appear to have systematically searched for overseas partners but looked for partners based on prior social relations, with individuals with whom they have business and or social relationships. Their strategy appears to be to examine the potential location and be on the lookout for someone they knew or were introduced to. This aspect of choosing an individual with whom they are familiar with fits in with the use of networks. However, it is not formalized networks that these SMEs relied upon, but upon an informal networks of contacts.

The strategy worked in providing a basis from which to formulated the cooperation. In the case of Stationery, for example, the Singapore entrepreneur had known his German partner for same 27 years prior to their alliance in Indonesia and Malaysia. This relationship contributed to both parties knowing each other very well in terms of personality and business. The same could be said for Leisure, who said that the partnership was based on the trust that existed in the friendship. The sincerity towards their partner was expressed through communication and by delivering as promised.

Whilst most of the SMEs employed a strategy involving the identification of individuals with whom they have prior dealings and about whom they have some awareness about, there was an alternative approach employed by Pneumatic with respect to its partner responsible for Australia and New Zealand. As an alternative to personal knowledge and familiarity, Pneumatic relied upon a trusted reference person, a common friend. Pneumatic attributed his trust of his Australian and New Zealand partner to his friend's trust of this partner. Hence, he felt that "trust is like something transferable". The same could be said of All Metal who relied on the new-found friend. However, in both All Metal and Pneumatic, the SMEs in question did take steps to find out more about the firms that they were introduced to and did enter into the social activities we discuss in the next section.

Role of social processes on the reduction of distrust

The cases reveal that distrust is reduced through familiarity with the partners that is built up through engaging in various social activities. The social interactions also act as a catalyst to speed up the deal-making process. Most companies agree that there is a need for mutual understanding in their alliances and that this could be cultivated through engaging in social processes to develop understanding. Also, it was found that appreciation of cooperative relations can develop over time and that this may deepen trust, which explains why most firms interviewed believe that trust is developed over time.

There is an apparent difference in the role that social processes play in the case of partners from western countries. The difference is seen in the selection criteria emphasized by the SMEs. With western partners, social processes feature but do not seem to play the role of distrust-reduction in the selection process as with partners from Asia. It was seen in the accounts of SMEs in this study with partners in developed countries like Germany and Australia; there is less need to socialize as compared to partners from Asia. There is less of a need to socialize as compared to Asian partners as the SMEs report that, when dealing with western partners, competence and results are a clearer evidence of capability. However, the social processes are necessary for the communication and fostering of better understanding in the implementation and during the operation of the alliance. In contrast, in developing countries like Indonesia

and China more often than not, it is necessary to invite government officials and prospective business partners to dinners, and give them presents in order to develop closer business relationships.

The social processes that we have examined are similar to the relationship-building activities that the Chinese businesses engage in relating to their partners in the Chinese business networks, called *guanxi*. Leung and Yeung (1995) found that personal relationship or *guanxi* is an important contributing factor to the success of business negotiations in China in the formation of strategic alliances. Social meeting in restaurants and sending gifts are found to be the two most popular ways of establishing relationships or *guanxi* followed by sending samples and proposals in the pre-negotiation stage. Whilst it may be tempting to think that what has been discovered in this study is nothing more than *guanxi*, it must be noted that not all the alliances we examined involved China. Furthermore, the emphasis of the research on *guanxi* is the use of networks of relationships that stem from Chinese culture. The similarity lies in the social processes and the role that relationships have to play. The finding from this study that distinguishes it from the *guanxi* stream of literature, is the rationale and role played by the social processes and the role that relationships have to play. The finding from this study that distinguishes it from the *guanxi* stream of literature, is the rationale and role played by the social processes engaged in by the SMEs in the formation of strategic alliances.

One plausible explanation for the need social processes lies in the criteria employed by the SMEs in partner selection. The character of the prospective partner, specifically the personal trustworthiness, appears to be key criterion in addition to the other criteria – competence, familiarity with local conditions and connections. It was mentioned in the interviews as honesty (Logistics), sincerity (Leisure) and trust (various interviewees). While not all the overseas partners are Chinese, majority are Asian and there is some similarity here with the Chinese emphasis on interpersonal trustworthiness (*xinyong*) in business dealings. Tong (1996b) observed that since interpersonal trustworthiness is of utmost importance, Chinese businessmen usually deal with those with whom they are familiar. Whilst he made these comments in the context of Chinese family firms and their familiars (the children, relations and clansmen), it seems plausible to argue that the SMEs in our sample apply the same principle when venturing overseas.

The preliminary studies show that the research would be relevant in Singapore as the sources of social capital conceived as assets may not be those traditionally identified in the literature. It is therefore useful to identify the sources of social capital in the types of networks or relationships, their relative usefulness, and the development of such capital.

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Annex 1

Survey of Singapore SMEs Engaged in Export

Part 1: Business Profile

1. **Name of Business:** *(optional)*

2. **Location:** (city & country)

3. **Which industry category is the business in?** *(Tick only one box)*

- ☐ Manufacturing
- ☐ Retail/wholesale trade
- ☐ Finance, property and business services
- ☐ Recreational, personal & other services
- ☐ Community services
- ☐ Other *(describe)*

4. **What is the ownership structure of the business? (Please tick one box only)**

- ☐ Sole proprietor
- ☐ Partnership
- ☐ Private limited company
- ☐ Publicly listed company
- ☐ Other (please specify)

5. **Do you consider the firm a family business?**

- ☐ Yes
- ☐ No

6. **How long has the business been in operation?**

- ☐ less than 2 years
- ☐ 2-5 years
- ☐ 6-10 years
- ☐ more than 10 years

7. **No. of people employed by the business:**

- ☐ fewer than 20
- ☐ 21-50
- ☐ 51-100
- ☐ more than 100

8. **Turnover of the business last financial year:**

- ☐ less than US$1 million
- ☐ US$1-5 million
- ☐ US$5-10 million
- ☐ more than US$10 million

9. **Percentage of export sales (average over the last financial years):**

- ☐ less than 10%
- ☐ 10-25%
- ☐ 26-50%
- ☐ 50-75%
- ☐ more than 75%

10. **What is the firm's major export region: (Tick one be only)**

- ☐ North America
- ☐ South America
- ☐ Europe
- ☐ Africa
- ☐ North-east Asia (Japan/Korea/Taiwan)
- ☐ South-east Asia
- ☐ China
- ☐ Australia/New Zealand/Oceania

11. **Percentage of export sales to the firm's major export region (average over the last 3 financial years):**

- ☐ less than 10%
- ☐ 10-25%
- ☐ 26-50%
- ☐ 50-75%
- ☐ more than 75%

12. **Profit as a percentage of sales, (average over the last 3 financial years):**

- ☐ 0%-5%
- ☐ 6%-10%
- ☐ 11%-15%
- ☐ more than 15%

Part 2: Business Relationships

This part of the questionnaire is about the relationships you have developed in the business with groups in society from which you have derived assistance, knowledge or understanding in your export venture(2). The relationship may be formal or informal, or it may be of assistance to you at various stages of production, marketing or distribution. In your response, please note that while these groups may overlap with each other, the focus is on the main purpose of the relationship i.e.

- Extended family networks (parents, brothers and sisters, uncles and aunts, cousins);
- Social networks (e.g. sporting clubs and social groups);
- Industry networks (manufacturers, wholesale, finance);
- Professional Networks/Associations (e.g. accountants, engineers);
- Informal networks (random meeting, people one is normally unconnected with)
- Other (any other networks not included above)

1. **Are any of the following networks useful for your export business?** *(Circle the number that most closely corresponds to the level of usefulness.)*

	Very Useful			Moderately Useful		Least Useful
Extended Family Networks	1	2		3	4	5
Social Networks	1	2		3	4	5
Industry Networks	1	2		3	4	5
Professional Networks/Associations	1	2		3	4	5
Informal Networks	1	2		3	4	5

2. **In what ways are these networks useful?** *(Tick any of the boxes that boxes that are relevant to your business)*

	Family Networks	Other Social Networks	Industry Networks	Professional Networks	Other
Help in raising capital for export venture					
Help in meeting production targets					
Help in sharing costs in marketing strategy					
Help in obtaining special knowledge of export market					
Share customer base					
Help overcome barriers (legal political etc.) to market entry					
Other (please specify):					

Annex 2

Suggestions for the implementation of the APO Research Project

The scope of the research project is wide and should be narrowed. As social capital has been used to refer to networks, trust and norms, it would be quite insurmountable in a short two-year span to provide a meaningful finding for the APO unless the goals are well defined and scaled down. In this regard, we must first decide whether the project must employ the same method and instrument/measures across the participating countries. Second, we have to consider the number of aspects that the project encompasses and, third, the way in which these aspects are examined. More clearly we could look at these aspects either by way of one omnibus study and data collection effort or as separate studies. If we were to bear in mind the end game of monograph, it makes sense to consider strategies that make for accomplishment of this outcome.

The project could examine social capital in the form of networks, formal and informal. In so doing, we could side-step the uncertainty of defining what social capital is. If we agree on social capital as networks that would be fine. If not, we would still be on the right track since there is research arguing that social capital is embedded in individuals but the networks are the means by which these assets are harnessed. We could examine the contribution of these networks to SMEs in their startups and existing businesses as sources of resources. In this regard, the usefulness of social capital of this form could be measured by way of a questionnaire survey. It would also be possible for us to examine the relationship between the respondents and the trust that is present in the networks, if any. In short,

1. Social capital as networks
   - 1.1 Do SMEs find the networks useful?
   - 1.2 In what ways do they find the networks useful?
     - 1.2.1 At the inception of the business
     - 1.2.2 At the other stages of the business
     - 1.2.3 How do networks facilitate transactions?
   - 1.3 Measures of productivity—frequencies, scale development to measure productivity
2. Social capital benefiting productivity through strategic alliances
   - 2.1 The extent to which SMEs use strategic alliances
   - 2.2 How does social capital in the form of the networks contribute towards alliance formation or management?

There are a number of reasons for suggesting the above scope for our research. First, it is justified as the study is linked to productivity. One way to link it to productivity is to examine the contribution of networks to the economic activities. In this regard, there is considerable literature on the role of social capital in the form of networks in Asia. It also links the social capital research to entrepreneurship, which many believe to be the way forward for increased national productivity.

Empirical evidence shows that entrepreneurship takes a variety of different forms and enterprises use various strategies, which partly reflect the external environment for private enterprise in different countries. In an unstable environment with a weak, state-deficient legal regulations, non-existent financial systems, etc., informal networks and contacts often play a key role in helping entrepreneurs to mobilize resources, and to cope with the constraints imposed by highly bureaucratic structures. This indicates the importance of personal trust for entering entrepreneurship as well as for consequent business development and growth. Whereas personal trust can exist regardless of any formal institutions, institutional trust requires stability and predictability of the institutional context, i.e. formal institutions need to be legitimized through societal norms and values. Low levels of institutional trust appear to constrain market entry, enterprise growth and competition whilst encouraging unproductive forms of entrepreneurship.

Entrepreneurial networks have been the subject of research in the entrepreneurship literature (for example, Birley, 1985). In particular, the literature has explored the use of networks as a source of resources that founders require for their ventures (Ostgaard & Birley, 1994), and in the context of high-technology ventures (for example, Zhao & Aram, 1995). National cultures have an impact on the types of networks and networks and business relationships that have prominence in various countries (Sandström, 1992). □

Cultural Heritage: A Fusion of Human Skill Capital & Social Capital

M.N. Murty & Suchetamurty

Cultural heritage, a fusion of human skill capital and social capital, is a capital good. While the role of human skill capital in economic development is well known, the definition and the role of social capital has not yet been clearly understood. Heritage capital, consisting of performing and visual arts, has public good characteristics. In addition the visual arts are subjected to cost disadvantage in the free market because of rigid input-output relationships in its production in comparison to the manufacturing of goods. There is a need for public subsidy for the visual arts and the conservation of built heritage by non-market institutions including the government. Unlike physical capital heritage capital appreciates as one uses it.

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Cultural heritage, comprising performing and visual arts, is capital. Performing arts consisting of music, dance, theatre, and cinema are a combination of social capital and human skill capital, whereas visual arts consisting of heritage monuments and museums, have elements of physical, human skill and social capital. Cultural heritage is a fusion of human skill capital and social capital. The human skill capital, the result of investment applied to labour, is understood now as an engine of economic development. There is still debate about the role of social capital comprising institutions and informal rules and regulations governing the behaviour of benefit-seeking individuals in the groups and networks in the economic development and growth (Piazza-Georgia, 2002a).

Cultural heritage or heritage capital has some distinctive characteristics as its constituents, human skill capital and social capital. It has both public good and private good characteristics like environmental resources. But unlike environmental resources, it is man-made. Because of rigidity of technology in producing performing arts, it could become less competitive in the market to other forms of human skill capital. Built heritage is subjected to irreversibility in production since it is not reproducible. Therefore, market management of heritage capital may result in the permanent loss of it. Availability of performing arts in the present, and their continuation in the future, requires a public subsidy. The conservation of built heritage has to be made either by the government or by the informal non-governmental institutions.

Heritage resources provide both private and public goods type of benefits. They have user and non-user values like environmental resources. User benefits are heritage-related amenities or recreational services. Individuals who may not be attending a performing art event or may not be visiting a heritage site (non-users), have bequest and altruistic or existence motives to conserve them for current and future uses. These benefits

have to be accounted for in the measurement of net national product similar to the accounting for environment values in the estimation of environmentally corrected net national product (UN, 1993).

Different Types of Capital

Capital as a productive asset has represented different things at different times in the history of economic thought. The conventional view of capital is that it constitutes land and natural resources. It took a long time to recognize the revolutionary thought that appeared in the classical economics, that capital represents physical and financial wealth too. But now the idea of physical capital as an engine of economic growth and development has been replaced by the more revolutionary idea of human and social capital as a resource that is as important as physical capital, if not more. Physical capital as a productive resource is the result of investment that distinguishes between land and labour. Just as investment that is applied to land (irrigation and land development) creates a capital good (improved land), investment applied to labour (education and health) creates human skill capital and investments applied to society (institution building) creates social capital. Thus human skill capital and social capital are productive assets created by investment of time resources. Joseph Schumpeter (1942), Theodore Schultz (1993) and Gary Becker (1975) have shown that the human skill capital is a more important factor of production than natural resources, ((Piazza-Georgia, 2000b).

A distinction between the forms of human capital could be used to identify various ingredients of it and the relationship between them. There are forms of human capital vested in individuals – education, experience, natural talents that are not easily transferable to other individuals. The other forms of human capital that are of public goods or public property, include the stock of knowledge found in books, museums, built heritage or heritage sites, media and others. The third category of human capital consists of forms vested in the relationship between individuals, that could be regarded as the social and institutional capital. The human capital vested in individuals in the form of education and acquired skills in arts and theatre is a private good in the sense that the market provides incentives by guaranteeing financial returns to the investment by individuals. Capital formation takes place in this case by the individual investment decisions made by comparing costs and benefits from investment in the human capital development. The human capital as a stock of knowledge in the form of books, built heritage and museums is a public good for which market incentives are absent for their conservation. The benefits from the stock of knowledge accrue to the society and there should be institutions other than the market for conserving them.

Social capital, a form of human capital vested in the relationships between individuals, is sometimes described as a private good in that it describes the circumstances in which individuals can use membership in groups and networks to secure benefits. Bourdieu (1984a) defines social capital as a capital of social connections, honourability and respectability that is often essential in winning and keeping the confidence of high society and with it a clientele, and which may be drawn on, for example, in making a political career. Social capital defined in this way has also public good dimensions. Robert Putman (1995) has said that there is a dramatic decline in the social capital measured as level of participation in the group activities in the United States resulting in the decline of the quality of democracy and the quality of life. He documents a downward trend in civic involvement that has far-reaching negative effects on democratic institutions, effectiveness of schools, and the institutions that improve collective health and well-being. There is enough empirical evidence to show that the social capital is required to ensure the sustainable use of environmental resources. (Ostran; 1990; Chopra et al, 1990a; Murty 1994a; Chopra, 2002). The aggregation over the various forms of capital to arrive at a single measure of capital requires the exchange rates between different types of capital. Sociologists say that it is not easy to arrive at such exchange rates because they depend upon the structure and distribution of each type of capital among the different social groups. The sociological view of three dimensional social space explaining the fundamental dimensions of social space as volume of capital, composition of capital and changes in these properties over time, opposes the aggregation over different types of capital. The overall volume of capital understood as the set of actually usable resources and power - economic capital, cultural capital and social capital determine the primary differences in social classes. The distribution of social capital determine the primary differences in social classes. The distribution of social classes is according to those who are best endowed with economic and cultural capital and those

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who are deprived of them. The differences in social classes stemming from the differences in total volume of capital conceal the secondary differences in each class faction arising out of different distributions of total capital among different types of capital within each faction. For example, in the case of artists cultural capital dominates, while in the case of industrial and commercial workers, economic capital is the dominant factor.

By taking into account the structure of total capital-distribution in aggregate between three types of capital, distribution of each type of capital among different social fractions, and the distribution between different types of capital within each social faction, one could make precise divisions of social classes and also observe the specific effects of the structure of distribution between different kinds of capital. Empirical observations about the changes in the volume of capital and structure of capital over time reveal the changing power relations between different social factions. Therefore in the three dimensional space described above, the exchange rate to convert one kind of capital to another depends upon the power relations between the holders of different forms of capital. In particular, this exchange rate is a stake in the struggle over the dominant principle of domination (economic capital, cultural capital or social capital), which goes on all the time between different factions of the dominant class (Bourdieu, 1984b).

Social Capital: A broader perspective

There are many views about the social capital is literature, but the common point is that the social capital is the existing stock of social relationships in a society. The social relationships constitute the institutions describing a formal or informal set of rules such as laws, regulations and standards. North (1990) defines institutions as a formalized set of rules such as laws, regulations and standards. They have been considered as the entities that strengthen property rights and lower transaction costs by either decreasing risk or improving information.

The earlier definitions of social capital emphasize that it constitutes informal institutions and lies beyond the formal regulations and organisations. Coleman (1988) mentions three forms of social capital: Obligations and expectations, information channels, and social norms. A more conservative view is that the social capital is opposite to government-related institutions and is more voluntary in character. Fukuyama (1995a) sees more of government-related institutions if less social capital (eg. collapse of civil society in Russia and Eastern Europe with communism). However, there is also the view that there is a positive dynamic relationship between social capital and formal institutions, changes in social capital affecting the formal rules of society and vice versa (World Bank, 1997, 1998).

It is important to look into the characteristic features of a society that promotes the social capital and determines the forms it takes. For example, the sources and the consequences of group membership depend upon the institutional environment of a society. Davis and North (1971) define the institutional environment as 'the set of fundamental political, social and legal ground rules that establish the basis for production, exchanges and distribution'. Societies may differ with respect to the extent of social trust that people have. Cultivation of social relations could be high in the society with high social trust in relation to the low trust societies. The social relations could take a different shape depending upon the nature of social trust a society has. Examples are a family-based social trust in China and community-based social trust in Japan (Fukuyama, 1995b).

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The social capital could be evaluated in terms of transparency in its effects and rationalization in dealing with the actual problems. Transparency is related to the transaction cost-reducing function of social capital due to improved information and the increased predictability it generates. Also, it is related to generating efficient outcomes in many situations in which unilateral decisions by individuals fail to obtain. Rationalization refers to the degree to which social capital moves from a more general set of rules to the rules that are operational and applicable in the current institutional environment.

There are a number of empirical studies in India and other developing countries highlighting the importance of transaction cost-reducing and efficiency-enhancing properties of social capital. These are related to the management of common property resources, irrigation projects, and industrial pollution among others. Chopra, Murty (1990b) and Kadekodi (1990) and Murty (1994b) have explained how the formation of groups with the binding informal rules and regulations by the villagers has resulted in the efficient management of village commons in some villages of the states of Haryana and Punjab in India. Ostrom (1990) explains how farmers in southern India need to work out a set of mutually

agreed upon rules to form a group to build and maintain irrigation systems and share the water that these systems provide. She calls the social capital as the ability of farmers to solve problems and trace their solutions to their capacity to construct commonly understood, commonly practiced and self- enforcing rules of behaviour. Murty et al., (1999) and World Bank (1999) have shown how informal regulation by networks and groups of local people, as opposed to formal regulation by the government, has made the polluters reduce pollution to a safe level in some developing countries including India.

Social capital appreciates as one uses it. Making use of social capital increases the stock of social capital available for future use (Ostrom, 1999b). For example, giving a gift by taking advantage of membership of a group creates for the receiver an obligation to accept and an obligation to reciprocate by honouring the future requests for assistance. Social capital by reducing the information uncertainty produces efficient outcomes in bargaining as in the case of repeated games in a prisoners' dilemma type of problem in the management of commons.

Social capital has positive third party effects. Expanding one's network indirectly increases the social capital of one's associates by giving them access to a larger network. The appreciating property of social capital could be better understood from Woolcock's (1998) definition of four dimensions of social capital in two opposing pairs: Embeddedness and autonomy and micro and macro level. Embeddedness means that all forms of exchange are inherently embedded in social relationships. Autonomy refers to the degree to which agents have access to non-community members and operate with wider values and rules than the community. In reality, various profiles of social capital could be observed as combinations of any two of the four concepts. The embeddedness at the micro level could be referred to as intra-social ties or integration and at the macro level as state society relationships, or what Woolcock calls synergy. Autonomy at the micro level is called extra-community links or linkage and at the macro level, the institutional competence and coherence or organisational integrity. Using social capital could result in the expansion of it in the form of any one of the above mentioned profiles. For example doing a favour to a member of the group by another member increases the intra-social ties in the group. Group management of common property could result in the state playing a complementary role in promoting state society relationships. See Chopra et al. (1990c) for examples from India for the state plying a catalytic role in the management of commons. Attempts by the community members to have links with other groups or members to obtain benefit could result in the expansion of social capital.

The magnitude of intra-social ties in the networks and groups could also be regarded as the density of networks, the concept introduced by Coleman. He argues that dense networks improve the effectiveness of group co-operative behaviour. Burt (1992) discusses about the importance of structural holes for individuals in the networks. By connecting two otherwise disconnected networks, individuals earn additional benefits from their membership of the network. Thus individuals' attempts for securing benefits from the memberships in the groups and networks could result in the expansion of social capital.

Cultural Capital: Is it human skill capital or social capital?

The concept of cultural heritage is built up on the concepts of culture and art. The anthropological and sociological view of "culture" is that it represents "shared norms of behaviour and values", which are, so to speak, "taken in with mother's milk". Culture therefore, is not something that can be deliberately created by the investment of resources in the economic sense (Towse, 1997a). The term "art" embraces both visual and performing arts. Visual arts consist of museums, books, set of ancient monuments and built up sites having an artistic, cultural or historical interest. Performing arts are music, theatre, cinema etc.

Unlike culture, arts are true economic activities forming part of the human skill capital.

Unlike culture, arts are true economic activities forming part of the human skill capital discussed above. Arts have both public and private good characteristics. Individuals may select how much and what type of the arts could be consumed and produced and they could be either supplied publicly or privately. On the other hand culture is a pure public good and its quantity cannot be increased by production. Towse (1997b) says "heritage consists of stock of artistic capital acquired by past generations and handed on to the present one. Like the wider concept of culture, it moulds our perceptions and values, and hence our notion of what art is or should be. The heritage consists not only of tangible objects, such as those to be found in museums or in buildings, parks and gardens, areas of natural beauty, archeological sites and like; it also consists of inherited traditions of performance and execution. How much of past artistic capital has been invested to achieve the present heritage is clearly an outcome of economic

decisions, as is the allocation of resources for its preservation and discovery".

The economic view of cultural heritage is that the artistic capital is subjected to scarcity like the physical capital. The production of a work of art requires scarce resources in the form of labour, physical capital, materials, inventiveness and originality. The production and consumption of art is the result of the behaviour of individuals. In a free market the cultural capital may be under supplied because (a) some forms of cultural capital possesses public good characteristics, and (b) some types of artistic capital offering live performances has the cost disadvantage in relation to other types of human skill capital and general manufacturing goods. This second phenomenon is called cost decease, Baumol's law or the earning gap in arts. It is reported that since the beginning of the 19th century the productivity of labour in manufacturing has risen 2000 per cent, but the number of person hours to perform a Beethoven quarter has not changed (Baumol & Bowen, 1996; Baumol & Baumol, 1984). The cultural output (ex. broadcasting and recording) become relatively more costly due to combination of fixed input coefficients in production and raising wages driven by increasing productivity in other sectors in the economy. For example, a Beethoven quarter must be performed by four string players and they take as long a time to perform it as did the first players who performed it. However the wage costs of performance will increase due to increase in labour productivity and economic growth. Therefore, the provision of some types of cultural output requires a public subsidy or direct state supply.

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One could observe a close relationship between human skill capital, and cultural heritage. Both forms of social capital, institutions and informal social capital, are closely connected to human skill capital. Both are found in human beings, in the case of social capital in relationships between them rather than in individual minds. The social capital in both forms has important public good characteristics that could be considered as the stock of knowledge form of human skill capital. The links between human skill capital and efficiency are well established empirically. There are some empirical studies recently establishing the links between social capital and economic efficiency and different kinds of well being (World Bank, 1997, 1998). Social capital in addition to operating directly through lowering transaction costs, operates to a greater extent through human skill capital by contributing to their formation both by facilitating investment in them and lowering the cost involved in their creation. Also, investment in human skill capital may be a substitute to some forms of social capital (Piazza-Georgi, 2002c).

Performing arts are a type of human skill capital, since individuals have to invest time and money to acquire skills to become artistes. They receive compensating return on investment in terms of higher wages for the artistic performances. In a continuum of generations the artistic skills are transmitted from one generation to another. If the intergenerational transfer of artistic skills is guaranteed by the market and other institutions, there will be a continuum of supply of services of performing arts as is the case with visual or built cultural heritage. The market may not do this because of the presence of some public features in the visual art and the problems arising out of cost decease discussed above. The formal institutions like government and social capital in the past and present could be responsible for the continuity and progress of performing arts.

Built heritage is output of human skill capital in the past carried to the present by the formal and informal institutions. The built heritage (visual arts such as heritage buildings, temples, churches, mosques) could be a medium for the intergenerational transfer of performing arts. The history of arts and culture in India provides evidence of transferring performing arts to future use through inscriptions, impressions and sculpture in heritage monuments. Since built heritage is again a public good, it could have been provided in the past by formal (government, kings or rulers or some religious or philanthropic organisations) or informal (informal groups and networks) institutions.

Valuing and Accounting of Heritage Capital

Heritage capital, a man-made capital, shares certain properties of natural capital. Many or almost all forms of heritage capital have public good characteristics. Like environmental resources they have user and non-user values (Freeman, 1993). Both visual and performing arts provide direct recreation benefits. Performing arts, a form of human skill capital, increases labour productivity or results in increased income to those who acquired artistic skills. Also there is uncertainty related to supply and demand of cultural heritage resulting in the existence of option value for it (Wiesbrod, 1964 and Arrow and Fisher, 1974). Individuals may like to pay a premium

for making sure that a heritage site or monument is available for their future use over and above the expected benefits their future visit to the site provides them. Similarly individuals may have option value for performing arts given the uncertainty of their continuance without the financial support from the public or non-market institutions. Also, there could be irreversibility in the supply of heritage services since they are not reproducible in their original form once lost. Also, given the uniqueness of heritage resources, especially visual arts, they could be permanently lost if the efforts are not made to conserve them. Furthermore, individuals could have bequest and altruistic motives to conserve them resulting in the presence of non-user benefits: bequest and existence values (Krutilla & Fisher, 1975a). Individuals may know that they will not be visiting or using the heritage resource in their life time, but still feel that the resource is of use for other people belonging to the present generation (existence value) or to the future generation (bequest value).

Heritage resources are renewable resources. There is a cost to the society for maintaining the continuity of performing arts and conservation of built heritage. There is an important difference between the performing arts and visual arts in that they differ with respect to the medium through which heritage services are offered. In the case of performing arts the medium is individuals; the heritage services are provided by them through the acquired skills. Built heritage is a combination of physical capital and human skill capital, and is transmitted to the public through the physical capital, the building. In the case of built heritage sites, there is a maintenance cost and there is an opportunity cost of keeping the land and building as the heritage resource. Many of world's built heritage sites are located in urban areas where the commercial value of the land and building is very high. As it is with the case of environmental resources (Krutilla and Fisher, 1975b), a choice has to be made between the use of heritage sites for the conservation of heritage or the development and conservation benefits from the heritage resource. The development benefits from the site could be constant or falling over time with more attractive and less expensive sites for commercial purposes available in the future with growing urban development. On the other hand, the benefits from the preserved heritage will be growing over time with the increased income, population, and changed preferences of individuals for cultural heritage.

Built heritage is a combination of physical capital and human skill capital, and is transmitted to the public through the physical capital, the building.

Heritage resources could be used to produce heritage goods. Increased competition in world trade and the need for keeping the country's share in the world market requires the countries to facilitate constant innovation and the introduction of manufacturing processes requires more research and original thinking. The heritage as a source of creativity could be used for introducing the cultural elements and identities in the production of new goods and services that could withstand world competition. Take for example the case of museums. Museums become a storehouse of knowledge by conserving and displaying artifacts as products belonging to different ages for developing innovative designs to produce new products that could be identified with the cultural heritage of specific communities and regions. The consumers may pay a premium to these newly produced good over others ensuring the demand for the goods with local cultural attributes. An interesting example is the cutlery industry in Thiers, a major centre for French cutlery industry (Greffe, (2001a). The Thiers municipality has set up a cutlery museum to highlight its local products in 1982. Further, the municipality acting in collaboration with the French government, the Chamber of Commerce and Industry and the trade unions has given a new dimension to the museum by making a 'House of Cutlery Makers' whose products stand out because of originality and creativity. The museum serves as a laboratory, inventing new designs and processes that are free to copy, and extends and enriches a tradition instead of simply highlighting it.

Heritage resources provide amenity services promoting cultural tourism, and option, bequest and existence value benefits to the individuals. These different types of benefits could be estimated by using hypothetical behavioural methods of valuation or contingent valuation methods using data from the household surveys. The benefits of recreational or amenity services could also be estimated using observed behavioural methods like travel cost and hedonic property values (Freeman, 1993). People may like to stay in the culturally rich areas and they could express their preferences by paying premiums for the houses located in these areas. The estimates 'of individuals' willingness to pay for user and non-user benefits from the heritage resources made using the contingent valuation methods could be used by the government for designing tax or price instruments for raising revenue to finance the conservation of heritage resources. In the measurement of net national product (NNP) using conventional national accounting methods, non-marketable benefits of heritage capital mentioned above are not accounted similar to

the benefits from environmental resources. There the national accounting methods are generalized for accounting non-marketable benefits from the natural capital. Similar methods could be used to account for the non-marketable benefits of heritage capital in the estimation of net social product of a country.

Built Heritage in India: Some dimensions

There are legal rules or laws protecting and conserving built heritage in developed as well as in developing countries and these laws are similar in defining the built heritage. Built heritage consists of "a set of ancient monuments and built-up sites having an artistic, historical and cultural interest" (French law since December, 31, 1913). They are buildings like castles, palaces, cathedrals and churches whose conservation is of public interest from the historic or artistic view point and movable objects whose conservation is of public interest from the historical, artistic, scientific or technical view point. According to Italian law, heritage is the sum total of artistic, historical and archeological assets. German law says that heritage consists of things that are useful to understand our society, they are created for this purpose and which is in public interest to safeguard them for artistic, scientific, technical, historical or town planning purposes. Greffe, (2001b) says that a heritage monument has three dimensions: (a) It is a source of history and informs people about their past in a more realistic manner having a cognitive value, (b) It is an artistic creation. It helps to identify the history of art and show how sequences in time can lead to the development of shapes, colours and materials, and (c) It is a manifestation of passing time. It helps us to recall our past highlighting in the process our common development, the osmosis of diverse aspirations and the development of a common conscience that can help us solve our present problems.

There are enough legal rules in India for the conservation of build heritage (Prasanna, 2001). The Indian Constitution (article 49) provides for the protection of every monument or place of artistic or historic interest by the government. Article 49 states: "Protection of monuments and places and objects of national importance: It shall be the obligation of the State to Parliament, to protect monuments or places of artistic or historic interest, declared by or under law made by Parliament to be of national importance, from spoilation, disfigurement, destruction, removal, disposal or export, as the case may be". Under Entry 67, list 1 of the seventh Schedule of the Constitution, Parliament is confirmed a legislative power to decide ancient and historical monuments and records, and archeological sites and remains as of national importance. Under Entry 12, List II, the power to protect lesser ancient and historical monuments lies with the State government. The concurrent powers are exercised by state and central governments to legislate on the protection of archeological sites and remains other than those declared by Parliament to be of national importance. Under article 51A of the Indian Constitution, (to value and preserve the rich heritage of out nation) every citizen has a fundamental duty to co-operate with the state and to ensure that the rich and diverse heritage in the country is preserved.

It is not easy to attempt a discussion about the history of built heritage in India given its vastness and diversity. Still an attempt is made here to highlight some aspects of it primarily to understand to what extent it represents various dimensions of cultural heritage of India. India, being the home of some of world's oldest civilizations, has a rich cultural heritage. Indian art and culture are a joint creation of the Dravidian and Aryan genius, a welding together of symbolic and representative, abstract and explicit language of thought (Coomarswamy, 1965). Prehistoric or early vedic Aryans were proficient in carpentry, building houses and racing chariots of wood, and in metal work presumably in copper. They wove, knew sewing and tanning, and made pottery. There is no evidence for the making of images of any kind and it seems that the earlier Aryan art is only decorative. The historic period said to be beginning with the first half of the sixth century B.C. saw a dramatic change in Indian art and culture as described in the contemporary Vedic (*Brahmanas, Upanisads,* and *Sutras*) and Buddhist (*Jatakas*) literature. Vedic books show the evidence of knowledge of metals, tin, lead, silver, copper and iron, wearing of cotton, silk and woolen garments and living in storyed buildings and round and square huts made using bricks and metals. The *Jatakas* provide evidence of the organisation of craftsmen in gilds, eighteen in number, including "the wood workers, the smiths, the leather dressers, the painters and the rest, experts in various crafts." The antiquities discovered at Taxila and other places show that glass-making and cutting and polishing of hard stones had reached the high level technical attainment in the fourth and fifth centuries BC. The oldest Indian sculpture in sandstone so far known is 'Parkham Statue' of the Mathura museum belonging to early 5th century B.C.

The Maurya period saw the influence of Western Asiatic and Persian art on Indian art and culture. During the Mauryan period, Indian art saw a continuation of pre-Mauryan tradition for instance the representation of Vedic deities, the influence of west Asian art seen in the monolithic columns on which Asoka's famous edicts are inscribed, and the beginning of brick and stone architecture as in the case of the original stupa at Ranchi. The Kusana period in Northern India and later Andhra

period in Deccan saw Buddhist sculpture reaching its heights. In Gandhara sculptures of the Kusana period, Western especially Greek influence is found side by side with elements of Indian origin. The remains of the magnificent stupa of Amaravati tracing to the develòpments during 200 B.C. to 250 A.D. is testimony to the status sculpture achieved during the Andhra dynasty in Deccan. During the Gupta period, the golden age of India, iconography and the theory of music and dance are codified. Images and temples of all religious forms appear in profusion. An identical quality appears not only in art of diverse sectarian application, but in the art of every province. All foreign influences have been absorbed and Indianised. Coomarswamy writes that "now for the first time and only time in Indian history we meet with practice of the arts as a personal achievement, side by side with vocational hieratic production. .....painting is an accomplishment of kings and queens .....secular painting was regarded, like music and poetry, ...".

Some of sculptures in caves of Ajanta and Ellora belong to this period. The medieval period following the Gupta period saw an even more abundant and elaborate production of art and sculpture. The national taste determines the character of art. Temple building and sculpture were at their peak during the seventh and eighth centuries as could be seen from the monuments at Ellora, Mahabalipuram and other places. Temple building and sculpture continues until the end of the twelfth century in northern, west and central India, to the end of the thirteenth century in Orissa and up to the present day in southern India.

A number of heritage monuments currently found in India is a testimony to the very rich historical background it has in art and culture. Many of these monuments are declared as world heritage sites by UNESCO. They are Ajanta Caves, Ellora Caves, Agra Fort, Taj Mahal, Sun Temple, Konark, Group of Monuments at Mahabalipuram, churches and convents of Goa, Group of Monuments at Hampi, Fatehpur Sikri, Group of Monuments at Pattadakal, Elephanta Caves, Brihadiswara Temple at Thanjavur, Buddhist Monastery at Sanchi, Humayun Tomb at Delhi, and Qutab Minar and Associated Monuments at Delhi. A brief description of three of these heritage sites, one belonging to the historical period (Ajanta Caves) and another two belonging to the medieval period (Ellora Caves and Khajuraho temples) in India is attempted below.

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Ajanta caves provide a rich culture of painting and sculpture during 2nd century BC to 8th century AD in India. They show how painting and sculpture have flourished when the people's faith in Buddhism was at its peak in India. The 30 excavated caves in Ajanta are lavishly adored with sculptures and some of them with paintings also portraying a number of events in Buddha's life. There is a display of vast drama of scenes in which princes, sages, heroes, men and women, animals, birds and plants are depicted (James, 1965). Coomaraswamy (1969) says that "the frescoes of Ajanta preserve an infinetely precious record of Indian painting. .....This is the picture of the halcyon age, where renunciation and intimacy are perfectly attuned, an art at once of utmost intimacy and reserve. Every gesture springs in godlike fashion directly from the natural disposition of the mind: this is not the self-betrayal of innocence, but utterance in terms of a supreme courtesy. .....It is on importance that we know nothing of painters names: all Indian was richly painted in these days, and the art is the art of race and not of any individual". James (1965) writes that "behind Ajanta lay a romantic mysticism in which the spiritual and the divine permeated life in all it manifestations, experiences as the ordered pattern of the spiritual values and realities of the universe. So great has been the artistic achievement of Ajanta and so varied, being not merely religious but dramatic, emotional, romantic and lyrical, that artists throughout the Buddhist world in south-eastern and eastern Asia have drawn their inspiration from its successive phases, techniques and traditions". There is a profound influence of the cultural heritage of Ajanta on the paintings and sculpture belonging to later periods in India.

Some of the sculptures in Ellora caves originating during 550 to 750 AD present a picture of tolerance and integration of different faiths: Hindu, Buddhist and Jain faiths with the cohabitation of sculptures representing different faiths in successive caves at one place. Kailasa temple, the most renowned monument in Ellora is cut from a living rock and standing from it. This temple is dedicated to Shiva. It is known to be constructed and equipped on the Brahmanic pattern. One could notice fully developed Dravidian or south Indian architecture in this temple. Cultural heritage found in Ellora caves and similar places in India could have a lot of influence on the people to accept religious tolerance or secularism as a faith practiced in India.

Temples at Khajuraho in the state of Madhya Pradesh in India built during 950-1050 AD, convey an

impression of religious tolerance that prevailed at that period. These temples are divided equally between the three great Indian religions: Jaina, Vaishnava and Saiva. While Vaishnava and Saiva faiths are parts of Hinduism, there is archeological evidence to show that Khajuraho also harbors some ruminants of Buddhism. Fergusson (1976) says that "a curious result of this toleration or community of feeling is that the architecture of all the three groups is so similar that, looking at it alone, no one could say to which of the three religions any particular temple belonged. It is only when their sculptures are examined their original destination becomes apparent." One could find in these temples the incorporation of all forms of life-plants, animals and humans-and all dimensions of cultural heritage-dance and music, spiritual life, religion, the state or kingdom.

Conclusion

There is now a lot of literature about the human skill capital and its role in economic development and growth. Similarly there is now a growing realization about the social capital as an economic good and its role in economic development. However, there is still no precise definition of social capital and no clear understanding of its properties. The social capital is understood as a multifaceted concept. Cultural heritage or heritage capital could be seen as a fusion of human skill capital and social capital.

Heritage consists of performing and visual arts. It consists not only of tangible objects, such as those to be found in museums or in buildings, parks and gardens, areas of natural beauty, archeological sites and like; it also consists of inherited traditions of performance and execution.

In a free market the cultural capital may be under supplied because (a) some forms of cultural capital posses public good characteristics, and (b) some types of artistic capital offering live performances has the cost disadvantage in relation to other types of human skill capital and general manufacturing goods. Therefore, there could be a need for government subsidy for the performing arts and the conservation of built heritage by the government or other non-market institutions.

Built heritage has three dimensions: A source of history, an artistic creation and a manifestation of passing time. All the three dimensions of built heritage are visible from the development of art and culture in India during prehistoric, historic and medieval periods. Unlike physical capital, heritage capital does not depreciate as we use it. It is a dynamic phenomenon expanding and changing its composition and structure over time.

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The best way to hold your customers is to constantly figure how to give more for less.

– Jack Welch

Feature

Industrial Sector Reforms: Tending Towards Inter-Regional Convergence or Divergence?

C. Thangamuthu & A. Sankaran

The reform process in the industrial sector has shown encouraging results on two counts: (a) better performance levels in terms of some principal characteristics such as number of factories, employment generation, fixed capital, value of output and value added. (b) more surprisingly, performance with reference to the all-India level appears to be better than even the industrially advanced states like Maharashtra, Gujarat, Tamil Nadu and West Bengal. This trend goes to prove that there is a clear and perceptible move towards "convergence", reducing the gap between the industrially advanced and less developed states in the country.

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The economic reforms introduced in India in 1991 essentially targetted the industrial sector. The logic behind the shift in the paradigm form "state–intervention-cum-import substitution" to that of "liberalization-cum-export-led growth" is perhaps no more a controversial issue. After initial apprehensions, people seem to have come to terms with the economic necessity behind the need for this shift in strategy. The reform period since 1991 is fairly long enough to assess its outcome and compare the same with progress just preceding the economic reforms. This paper seeks to analyse the all-India industrial performance during the pre-reform and post–reform periods and compare the all-India industrial progress during these periods, with the corresponding progress in four select leading states. Whether the reforms have led to a tendency of inter-regional convergence or divergence, is the main focus.

The data-base for the above analysis has been the Annual Survey of Industries (ASI), for the latest available years, 1979-80 to 1997-98. The 12-year period prior to reforms is taken as the benchmark for comparison with performance in the post-reform period (from 1991-98). The principal indicators of performance taken for analysis include number of factories, employment, fixed capital, value of output and value added.

State intervention vis-à-vis liberalization

The contextual justification for the protracted phase of state intervention and import substitution strategy is not far too seek, and the Indian case is not an exception. As has been well observed (Mundle, 1993), in the sphere of economic policy development theory provided the intellectual foundation for widespread government intervention, restriction of the market mechanism, and government-controlled allocation of investment funds in accordance with a comprehensive economy-wide plan of production. Indian planners like Mahalanobis, Pitamber Pant and Chakravarty, were

Table: 1: Principal characteristics during pre-reform and post-reform periods [Rs in lakhs]

	Fixed Capital				Value of Output				Value Added			
	Per Factory		Per Worker		Per Factory		Per Worker		Per Factory		Per Worker	
States	PRR	PTR	PRP	PTR	PRR	PTR	PRR	PTR	PRR	PTR	PRR	PTR
Tamil Nadu	40.99	133.32	0.60	2.13	107.56	306.42	1.56	4.90	20.71	58.93	0.31	0.94
Maharashtra	68.44	260.04	0.84	3.55	189.20	606.84	2.33	8.26	38.37	127.77	0.47	1.74
Gujarat	55.07	284.09	0.86	4.36	132.53	504.59	2.07	7.76	22.05	93.92	0.34	1.44
West Bengal	77.91	332.22	0.54	2.65	169.68	447.66	1.18	3.57	34.33	97.60	0.24	0.78
India	62.80	223.24	0.82	3.05	127.31	424.01	1.66	5.80	24.90	84.91	0.32	1.16

Note: PRR- Pre-Reform Period, PTR- Post-Reform Period.
Source: Computed from ASI data

leading contributors to these exercises in development planning.

Though at the formal analytical level, these exercises bore a resemblance to comprehensive planning based on material balancing in the Soviet economy, the policy instruments employed for implementing such plans in India and many other developing countries were quite different from those employed in the command economy of the Soviet Union. Nevertheless, the consequences of such widespread state intervention in developing countries was, in a qualitative sense, not very different from that in the more centrally planned economies. The differences have been more of degree rather than substance. They may not have been so severe as to lead to a total collapse, as observed in the former USSR and other east European countries. However, the adverse effects of such indiscriminate intervention have been quite severe as we know from our own experience here in India.

Manmohan Singh (1986) rightly observed the conditions of state failure: "It ought to be pointed out that those who argue in favour of planning are implicitly assuming that the state is a custodian of public interest. In addition, they are also assuming that public authorities have on the whole superior information and knowledge of issues having a bearing on investment decision... It must be frankly admitted that in many developing countries these conditions are not always satisfied. It is futile to expect rationality or optimality of investment decisions in a situation in which those who control the machinery of the state use it for their personal or group aggrandizement. Where there is rampant corruption in public services, the information available to the public authorities is also likely to be fouled. It thus needs to be emphasized that successful planning assumes a high degree of integrity in public services and political leadership. In addition, the success of planning depends on the technical competence of the administrative machinery, its capacity to anticipate events and take necessary corrective action fast enough. For this purpose, among other things, it is essential that those who make crucial economic decisions should be secure enough to take a fairly long view of the economic processes. Political instability or insecurity of tenure can have a highly destabilizing effect on the quality of economic decision making processes."

Singh further describes the persistent failure of most public enterprises to generate surpluses, thereby placing the entire decision-making process under great pressure. He also refers to the inefficient licensing restrictions used to guide private investment, the quantitative restrictions on trade and the excessively high tariff barriers, all of which have led to unnecessary distortions, a high cost structure, the frittering away of scarce resources and the consequent shortage of resources for promoting rapid growth.

Reforms leading to convergence or divergence?

After path-breaking industrial reforms, it is now time to take stock of the situation and assess the implications of liberalization and also to compare this with the pre-reform performance. There is general apprehension that reforms encouraging private initiative are likely to benefit industrially-advanced states more than others for the simple reason that in the former private initiative and the industrial/infra-structural potential can take better advantage of the liberal atmosphere provided by the reform process. As a result the gap between the industrially, better-developed states and the lesser developed ones is likely to widen further. This is what happened as the consequence of the Green Revolution, inadvertently though.

Some studies corroborate the above expectation. Ghuman's (2002) study sums up the scene as follows: "In India, it has been found that economic liberalization has accelerated industrial development. However, the benefits of industrial development are not evenly dis-

tributed across states. Two western states - Gujarat and Maharastra and one southern state - Tamil Nadu, have gained the most from liberalization policy initiatives. The other beneficiaries are West Bengal, Karnataka and Orissa. These states enjoy certain added advantages such as proximity to ports, vigorous implementation of economic reforms, a strong industrial base (except Orissa), greater availability of mineral resources, relatively better developed infrastructure in many of them and political stability. The remaining states have either gained moderately or have suffered losses during liberalization. Most of these states are located in the North".

The post-reform industrial growth, in aggregate, has been generally found to be better, and in some respects more impressive, than in the pre-reform period. In India, there has been a faster rate of growth of output in manufacturing since 1991, but then this by no means is dramatic. As we would have expected, there is also a rise in employment, though perhaps not commensurate with the increase in the rate of growth of output. However, the much-mooted suggestion of a jobless growth, appears exaggerated. The principal cause of output growth in the nineties was investment, with the share of investment in output having increased very substantially overall, and pretty much across the board in Indian manufacturing (Balakrishnan and Bhabu, 2003).

The post-reform industrial growth, in aggregate, has been generally found to be better, and more impressive, than in the pre-reform period.

However, according to others (Nagaraj, 2003), the post-reform period has not registered any spectacular or marked progress on the industrial front. In India, the annual trend growth rate of total manufacturing gross value added ("output", for short, hereafter) during the last two decades (1980-2000) is close to 7 per cent. The manufacturing sector's share in the work force has remained roughly constant at around 12 per cent. Registered manufacturing employment in factories regularly employing 10 or more workers constituting about one-fifth of total manufacturing employment has steadily risen from around the mid-1980s for over a decade, without a trace of the effect of the 1991 reforms in the trend. The trend growth rates of output in general, lower in the 1990s compared with those in the previous decade.

The regional spread of industrial development in the post-reform period reinforces the already well established inter-state differences and brings inequalities into sharp focus. The top two states (Gujarat and Maharashtra) alone account for almost half of the value-added of the nation's industrial sector. This trend of inter-regional inequality has been accentuated further by the reform dynamics. The regional share of manufacturing value added of industries under major groupings with detailed break-ups for the four southern states indicates that while the west dominates the manufacturing sector with a share of above 45 per cent of value added, the south follows at 26 per cent. Among the southern states, Tamil Nadu has the highest share of 9.1 per cent followed closely by Karnataka at 8.6 per cent. Andhra Pradesh is at 5.7 per cent and Kerala comes last at just 2.4 per cent of the manufacturing value added during 1999-2000 (Joseph, 2003).

Principal characteristics

The principal characteristics analysed here includes the fixed capital, value of output and value added. All these magnitudes have been analysed in terms of their average values per factory and per worker. The values in respect of the pre-reform period (1979-80 to 1990-91) have been compared to that of the post-reform period (1991-92 to 1997-98). The values have been taken in the current prices; as it is an inter-state comparison, the current values have been taken as such (underflated). Even if they are converted into constant values, the comparative picture is not to be altered as all the states have only common denominator of deflation (in terms of the price index).

Fixed capital

The fixed capital per factory has grown substantially in Gujarat (5.15 times) followed by West Bengal (4.26 times), Maharashtra (3.79 times) and Tamil Nadu (3 times). The same trend is reflected when it comes to fixed capital per worker. It is surprising that Tamil Nadu has relatively lower fixed capital per factory and per worker when compared to the all-India position. The capital intensity (per factory and per worker) have thus registered substantial increase during the post-reform period ranging from three times to 5.15 times. The increase in capital intensity in a matter of seven years seems to be stupendous. The reform period has encouraged greater capital intensity in production, with much less scope for employment generation.

Value of output

The increase in value of output per factory between the pre and post reform periods indicate the dominance of Gujarat followed by all-India (233 per cent),

Table: 2: Annual Average Growth Rates [in Percentage]

	No of Factories		Fixed Capital		No of Employees		Value of Output		Value Added	
States	PRR	PTR	PRP	PTR	PRR	PTR	PRR	PTR	PRR	PTR
Tamil Nadu	3.76	4.51	18.36	17.89	1.73	3.87	15.78	17.18	16.96	13.63
Maharashtra	0.57	4.28	16.85	19.71	-0.69	2.61	15.79	16.90	14.92	17.86
Gujarat	0.42	3.04	17.38	29.62	-0.34	4.15	15.32	22.32	15.19	22.94
West Bengal	-0.65	3.18	11.78	18.21	-2.32	1.83	11.17	14.53	10.17	17.52
India	1.47	3.05	15.80	18.03	0.60	2.92	16.21	17.55	15.38	17.61

Note: PRR- Pre-Reform Period, PTR- Post-Reform Period.
Source: Computed from ASI data

Table 3: Percentage shares of the leading states in All-India [P.C. shares]

	Number of Factories		Fixed capital		Number of Employees		Value of Output		Value Added	
States	1979-80	1997-98	1979-80	1997-98	1979-80	1997-98	1979-80	1997-98	1979-80	1997-98
Tamil Nadu	10.3	14.6	7.1	8.2	10.3	12.8	10.7	10.0	9.9	8.7
Maharashtra	15.5	15.2	15.1	18.1	17.4	14.8	23.7	21.0	24.9	21.7
Gujarat	11.1	9.9	8.8	15.2	9.3	8.9	11.2	12.9	9.5	9.2
West Bengal	6.6	5.1	6.4	6.2	12.6	8.4	9.8	5.1	10.96	6.2

Source: Computed from ASI data

Maharashtra (220 per cent), Tamil Nadu (185 per cent) and West Bengal (164 per cent). The value of output per worker also ranges about the same. The growth of output per factory has been largely impressive at the all-India level, while the states of Tamil Nadu, West Bengal and Maharashtra have been lagging behind the all-India position. Only the state of Gujarat has fared marginally better than the all-India position. The fact that the leading states like Maharashtra, Tamil Nadu and West Bengal tend to lag behind the all-India level, proves that in the value of output there is no growing inequality across the states. It should be observed that other less advanced states had performed better, taking the all-India figure upward.

Value added

The increase in value-added-per-factory during the above reference periods indicates that Gujarat leads other states. Interestingly enough, the all-India position in this respect ranks second, even higher than that of Maharashtra, West Bengal and Tamil Nadu. However, when it comes to increase in value-added-per-worker the all-India figure takes third rank next only to Gujarat and Maharashtra. Again the tendency of industrially less-developed states to grow faster and catch-up with the advanced states is perceptible, so much so that West Bengal and Tamil Nadu lag behind the all-India average.

Growth Rate

Number of factories

The number of factories has registered a fairly rapid increase during the post-reform period, the annual growth rate ranging from 3.05 per cent (all-India) to 4.51 per cent (Tamil Nadu). The West Bengal state, which registered a negative growth rate during the pre-reform period has made an impressive mark during the post-reform period (3.18 per cent), even better than Gujarat (3.04). The all-India growth rate has been just above the rates of Gujarat and West Bengal. These dynamics imply that the industrially less developed states have fared relatively better pushing up the all-India average.

Fixed capital

The growth rate in fixed capital during the post-reform period has been quite substantial in Gujarat (29.62 per cent), against its pre-reform figure of 17.38 per cent. West Bengal also registered a good growth rate of 18.21 per cent during the post-reform period, against 11.78 per cent during the pre-reform period. Tamil Nadu, surprisingly suffered a marginal declined. The all-India growth rate (18.03 per cent during post-reform period) has been quite close to that of Maharashtra, Tamil Nadu and West Bengal, again reinforcing the catching-up trend of the lagged states.

Table 4: Correlation results

State	No of Factories &Value of Output		Fixed Capital &Value of Output		Fixed Capital & Value Added	
	PRR	PTR	PRR	PTR	PRR	PTR
Tamil Nadu	.9720	.8929	1.00	1.00	1.00	.892
Maharashtra	.2308	.9643	1.00	.96	1.00	.96
Gujarat	-.0490	.8929	1.00	1.00	.979	.892
West Bengal	-.7273	.7857	.99	.96	.965	.964
India	.7622	.9643	1.00	1.00	1.00	1.00

Note: PRR - Pre-Reform Period, PTR - Post-Reform Period.
Source: Computed from ASI data.

Employment

The growth rates in employment during the pre and post-reform periods reveal some striking features. During the pre-reform period, the employment growth rates were negative in the states of Maharashtra, Gujarat, and West Bengal; quite negligible in all-India and fairly satisfactory in Tamil Nadu (1.73 per cent).

In the post-reform period, there is a sharp contrast. Against the negative and negligible growth rates in the pre-reform period, the growth rate of employment ranged form 1.83 per cent (West Bengal to 4.15 per cent Gujarat). The all-India position was 2.92 per cent, surpassing the employment growth rates in West Bengal and Maharashtra. Thus the apprehension that the industrial sector reforms would be less employment generating has been proved wrong. In fact, the pre-reform period was rather depressing on the employment front in the industrially advanced states. The advent of the reform process has generated industrial employment in the private sector.

Value of output and value added

The growth rates of value of output and of value added also show a strong tendency towards convergency (less of inter-state disparity). Gujarat made a spectacular progress: As against 15.19 per cent growth rate in value added during pre-reform period, it has registered 22.94 per cent growth during post-reform period. In Tamil Nadu, however, the value added suffered a declining growth rate, which slipped down to 13.63 per cent in post- reform period against 16.96 per cent during pre-reform period. The all-India growth rates in value added caught up quite closer to advanced states, next only to Gujarat. The reforms have thus rather narrowed down the inter-state differences.

Trends in relative shares of industrially advanced states

The relative shares of the industrially advanced states in the all-India level, in terms of number of factories, fixed capital, employees, value of output and value added, go largely to prove the trend towards more of convergence and less of inter-state inequality. Particularly, the all-India position has considerably improved effectively bringing down the relative shares contributed by the industrially advanced states. The relative shares of Tamil Nadu, Maharashtra, Gujarat and West Bengal in the value-added of the all-India industrial sector have consistently declined during the post-reform period. The same is the case with relative shares of industrial employment (expecting Tamil Nadu's share which has increased), and in the relative shares in the number of factories. Here too only Tamil Nadu has registered an increase in its share while all the other advanced states have suffered in their relative shares. But in terms of shares of fixed capital, Gujarat and Maharashtra, and marginally Tamil Nadu, have recorded considerable increase. However, largely, the all-India position has improved vis-a-vis the progress made by the so-called industrially advanced sates.

Some correlations

The efficiency parameters of the industrial sector may include correlations between certain principal characteristics such as the number of factories and value of output, fixed capital and value of output and fixed capital and value added. When we compare the correlation of values in respect to the above variables between the pre-reform and post-reform periods, we find better positive relationships in the post-reform period. The correlation of values between the number of factories and the value of output which were negative (or negligible) in the states of Gujarat, West Bengal and Maharashtra during the pre-reform period, have especially turned out to be positive and significant in the post-reform period. This trend indicates a clear-cut improvement in the performance of the industrial sector. The all-India figure in this regard also corroborates this. However, the picture regarding the correlation between fixed capital and value added is slightly different. The post-reform values

are marginally lower (but still, the values are positive and significant, indicating no big decline in the performance level).

Conclusion

The reform process, especially in the industrial sector has shown encouraging results on two counts: Considerably better performance levels in terms of some principal characteristics such as the number of factories, employment generation, fixed capital, value of output and value added; and more surprisingly, the performance with reference to the all-India level appears to be better than even the industrially advanced states like Maharashtra, Gujarat, Tamil Nadu and West Bengal. This trend goes to prove that there is a clear, perceptible move towards "convergence", reducing the gap between the industrially advanced and less developed states in the country. This is something contrary to general expectations. Unlike the Green Revolution spearheaded by the state and resulting in accentuating of inter-regional inequalities, the industrial sector reforms (where the private initiative has been allowed and facilitated to play its potential) have been tending to reduce inter-state disparities. Going by certain relationships, particularly between the number of factories and value of output, the performance level in the post-reform period is far better than during the pre-reform period. The above trends, if sustained, are likely to result in substantial developmental implications.

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The surest foundation of a manufacturing concern is quality. After that, and a long way after, comes cost.

– Andrew Carnegie

Feature

Future of the Indian Textile Industry under WTO

K.U. Umakrishnan

A lot of uncertainty exists within the Indian textile industry as well as among policy-makers regarding the implications of the phasing out the Multi Fibre Agreement and the implementation of the Agreement on Textiles and Cloth under the WTO by 2005. This paper tries to address this and related issues using a segment-wise approach. The Indian industry is going through a stage of restructuring in which it will have to meet challenges head-on in order to survive domestic and international competition.

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The World Trade Organisation (WTO) was founded on January 1, 1995, with the idea of promoting unfettered international trade. The basic goal of free trade was to be attained through the Most Favoured Nation Status and non-discrimination clauses, whereby it was ordained that every country has to be extended the best treatment accorded to any other country and that there can be no discrimination between imported and domestic goods. For this purpose quantitative restrictions were to be completely eliminated and the tariff walls were to be lowered. While for most of manufactured goods the above clauses were considered binding, trade in textiles and clothing was to remain outside the WTO rules to protect the interests of the developed countries. Therefore, textiles continue to be accorded special treatment and are governed by the Multi Fibre Agreement.

Since the early 20th century, developed countries have followed protectionist policies to restrict the import of textiles and apparels from developing countries. As early as 1935 the United States negotiated the first voluntary export quota on Japanese exports in addition to the already high tariff rates of 40-60 per cent. This was followed by the Short Term Cotton Textile Arrangement in 1961 (Prasad, 1997) and the Long Term Arrangement Regarding International Trade in Cotton Textiles (LTA), in October 1962, which controlled cotton textile exports for the next ten years. Although the LTA was a multilateral document, it essentially functioned as a set of bilateral agreements, which allowed importing countries to negotiate quotas on a country-by-country basis and in some cases to impose unilateral quotas without penalty.

In 1974, the Multi Fibre Agreement (MFA) was entered into to incorporate the so far excluded segments of synthetic fibre and the smaller textile exporting countries of south east Asia. Of the MFA eight "importers" (Canada, EU, Norway, US, Japan, Switzerland, Finland and Austria) four namely, Canada, EU, Norway and the US were applying restrictions under the MFA when the ATC came into force (MVIRDC, 2002).

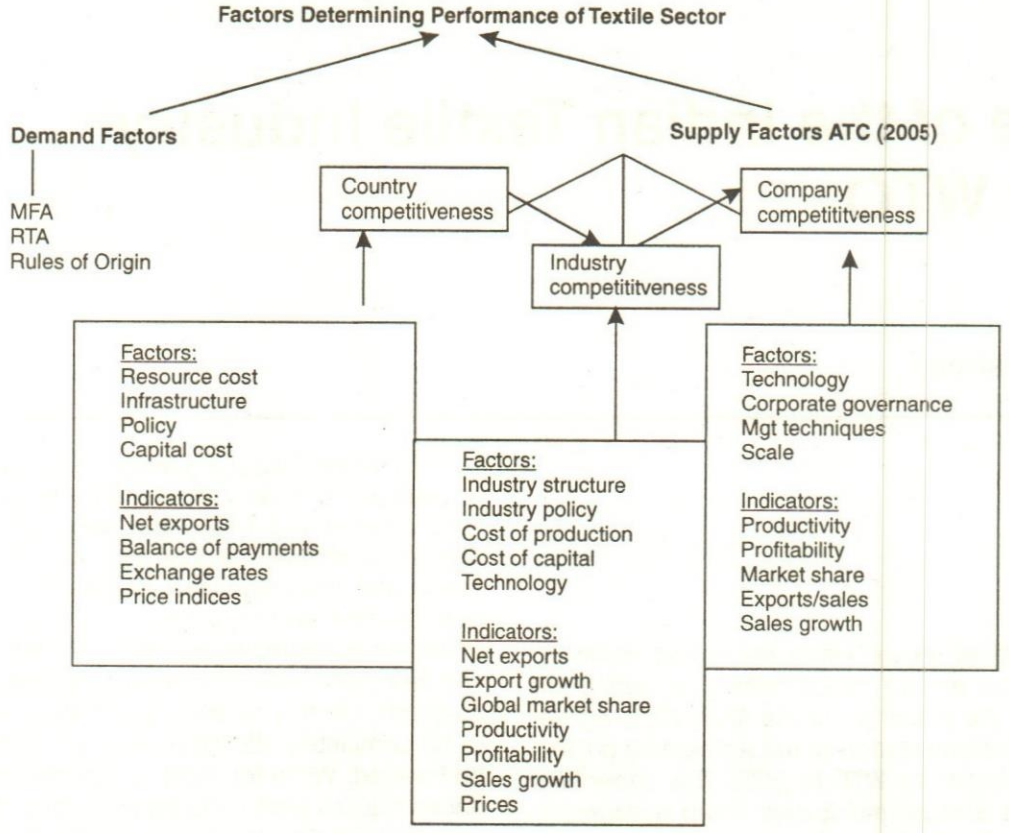


Fig. 1. Factors determining performance of textiles sector

The other participants in the MFA are the "exporters" (mainly developing countries), whose exports or part of exports covered under the MFA are subject to bilaterally agreed quantitative restraints or unilaterally imposed restraints on imports typically applied at the product level, but in some cases to various aggregate levels as well (Narasaiah, 2001).

In 1978 the MFA was amended to make it more restrictive and further protect the textile industry of the developed countries. Additional constraints on exporters were introduced under the MFA in 1982. Despite this, textile and clothing exports to the industrialized countries have continued to grow and in response to this in 1986, the MFA was further amended to specifically include silk, linen, and jute to the existing fibres in an attempt to finally control trade in all products. This continued till 1991 and was extended to 1995 when the WTO was formed.

Given the history of protection given to the textile industry in the developed countries, it was not surprising that these countries could not accept the philosophy of free trade of the WTO in 1995. Hence, it was negotiated that the Agreement on Textiles and Clothing under the WTO, under which non-tariff barriers like quota were to be eliminated, would be introduced only after a gap of 10 years in 2005. According to the WTO agreement on textiles and clothing in 1995-2005 the MFA is to be phased out in four steps: 16 per cent of 1990 imports, (by volume) were required to be integrated on 1 January, 1995, followed by a further 17 per cent on January, 1998 and another 18 per cent on 1 January, 2002. The remaining 49 per cent will be integrated on 1 January 2005. This, however, does not mean absolute lack of protection for importing country industries after 2005. While the existing MFA restrictions are being phased out, new restrictions permitted by the WTO under "transitional safeguards" are being introduced (Bhatia, 1977). Despite this world trade in textiles is expected to sharply increase after 2005.

International trade in textile is estimated to be worth $240 billion a year. Estimates are that after the phasing out of the MFA, world export of textiles may go up by $25 billion a year. The implications of the phasing out of quota is of critical importance for the textile exporting countries, as foreign country markets with quota restrictions will become open to free competition. While on the one hand, competitive exporters can expand their market without limit, on the other hand, the less competitive exporters will lose their assured quota. While the

demand factors played an important role under the MFA, after 2005 the supply competitiveness will come forth as the most critical factor in determining the export growth of the textile exporting countries.

Given the changed context, it becomes imperative to assess India's prospects in the post-MFA era. This is especially so because quota restrictions on textile exports from India under the MFA exist with these six countries, and USA and EU account for over 60 per cent of Indian textile and clothing exports.

Indian Textile Industry

Supply

The Textile industry has traditionally held a place of great importance in the Indian economy. It accounts for 3 per cent of GDP, 21 per cent of the organized workforce, 14 per cent of the national industrial production and 35 per cent of gross export earnings (Planning Commission, 2002). This is primarily because India is blessed with a rich variety of cotton produce. At the time of independence the textile industry was the most vibrant industry of the Indian economy, especially natural fibre-based, textiles. The textile policies since independence were tailored primarily for employment generation rather than for the rapid growth of the industry itself. The handloom sector, which is more labour intensive in relation to the powerloom and mill sectors, was encouraged as it was thought to be an effective way to generate employment. To protect and sustain the handloom sector, imports were completely restricted, domestic production of various products and items were reserved for this segment, fiscal incentives were provided, and the powerloom and mill sectors were discriminated against (Roy, 2004). Licensing was made compulsory for the powerloom and mill sectors, capacity enhancement was discouraged due to which scale economies could not be reaped, and technology upgradation through technology imports were restricted. As the handloom sector is primarily cotton-based while the other sectors are synthetic-based, the discrimination against the latter was manifest in the synthetic-to-cotton cloth price ratio in the world. The SSI policy of the government also played a role in limiting the efficiency of the powerloom sector. This is because powerlooms had more to lose by expansion or vertical integration in order to enhance productivity and efficiency, as by doing so they would forsake the incentives enjoyed under their SSI status.

The textile policies since independence were tailored primarily for employment generation rather than for the rapid growth of the industry itself.

Under this protectionist umbrella the handloom sector and small powerloom units thrived even with low quality, high costs and high inefficiencies, while the health of the mill sector deteriorated given the unfair playing field. Ultimately a large number of mills had to be nationalized in the late seventies and National Textile Corporations were formed across the country. Moreover the closed-door trade policy followed which meant that while the industry basked under protectionism, it was at the same time deprived of export markets. The biased policy that followed, therefore, resulted in the creation of serious distortions in the industrial structure. Due to the high costs, per capita cloth consumption of India remained extremely low.

The mid-eighties saw the beginning of a shift in the policies of the government from inward-looking to efficiency driven outward-looking growth. It was realized that enhanced efficiency through the open market approach is in the long-run a more sustainable and realistic path to overall growth and development through the optimal allocation of resources within various sectors. The need for technology upgradation and import of textile machinery, capacity enhancement and promotion of efficiency in production was finally realized as essential for international markets. This resulted in the gradual withdrawal of support to the handloom sector and the introduction of a level playing field between the sectors. Hitherto reserved items for the handloom sector were delisted, and by the nineties imports were also permitted. With the economic reforms and market-alignment of exchange rates, the share of cotton in total exports had gone up to 30 per cent in 1995 from 19 per cent in 1970 and 25 per cent in 1980.

Demand Side

The demand for the Indian textile industry is driven by both domestic as well as international markets.

On the export front, Indian exports have primarily been concentrated in countries which have traditionally imposed quota restrictions. The increasing share of textiles in exports, therefore, is not fully indicative of India's competitiveness as the major textile importing countries of Europe and North America operate under the Multi Fibre Agreement whereby textile exporting countries are given fixed quotas. With a 2.2 per cent share in the world textile trade, India's share in the additional exports could be $0.55 billion. But the real gain will depend on the country's ability to compete with other textile export-

ing countries. Apart from the export angle, the Indian market itself is now open to import of textile and the survival of the segment catering to the domestic market itself has become open to debate.

Demand for textiles in India has grown with an increase in economic growth rates. The per capita consumption of textiles in India is one of the lowest in the world (at less than 2.5 kgs) and is targeted to double in the next ten years. With the liberalization of imports whether Indian textile industry can benefit from the increased domestic demand will depend on its competitiveness in terms of price and quality *vis-a-vis* the imports in the years ahead. It is in this context that it becomes necessary to evaluate the competitiveness of Indian textile industry not only in the international market but also in the domestic market. However, finding a single measure of "competitiveness" is extremely difficult (Turner and Van't Dack, 1993) and has been limited to in production, imports, exports and the cost of production.

This study undertaken is based on both quantitative information. The quantitative information is drawn from various secondary data sources like the Textile Commission for the production data, DGCI&S and UN International Trade Statistics for trade data, CMIE Prowess Sample (segment-wise details given in Table below) for the industry performance and production cost structure. In addition qualitative information was collected through discussions with various industry associations.

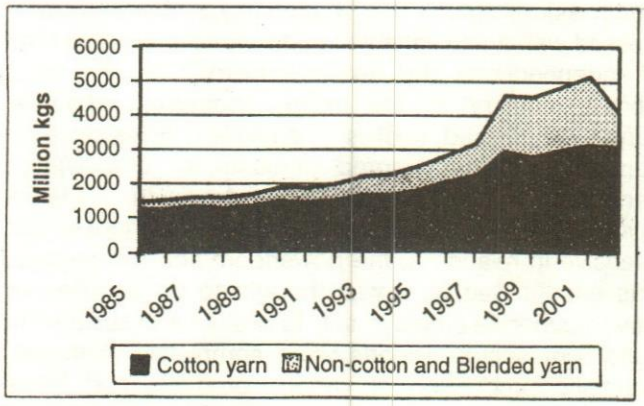
Table 1: CMIE sample

Classification	No. of companies
Cotton	142
Cotton cloth	41
Cotton yarn	101
Synthetic	53
Synthetic fibre	47
Synthetic fabrics	6
Others	74
Textile Processing	22
Readymade garments	13
Silk textiles	5
Woollen textiles	6
Jute products	12
Miscellaneous	16
Total	317

Performance of Indian Textile Industry

Indian textile industry can be broadly divided into three segments: fibre and yarn, cloth or fabric and apparels or garment segment. The yarn may be natural-based (cotton, silk, jute, etc) or synthetic-based (nylon, polyester, acrylic, etc). Raw material in spun into yarn by the spinning mills and passed on to the next state for weaving either by handlooms (in the case of natural- based yarn), powerlooms or at composite mills.

The turn-around in the government policies since the eighties has led to a rapid growth in the yarn production of the country (see figure 2 below). Although both cotton as well as non-cotton yarn has contributed to the overall growth in yarn production, the growth of non-cotton yarn has been more impressive leading to an increased share from less than 15 per cent to almost 40 per cent of the total yarn production in the country. However, cotton yarn continues to be the single largest component in the total yarn production, though its share has fallen from over 85 per cent to just over 60 per cent.



Source: Textile Commission

Fig. 2. Yarn production in India

Table 2: Share of cotton and non-cotton in total yarn production

	1985	1995	2001
Cotton yarn	85.53	73.22	61.26
Non-cotton and blended yarn	14.47	26.78	38.74

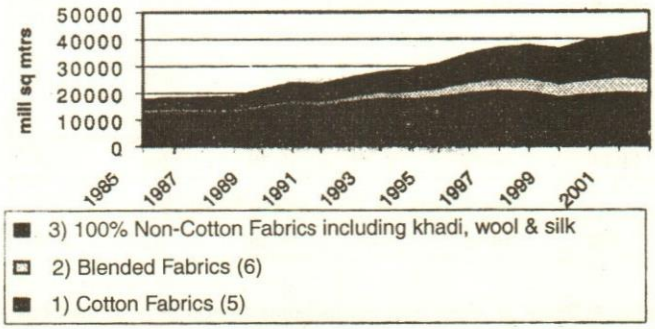
Source: Textile Commission

Fabric production in India also indicates rapid growth although the rate of growth is less impressive compared to yarn production (see Fig. 3). The growth can be attributed mainly to the non-cotton and blended fabrics, while cotton fabrics production seems to have more or less stagnated. As a result the dominant share of cotton fabrics of over 71 per cent in 1985 has been reduced to 45 per cent in 2001 (See table 2).

Table 3: Share of cotton and non-cotton in total fabric production

	1985	1995	2002
Cotton Fabrics (5)	71.50	53.63	45.98
Blended Fabrics (6)	9.52	12.53	14.00
100 per cent Non-cotton Fabrics Including Khadi Wool & Silk	18.98	27.47	40.02

Source: Textile Commission



Source: Textile Commission

Fig. 3. Fabric production in India

The production figures of yarn and cloth raise some interesting questions. Why has cotton cloth production not increased as rapidly as cotton yarn production? Obviously, it indicates that cotton yarn is being exported for further processing and value addition to other countries where it is converted to cloth. It is interesting to note that 75 per cent of exported yarn is grey yarn, which means we are exporting at the lowest on the value chain. But why are we not able to take advantage of the possibilities of exporting processed yarn or better still, cloth rather than yarn? The answer lies in the industrial structure. Due to years of neglect, the Indian processing as well as weaving industries are neither cost-efficient nor able to ensure high quality. This is mainly because vertical integration of processes was discouraged due to the SSI incentives.

These facts are also brought out by the import trends. Textile imports show a growth of 71.5 per cent between 1997-98 to 2000-01. Synthetic yarn continues to be the single largest component of textile imports (See Fig. 4). This comprises basically of high value technical fibres for industrial and medical purposes which are not produced in India at present and are, therefore, imported from countries like Indonesia, Korea, China and the US (see table 3). Cotton and synthetic cloth imports come next. It is obvious that India exports cotton yarn to countries like Hong Kong, Korea and China and then imports cotton cloth mainly from these countries. A major point emerging is the need to strengthen the processing and weaving sectors in India.

Given the higher cost of production and lower level of efficiencies, the increased competition through imports has had an adverse impact on the margins of the Indian firms. The average operating profit of firms across segments have moved in a southward direction. It is obvious that the textile industry as a whole has been

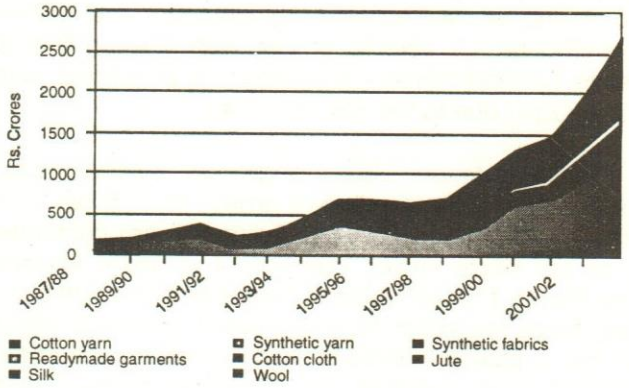
Table 4: Sources of textiles imports to India (share in %)

Total Textiles	Share	Cotton Fabrics	Share	Cotton Yarn	Share	Synthetic Fibre	Share	Synthetic Fabrics	Share	Silk	Share
Germany	2.2	Pakistan	1.36	Tunisia	0.7	Italy	0.5	UK	0.5	Japan	0.3
New Zealand	2.2	Turkey	1.37	Singapore	1.0	UK	0.7	Malaysia	0.6	Indonesia	0.3
Egypt	2.2	USA	1.44	Germany	1.0	South Africa	1.0	Italy	0.8	UAE	0.3
Hong Kong	2.9	Thailand	1.59	Switzerland	1.1	Netherlands	1.2	Switzerland	0.9	Brazil	0.4
Japan	3.1	UK	1.78	UAE	1.2	Germany	3.2	Germany	1.3	Thailand	0.4
Malaysia	3.2	France	2.26	Japan	1.6	Singapore	3.2	USA	1.4	Germany	0.7
Bangladesh	3.3	Indonesia	3.43	USA	1.7	USA	3.5	Thailand	2.0	Italy	0.8
Nepal	3.5	Malaysia	4.29	Taiwan	1.8	China	5.6	Hong Kong	2.1	USA	0.8
Thailand	3.8	Italy	4.97	Malaysia	2.6	Thailand	6.8	Nepal	3.6	Taiwan	0.8
Australia	4.3	Switzerland	6.32	Italy	3.0	Japan	7.6	Japan	4.2	Singapore	1.0
USA	4.5	Japan	6.47	Nepal	4.2	Nepal	7.7	Indonesia	5.7	Korea R	1.2
Indonesia	5.1	Korea R	9.21	Indonesia	5.5	Taiwan	10.9	UAE	6.9	Hong Kong	2.8
Korea R	7.6	Taiwan	9.35	Pakistan	10.7	Korea R	11.1	Taiwan	14.3	Nepal	3.2
Taiwan	8.7	Hong Kong	14.48	China	17.6	Malaysia	12.8	China	16.3	Switzerland	3.2
China	13.5	China	23.64	Hong Kong	38.9	Indonesia	19.6	Korea R	36.1	China	82.3

Source: Estimated from DGCI&S Foreign Trade Data

Note: Share estimated as average for the period 2000-01 to 2002-03

badly hit. But the intrasegment differences are glaring and firms that have updated their technology and enhanced capacities to reap scale economies continue to perform well despite the increased import competition.



Source: DGCI&S Foreign Trade Data

Fig. 4. Segment-wise trends in Indian imports

Table 4 shows a cost comparison between India's major competitors. India has the highest power and steam cost in comparison to the other countries. The share of power and fuel in the total cost of production in India has grown from less than 7 per cent in 1992 to almost 10 per cent in 2002 (table 5). Except for China, India has the lowest interest rates. The recent reduction in the interest rates is reflected in the falling share of this component in the total cost of production of Indian textile firms since 1998. Despite this, compared to 1992 the share of interest payments has gone up from 7.5 per cent to almost 9 per cent in 2002. Falling share of the raw materials and salary components indicate increased productivity in the industry. However, it is evident that in order to attain better competitiveness, it is imperative to reduce fuel cost differences between India and other countries.

Table 5: Cross-country comparison of key cost drivers

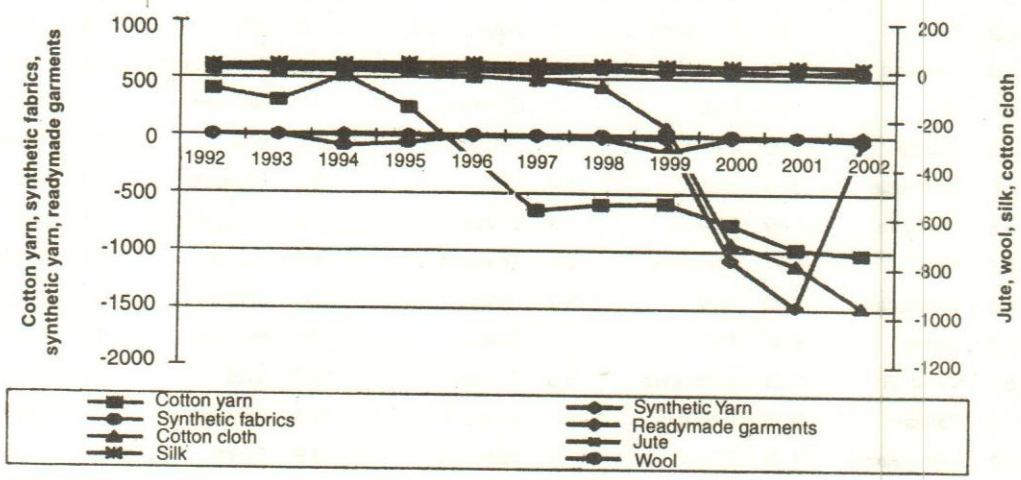
India	Bangladesh	Indonesia	Sri Lanka	China	Pakistan
Power cost-US cents per kWH					
8.87	3.49	3.65	7.78	6.04	6.57
Steam cost - US cents per hour					
1.96	0.78	0.73	1.52	0.58	1.41
Labour cost - US cents per hour					
50.18	22.68	34.33	37.04	57.03	38.79
Price of cleaned cotton (US cents per Kg.)					
130.82	–	–	–	113.38	129.91
Nominal Rate of Interest (%)					
11-14	14-16	16-18	16-18	5.5	13-14
Interest Rate for Tech. Upgradation (%)					
6-9	14-16	16-18	16-18	3	13-14

Table 6: Share of major cost components (percentage of total cost of production)

	1992	1995	1998	2001	2002
Raw material	59.6	59.5	57.1	56.0	55.9
Power & fuel	6.3	7.3	8.9	9.6	9.5
Salaries & wages	9.5	9.1	9.5	8.4	9.3
Royalty	0.0	0.0	0.0	0.1	0.1
Marketing	2.2	2.2	2.3	2.6	2.8
Depreciation	4.6	3.7	5.4	5.5	6.6
Interest payments	7.5	7.3	11.6	9.1	8.9
R&D	0.1	0.2	0.1	0.1	0.1

Source: Estimated from CMIE "Prowess" sample

Note: The above components do not add upto 100, as the component list is not exhaustive



Source: Sample data from CMIE "Prowess"

Note: Sample consists basically of domestic market-oriented firms.

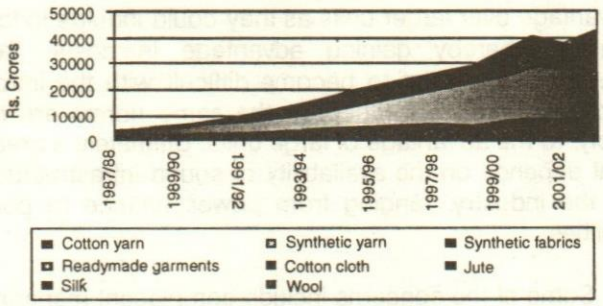
Fig. 5. Operating profit to sales Ratio (%)

Table 7: India's exports as proportion of world imports (%)

Commodities	1997	1998	1999	2000	Growth rate % 1997-2000
651 Textile yarn	5.40	4.16	5.01	5.69	5.38
652 Cotton fabrics, woven (not including narrow or special fabrics)	4.79	4.65	5.05	5.41	13.00
653 Fabrics, woven, of man-made fibres (not narrow or special fabrics)	1.25	1.24	1.42	1.78	43.06
654 Textile fabrics woven, other than cotton or man-made fibres	2.92	2.73	3.27	4.42	51.64
658 Made-up articles, wholly or chiefly of textile materials, nes	6.01	5.26	5.71	6.82	13.50
659 Floor coverings, etc.	6.32	7.04	8.10	7.55	19.46
842 Men's and boys' outerwear, textile fabrics not knitted or crocheted	0.52	0.82	0.88	1.29	145.63
843 Women's, girls', infants' outerwear, textile, not knitted or crocheted	3.63	4.01	3.88	4.22	16.44
844 Under garments of textile fabrics, not knitted or crocheted	0.63	5.76	6.09	7.26	1053.66
845 Outerwear knitted or crocheted, not elastic nor rubberized	0.82	0.88	1.16	1.26	54.04
846 Under garments, knitted or crocheted	2.19	2.67	3.00	3.22	46.69
847 Clothing accessories, of textile fabrics, new	1.90	1.76	2.83	3.25	71.09

Source: Estimated from UN International Trade Statistics 2002.

Despite these factors, following the shift in the 80s from inward looking policies to export promotion, Indian textiles and apparel exports have grown steadily. Growth of Indian exports was higher than the world average, due to which India has increased her share in the world market in almost all the textile and clothing segments. This has led to an increase in India's share in the world textile and garment segment from 2.21 per cent in 1990 to 2.87 per cent in 2000. Readymade clothes constitute the single largest component of Indian textile and clothing export, followed by cotton, yarn and cotton cloth, both basically in grey form.



Source: DGCI&S Foreign Trade Data

Fig. 6. Segment-wise trends in Indian exports

The question is whether India can maintain the above world average rates of growth of exports once the quota restrictions are done away with. India's strong points in this regard are cotton raw material availability, small batch flexibility, high value products and ethnic designs. India is blessed with the most diverse variety of cotton, giving it a resource advantage. However, due to certain policies India did not consolidate this advantage in building integrated production capabilities with economies of scale and modern technology, resulting in poor processing and low quality products.

China's competitiveness arises out of largescale production of low value items. On the other hand the smallscale production of Indian firms has brought in advantages of other kinds, like flexibility, which countries like China are unable to provide. This is especially important in high value fashion items. Moreover, the markets catered to by India and China are different. Quota countries account for 60 per cent (EU, Canada and US) of Indian exports implying drastic changes, while Hong Kong, Japan and South Korea are the major destinations accounting for over 50 per cent of Chinese textile exports. China, therefore, does not pose a direct threat to India as it specializes in largescale production of low value items primarily for the Asian markets. However, given Indian consumption pattern, and China's advantage in low value products, China poses a serious threat to Indian firms catering to Indian markets.

Competition for Indian exports basically come from other countries like Pakistan, Bangladesh, and Sri Lanka. However, given the fact that between the year 1991-92 and 1999-2000, non-quota exports items from India has grown at a faster rate than items restrained by quota, it may be hoped that post-quota, Indian exports can grow at a faster pace, with the assumption that India enjoys similar competitive levels in quota and post-quota items.

Table 9: Destinations of Indian textile exports (share as percentage)

Total Textiles	Share	Cotton Cloth	Share	Cotton Yarn	Share	Readymade Garments	Share	Synthetic Fibre	Share	Synthetic Fabrics	Share
Bangladesh	1.90	Turkey	1.71	Malaysia	2.3	Denmark	1.3	Bangladesh	1.8	France	1.4
Saudi Arabia	2.07	Togo	1.85	Canada	2.3	Switzerland	1.3	USA	2.0	Spain	1.7
Belgium	2.17	Hong Kong	1.92	Sri-Lanka	2.3	Belgium	1.7	Germany FR	2.1	Kuwait	2.1
Spain	2.19	South Africa	1.98	Egypt	2.6	Spain	1.9	Brazil	2.3	Togo	2.3
Hong Kong	2.20	Ivory Coast	1.98	Israel	2.8	Japan	1.9	Syrian Rep	2.7	Oman	2.5
Netherlands	2.40	Benin	2.01	Russia	3.6	Saudi Arabia	2.5	Iran	2.9	Mauritius	2.8
Japan	2.48	Germany FR	2.21	Korea DPR	3.6	Italy	3.4	Portugal	3.0	Nigeria	3.1
Canada	3.20	Belgium	2.77	Taiwan	3.7	Netherlands	4.0	UAE	3.8	USA	3.5
Russia	3.30	Nigeria	3.33	China	4.2	Canada	5.1	Belgium	5.3	Indonesia	3.7
Italy	4.09	Sri Lanka	3.86	Japan	5.0	Russia	5.8	Egypt	5.4	Sri Lanka	4.6
France	4.86	Italy	4.94	Italy	5.1	Germany	7.1	Spain	5.9	Malaysia	4.8
Germany FR	5.90	UAE	5.32	Mauritius	5.9	France	7.96	UK	5.9	Saudi Arabia	6.7
Uae	7.02	UK	6.15	Bangladesh	9.3	UK	8.9	Ireland	6.1	Singapore	7.3
UK	7.38	Bangladesh	6.54	Korea R	11.4	UAE	9.1	Italy	9.1	UK	7.9
USA	18.75	USA	11.32	Hong Kong	11.6	USA	22.5	Turkey	9.7	UAE	25.0

Source: Estimated from DGCI&S Foreign Trade Data

Future of Indian Textile Industry

The competitiveness of the Indian textile industry is contingent upon a restructuring of the industry structure based on continued reforms to remove the fiscal distortions and constant technology upgradation. Elements of flexibility have to be incorporated in order to make the industry better geared to the Technology Upgradation Fund Scheme introduced for the purpose of technology upgradation. Financial and technical collaboration has to be encouraged between foreign and Indian firms to ensure constant and continuous updating of technology. Special efforts are necessary to encourage capacity enhancement to reap scale economies. Furthermore, the need to encourage integrated production cannot be overemphasized. In order to assure quality of raw materials, some firms have taken-up backward integration through cotton contract farming.

Table 8: India's exports of clothing in quota items

	Quota Exports		Non-Quota Exports	
Year	Value	Growth	Value	Growth
1991-92	3616		2666	
1999-2000	12279	239.57	11704	339.01

Source: Nair (2002)

On the other end, large mills are not stopping with supply of fabric but are progressing towards garment manufacturing. This phenomenon has to be replicated by the industry as a whole. Cluster approach on the lines of Tirupur may also be developed to take advantage of the synergies provided by proximity. Within clusters more formal arrangements through consortiums for purchases or marketing have been successful in getting a better bargain in the competitive world. Novel structures are also being experimented with, like the margin-sharing arrangement whereby like-minded firms vertically linked with each other come into an agreement to share the final margin instead of taking margin at each value addition, which would make them uncompetitive. Introduction of CENVAT is also expected to give rise to a fair playing field. Smaller units had an advantage over larger units as they could indulge in tax evasion, thereby gaining advantage in costs. Tax evasion is expected to become difficult with the introduction of CENVAT, whereby, the same norms are to apply, to the advantage of large units. Ultimately a great deal depends on the availability of sound infrastructure for the industry, ranging from power, finance to port facilities.

Some of the concerns include complacent managements who are used to functioning in the state policy dominated environment and are slow to react in the changing scenario. More worrying for the export-oriented units is the recent sustained rupee appreciation, especially since the currency of our competitors like Pakistan and Bangladesh have not appreciated to the same extent. Uncertainties in policy and insufficient labour law reforms are also holding back investments in the industry. Social accountability norms on working

hours, child labour, salaries and other benefits to employees have already become a critical issue, although it has not been incorporated as part of the WTO as yet. Importers from developed countries insist on undertaking inspections and audits to ensure that these norms are complied with. There is hence a need in the industry to move towards social accountability of the highest standards, although India is believed to have a comparative advantage in this aspect compared to other textile exporting countries in Asia. Similarly, the Indian industry needs to work towards maintaining the highest standards of environment norms and undertaking eco-labelling and recycling of waste.

Conclusion

This study made an effort to understand the likely impact of the impending changes in the endogenous and exogenous environment on the Indian textile industry. It is evident that India is to be an important player in global supply, especially cotton-based products, and that after 2005, export-oriented units will get a boost.

However, there are areas of serious concern which must be taken into consideration:

- Sustained currency appreciation might reduce the competitiveness of export-oriented units and also make competition for domestic market-oriented units stiffer through cheaper imports.
- The wait-and-watch policy of traditional management might be a liability as quick market response decisions are required in the changing business environment.
- India is not a member of any trading agreement. Thus, other competitors who are members of the Regional Trading Agreement are likely to have undue advantage through zero tariff market access.
- Social accountability norms and environmental standards will become more critical for export-oriented units.

The restructuring of the Indian textile industry has become inevitable with the larger modern integrated units standing to gain at the cost of the handloom and smaller powerloom sector. Vertical integration, hi-tech processing units, technology upgradation and capacity expansion will be the main driving forces for investment in textile industry. These are necessary to counter the increased internal as well as international competition for domestic and export markets, which has resulted in falling margins in the industry, and which has necessitated the survival of the fittest.

(The author is indebted to Dr. R. Dasgupta, Dr. Asish Saha and the representatives of all the textile associations involved in the study for fruitful discussions, and to Ms. Deepa Nayak for efficient research assistance).

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I'm a brand.

– Martha Stewart

Feature

Lean Manufacturing in Indian Industry

Nitin Upadhye, S. Garg & S.G. Deshmukh

Lean manufacturing is a philosophy and set of techniques to meet customer requirements with a minimum of every resource. This makes an organisation competitive in the market and provides growth through customer satisfaction. This paper discusses the approach of the Lean Manufacturing System and presents a case study of a leading auto component's manufacturing unit in India. The initiatives taken by the organisation and results achieved are discussed.

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Many manufacturing firms fail in their aspirations to becoming "lean", "flexible" and "world class", not because they are incompetent but because they miss out on key, strategic ingredients that enable outstanding capabilities to be put in place. These capabilities do not come about by chance but follow from an enlightened approach to manufacturing (Brown, 2000).

Globalization has offered many opportunities bundled with many challenges to Indian industries. The demand from global industries, especially the auto industry, for cheaper components with world-class quality have opened windows across India. Automotive Component Manufacturers Association of India (ACMA) data shows that the 20,000 crore Indian auto industry is less than one per cent of the global industry. The key challenge to become a global organisation is by transforming traditional working style into a competitive strategy to satisfy global as well as local customers. The situation can be well described in the words of Covey (2003) "In this turbulent world we face a new economy characterized by the globalization of markets and technology."

One of the major challenges is to produce variety products with minimum lead-time, reduced inventory and world-class quality. The Indian organisations must take some firm steps to improve their competitiveness to cater to the fast changing market. To understand the customer and identify his needs is the main task of any organisation. As marketing expert Theodore Levitt once told his MBA students at Harvard: "People don't want to buy a quarter inch drill. They want a quarter inch hole." (Clayton and Raynor, 2003). Chandra and Sastry (1998) reported that Indian manufacturers are paying attention to quality but not sure about the faster throughput and delivery with variety. They further stated that in Indian organisations material constitutes 66 per cent of total cost, direct labour 10 per cent and overheads 24 per cent. This implies that initiatives must be focussed on the material and overhead costs to control the overall cost. Their survey highlights that quality without process improvement is not possible. These facts and the exist-

ing scenario force the top management to take proper initiatives and lead the organisation in the right direction. The leader's job is to set a clear direction of what their organisation means by results. Drucker (2003) highlights that one of the most important tasks ahead for top management will be to balance the conflicting demands on business being made by the need for both short-term results and by various constituencies i.e. customers, shareholders, knowledge employees and communities.

Throughout the history of civilization the main focus is always on better utilization of resources. Human beings always seek areas where the resources are wasted or not converted fully to the desired output. The removal of waste or unnecessary work leads to improvised productivity and quality and ultimately to customer satisfaction and profit. Firms are increasingly seeking new templates for change to remain competitive in the face of globalization of markets. The key question for any organisation is how to use technological and organisational changes to move to more competitive modes of operation. Some widely used philosophies for change are world class manufacturing (WCM), lean manufacturing system (LMS), total quality management (TQM) and business process re-engineering (BPR) (Lee & Oakes, 1996). Some researchers add another group of techniques to the above list, which are known as agile manufacturing, quick response manufacturing and just in time (JIT). Bessant (1991) suggests that "experimentation, innovation and learning" are needed as new models and evaluated for "best practice".

Lean manufacturing system

The high quality product produced by the Original Equipment Manufacturer (OEM) has put tremendous pressure on suppliers and vendors to understand and implement JIT/lean manufacturing system. Many researchers have emphasized that organisations adopt JIT purchasing to reduce costs by minimizing inventories. (Harland 1996, Cooper et al. 1997, Markland et al. 1998). Womack et al. (1990) used the term "lean" to describe the Japanese system, which uses a minimum of everything to achieve a better product, which closely matches customer needs. LMS has shorter manufacturing and new product lead times; team-based work organisation with responsibility for quality and a smaller component base providing JIT deliveries (Cooper & Lily, 1993).

Lean manufacturing uses concepts pioneered by Ohno, former vice president of Toyota Motor Company, by instilling the discipline to reduce cost, to generate capital, to make money, to bring in more sales, to remain competitive in a growing global market. The basic elements of LMS are presented in Figure 1. LMS culture is based on working in every facet of the value stream by identifying and eliminating waste. Waste in Japan as defined by Toyota's Fujio Cho is anything other than the minimum amount of equipment, materials, parts and workers (working time) which are absolutely essential to production (Suzuki, 1978). At Toyota there is great emphasis placed on workers' awareness through training and problem solving attitudes. The problem solving process is based on a self-initiative planned approach, hard work, and desire for improvement and teamwork. The key concepts in the TPS are JIT manufacturing, autonomation (Jikoda), flexible workforce (Shojinka) and creative thinking or inventive ideas (Soikufu).

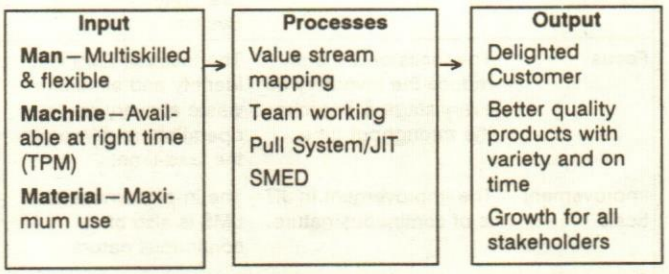

Fig. 1. The Basic elements of Lean Manufacturing System

The Just in Time is defined as the philosophy of manufacturing based on planned elimination of all waste and on continuous productivity improvement, having only the required inventory when needed. (Maynard's Industrial Engineering Hand Book, 2001). JIT is a highly integrated production, sales and distribution system leading to continuous flow through the whole supply chain. It is viewed as "continuous flow manufacturing" (Koregaonkar, 1992). JIT calls for raw materials and components to reach the production operation in a small quantity when they are needed and not before. Though JIT and LMS have similar philosophies, the key difference between them is given in Table 1. JIT helps an organisation to minimize its inventory-related costs. JIT is considered as a philosophy to reduce the inventory and throughput time, while lean manufacturing is a conceptual framework based on a few established principles and techniques to reduce waste and improve lead-time. Some of them affect exclusively the production department, while others integrate several company functions.

Lean manufacturing system is not just JIT or Toyota Production System (TPS). The lean principles can be applied in any situation. It is suitable for both manufacturing as well as the service sector. It is necessary to

apply these concepts in a context sensitive manner. Cellular manufacturing and activity-based costing are not considered as principal tools or elements of JIT, but they can be used in the lean Manufacturing system. JIT seeks improvement through reduction of waste. Lean ensures that the improvements are of a permanent nature and not superficial. For example, inspection is considered as an improvement because it reduces bad products reaching the customer. It did reduce the waste and it was an improvement. But still the root cause of defects was not attacked, which allows the cause to stay in the system forever, and so the improvement was not fundamental. Fundamental improvement seeks ways to eliminate the source of the problems, not just the symptoms.

Table 1: Key difference between JIT and LMS

Element	JIT	Lean Manufacturing System
Focus	The focus of JIT is to reduce the inventory at every stage & improve the throughput time.	The focus of LMS is to identify and eliminate waste at every stage of operation, and improve the lead-time.
Improvement Scale	The improvement in JIT is of continuous nature.	The improvement in LMS is also of continuous nature.
Organisation	The organisation works on the concept of cells & team work.	The work is organized through the smooth flow of material (flow lines)
Customer Focus	Initiator of action pulls production	External
External	Process FocusWork-flow/throughput efficiency	One piece flow production
Tools and Techniques	Visibility, kanban small batches, quick setups, kaizen	Value stream mapping, SMED, automation, TPM, Poka yoke, Kaizen, Pull, Kanban, 5S, visual management

Eliminating waste in manufacturing, however, cannot be achieved solely through efforts in manufacturing. It requires changes in other functions such as product design, materials section, marketing etc. A company-wide integrated effort is needed for process improvement and waste reduction.

In most processes, the biggest detractor from reliability and stability is uncontrolled process variability in production schedules, procedures, materials, tools, and machine functioning and workers skill. Lean provides procedures tools for identifying and eliminating the sources of variability. The changing manufacturing environment (both internal and external) forces companies to change products, processes and during this change process any source of variability once identified and removed, will soon be replaced by others. As long as the lean manufacturing system is in place, it will deal with new sources of variability. In any manufacturing plant it is easy to find such variability causing waste in the form of product defects, inventory, overproduced components, idle workers and machines and unnecessary motions. The lean manufacturing system helps the shop floor teams to identify the sources of these wastes and eliminate them. In every case the shop floor worker plays a central (significant) role.

Today every organisation looks at the lean manufacturing system as a solution for all their problems ranging from low sales, less margins, inefficient employees, higher rejection rates, inventories, customers complaints. Researchers at MIT describe the activities and programmes that seemed to explain Toyota's success, as "lean production": The efficiency with which they produced cars and the quality of the cars they produced. The MIT research project came to be known as International Motor Vehicle Programme (IMVP). Included in the research was a survey of 87 automobile assembly plants throughout the world. The book "The machine that changed the world" popularized the research. In the subtitle of the book was the term lean manufacturing. Companies, which are working on the lean manufacturing concepts, are now doing the previous jobs by using half of their resources. The term "lean" describes Japanese systems, in which comparative to mass production fewer resources are used to achieve the output, which is better in terms of quality and customer satisfaction. The main features of LMS are shorter manufacturing and new product development times, team-based work organisation with responsibility for quality and a smaller component supplier base providing JIT deliveries. The LMS changes how people work. For most people, this will mean more challenging jobs, greater responsibilities and team working rather than narrow professional careers (Womack et al. 1990).

Companies, which are working on the Lean Manufacturing concepts, are now doing the previous jobs by using half of their resources.

The automobile sector can be a good candidate for the lean manufacturing philosophy because these concepts can be intensively adopted at every stage. An automobile organisation spends a substantial amount, almost 60 to 70%, of the cost of goods sold on the purchase of raw materials, components and services. Furthermore:

- The competition in the automobile sector is increasing day by day.
- The customers are becoming highly demanding on quality, cost and new models and features.
- The research in automobile sector is leading towards more fuel-efficient and environment the friendly technologies.
- Government regulations are forcing the automobile sector to reduce pollution.
- Technological changes in manufacturing technology help in the use of new materials, efficient processes and higher precision.
- Information technology has created an environment by which the different activities of manufacturing can be performed at different geographical locations depending upon the core competency and cost advantages.

Industry analysts say by 2004 the total Indian car export could hit Rs. 5000 crore, which shows that the auto sector has similar export potential as software and pharma sectors. In the domestic market, also, sales are picking up. As per the data provided by Siam (Society of Indian Automobile Manufacturers), till December 2003 the cumulative car sales increased by 27% compared to last year and truck sales by 12%.

In his inaugural speech at Auto Expo' 2004, Deputy Prime Minister, L.K. Advani, said that India is gradually becoming a global hub for detailed engineering research and development. The government encourages more OEM around the world to use India as a platform for outsourcing. He advised the Indian auto component industry to partner not Indian auto manufacturers but the global OEM's as well. He said that the global rush towards low cost component outsourcing has opened a window of opportunity like never before.

Concepts and literature

Several philosophies have been developed over the past several decades to improve manufacturing and operational activities. All over the world TQM, lean manufacturing and other world class manufacturing concepts are being practiced by several organisations to achieve the leader position and maintain it. Li and Hamblin (1996) have studied the importance of different manufacturing practices such as quality management programmes, new product development, cost reduction, FMS, lean manufacturing, JIT, MRP, TQM and many other to improve the performance of the manufacturing organisations. Nicholas (2001) states JIT, also called lean manufacturing, is management that focuses the organisation on continuously identifying and removing sources of waste, so that processes are continuously improved. He further states that JIT and TQM are mutually dependent and in certain respects the same. A lot of research has been done and is happening on Lean Manufacturing System, and it has been established that LMS helps to improve the overall performance of an organisation. Pandit et al. (2000) states that JIT is closely related to "lean manufacturing" which takes this philosophy a stage further by attempting to eliminate waste in all areas of the organisation. They further add that an organisation which seeks to become a world class manufacturing organisation must practice JIT/lean manufacturing system, TQM and total employee involvement.

Table 2: Some definitions of lean manufacturing system

Book/Author	Definition
Womack et al. (1990)	The lean manufacturing has been described as one, which seeks to eliminate unnecessary processes, to align processes in a continuous flow and to use resources in order to solve problems in a never-ending process.
Maynard's Industrial Engineering Hand Book (2001)	A comprehensive process improvement methodology that streamlines operations from concept to customer delivery, reduces inventory, speeds production, reduces cost and improves quality and response time using state of art industrial engineering tools.
Sohal (1996)	Lean manufacturing has become the goal of manufacturers aiming for world-class status. Achieving lean manufacturing status requires dramatic changes in all areas of the organisation, in particular in product design, inbound logistics, manufacturing processes and outbound logistics.
King & Lenox (2001)	Lean manufacturing reduces production waste and encourages managers to reduce onsite waste treatment.
Emiliani (1998)	Lean manufacturing is a total business approach designed to identify and eliminate forms of waste in the process of producing goods, services or combination of both. Typical forms of waste include defects, transportation, overproduction, waiting, unnecessary processing, unnecessary movement, inventory, behaviours.
Shankar (2000)	In broad sense JIT
Katayama (1996)	The key feature of lean manufacturing is that fewer resource inputs are required by the manufacturing system (less material, fewer parts, shorter production operations, less unproductive time needed to setup etc.) At the same time there is a pressure for higher output performance to be achieved (better quality, higher technical specifications, greater product variety etc.)

Some definitions of lean manufacturing are given in Table 2. It is very difficult to give a single definition, but it

is very clear that lean manufacturing is a business philosophy that continuously aims to trace and eliminate the *muda* (waste) permanently from each and every function of the company.

The focus is always to achieve a perfect value stream for every product and process with the help of suitable tools and techniques such as JIT, 5S, TPM etc. It needs great teamwork among all the functions throughout the supply chain. The desired result is low lead-time with fewer resources at reduced cost to provide a variety product with better quality.

Further we can state that the lean manufacturing system is a total business approach designed to identify and eliminate forms of waste in the process of producing goods, services or a combination of both. Typical forms of waste are defects, rework, setup, inventory, waiting, transport etc. Identification of such activities, which do not add any value to the process, is termed as "waste" and that which directly adds value to the process, is termed "value adding activities". These should be the focus of continuous improvement in the organisation. The waste increases the cost but not the value of the product. Waste identification is not an easy task; a proper focussed approach and attention has to be provided for such activities. It may look easy but after removing the visible waste it is difficult to locate the hidden one. The continuous improvement leads to end product quality improvement, overall organisational performance, and a boost in employee's morale and customers satisfaction. This not only strengthens the organisational financial conditions but also the environment. Less waste means fewer resources, less pollution, less energy, less space etc.

The logic of lean production describes value adding processes unencumbered by waste (non-value adding activities). This is intuitively appealing in a scientific sense for two reasons:-

It implies a total view of the process—from raw material source to end consumer and perhaps beyond, through the recycling of material.

It does not limit the focus to traditional assumptions on "necessary" or unnecessary activities: Wasteful practices must be defined anew in the search for lean systems.

In simple terms "lean" means an effective way to provide the desired products and/or services to the customers as per their need by maximum waste. So it is not surprising that many Indian Industries are looking to LMS as a manufacturing strategy to enable them to attain and sustain their competitive advantage. Customers are demanding better products more quickly at a price comparable to or lower than previously paid. Companies that cannot meet this demand will loose in the market place and eventually go out of business. In short "lean" means providing customers the product or service they desire when they desire it and in the most effective manner possible. Lean means maximizing the power of human resources to minimize waste to better meet customer demand.

Characteristics of a lean organisation: (Maynard's Industrial Engineering Hand Book, 2001)

To implement and practice lean manufacturing systems an organisation should have the following characteristics:

- Strong leadership committed to all lean principles.
- Effective production & delivery of products and services based on customer demand.
- An exceptionally safe, orderly and clean work environment.
- A commitment to design & build quality into the products, services & supporting processes.
- A culture of teamwork where everyone is empowered to make and act upon decisions.
- Appropriate and active use of visual management tools.
- Continuous improvement as an obvious way of life throughout the organisation.
- A strategy embracing lean principles.

Lean manufacturing system implementation is based on a balance of systematic and process improvements. They are simplistic in nature but require deep understanding, relentless commitment and perseverance. There is no "magic pill" or generic template, which can be placed over the organisation in order to become lean. While it is a challenging journey, the benefits are enormous. A conceptual model of lean temple with its foundation and pillars is given in Fig. 2.

The following phases are the key elements needed in order to successfully achieve these goals:-

1. Stability: Stable manufacturing processes and 100% quality parts
2. Jidoka: Building quality into the production processes
3. Continuous flow: Produce one-by-one as efficiently as possible

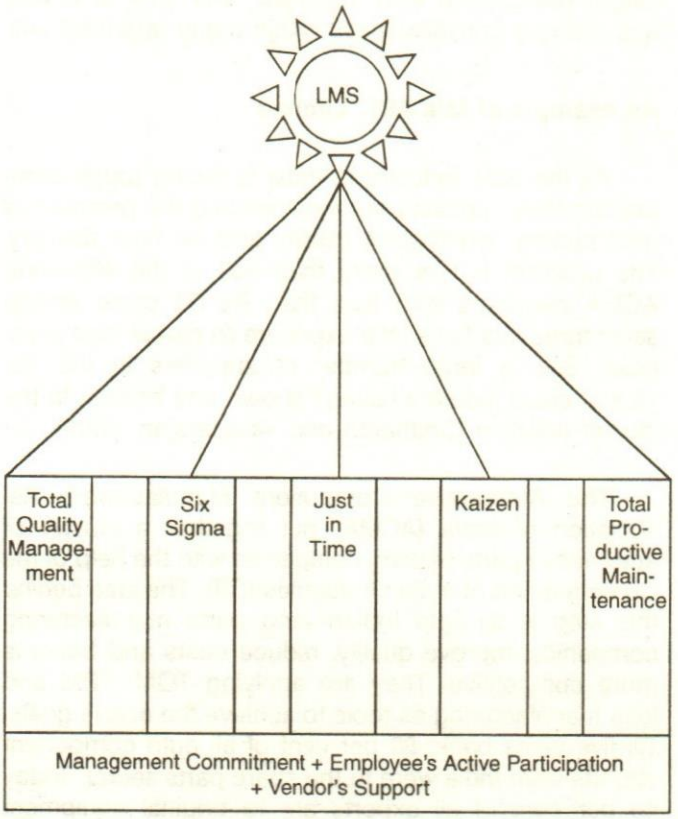

Fig. 2. The Foundation and Pillars of Lean Temple

4. Takt Time/Standardized Work/Kaizen: Responding to ever-changing demand while eliminating waste.
5. Pull System: System designed to produce only sold products
6. Heijunka: Level production according to volume and variety

The other tools used to implement LMS are:

- 5S
- The 5 Why's
- Just In Time/Kanban
- Kaizen
- Single Minute Die Exchange
- Value Analysis
- Problem solving approach
- Poka Yoke (Mistake Proofing)
- Elimination of Seven Wastes
- TPM
- Work Balancing Cells
- One Piece Flow
- Quality Tools

For any organisation the selection of a compatible supplier/vendor is very important for successful implementation of LMS. In the last few decades the supply chain management and the vendor selection process has been given significant attention by the business management literature (Verma and Pullman, 1998).

The goals of LMS are simple and straightforward; provide the best quality product, in the shortest time period possible, with the best price to the customer. Burcher et al. (1996) was of the opinion that lean manufacturing is not just the Toyota production system. The underlying philosophy can be applied universally within manufacturing, but the tools used to enable the philosophy need to be applied in a context-sensitive manner. For repetitive batch manufacturers, the kanban approach may not be appropriate. Toyota itself does not manufacture cars using kanban; it uses highly engineered production lines. The items controlled by kanban are generally line side production replenishment.

To implement LMS it is necessary for an organisation to understand, perceive and anticipate the customer's requirement and identify the waste locations. A lean organisation is an organisation with a clear-cut view of their business priorities and well-equipped and prepared to deal with the ever-changing demands of customers. Garg et al (1994) questioned whether the same set of tools and techniques, which are applied in Japan or USA/UK and other developing countries will be useful in the Indian context or a modification is necessary. Pilkington (1998) compared lean manufacturing in Japan and UK and found that there is a basic difference between these two countries. Non-transformable 'Japanization' was discovered. He stressed that Business level strategies are more important for an individual organisation's success and survival.

Much lean manufacturing system-related research literature dealing with its different techniques and tools is available, mostly referring to developing countries and the US. But literature on implementation of the lean manufacturing system in the Indian context is very limited. The emphasis was always on the theory, and the difficulties associated with the implementation of different tools and techniques of lean manufacturing in Indian manufacturing organisations, is yet to be studied. As it is a very slow process and requires much patience at the management level, a detailed survey/empirical study will definitely help to understand lean manufacturing in the Indian context. Lean manufacturing system is a management strategy, which can guide Indian

manufacturers owing to its proven ability in Japan and the US/UK.

Literature on implementation of lean manufacturing the system in the Indian context is very limited.

Benefits, difficulties and barriers of LMS

Various authors have studied the benefits, difficulties and barriers in the implementation of LMS using case studies and empirical studies. Oliver et al. (2002) analyzed the results of a longitudinal study of manufacturing performance, lean manufacturing principles and buyer supplier relationship in the Japan, UK automotive industries and the US. The result shows an improvement of 20% in labour productivity between 1994 and 2001 in Japanese plants whereas in the US plants the productivity was the same. Japanese plants retained an average external defect rate at 81 ppm compared to 111 ppm (US) and 416 ppm (UK).

Sanidas (2001) provides quantitative evidence, based on the American sectoral data (for the period between (1958 to 1996) that the lean manufacturing system (equivalently the holistic JIT/Q.C. system) and sectoral (micro) economic growth have a direct relation. Copeland Corporation, a manufacturer of air conditioning and refrigeration reciprocating compressors, began adopting an adaptation of Kaizen and lean manufacturing in the early 1990s. Since then productivity has doubled and there has been a 33% reduction in manufacturing floor space. In addition, time per unit has been reduced by 35%. But the smaller firms regard JIT as both a threat and an opportunity. Ongoing variations in demand schedules from their customers are a major problem, restricting the wider implementation of JIT production (Lee & Oaks, 1996).

Kumar and Garg (2000) take a closer look at JIT implementation problems and benefits in the Indian context. The survey result shows that cellular manufacturing and kanban-system are difficult to implement. It was suggested that JIT should be implemented in a phased manner. Kannan & Tirupati (2000) reported in their case study of Lucas TVS Limited, that when the top management realized the need to become leaner and more efficient, the general feeling was that these improvement techniques were effective on foreign soil, and they would not work in the Indian environment. The concerns were about the lack of infrastructure in India, uncertainties with respect to procurement arms length relationship with suppliers, and lack of quality and delivery consciousness within many organisations.

An example of M/s ABC Limited

As the auto industry in India is facing tough competition their suppliers are experiencing the pressure of cost cutting, world-class quality and on time delivery. The problem is that more than 300 of the 400–odd ACMA members with less than Rs 50 crore annual sales turnovers have little exposure to global best practices. Still, a large number of suppliers in the Rs. 19,600 crore industry haven't shown any interest in the cluster initiative (Sridharan and Varadarajan, 2002).

The Automotive Component Manufacturers Association of India (ACMA) put together a cluster of automobile parts making companies with the help of the Confederation of Indian Industries (CII). The idea behind this step is to help Indian auto parts manufacturing companies improve quality, reduce costs and become more competitive. They are applying TQM, TPM and lean manufacturing as tools to achieve the above goals. Till five years back, 80 per cent of all auto component exports from India were to the spare parts sector. Today 40 per cent of all exports are to original equipment manufacturers.

A case study was done to find out the different initiatives taken by a leading auto component manufacturing company. The company, ABC Limited, supplies its products to many automobile manufacturers in India as well as abroad. The company profile is summarized in table 3.

Table 3: Company profile of M/s ABC Limited

Factors	Company status
Location:	North India
Annual turnover:	Rs. 120 crore
No. of employees:	650
Product variety:	129
Rejection rate (ppm):	12000 to 15000 (1.2 to 1.5%)
Inventory:	10 days for raw material and one day for vendors
Response time:	3 days

This 17-year-old company of Rs. 120 crore turnover is a tier 1 supplier of world repute. The demand for its wide range of products varies as per market fluctuations at OEM's end. The company's products vary in shape, size and material as specified by the OEMs. The different milestones during its journey towards attaining ultimate customer satisfaction are listed as under:

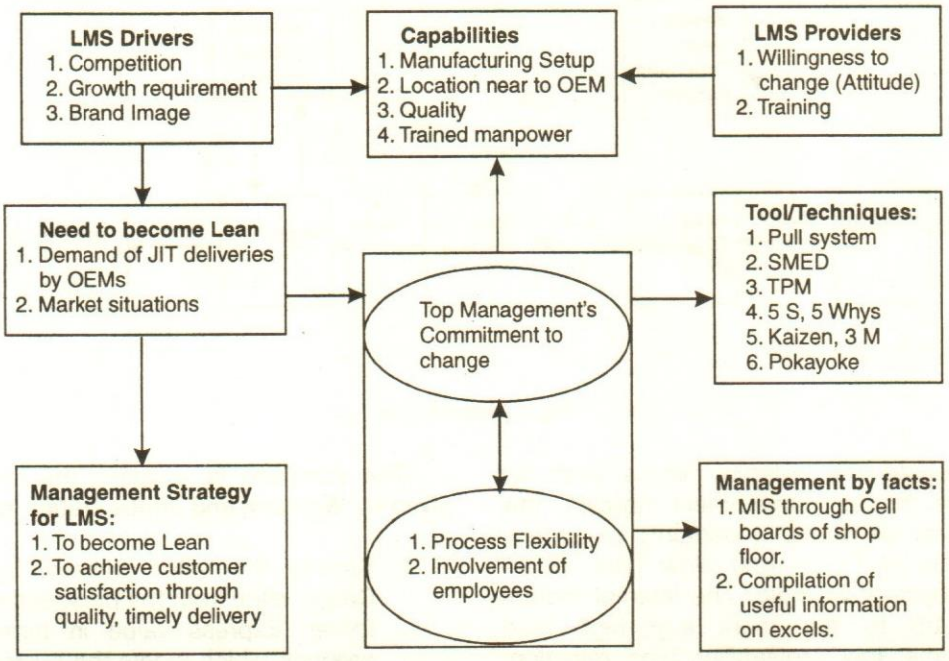

Fig. 3. The Conceptual Model adopted by M/s ABC for Lean Manufacturing System

1986-88 The incorporation of M/s ABC Limited and successful operation started after the installation of machines and set up of production systems.

1990-95 Appreciation for overall supply performance from the major customers; technology transfer from Japan and USA; backward integration started. Selected as a single major source for one cutover.

1996 onwards Journey towards quality management system continued, company received ISO-9002 IN 1996 & QS-9000 certificate.

2000 onwards Working on lean manufacturing system

The company's philosophy can be summarized as follows:-

1. Focus on the customer:
   - Customer driven policies and procedures
   - Quality assurance systems in place
   - Supplies on "self-certification" basis
   - QS-9000 and ISO-9002 certification
   - Company wide focus from top to grass root level on customer satisfaction
   - "Zero defect", the ultimate goal
2. Other important points:
   - People are our true asset base.
   - Promoting team-work and innovation.
   - Enhancing skills through training, providing employees with a career & not just a job.
   - Use of world-class technology at design, shop floor and other areas.
   - Maintain a reasonable profit and growth level keeping in view the commitments to customers, shareholders, employees and society.

Quality initiatives

The company is a customer centric organisation. The management is fully devoted to this goal and continuously engaged in world class benchmarking, LMS, TQM and TPM practices. The ISO-9002 and QS-9000 certification prove this point and in 1997 the company started company-wide business process re-engineering to upgrade the products and processes and completed the pilot phase in 1999. To facilitate the above world-class manufacturing strategies appropriate steps were taken by the management to modernize the manufacturing facilities.

Two-and-a-half years ago the top management realized the importance of LMS and predicted it as the future of Indian industries. Their model of LMS is given in figure 3. They knew that LMS would become the way of business for survival in the global market.

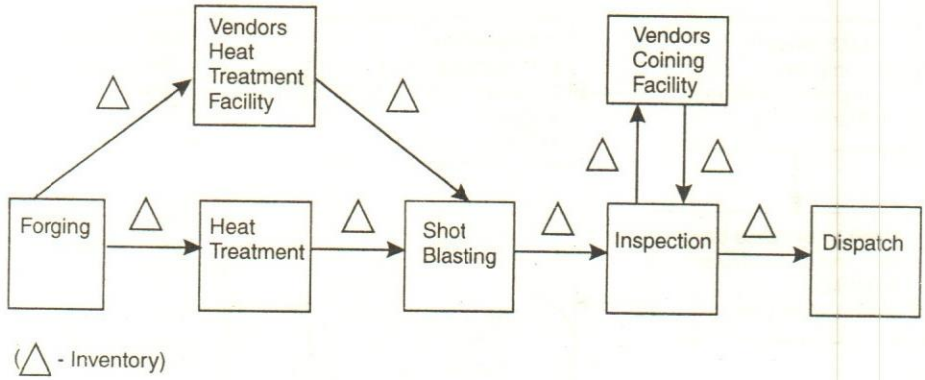

Fig. 4. Material Flow

They clearly visualize the external forces such as highly competitive market, government policies, low volume high variety products, uncertainty of orders, and the JIT status of OEMs and slow pace of infrastructure development in India. The internal factors were also not up to the mark e.g. high lead time/throughput time, low profitability, high rejection, delay in deliveries, high cost of quality, low employee morale, incompetent technology etc.

A clear-cut strategic importance for quality and LMS developed an environment in the company right from top to the bottom. The employees are aware that they have to strive continuously to find and eliminate waste at every stage to become a truly lean company. The employees work with team spirit and held each other to achieve "first time right quality".

The top management inspired by the idea of LMS studied lean practices under the lean gurus. Their LMS implementation strategy works on:

1. Cross functional teams
2. Improve process flow through value stream mapping
3. Improve equipment reliability through TPM
4. Cell working based on pull system in place of push system
5. Setting concepts on Single Minute Exchange of Die
6. Training to all levels of workforce.
7. Continuous improvement (Kaizen) and review of performance
8. Elimination of waste at all levels
9. Two way communication
10. Use of pokayoke, Kanban system (JIT) concept

The company is adopting the five lean principles given by Womack and Jones (1996), namely:-

1. Specify the value desired by the customer: Define value from the perspective of the final customer. Express value in terms of a specific product, which meets the customer's needs at a specific price and at a specific time.
2. Map-identify the value stream: The set of all specific actions required bringing a specific product through the three critical management tasks of any business: The problem-solving tasks, the information management task, and the physical transformation task, the information management task, and the physical transformation task, create a map of the current state and the future state of the value stream. Identify and categorize waste in the current state, and eliminate it.
3. Flow: Make the remaining steps in the value stream flow. Eliminate functional barriers and develop a product-focused organisation that dramatically improves lead-time.
4. Pull: Let the customer pull products as needed; eliminating the need for a sales forecast.
5. Perfection: There is no end to the process of reducing effort, time, space, cost, and mistakes. Return to the first step and begin the next lean transformation, offering a product, which is ever, more nearly what the customer wants.

The case of a two-wheeler transmission component shows how the organisation adopted the lean principles and LMS. The component is supplied to OEM as a forging part. The requirement is around 2,00,000 components per month. Before implementation of lean manufacturing the part was made by traditional manufacturing concepts. There was a problem of high rejection of 40% due to total indicated run-out (T.I.R.). In

traditional manufacturing system the problem of T.I.R. was accepted and an additional operation i.e. coining was added to maintain the drawing specifications. Coining was the process in which these 40% pieces were rectified. The operation was performed at the vendor's end. At the vendor's end, it was a loop of repair and inspection. Even after coining operation 8% components were rejected at the final inspection stage. That means 16,000 components were rejected per month. At the same time components were sent to the vendor for heat treatment because of under-utilization of the heat treatment furnace. Fig. 4 shows the flow of material due to this process of rejection and rectification.

In this figure the shot-blasting machine was kept outside the shop floor to avoid dust on the shop floor. This arrangement had resulted in more transportation time as well as delays. More inventories had to be kept due to high rejection rate, heat treatment and coining operations at vendor's end and more transportation. The average number of components at any time on the shop floor was to the order of 60,000. Seven persons were engaged per shift on these operations. The company identified the above problem and prepared a value stream map.

Value Stream Map

The five steps of value stream mapping are discussed below:-

1. Specify the value desired by the customer: To understand the value of any product interaction with the customer is a must. Also the customer is not paying for the wastage such as rejection, waiting time, excess inventory, and extra operations as well as for additional inspections. Through interactions M/s ABC Limited learnt more about the requirements of the customer. The customer needs are converted as subjective. For example, the packaging of component X in gunny bags is decided after the interactions with the customer. While doing value stream mapping it is decided that the customer is considering a processing time of 2 hours and paying according to it, while the actual lead-time was 15 days. It means the value addition to lead time ratio was (2/15 Û 24) = 0.0055. After forging, the components were first allowed to cool down to room temperature and then sent to a continuous type heat treatment furnace. This cooling down requires more waiting time and processing time at the furnace. As a result, the furnace couldn't produce the required quantity. The waste at each and every stage has to be eliminated. New trials were taken up where components were processed to furnace directly after the forging and shot blasting operation (at 600ãC). The savings in energy and time resulted in faster output. The heat treatment process time is now 33% less than the previous one, and capacity is increased by 2.2 times. As the output is increased the quenching bath oil gets heated, so to maintain the temperature some modifications were done.

   5 why's, 3 M, Ishikawa diagram were among other management tools, which were used to arrive at the new process. Also TTT diagram and Iron-carbon diagram were referred. In-house metallurgical tests were conducted to find out any type of micro-structural changes, hardness and internal cracks due to the new process and the results are under specifications. To minimize T.I.R. instead of open die, closed die is used at trimming operation. The closed die guides the stem and doesn't allow it to bend.

2. Map-identify the value stream: Value stream mapping is performed for the current state of information flow; process flow and accordingly lead-time calculations were done. The following wastes of current state were identified:
   a. Excess WIP at every stage
   b. High rejection due to T.I.R.
   c. Coining operation
   d. Under-utilized heat treatment process
   e. Very poor value addition to lead time ratio
   f. Poor lay out resulting in more WIP and more transport time
3. Flow: The following steps were taken to improve the material flow at the shop floor:
   a. Change of layout: The shot blasting machine and dispatch department are added at the shop floor just after heat treatment furnace. To change the mindset of shop floor persons so that they can accept a shot blasting machine at the shop floor was not an easy task. To control the dust problem special arrangements of dust collectors were made as well as measures for regular cleaning and maintenance.
   b. The coining operation is eliminated.
   c. The hot heat treatment process improved the flow.
4. Pull: Previously due to high rejection rate and subcontracting the WIP was more. The output at

every stage was different so every one was pushing components to his internal customer. Now after the implementation of lean manufacturing internal customers pull the components.

5. Perfection: M/s ABC Limited is continuously working on value stream mapping. Now they are working to improve the yield of material, reducing inspection by improving process capability and deploying this experience in other areas.

Table 4: Improvements made in the production of component

Improvement Area	Previous status	Current status
WIP	60,000 components	8,000 components
Value addition/Lead time	0.0055	0.042
Man power	7 workers	3 workers
Heat treatment process time	3 hours	2 hours
Rejection due to T.I.R.	40%	1%

The improvement made in the production of component is given in table 4 and the advantages achieved in the organisation summarized in table 5. Applying small and simple suggestions from the workers reduced the machine cleaning time. Cross-functional teams work on different improvement areas to find out and reduce the waste in value stream. The company encourages its employees for active participation.

Table 5: Improvements achieved in M/ABC Limited

Area of Improvement	Previous status	Present status
Inventory turn over ratio	7	17
Production per shift	1000 units	1500
Machine shop defects	16,645 PPM	14,100 PPM
Sales growth without any big investment	–	+30%
Rejection in some areas	40%	1%
Machine cleaning time on some machines	2 hours	5 minutes

The top management supported the lean implementation. They clearly defined the vision and mission of the organisation, provided proper training to its employees and supported their decisions. They encouraged and motivated their employees for active participation in teams. They regularly monitor the improvements and provide directions.

M/s ABC Limited has to overcome a number of problems and difficulties in implementing its lean manufacturing programme. It had to overcome the following problems:

- Changing the attitudes of the people on the shop floor. One example of this was installing the shot-blasting machine on the shop floor.
- Making operators understand that overproduction as a waste was a difficult task. For example, getting operators to produce only the quantities required – as specified by the kandan card.
- To convince the shop floor persons that the way they had been doing their job for the past 10 years was not necessarily the correct way and that they can do it better by other ways.
- Developing and maintaining discipline on the shop floor.
- Education (Training) of operators was a critical element.

Conclusion

It is very clear that the Indian industries must adopt a suitable competitive strategy to survive in this turbulent market place. Also, they should take advantage of the opportunities available to them by overcoming the common weakness, such as high cost, delayed deliveries, low quality and resistance to change. The Indian industries have to work hard to achieve the goals by using proper tools and techniques, which are suitable to their work culture, conditions and available infrastructure. The above case study sets an example for many companies, that with a clear-cut strategy the committed management can motivate its employees to find and remove "muda" in the value stream. The removal of waste will not only help them but the society and the world to face the increasing scarcity of natural resources.

The lean manufacturing system will be definitely helpful for Indian industries to improve quality and reduce cost with faster delivery. As the ACME has understood its importance, now the need of hour is to percolate its concept to all big and small companies, irrespective of its status i.e. whether it is an OEM, Tier I company or Tier II Company. The implementation of lean manufacturing system at the small vendor's end will help their OEM's to implement lean at a faster pace.

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The worm lures the fish, not the fisherman and his tackle.

– Angler's maxim

Feature

Critical Chain Project Management: Fundamentals and a Critical Analysis

Subrata Mitra

Critical Chain Project Management (CCPM) was conceptualized by E. M. Goldratt as a natural extension of his Theory of Constraints in production, manufacturing and project management. CCPM was brought into existence to address the problems of time and cost overrun that conventional project management techniques fail to handle. CCPM drew both accolades and critical reviews from different quarters. The objective of the current paper is to explain the fundamentals of CCPM including the background of its evolution, and critically analyze it in the perspective of conventional project management techniques.

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The concept of Critical Chain Project Management (CCPM) was brought into existence by Goldratt (1997) as a natural extension to his Theory of Constraints (TOC) in production, manufacturing to project management (Goldratt and Cox, 1993). Thereafter, a couple of books (Newbold, 1998; Leach, 2000) were written and a number of papers which described this new approach to project management as a solution to the problems that conventional techniques fail to address. Many corporations such as Honeywell, Boeing, Harris, Lucent Technologies, Israeli Aircraft Industry and so on have reported substantial benefits in project execution upon adoption of the CCPM philosophy.

The objective of this paper is to explain the fundamentals of CCPM and critically analyze it with respect to the knowledge base of project management created after decades of research.

The Evolution of CCPM

The typical objective of any project management technique is to ensure that the project is completed on time, the project costs are within budget and that the project is delivered with full scope and quality to the satisfaction of the customer. But, in practice, all conventional project management techniques fail to meet these objectives almost all the time (Goldratt 1997). From practical experience we see that more than 70% of the public projects like construction of roads, bridges and flyovers are delayed due to various reasons, and as such estimated costs increase by 200% and 500%. When a project is likely to miss the deadline, expediting efforts are initiated on a war footing to meet the deadline or to make the spillover as minimal as possible. This might result in a compromise on the contents of the project and a loss of goodwill. There have been cases where the construction of flyovers have been hastily completed for inauguration by a Minister for public use, but after some time chunks of concrete fall off the

flyovers and the underlying roads, and these continue to remain unrepaired for a long time.

In today's time-based competitive world, project lead times and expenses should be minimized as far as possible without compromising on the scope and quality of the projects. This is indeed a challenging task faced by project managers of today, in view of increased competition and various uncertainties related to project management. Those who can take care of these factors more efficiently and effectively are almost always likely to win contracts.

According to Goldratt, time overrun in projects occurs in spite of overestimates given by workers and project managers. Workers provide inflated time estimates for the tasks they perform in order to accommodate unforeseen uncertainties like non-availability of materials, breakdown of machines etc. Also, they know from experience that the management in all likelihood will instruct them to reduce their estimates on the ground that the original project duration is too long and uncompetitive. Hence, the a priori protection against the global cut. Moreover, since the performance appraisal of the workers are linked to the tasks they perform, they do not want to take any chance, and so they give inflated time estimates to be on the "safe side". Like the workers, project managers are also answerable to their boss, and their appraisal is based on the performance of the projects they supervise. So, in order to protect themselves, project managers also inflate the estimated duration of the projects.

Despite the inflated time estimates given by the workers and project managers, projects do go beyond the deadline. Goldratt holds the following reasons responsible for this:-

- Workers rarely report early finishes. If they feel they will be able to finish their tasks before the scheduled time, they will go slow and make sure that they finish their tasks on time. This is called the Parkinson's law, which states that work expands to fill the time slot available to it. Workers do it because they feel if they report early finishes, they will be asked to do more work. Also, if they consistently finish early, the time estimates may be slashed in the future. On the other hand, if tasks are delayed, due to dependencies between activities, delays will accumulate, and propagate from one stage to the subsequent stage disrupting schedules, resource allocation etc.
- Workers are affected by what is called the "student syndrome". As the students suddenly realize that exams are knocking on the door and project submission deadlines are approaching, they get back to studying and working on their projects, but in all probability will leave part of the syllabus and miss the submission deadlines. Similarly, workers at the comfort of inflated time estimates start working as late as possible and may miss the scheduled due dates if some unforeseen events take place.
- It is a common practice in many project organizations that when a scarce resource is required to work on more than one ongoing project, it is deployed simultaneously to all the projects. This "multi-tasking" of scarce resources causes delays, additional set-ups and a loss of focus.

Consider three activities, A, B and C. Each requires 10 days to complete three different projects, project 1, project 2 and project 3, respectively. Each activity requires one worker, and there is only one worker available who can work on the activities. Figure 1(a) shows the schedule when the activities are sequentially done. Figure 1(b) shows the schedule when the worker resorts to multi-tasking, i.e., he works for 5 days on an activity before hopping on to the next activity.

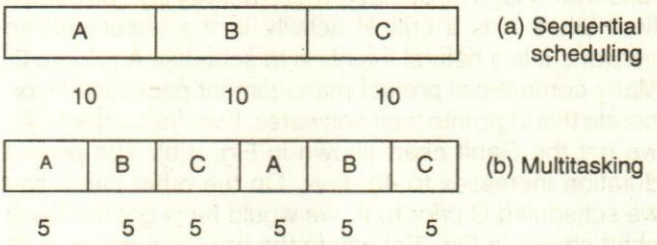

Fig. 1. Schedule of activities with a scarce resource

From Figure 1(b), we see that with reference to the schedule shown in Figure 1(a), Activity A and Activity B are late by 10 days and 5 days respectively, and Activity C is on time. If Activity A and Activity B happen to be on the critical paths of their respective projects, then Project 1 and Project 2 are likely to overrun in time.

The inability of the conventional project management tools to handle the problems of time and cost overrun was the motivation for developing a new approach, i.e., CCPM.

What is a critical chain?

Consider the project network shown in Fig. 2. The activity symbols, durations in days and resource type requirements are shown along the activities.

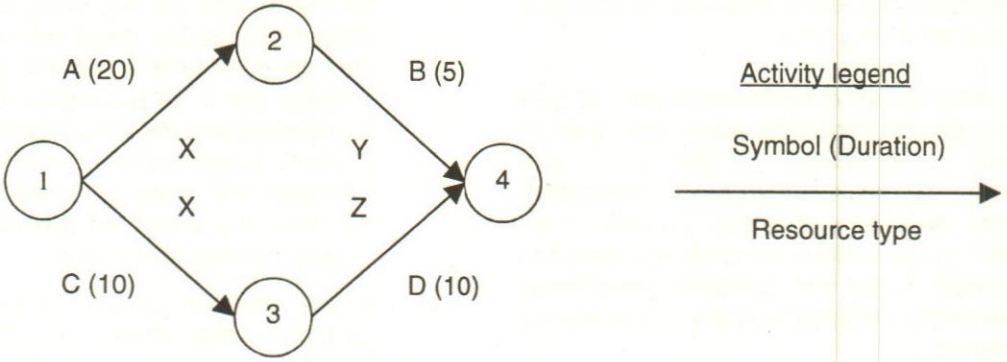

Fig. 2. Project network with activity durations and resource requirements

Let us first assume that there is no resource constraint. Figure 3(a) shows the Gantt chart for the project. We see that the project duration is 25 days, and it is given by the path A-B. A-B is called the critical path. The critical path is the longest path in a project network, the length of which determines the duration of the project. Any delay along the critical path will delay the project.

Next we consider the project under resource constraints. We assume that each activity requires one unit of the resource type shown in Fig. 2, and that one unit of each resource type is available. Hence A and C cannot be started together since they require the same type of resource. It is to be decided which activity is to be started first. Since A is a critical activity in the unconstrained network, it is a natural intention to schedule A prior to C. Many commercial project management packages incorporate this logic into their softwares. If we follow this logic, we get the Gantt chart shown in Fig. 3(b). The project duration increases to 40 days. On the other hand, had we scheduled C prior to A, we would have got the Gantt chart shown in Fig. 3(c) where the project duration is 35 days! Hence the logic that critical activities should be given priority over non-critical activities under resource contention, does not always produce better results.

With reference to Fig. 3(c), the project duration is given by the path C-A-B, but not all of these activities lie on the same path in the project network. C-A-B in this case is referred to as the critical chain. The distinction between the critical path and the critical chain is that while the critical path takes into account precedence relationships only, the critical chain considers precedence relationships as well as resource constraints. When there is no resource constraint, the critical chain is identical to the critical path.

Fundamentals of CCPM

The basic idea in CCPM is to take away safety margins from individual task duration estimates before scheduling and add buffers at the end of the project to protect it from time overrun. The size of the buffers should be ideally lower than the total time stripped off the activities because of a phenomenon known as the "portfolio effect" in the finance literature, which means that the standard deviation of the sum of a number of random variables is lower than the sum of the standard deviations of the random variables. This implies a reduction in the estimate of the project duration as worked out by conventional project management tools, and puts the organization in the position of competitive advantage. The steps of CCPM are described below.

Step 1: Halve the original time estimates and apply the Critical Path Method (CPM) to prepare a Late Start (LS) schedule.

Goldratt (1997) advocates for the median durations (within which there is a 50% chance to finish the tasks) to start with, and according to his experience the estimates given by the workers are approximately double the corresponding median values. With respect to activity scheduling, there are two choices: Early Start (ES) and Late Start (LS). In an ES schedule, all the activities are started as soon as their predecessors have been completed, while in an LS schedule, all the activities are started as late as possible without affecting the duration of the project. Each has its own advantages and drawbacks. An ES schedule is likely to absorb any delay caused by unforeseen events; also, it is relevant for progress payments, i.e., release of payments based on milestones as agreed upon in the contract. On the other hand, an LS schedule delays capital outflow, reduces Work-in-Process (WIP) and minimizes the impact of last minute design changes. In CCPM, LS schedules are given preference over ES schedules.

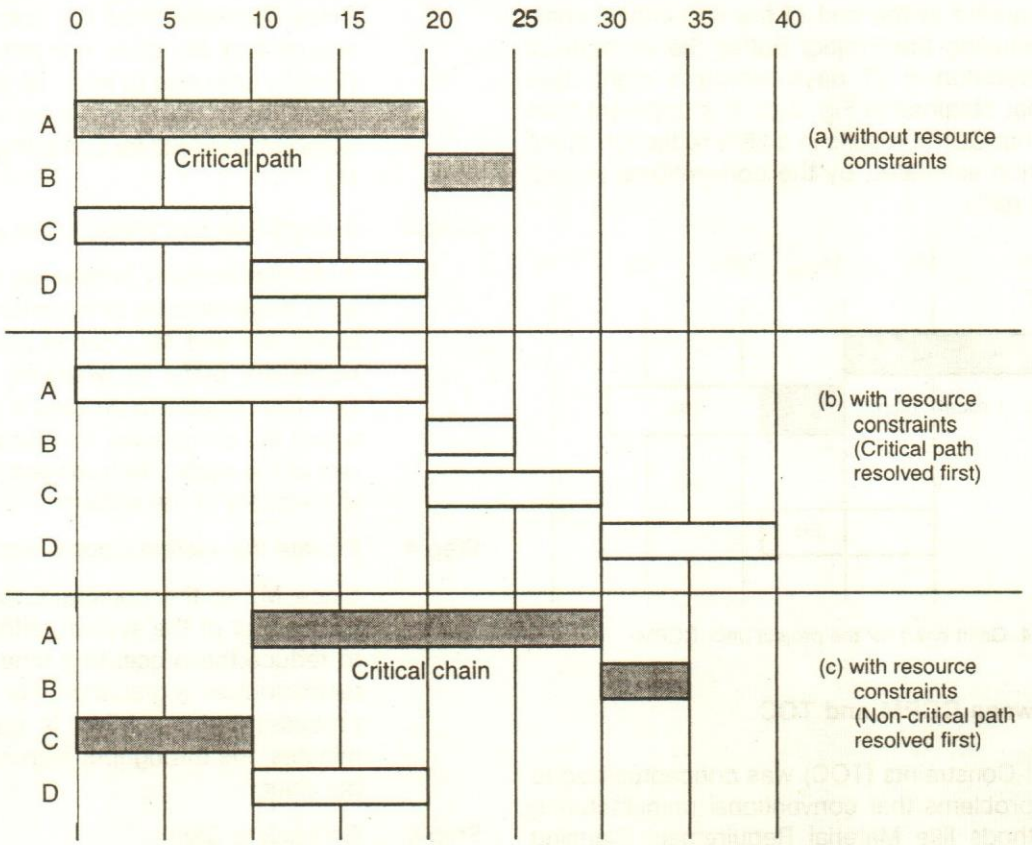

Fig. 3. Gantt charts for the project with and without resource constraints

Step 2: If there is resource contention in the schedule obtained in step 1, resolve it going backward in time and reschedule the activities ensuring the minimum increase in the project duration. Avoid multi-tasking in the process.

Step 3: Identify the critical chain. If there are more than one, choose any one of them.

Step 4: Add a Project Buffer (PB) at the end of the project. It is equal to half of the total time stripped off the critical chain activities. This method is called the cut-and-paste method of buffer sizing. There is another method called Root Square Error (RSE) where the PB is set equal to the square root of the sum of the squares of the times stripped off the individual activities.

Step 5: Add Feeding Buffers (FB) at the places where non-critical chain activities merge into the critical chain, to protect the critical chain from any variations in the non-critical chain activities. The size of FB is again equal to half of the total time stripped off the longest chain of non-critical chain activities.

Apart from Project Buffers and Feeding Buffers, there is another kind of buffer in CCPM called the Resource Buffer (RB), which is nothing but a "wake-up" call or warning issued to the resource to work on a critical chain activity, especially when the earlier critical chain activity is performed by a different resource. It may be in the form of a scheduled idle time.

CCPM advocates that the critical chain should not be altered in the course of execution of the project, and that critical chain activities should be started as soon as their predecessors have been completed and resources are available. As long as the buffer consumption remains below a critical value, no action needs to be taken. Only when it crosses the critical value, should corrective actions be initiated. When an idle resource is to be assigned to an activity, critical chain activities will get preference over non-critical chain activities, and among non-critical chain activities the priority is based on the consumption of feeding buffers.

If we apply CCPM to the project network of Fig. 2, we get the following Gantt chart shown in Fig. 4.

In this example, the activity duration and buffer size calculations are rounded off to the next higher integers. Accordingly, a project buffer of nine days is added at the end of the critical chain C-A-B, and a Feeding Buffer

of 3 days is added at the end of the non-critical chain activity D. Including the Project Buffer, the estimate of the project duration is 27 days, which is eight days lower than that obtained in Fig. 3(c). It is apparent from the method that CCPM results in a 25% reduction of the project duration estimated by the conventional project management tools.

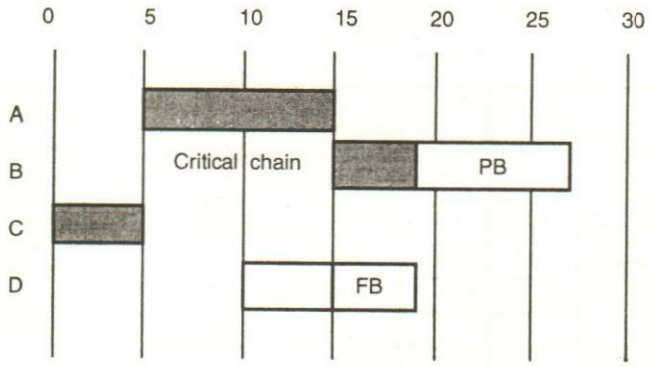

Fig. 4. Gantt chart for the project undr CCPM

Analogy between CCPM and TOC

Theory of Constraints (TOC) was conceptualized to address the problems that conventional manufacturing planning methods like Material Requirement Planning (MRP) were not able to handle. The idea behind TOC is to identify the bottleneck(s) or constraint(s) of the system, which determines the throughput, and utilize it to the maximum, ensuring little or no idle time. The TOC steps are explained with reference to the system shown in Fig. 5.

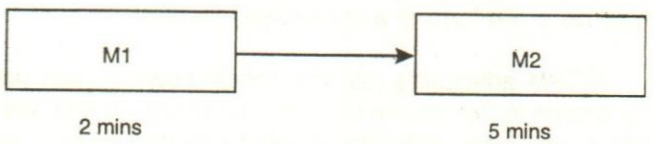

Fig. 5. A two-machine flowshop with processing times

Figure 5 shows a flowshop comprising machines M1 and M2. A part is processed sequentially by M1 and M2 before coming out of the system. The processing times of M1 and M2 are two minutes and five minutes respectively.

The TOC steps are as follows.

Step 1: Identify the constraint(s).

Since M2 takes more time for processing than M1, the throughput or output rate of the system is determined by M2, which is 12 parts per hour. M2 is the constraint of the system.

Step 2: Exploit the constraint(s).

Since M2 determines the output rate, it is to ensure that M2 does not remain idle at any point in time due to want of parts. Hence an inventory of parts is to be maintained between M1 and M2 for uninterrupted running of M2.

Step 3: Subordinate everything to the above decision.

If M1 continuously processes parts, there will be a huge amount of inventory piling up between M1 and M2. Hence after allowing the necessary buffer in between, M1 can either take five minutes to process a part or process a part in two minutes and remain idle for the rest of the cycle. Both will ensure no additional inventory in the system.

Step 4: Elevate the system's constraint(s).

Since M2 is the constraint, to increase the throughput of the system, efforts are needed to reduce the processing time of M2, say by technological upgradation. For example, if the processing time of M2 is reduced to four minutes, the throughput increases to 15 parts per hour.

Step 5: Go back to Step 1.

In Step 4, if the processing time of M2 is reduced to 1 minute, then M2 no longer remains the constraint. The constraint shifts to M1, which has a higher processing time of 2 minutes. Hence every time the processing time of M2 is reduced, one has to check if the constraint has shifted and all the steps of TOC have to be repeated.

TOC is also known as a "Drum-Buffer-Rope" arrangement. While drum and buffer refer to the constraint, M2, and inventory between M1 and M2 respectively in Fig. 5, rope refers to the information flow from M2 to M1 as to the rate at which the latter is to process.

In the context of CCPM, the constraint that was referred to in TOC is the critical chain, which determines the project duration. Exploiting the critical chain involves early starts of critical chain activities, giving priority of critical chain activities over non-critical chain activities in case of resource contention and adding various buffers. Non-critical chain activities are scheduled based on late starts, which corresponds to Step 3 of TOC. Step 4 and Step 5 are not much relevant in the context of CCPM since it is a project rather than a manufacturing process, and, as mentioned before, CCPM advocates for keeping the critical chain unchanged during the execution of the project. But, of

course, if one is not rigid about this, steps 4 and 5 of TOC can also be put in place.

Critique of CCPM

Every new methodology is subjected to a critical analysis. CCPM is no exception. The major point that has been raised is that the concept of critical chain is nothing new. It was conceptualized and referred to as a critical sequence by Wiest as early as 1964 (Wiest, 1964). There is also no scientific basis for reducing the original estimates of task durations and deciding on the buffer sizes (Raz et al., 2003). The 50% rule may sometimes result in underestimation of task durations and overestimation of buffer sizes leading to a grossly wrong estimation of the duration of the project. In all the literature related to CCPM, the feeding buffer computation is shown for the longest chain of non-critical chain activities in series. But in a practical project network, the non-critical chain activities may form an arborescent or more complex structure for which the method of calculation of the feeding buffer is not discussed in CCPM. The implicit assumption about the rational behaviour of the workers under a 50% cut of their estimates is also questionable (Mckay and Morton, 1998). The possibility that the workers under the new situation will not add twice the safety margin as they were adding before, cannot be ruled out.

Nothing has been mentioned in CCPM about how to resolve resource constraints, given that it has been a topic of serious research for decades. The problem is hard, and efforts are on developing efficient heuristics rather than trying to find the optimal solutions (Kolisch, 1995; Kolisch and Padman, 2001). In the resource-levelled schedule, if there are more than one critical chain, Goldratt suggests to pick any one of them, as the choice really does not matter. But Herroelen et al. (2002a, 33) gave an example for which different softwares generate different baseline schedules with different project durations and critical chains. Hence the baseline schedule is really important in terms of determining the minimum duration of the project.

To insert feeding buffers, non-critical chain activities have to be shifted backward in time, which might create resource conflicts and even change critical chain. CCPM does not address this issue or dwell what actions need to be taken should such a situation arise. When a resource is required to work on non-critical chain activities followed by a critical chain activity, a small delay in a non-critical chain activity will eat into too small a portion of the feeding buffer to raise a warning, but could still delay the start of the critical chain activity (Herroelen et al., 2002b). This issue is not discussed in CCPM.

CCPM advocates keeping the baseline schedule, critical chain and buffer sizes unchanged during the execution of the project. According to CCPM, frequently changing the baseline schedule may result in a loss of focus and bring in nervousness in the system. But Herroelen and Leus (2001) show that updating the baseline schedule, critical chain and buffer sizes based on the availability of new information not only gives the project management team the right focus, but also yields the best intermediate estimates of the final project duration. Cohen et al. (2004) demonstrate the superiority of some alternative control mechanisms over CCPM in a multi-project environment.

CCPM has been in the field for too short a time to assess its potential in the long term. In the meantime, it has drawn both accolades and critical reviews from academicians and practitioners. On the one hand, there are companies, which reported substantial reduction in project execution time, boost in employee morale and better project management upon adoption of CCPM. On the other hand, there are others, who are critical about the limitations of CCPM.

CCPM is a new approach to project management, conceptualized to address the problems of time and cost overrun that conventional project management techniques fail to handle. One of the main concerns that have been raised by academicians and practitioners is the oversimplification of the approach. Experts are of the opinion that CCPM may not work well in all the situations and that companies should exercise caution while using this approach. There is no empirical evidence so far that shows the superiority of CCPM over conventional project management techniques.

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Honest disagreement is often a good sign of progress.

– Mohandas K. Gandhi

Feature

Quality Consciousness among Indian Consumers: Measurement and Impact of Demography

Anupam Bawa

This research effort has set out to measure the extent of quality consciousness among Indian consumers and to determine the relationship of socio-demographic variables with quality consciousness. As a first step the psychometrics of two versions of the scale on "Perfectionist / High Quality Conscious Shopping Style" were examined. The three item version of the scale was found more suitable than the seven item version of the scale. Contrary to the hypothesis, the mean scores on quality consciousness obtained in India were higher than those obtained in a comparable sample in the USA, and quality consciousness showed no relationship to socio demographic variables.

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While the areas of quality management and consumer behaviour have attracted considerable attention from researchers in India, the topic of quality consciousness among consumers - including its measurement and extent - has been a neglected one.

This is an omission that, for many reasons, needs to be rectified. Quality management cannot be an internal matter of organizations conducted without reference to the expectations of consumers. To quote Novak (1997), "Quality-oriented activities focus on achieving maximum compliance with customer's expectations with respect to design, operation reliability and safety in the most effective and efficient manner".

Quality consciousness among consumers is a desirable trait from the viewpoint of business. Porter (1990) explained at length and convincingly that sophisticated and demanding buyers boost the competitive advantage of a nation.

Proper measurement is a *sine quo non* for theory development. Believing in the adage 'quality doesn't improve unless you measure it', many prominent authors have worked on the measurement of some quality related aspects (Garvin, 1987; Reichheld and Sasser, 1990).

The credit for providing a scale to measure 'Perfectionist/High Quality Conscious Shopping Style' goes to Sproles and Kendall Sproles (1986, 1990). This is one of the eight shopping styles identified by them and they describe it as the degree to which a consumer searches carefully and systematically for the best quality in products. The seven-item Likert type scale provided by them contains within it a three item short form of the scale too (see appendix A).

The research objectives of this study are to determine the suitability of Sproles and Kendall Sproles' (1986,1990) seven item scale and its short form, the three item scale, for measuring quality consciousness among consumers in India; and its extent, and to determine the relationship of socio demographic variables with quality consciousness.

Hypothesis

No hypothesis was framed for the research objective pertaining to the suitability of the two versions of the scale. The pscyhometrics of both the scales were going to be examined in detail.

Hypothesis about the extent of quality consciousness among consumers in India was framed with the help of information and insights gained from the few studies on quality-related issues that have included goods of Indian origin/Indians in their scope.

The Bozell Gallup Worldwide Quality poll is one such research effort (Le Barre, 1994). Results from the poll, covering 20 countries, showed that perceived quality of goods 'made in India' is low. The self-rating of domestic goods by Indians is also only of a middling level. Schooler and Sunoo (1971) found that American respondents did not rank goods from India as highly as they did goods from West Germany. Rahman (2001) found that consumers in neighbouring Bangladesh perceived Indian goods to be of an inferior quality. Reading these results together with Porter (1990), who sees demanding domestic consumers pushing their country's industries to higher levels of performance, it was a small logical step to the hypothesis that quality consciousness among Indian consumers would be lower than that in a country whose goods rank higher than India's on perceived quality.

It was decided to select USA as the country with which to compare extent of quality consciousness. Sproles and Sproles (nee Kendall) were researchers working in USA and they have reported mean scores obtained by them on the scale in question. Le Barre (1994) had found USA to be one of the quality leaders of the world. The position of India was found to be much lower than that of USA. Rahman (2001) included goods from USA also in his study and found that the Bangladeshis perceived them to be of much higher quality than goods from India.

H_1: The mean scores on perfectionist/high quality shopping style scale obtained by Indian consumers will be lower than those obtained by consumers in USA.

The foregoing account relates quality consciousness in a country to perception of quality of goods "made in" a country. But this concept of "made in" is related to the level of development of a country also. The countries whose goods invariably rank high on quality are the development countries of the world (Agbonifoh and Elimimian, 1999; Dzever and Quester, 1999; Mohammad *et* al 2000; Papadopoulos *et al,* 1999 and Zhang 1996). Quality consciousness can then safely be expected to go hand in hand with the level of development in a country also. What is true at the global level should ideally be borne out even within a country. It was against this backdrop that quality consciousness was expected to be higher in the more developed sections of society, that is, those sections that have greater access to resources and greater access/exposure to information. Thus, quality consciousness was expected to be higher in respondents who were older, had higher education, were males, belonged to a higher income class or socio-economic classification category (SEC) and lived in urban areas.

H_2: Respondents of different age groups differ significantly with respect to quality consciousness. Quality consciousness is significantly higher among the respondents who are older.

H_3 to H_7: The words 'age groups' and 'older' that appear in H_2 were replaced respectively by the words 'education levels' and 'highly educated', 'genders' and 'males', 'income classes' and 'from a higher income class', 'SEC categories' and 'from a higher SEC category', 'place of residence' and 'urban'.

Methodology

Questionnaire: The scale used for measuring perfection/high quality conscious shopping style was the one used by Sproles and Kendall (1986) (see appendix A).

In addition to getting the scale filled, data was collected on the socio-demographic variables that figure in hypothesis H_2 to H_7 viz. age, education, gender, income and place of residence of respondent. To determine the SEC grade of respondent's household, information was sought on the education and the occupation of head of the household. Data was also collected on the four constructs with the help of which validity of the scales was to be assessed. These four constructs were beliefs about foreign products, beliefs about Indian products, attitude towards foreign products and attitude towards Indian products.

Sampling: Data was collected from three socio demographic groups. A sample of 188 senior secondary

school students was randomly selected from amongst the students of government schools of the Union Territory of Chandigarh. This sample is of special significance in the present study because it will facilitate comparison with the results obtained by Sproles and Kendall (1986) as their sample was of high school students. A sample of 104 students was randomly selected from amongst the students of University Business School, Punjab University, Chandigarh. Sixty filled questionnaires were obtained by mail from members of the Chandigarh branch of the Indian Institute of Materials Management.

Data Collection: Data was collected from November 2002 to February 2003.

Analysis: At the outset the psychometrics of the two versions of the 'Perfectionist/High Quality Consciousness Shopping Style' scale were assessed. The tools used were coefficient alpha, item analysis, item to total correlation, exploratory factor analysis and assessment of nomological validity with the help of correlations. ANOVA was used to test the hypothesis relating to socio-demographic variables.

Findings

Suitability of the Scale(s)

As mentioned before, Sproles and Kendall Sproles (1986, 1990) have given a seven-item scale as well as an abridged version of that scale containing the first three items only. At the outset, before the testing of hypothesis, these two scales were compared to assess which one (s) should be used on Indian consumers. It was considered important to estimate the psychometrics of the scale right in the beginning as these scales have been developed abroad and have not been validated on Indian consumers.

Paying heed to the exhortation of Churchill (1979), coefficient alpha was the first measure used to assess the quality of the seven-item scale and the three-item scale. The results are presented below:

	Materials Management Professionals		University Students		Senior Secondary School Students	
	7 item scale	3 item scale	7 item scale	3 item scale	7 item scale	3 item scale
Coefficient alpha	.6675	.6435	.6862	.7186	.3960	.5703
*n**, 54	58	104	104	173	187	

* The value of *n* varies within a sample because of item non-response.

As can be seen, in two of the three samples, viz, materials, management professionals and university students, the two scales give comparable results and coefficient alpha is above .60. In the sample of senior secondary school students the seven-item scale has a coefficient alpha of .396, which is below the generally considered acceptable level of .50. The corresponding score of the three item scale is .570.

Table 1: Discriminatory power of the items of the perfectionist/high quality conscious shopping style scale

Item	Mean for all respondents (n)	Standard deviation	Mean for low quartile	Mean for high quartile	t (df)	P value
Materials management professionals			n = 13	n = 9		
1.	4.53 (59)	.63	4.23	5.00	-3.33 (12)	.00
2.	4.40 (58)	.53	4.15	4.89	-4.72 (20)	.00
3.	4.46 (59)	.65	3.92	5.00	-11.56 (20)	.00
4.	4.23 (57)	.73	3.69	4.78	-5.38 (20)	.00
5.	4.19 (58)	.96	3.23	4.89	-5.14 (15.04)	.00
6.	3.98 (59)	.88	3.38	5.00	-6.06 (12)	.00
7.	3.51 (57)	1.24	2.23	4.67	-7.16 (20)	.00
University students			n = 27	n = 24		
1	4.51 (104)	.64	3.96	4.88	-5.43 (49)	.00
2	4.45 (104)	.62	3.85	4.92	-8.23 (37.86)	.00
3.	4.28 (104)	.68	3.63	4.75	-7.82 (49)	.00
4.	3.88 (104)	.90	3.04	4.75	-8.79 (38.86)	.00
5.	4.17 (104)	.73	3.78	4.75	-5.54 (49)	.00
6.	3.78 (104)	.78	3.19	4.46	-6.48 (49)	.00
7.	3.48 (104)	1.14	2.93	4.25	-4.57 (46.62)	.00
Sr. secondary school students			n = 49	n = 35		
1	4.47 (187)	.74	4.00	4.80	-5.23 (69.02)	.00
2	4.34 (188)	.95	3.80	4.86	-5.74 (64.13)	.00
3.	4.50 (188)	.78	3.98	4.80	-4.90 (65.52)	.00
4.	4.29 (185)	.90	3.82	4.80	-5.39 (68.06)	.00
5.	3.32 (185)	1.22	2.69	3.91	-4.92 (82)	.00
6.	3.41 (184)	1.08	3.00	4.23	-5.69 (82)	.00
7.	3.48 (181)	1.27	2.78	4.60	-8.98 (70.11)	.00

Item analysis was done separately for each of the three samples to check the discriminating power of each of the seven items of the scale. The results are given in table 1. Each of the seven items convincingly discriminates between the high scorers and the low

scorers in each of the three groups. All the *p* values are less than the previously determined *p* value of .05.

Item to total correlation was the next measure to be calculated. As can be seen from tables 2 and 3, while for both the scales all the item to total correlation values are significant at the 0.01 level, it is the three-item scale that has the higher range of values and has all values above .50. In each of the three samples the seven-item scale has some statements showing item to total correlation of less than .5 (materials management professionals sample: 2 items, university students sample: 2 items and senior secondary school students sample: 5 items).

Table 2: Item to total correlations of the seven item scale

Item correlated with total of 7 items	Sample		
	Materials management professionals n = 54	University students n = 104	Sr. sec. School students n = 173
1	.449[a]	.538	.418
2.	.464	.654	.450
3.	.625	.715	.576
4.	.593	.742	.567
5.	.674	.488	.455
6.	.574	.628	.388
7.	685	.491	.484
Range	.449-.685	.488-.742	.388-.576

a - all correlations are significant at the 0.01 level (2 tailed)

Table 3: Item to total correlations of the three item scale

Item correlated with total of three items	Sample		
	Materials management professionals *n* = 58	University students *n* = 104	Sr. sec. School students *n* = 187
1.	.760[a]	.749	.689
2.	.763	.764	.798
3.	.778	.883	.711
Range	.760-.778	.749-.883	.689-.798

a - all correlations are significant at the 0.01 level (2 tailed)

To assess the undimensionality of the scales, exploratory factor analysis was conducted, on both the scales in each of the three samples. The results are presented in tables 4 and 5. For both the scales, Bartletts test of spherecity is significant in all the three samples and the KMO is also large (.5) in all the three samples. These imply that the data is fit to be analyzed with factor analysis.

From the number of factors extracted and factor loadings it is evident that it is the three-item scale and not the seven-item scale that is undimensional. For the three-item scale all items are loaded on to one factor and all loadings are above .50. The factor loadings of the seven-item scale do not meet the stringent criteria of factor loadings (Tansey *et al* 2001). The highest factor loadings of each item do not exceed .5. In addition, in the sample of materials management professionals there are three items (items 3,4 & 6), which do not have 'pure' loadings on 1 factor. Their difference between loadings on two different factors is less than .20. The seven-item scale yields two factors each in the sample of materials management professionals and university students, and three factors in the sample of senior secondary school students.

The percentage of variance explained by extracted factors does not give results clearly favouring any one version of the scale over the other. In the sample of materials management professionals the seven item version and three-item version of the scale explain a roughly equal percentage of variance at 38.47% and 39.25%, respectively. In the sample of university students the three-item version explains 52.79% of the variance, which is much higher than the 42.84% of variance explained by the seven-item version. The situation was reversed in the sample of senior secondary school students where the seven-item version explains 36.22% of the variance and the three-item version 31.41% of the variance. All these percentages are much less than the recommended level of 60% (Malhotra, 2001) and thus indicate scope for improvement.

Nomological validity of the two versions of the scale was assessed by examining the pattern of their correlations with other constructs of interest. The four constructs of interest identified were belief about foreign products, belief about Indian products, attitudes towards foreign products and attitude towards Indian products.

The literature reviewed in the "Hypothesis section" had shown that foreign countries, particularly the developed ones, performed much better than Indian on quality. It was expected that correlation of quality consciousness with belief about foreign products would be higher than correlation with belief about Indian products. It was also expected that correlation of quality consciousness with attitude towards foreign products would be higher than correlation with attitude towards Indian products. These two sets of correlations were examined separately in each of the three samples for both the seven-item scale and the three-item scale.

Table 4: Results of Exploratory Fact or Analysis Conducted on the Seven-item Scale

	Materials management professionals		University students		Sr. secondary school students		
No. of factors (Eigenvalue >1)	2		2		3		
KMO	.676		.765		.567		
Bartlett test of spherecity							
Chi square	59.28		171.11		114.85		
df	21		21		21		
Significance	.00		.00		.00		
Percentage of variance explained	38.47		42.84		36.22		
Items/factors and loadings	a	b	a	b	a	b	c
1.	.436		.559		.444		
2.	.899		.597		.694		
3.	.468	.374	.927		.591		
4.	.365	.364	.681			.563	
5.		.635		.965			.727
6.	.209	.382	.457			.574	
7.		.668		.334			.371

Note: For each item the highest factor loading is reported. The other factor loadings are reported only if their difference from the higher one is <.2.

Analysis was done using common factor analysis (with principal axis factoring). These are rotated labour loadings obtained using varimax rotation.

Table 5: Results of Exploratory Factor Analysis Conducted on the Three Item Scale

	Materials Management Professionals	University Students	Sr. Sec. school students
No. of factors (eigenvalue > 1)	1	1	1
KMO	.646	.575	.626
Barlett test of spherecity			
Chi square	22.705	73.414	48.508
df	3	3	3
Significance	.000	.000	.000
Percentage of variance explained	39.253	52.788	31.413
Items/factors and loadings	a	a	a
1	.561	.513	.507
2.	.727	.568	.637
3.	.578	.999	.529

Note: Analysis was done using common factor analysis (with principal axis factoring)

When it comes to relationship with constructs in the nomological net, the two versions of the scale fare equally well, as can be seen in table 6. The three-item scale behaves as expected in four out of the six sets of correlations examined i.e. in the sample of materials, management professionals and university students, but not in the sample of senior secondary school students. In the first two samples mentioned the correlation of the three-item scale is higher with belief about foreign products than with belief about Indian products and again higher with attitude towards foreign products than attitude towards Indian products. These correlations are as desired/expected. This pattern is not found in the sample of senior secondary students.

The seven-item scale also behaves as expected in four out of the six sets of correlations examined viz – both the sets in the sample of university students and the belief about foreign/Indian products set in the sample of materials management professionals and the sample of senior secondary school students. In the sample of materials management professionals the set of correlations relating to attitude towards foreign/Indian products is not in the expected direction. In the sample of senior secondary school students this set of correlations is almost equal at .86 and 0.85.

In the overall assessment it is the three-item scale

Table 6: Assessment of Construct validity of the Seven-item Scale and Three-item Scale using correlations

	Three-item Scale			Seven-item Scale		
Materials, Management Professionals	r	n	p	r	n	p
Belief about foreign products	.121	57	.414	.206	53	.139
Belief about Indian products	-.124	57	.357	-.292	53	.034
Attitude towards foreign products	.150	58	.261	.070	54	.613
Attitude towards Indian products	.045	58	.735	.154	54	.267
University Students						
Belief about foreign products	.184	104	.061	.127	104	.200
Belief about Indian products	-.021	104	.833	.066	104	.505
Attitude towards foreign products	.270	104	.006	.133	104	.179
Attitude towards Indian products	.046	104	.641	.071	104	.475
Sr. Sec. School Students						
Belief about foreign products	.079	181	.290	.136	168	.078
Belief about Indian products	.083	183	.264	.074	169	.074
Attitude towards foreign products	.005	186	.951	.086	172	.261
Attitude towards Indian products	.097	186	.189	.085	172	.269

that is more suitable than the seven-item scale to measure the perfectionist/high quality conscious shopping style in India. It's coefficient alpha never dips below .5, all the items have item to total correlation .5 and the scale is undimensional with all items loading highly on to one factor. However, on other aspects like discriminating power of scale items and correlation with other items in the nomological net the two scales fare equally well.

There is still scope for developing a better scale to measure quality consciousness in Indian consumers. The coefficient alpha of the three-item scale, while acceptable for early stages of research still has room for improvement. The percentage of variance explained by extracted factors is still less than the recommended level of 60% (Malhotra, 2001).

Extent of Quality Consciousness in Indian Consumers

All the hypothesis in this paper are tested with the help of scores obtained on the three-item scale, as it has better psychometrics than the seven-item scale.

The mean total scores obtained by the respondents on the five point, three-item scale are very high and there is no significant difference in the mean scores of the three different groups of respondents (Materials Management Professionals: $M = 13.40$, $SD = 1.388$, $n = 58$; university students $M = 13.24$, $SD = 1.549$, $n = 104$; Senior Secondary school students $M = 13.30$, $SD = 1.828$ and $n = 187$).

The mean scores for the three-item versions of each of the eight shopping style scales, are reported by Sproles and Kendall (1986). According to Bearden and Netemeyer (1999: 258) 'These mean scores ranged from 8.7 for "brand consciousness" to 11.8 for recreational shopping consciousness".

Thus, the mean scores obtained in the present research study are higher than those detained by the authors of the scale.

This is contrary to hypothesis one where in it was hypothesized that the mean scores on perfectionist/high quality shopping style scale obtained by Indian consumers would be lower than those obtained in USA.

Relationship of Socio-Demographic Variables with Quality Consciousness

In hypothesis two to seven it was hypothesized that quality consciousness would differ in different socio-demographic groups – the relevant variables being age, education level, gender, income class, SEC category and place of residence. Quality consciousness was expected to be higher among respondents who were older, highly educated, males, belonged a higher income class, a higher SEC category and belonged to the urban area.

This hypothesis was tested with the help of ANOVA. The results are summarized in table 7.

Table 7: Relationship of Quality Consciousness with Socio-demographic Variables

Source	Source of Squares	*df*	Mean Squares	*f*
Materials Management Professionals				
Age	3.09	5	.62	.30 ns
Education	.10	2	.05	03 ns
Gender*	-	-	-	-
Income	2.32	4	.58	.29 ns
SEC	4.58	2	2.29	1.18 ns
Residence (Rural/Urban)**	-	-	-	-
University Students				
Age	7.35	2	3.68	1.55 ns
Education	2.02	1	2.02	.84 ns
Gender	2.76	1	2.76	1.15 ns
Income	17.03	4	4.26	1.83 ns
SEC	17.61	4	4.40	1.91 ns
Residence (Rural/urban)	6.84	1	6.84	2.91 ns
Sr. Sec. School students				
Age	10.95	1	10.94	3.32 ns
Education***	-	-	-	-
Gender	.82	1	.82	.24 ns
Income	31.13	6	5.19	1.63 ns
SEC	17.78	7	2.54	.76 ns
Residence (Rural/urban)	1.95	1	1.95	.58 ns

ns – not significant

* hypothesis could not be tested as all respondents were male; ** all respondents were urban; *** all respondents had the same level of education

The results go counter to the hypotheses. Not one of the results is significant. Not one of the six variables is related to quality-conscious shopping style in any of the three samples.

Findings, Managerial Implications and Directions for Future Research

This study has assessed, on Indian consumers, the reliability and validity of a quality-related scale. Succeeding researchers can now use this scale. In India there is a dearth of previously validated scales. Any scale formed subsequent to measure the construct of quality consciousness can use the results presented in this study as base level figures.

None of the seven hypothesis framed have been borne out. The rejection of the hypothesis is very complimentary to the Indian consumers. The Indian consumer is revealed to be highly quality conscious, more so than even his American counterpart. Quality consciousness is a pervasive phenomena in India. All the three samples have it to an equal degree. Socio demographic variables are not related to quality consciousness.

These findings should ring warning bells in oragnisations that cater to the Indian consumer. The Indian market deserves to be treated with greater respect than shown to it so far. Providers of products and services would do well to pay more attention to quality related aspects of their business.

These findings do raise some questions. Why has this level of quality consciousness not translated into higher quality of goods produced in India? Overall, India's competitiveness in the international markets is not high. Porter's (1990) thesis that sophisticated and discerning consumers push home industry to better performance not been realised in the case of India.

Why do consumers coming from different socio-demographic groups not exhibit differences with respect to quality consciousness? What is that powerful interviewing variable that results in disparate socio-demographic groups expressing similar responses?

There is a need to search for variables that will explain differences in quality consciousness among consumers. As most of the commonly used socio-demographic variables have failed to explain these differences, some relevant psychographic variables should be identified and their relationship with quality consciousness be examined.

There is need for an even better measure to assess quality consciousness. The effort to develop such a measure should begin with attempts to determine the nuances of the concept of quality consciousness as it is understood in India. A pseduoetic approach should be shunned. Scale items suited to Indian consumers should be generated. A form of research/questionnaire that does not rely on direct and undisguised questions may be tried. The intent behind each of the seven items in the scale(s) given by the Sproles' is clear to the respondent. The social desirability bias may well have prevented respondents from giving answers different from the ones they have given.

Research on scalar equivalence will help understand the results better (Craig and Douglas, 2001). Is a score of thirteen in India equivalent to, say, a lower score in USA?

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Appendix A

Scale for Measurement of Perfectionist/High Quality Consciousness Shopping Style

Now there will be statements with five numbers against them. Please encircle the appropriate number: The meaning of the numbers is as follows:-

1	2	3	4	5
Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree

Getting very good quality is very important to me	1	2	3	4	5
When it comes to purchasing products I try to get the very best or perfect choice.	1	2	3	4	5
In general, I usually try to buy the best overall quality products	1	2	3	4	5
I make a special effort to choose the very best quality products	1	2	3	4	5
I really don't give my purchase much thought or care*	1	2	3	4	5
My standards and expectations for products I buy are very high	1	2	3	4	5
I shop quickly, buying the first product or brand I find that seems good enough*	1	2	3	4	5

Notes: Source: Sproles and Kendall (1986)

* There was reverse scoring for items 5 and 7

The abridged scale consisted of items 1 to 3 only.

□

Feature

Improvement in Worker Productivity Through Interventions in Repetitive Production Tasks

T.P. Singh & Ajay Batish

This paper presents the results of a study carried out to improve productivity of workers performing highly repetitive tasks through various interventions. The study was conducted in an engine bearing manufacturing facility at the hole-punching station. Motivating workers to improve productivity has been a major agenda for the management of this operation. The study was conducted after ensuring proper ergonomic conditions. The subjects were randomly divided into four groups. Each group was given training and subsequently working sessions were assigned. Worker productivity was found to improve most as a result of participative target setting and the management providing continuous feedback on performance. The performance without such controls was far below the normal standard. It is concluded that good working conditions, providing a challenge and ongoing feedback can be advantageously applied to improve worker productivity in industry for repetitive tasks.

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Repetitive tasks are viewed as highly monotonous, boring and unmotivating, resulting in reduced worker productivity. Repetitive work is considered hazardous if it lasts for more than 3 – 4 hours a day with a cycle time of less than 30 seconds, or the same movements are repeated more than 50% of the cycle time. In addition, the risk can be increased by reinforcing factors such as:

- High demands for precision
- High demands on vision
- Low level of influence
- Heavy lifting and carrying
- Awkward work postures
- Large use of force

Providing ergonomic conditions should be considered as a minimum requirement to reduce risk and motivate workers to enhance productivity.

Goal-setting and performance feedback are considered to have a motivating effect on performance and productivity. In this study an attempt is made to find out the relationship between goal-setting and performance feedback on the worker's performance and productivity for a highly repetitive task. For this purpose a set of experiments were conducted on hole-punching operations in a bearing production line, using measured time standards and ergonomic design principles.

Worker productivity is found to improve the most as a result of participative goal-setting with performance feedback. The performance without interventions was far below the normal standard. In general, standard setting with feedback, with or without monetary incentives, improved worker productivity. It was concluded that under good ergonomically designed working condi-

tions, challenges and monetary incentives can be advantageously applied to improve worker productivity on highly repetitive tasks.

Method

The experimental method for the study was designed and developed in such a way so that minimal disruption to the normal production line takes place. Hole-punching operation involves piercing the coined engine bearing at the specified location using a punch and die arrangement. The task was standardized so that the experiment would be conducted under the same working conditions and methods. An instruction sheet of the standardized task was developed and used, (see fig. 1). The task was performed in a sitting position. The workplace was designed considering ergonomic guidelines with respect to layout, posture and height. The controls were implemented with regard to ergonomics after assessment by the RULA methodology. Combined male and female anthropmetric data was used for this purpose. The individual operators according to their requirement adjusted the sitting height.

Process Name: Hole Punching
Machine Name: 16 Ton Press

Location: Bearing Production Line II
Machine No: L2-16T

Right Hand

- Put the incoming pan of bearings on the side table of the press
- Unload parts on the press-loading tray on the right of the machine
- Pick the part from the loading tray on the right side of the operator
- Load the part into the die
- Press the two control switches for operating the press ram

Left Hand

- Unload the part from the die
- Place in the unloading tray on the left of the operator
- Unload parts into the pan placed on the side-table located on the left as outward pan.
- Press the two control switches for operating the press ram.

Repeat steps for the next incoming pans until the outgoing pans are filled

Fig. 1. Operator Instruction Sheet

Work environment

The physical environment with regard to temperature, humidity and light was within normal levels. The temperature was 28°c, relative humidity 56%, and light 2500 Lx on the punching press. The sound level was, however, above 85 dBA, thus, the subjects used earplugs. The operator wore safety armbands in both hands, which were hooked to steel ropes, and attached vertically through two pulleys hanging overhead and then connected to the press ram. The motion of the ram was synchronized in such a way that as the ram went down to complete a punching stroke, the rope attached through the pulleys pulled the two hands of the operator wearing the armbands, away from the work area. This ensured that the hands of the operator were always away from the die block when the press ram is completing the stroke.

Production standard

Proper motions to perform the task were established through methods-time measurement (MTM) and ergonomic analysis. The normal time to punch holes for a pan containing 200 parts was determined through MTM, and a stopwatch study was made to check the accuracy of the MTM standard. The standard time was calculated using the formula

Standard Time = Normal Time (1 + allowance in per cent)

A 16% allowance, comprising 6% for unavoidable delays, 5% for fatigue and 5% for personal needs, was added to the normal time for the task. The normal production was calculated in terms of number of parts processed per hour. For example:

Normal time to process one pan of 200 parts = 13.7 minutes,

Standard time = 13.7(1 + 0.16) = 14.86 minutes

Normal production standard = 200/14.86 x 60 = 807.53 parts per hour.

The hard standard was established on the basis, that, in an incentive plan with manual tasks, workers could perform up to a pace of 200%, and for this study it was taken to be 140% of the normal standard (normal standard x 1.4), based on the assumption that offering monetary benefits was within the scope of this study. Each individual operator in consultation with the experimenter sets the participative standard. The operator was asked to set a standard above 100% normal that he/she thought was challenging and would like to achieve. Each standard was presented on a special feedback card for each individual operator in terms of parts per hour against the standard.

A special feedback card was prepared for each operator who received feedback on results. Feedback was provided in terms of production output (parts/hr) and performance (% of standard achieved) every 2 hours. The performance of each day was recorded on the card in graphical form for easy visualization. An ex-

ample of the card is shown in Fig. 2. Workers productivity in terms of quantity output (parts produced/hr) and performance (% of normal standard achieved) was measured every 2 hours. The full day's output was converted to performance per hour in the percentage of normal standard achieved, for statistical analysis.

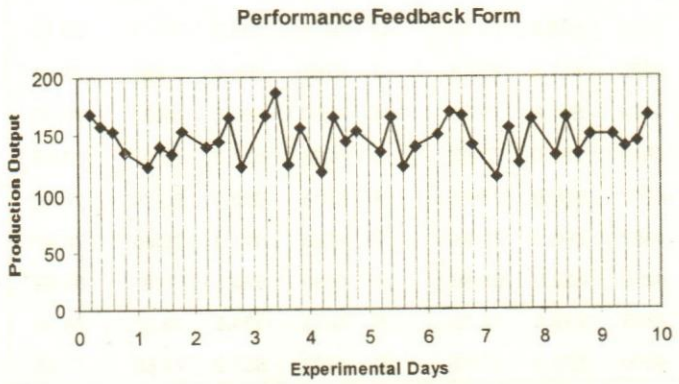

Fig. 2. Example of a Performance Feedback form

Subjects

Sixteen operators from among the regular employees were selected on a voluntary basis as subjects for the experiment. The criteria of screening was based on the following parameters:

- At least 6 months of job experience
- At least 8^{th} grade education
- Not planning to quit the job in the near future

The subjects were paid in the usual manner (company wage rate) except for the incentive which is payable on a certain productivity index achieved by each operator for the month. The participants were given adequate demonstration and instructions to familiarize them with the standard method of task performance. The subjects performed the same task in the experimental sessions under specific experimental conditions.

Experimental design

The 16 subjects were divided assigned randomly into four groups and the four experimental conditions were randomly assigned to each group. The experimental conditions and assignment of groups to these conditions are presented in table 1. The experimental conditions for each group were explained to its members. The subjects for each group performed one training and ten experimental sessions, each session being a full day's work, over a three-month period. Only one session was held on one day for only one group. In every session the subjects of the group were reminded about their experimental condition. The subjects of group 1 (control group) were simply asked to do their best. All the participants were requested not to discuss their results.

Table 1: Characteristics of the Experimental Group

Group	Instruction	Production Standard (PS)	Performance Feedback (PF)
1	Control	No PS	No PF
2	Assigned	PS: 100% Normal	PF
3	Assigned	PS: 140% of Normal	PF
4	Participative	PS: Participative	PF

The day's output was noted at the end of the day's work from the production logbook for each of day when the experiment was conducted. The data for each group is shown in tables 2, 3, 4 and 5. The production per hour was calculated by dividing the day's output by 8. Also, the percentage of normal standard achieved was calculated by dividing the production output per hour by the normal production standard for this task. Thus,

Production output per hour = Day's total output/ number of working hours, where, number of working hours per day's work = 8 hours

Normal standard achieved = production output per hr/ Normal Production Standard, where, the normal production standard per hour for hole-punching = 807.53 parts/ hr.

Analysis

The production output data was collected in terms of percentage of the normal standard as described above for statistical analysis. Analysis of variance (ANOVA) and Student Newman-Kuel's range test was employed for the analysis. The results of ANOVA

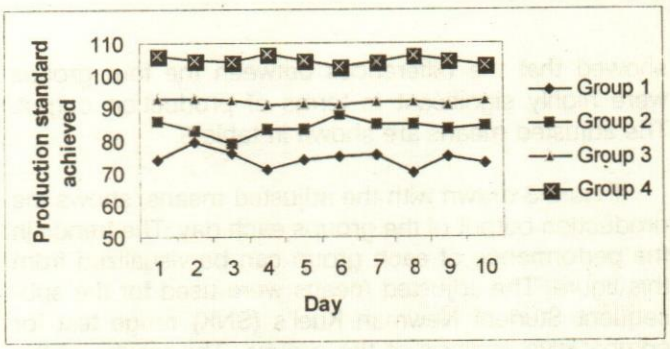

Fig. 3. Production output of groups by day

Table 2: Output data of workers of group 1

Group 1 - Control with no performance feedback

Operator 1				Operator 2				Operator 3				Operator 4				Group
Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Mean
1	4478	559.8	69.32	1	4609	576.1	71.34	1	5234	654.3	81.02	1	4790	598.8	74.15	73.96
2	5175	646.9	80.11	2	5478	684.8	84.80	2	5110	638.8	79.10	2	4678	584.8	72.41	79.10
3	5346	668.3	82.75	3	4780	597.5	73.99	3	4660	582.5	72.13	3	4768	596.0	73.81	75.67
4	4876	609.5	75.48	4	4124	515.5	63.84	4	4734	591.8	73.28	4	4509	563.6	69.80	70.60
5	4890	611.3	75.69	5	4467	558.4	69.15	5	4640	580.0	71.82	5	5098	637.3	78.91	73.89
6	4356	544.5	67.43	6	4965	620.6	76.85	6	4807	600.9	74.41	6	5216	652.0	80.74	74.86
7	4657	582.1	72.09	7	5089	636.1	78.77	7	4867	608.4	75.34	7	4888	611.0	75.66	75.47
8	4267	533.4	66.05	8	4966	620.8	76.87	8	4256	532.0	65.88	8	4580	572.5	70.90	69.92
9	4770	596.3	73.84	9	4470	558.8	69.19	9	4955	619.4	76.70	9	5076	634.5	78.57	74.58
10	4986	623.3	77.18	10	4378	547.3	67.77	10	4590	573.8	71.05	10	4823	602.9	74.66	72.66
														Group Mean		74.07

Table 3: Output data of workers of Group 2

Group 2 - Production Standard: 100% with performance feedback

Operator 1				Operator 2				Operator 3				Operator 4				Group
Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Mean
1	5890	736.3	91.17	1	5456	682.0	84.46	1	5466	683.3	84.61	1	5367	670.9	83.08	85.83
2	4789	598.6	74.13	2	5567	695.9	86.17	2	5509	688.6	85.28	2	5565	695.6	86.14	82.93
3	5467	683.4	84.63	3	4805	600.6	74.38	3	4465	558.1	69.12	3	5578	697.3	86.34	78.62
4	4467	558.4	69.15	4	5765	720.6	89.24	4	5335	666.9	82.58	4	5876	734.5	90.96	82.98
5	5347	668.4	82.77	5	5278	659.8	81.70	5	5278	659.8	81.70	5	5545	693.1	85.83	83.00
6	5877	734.6	90.97	6	5768	721.0	89.28	6	5578	697.3	86.34	6	5478	684.8	84.80	87.85
7	5769	721.1	89.30	7	5523	690.4	85.49	7	5783	722.9	89.52	7	4790	598.8	74.15	84.61
8	5604	700.5	86.75	8	5468	683.5	84.64	8	5426	678.3	83.99	8	5430	678.8	84.05	84.86
9	5880	735.0	91.02	9	5632	704.0	87.18	9	4467	558.4	69.15	9	5579	697.4	86.36	83.43
10	5567	695.9	86.17	10	5346	668.3	82.75	10	5412	676.5	83.77	10	5467	683.4	84.63	84.33
														Group Mean		83.84

showed that the differences between the four groups were highly significant in terms of production output. The adjusted means are shown in table 6.

Figure 3 drawn with the adjusted means, shows the production output of the groups each day. The trends in the performance of each group can be visualized from this figure. The adjusted means were used for the subsequent Student Newman Kuel's (SNK) range test for comparative analysis of the groups. The results of the test are shown in table 7.

Normal production standard

The comparison between group 2 (Performance Standard 100% Normal with Feedback) and Group 1 (Control: No standard and no feedback) showed that if the operators are assigned a task to achieve the required target of 100% of standard and are also provided feedback as they carry out the production activity, the increase in production was 13.19% as compared with the control group (see table 8). Thus, provision of normal production standard with feedback on performance

Table 4: Output data of workers of group 3

Group 3 - Production Standard: 140% with performance feedback

Operator 1				Operator 2				Operator 3				Operator 4				Group
Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Mean
1	5980	747.5	92.57	1	6107	763.4	94.53	1	6090	761.3	94.27	1	5734	716.8	88.76	92.53
2	6012	751.5	93.06	2	6056	757.0	93.74	2	5909	738.6	91.47	2	5965	745.6	92.33	92.65
3	5980	747.5	92.57	3	5980	747.5	92.57	3	5860	732.5	90.71	3	6013	751.6	93.08	92.23
4	5679	709.9	87.91	4	5879	734.9	91.00	4	5780	722.5	89.47	4	6124	765.5	94.80	90.79
5	5978	747.3	92.54	5	6020	752.5	93.19	5	5798	724.8	89.75	5	5698	712.3	88.20	90.92
6	5567	695.9	86.17	6	6100	762.5	94.42	6	5967	745.9	92.36	6	5745	718.1	88.93	90.47
7	5807	725.9	89.89	7	5890	736.3	91.17	7	6054	756.8	93.71	7	5987	748.4	92.67	91.86
8	5980	747.5	92.57	8	5800	725.0	89.78	8	6020	752.5	93.19	8	5876	734.5	90.96	91.62
9	5712	714.0	88.42	9	6030	753.8	93.34	9	5955	744.4	92.18	9	5790	723.8	89.63	90.89
10	5690	711.3	88.08	10	6075	759.4	94.04	10	6080	760.0	94.11	10	5984	748.0	92.63	92.21
															Group Mean	91.62

Table 5: Output data of workers of group 4

Group 4 - Production Standard: Participative with performance feedback

Operator 1				Operator 2				Operator 3				Operator 4				Group
Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Day	Day O/P	Pf / h	% of N S	Mean
1	6523	815.4	100.97	1	6987	873.4	108.15	1	6980	872.5	108.05	1	6876	859.5	106.44	105.90
2	6672	834.0	103.28	2	6650	831.3	102.94	2	6780	847.5	104.95	2	6890	861.3	106.65	104.45
3	6478	809.8	100.27	3	6790	848.8	105.10	3	6650	831.3	102.94	3	6945	868.1	107.50	103.96
4	6608	826.0	102.29	4	6954	869.3	107.64	4	6975	871.9	107.97	4	6985	873.1	108.12	106.51
5	6780	847.5	104.95	5	6880	860.0	106.50	5	6704	838.0	103.77	5	6655	831.9	103.01	104.56
6	6670	833.8	103.25	6	6578	822.3	101.82	6	6656	832.0	103.03	6	6580	822.5	101.85	102.49
7	6875	859.4	106.42	7	6675	834.4	103.32	7	6478	809.8	100.27	7	6904	863.0	106.87	104.22
8	6890	861.3	106.65	8	6810	851.3	105.41	8	6856	857.0	106.13	8	6840	855.0	105.88	106.02
9	6725	840.6	104.10	9	6780	847.5	104.95	9	6723	840.4	104.07	9	6729	841.1	104.16	104.32
10	6470	808.8	100.15	10	6640	830.0	102.78	10	6654	831.8	103.00	10	6860	857.5	106.19	103.03
															Group Mean	104.55

is expected to show better results on worker productivity compared to the "Do your best" kind of instructions as was given to the operators of group 1.

Assigned hard production standard

A comparison between group 3 (Hard Standard of 140% with performance feedback) with group 1 showed that the provision of hard target along with feedback had a highly significant effect on the worker's performance with the results showing an increase of 23.69% (see table 8).

Also, the production output of group 3 was significantly better than the performance of group 2 with an increase in output by 9.28% compared to Group 2. We can safely make the assumption that sufficiently hard challenges, which are realistic and provide objective feedback on a continuous basis, motivate workers to improve their performance in repetitive tasks.

Participative Production Standard

The subjects of the participative group had set their own standard at 120% of the normal production per

hour, after discussions between themselves. A comparison between the performances of Group 4 (PS: 120% with performance feedback) with Group 1 (Do your best with no feedback) showed a highly significant improvement of 41.15%. (see table 8).

A comparison between groups 4 and 3 showed that the production output of the participative standard group was superior to the assigned hard standard group which means provision of a participative standard where the members decide their output performance along with continuous feedback which led to a better performance than did an assigned hard standard of 140% of normal with feedback.

Table 6: Group mean performance (% of Normal Standard)

Group			
1 (Control)	2 (PS:100% + PF)	3 (PS: 140% + PF)	4 (PS: Partcip. + PF)
74.07	83.84	91.62	104.55

Table 7: Student Newman Kuel's range test for worker production output data

Groups/Differences in means between groups

Groups	1 (Control)	2 (PS: 100% + PF)	3 (PS: 140% + PF)	4 (PS: Partcip. + PF)
1	-	9.77**	17.55**	30.48**
2		-	7.78*	20.71**
3			-	12.93**
4				-

Groups in order of increasing differences in means (production output, % of normal)

* p 0.05 (Significant), ** p 0.01 (Highly significant)

Table 8: Percentage increase or decrease in performance

Comparison between Groups	% Increase in performance
2 (Assigned normal) vs 1 (Control)	13.19
3 (Assigned Hard) vs 1	23.69
3 vs 2	9.28
4 (Participative) vs 1	41.15
4 vs 2	24.70
4 vs 3	14.11

Conclusions

On the basis of the results obtained after the study of the hole-punching operation the following conclusions are drawn:

The provision of an assigned normal production standard (100% normal) with feedback improves worker productivity significantly.

An assigned hard standard with feedback, which is realistic and achievable, further improves productivity. However, a participative standard with feedback, improves worker productivity significantly, compared with the provision of an assigned normal standard with feedback. A participative standard was superior to the assigned hard standard with feedback in terms of worker productivity.

For maximum worker productivity improvements, a participative standard with feedback could be employed in industry for a repetitive production task under ergonomically designed working conditions. Improvement is the result of introducing a fair degree of challenge in the assigned task and goals and also for generating interest due to participation.

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Feature

Quality Function Deployment for Operation Theatres

Akshay Dvivedi, Pradeep Kumar & Sanjay Dvivedi

This paper is aimed at improving the quality of service functions in the operation theatre of hospitals by improving the work environment using Quality Function Deployment. The study was conducted at the "Himalayan Institute of Medical Sciences," Swami Ram Nagar, Jolly Grant, Dehradun, U.A. India. The objective of this paper was established after intensive discussions with doctors, the surgical team and supporting staff along with patients at the above institute. It was found that despite all care in the operation theatre there still exist some shortcomings that are generally overlooked. In this study these problems were identified and using the quality function deployment technique, guidelines were developed to rectify them.

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Quality control has been in existence for a long time, but it was not until the 1920s that statistical theory was applied effectively to quality control as a result of the development of sampling theory (Prins, 2000). Since then, the method of statistical quality control (SQC) with sophisticated tool control charts has been applied to many manufacturing areas. SQC was introduced in Japan after World War II and became the central quality activity. SQC was transformed into Total Quality Control (TQC) in Japan from 1960 to 1965 (Menks, 2000). While SQC emphasizes the quality control of production only, TQC is the application of quality principles for the integration of all functions and processes within the organization (Lockamy and Khurana, 1995). Among many tools used in TQC, quality function deployment or QFD, as it is commonly known, is one of the effective tools for product and process development. It was conceived in Japan in the late 1960s by Yoji Akao but did not become a viable methodology until 1972, when it was applied at the Kobe shipyards of Mitsubishi Heavy Industries Ltd. in Japan. QFD reached its peak after four years of case study development, refinement, and training in the 1970s when Toyota Auto Body developed a quality table that had a "roof" on top, and nicknamed this quality table as "quality house," which is also known as "the House of Quality" in the United States (Chen and Chen, 2002).

QFD has been a successful tool implemented in both the manufacturing and service industry arena for product/service design via customers' voices. Also, QFD can be applied to practically any manufacturing or service industry - it has become a standard practice by most leading organizations, which also require it from their suppliers (Clockamy and Khurana, 1995). Increasing economic pressures from competition, government, and rapidly changing technology have forced companies to ask for more, from fewer employees. Internal company services such as personnel, accounting, information management, etc. are no longer ancillary activities, but have become critical processes in assuring

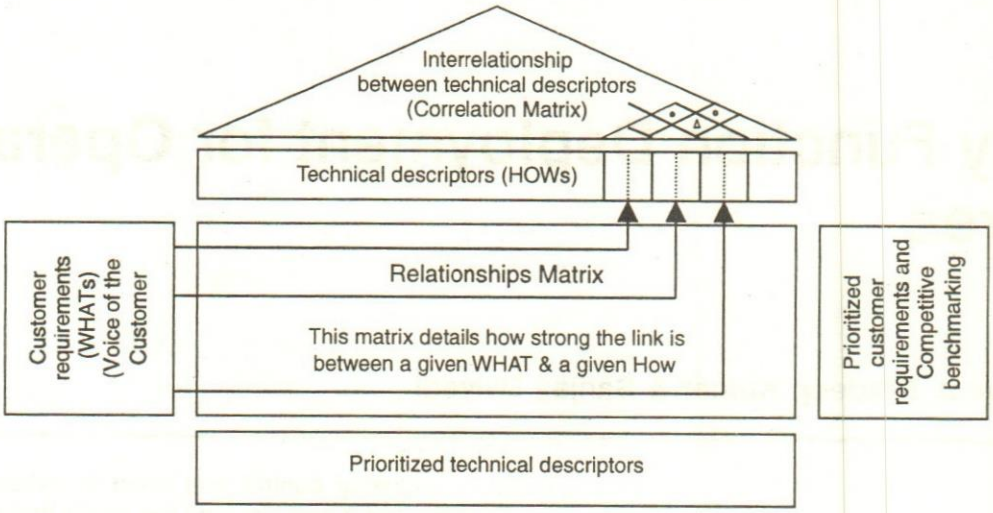


Fig. 1. Basic Skeleton of the House of Quality

end customer satisfaction and in achieving organizational objectives (Mazur, 1993, 1997). How will they do this with ever-diminishing finances and human resources and less time? What about service-oriented businesses? For instance, there is mounting pressure for healthcare reforms that will undoubtedly mean fewer people with less resources, performing better and more for more customers. How will they ensure that the quality of healthcare does not suffer? A similar scenario exists for the hospitality industry, banking industry, airlines, insurance sector and so on.

Why look upon QFD for addressing the problem of services? Although the concept of QFD was originally developed and widely adopted by manufacturing companies for product development purposes, QFD researchers have endlessly argued that this framework can be applied in non-manufacturing environments as well, such as airlines, hotels, and utilities.

What can QFD do that is not already being done by traditional quality systems? In understanding the applicability of QFD to the service sector, it is helpful to understand the differences between modern and traditional quality systems.

The traditional approaches to assuring service quality often focus on work standards, automation to eliminate people, or in more enlightened organizations, quality improvement teams, to empower employees to resolve problems. As manufacturers are finding out, however, consistency and absence of problems are not a competitive advantage when only good players are left. For example, in the automobile industry, despite the celebrated narrowing of the "quality" between U.S. and Japanese makers, Japanese cars still win the top honours in J.D. Powers Survey of New Car Quality (Hermann et al, 2000; Mazur, 1993).

QFD is quite different from traditional quality systems, which solely aim at minimizing negative quality (such as poor service, inconsistency, broken product). With those systems, the best you can get is nothing wrong – which can be seen as not enough when all the players are good. In addition to eliminating poor service, one must also maximize positive qualities (such as fun, luxury). This creates value (Mazur, 1993).

Quality function deployment is the only comprehensive quality system aimed at satisfying the customer (Bosser). It concentrates on maximizing customer satisfaction (positive quality) by seeking out both spoken and unspoken needs, translating these into actions and designs, and communicating these throughout the organizations end-to-end. Further, QFD allows customers to prioritize their requirements, benchmark a product / service against competitors, and then optimize those aspects of product, process, services and organization that will bring the greatest competitive advantage (Mazur, 1993, 1997). Quality function deployment is a process that provides structure to the development cycle. This structure can be likened to the framework of a house (Fig. 1). The foundation is customer requirement. The frame consists of the planning matrix, which includes items such as importance rating, customer-perceived benchmarking, sales point and scale-up factors. The second floor of the house includes the technical features. The walls are the correlation matrix between customer's requirements and the technical descriptors (Besterfield et al, 2003).

Proposed procedure of QFD-based approach

The intent of this study was to introduce the proce-

dure of a QFD-based approach to include the voices of the customer, i.e., users of operation theatres, in identifying the desires and key problem areas in the operation theatres. The procedure in building the initial house of quality for improving the service function of operation theatres was proposed to consist of four steps.

Step One: Customer requirements (WHATs)

The opinions of the customer (viz. surgeon, supporting staff, patients, visitors and attendants) concerning the O.T are gathered and documented. Customer responses are generally vague and staggered in nature, thus, these responses are grouped together reflecting similar statements. Also, all the requirements are prioritized depending upon the nature and frequency of use by customer.

Step Two: Technical Descriptors (HOWs)

Technical descriptors or engineering characteristics (basically based on fulfilling customer requirements) are collected which directly affect a customer perception and is expressed in measurable terms.

Step Three: Developing relationship matrix between WHATs and HOWs

The relationship between the customer voices (WHATs) and the technical descriptors (HOWs) is decided. The raw importance weight for technical descriptor is calculated by adding all the cell numbers, each multiplied by its strength ratio. Also, relative weights are calculated which shows the importance of the technical descriptor in solving the problems or fulfilling customer desires.

Step Four: Developing an interrelationship matrix between HOWs

An interrelationship matrix is developed between the technical descriptors showing the direction of correlation, i.e., which technical descriptor support one another and which are in conflict.

The case study

Healthcare had been and is one of the most important service functions of mankind. It is the sole barrier between human existence and extinction. The prime step was to mark out which department of the hospital to choose so as to employ the quality function deployment technique with a view to develop and strengthen it according to customer desires (Radharaman and Godoy, 1996). A patient goes to an operation theatre when, either there is a life threatening situation or for repair, reconstruction or removal of some organ to prevent further loss to human body and psyche. Hence, any form of service failure in such a situation will create havoc, further, any enhancements in the service functions will not eliminate the sufferings of the patient but can still reduce them. Operation theatres were therefore selected for quality assessment and enhancements in services. Unlike manufacturing problems, the link between satisfied patients is something more than the financial or business outcome. The operation may be a success in medical terminology, but in terms of satisfactory service provision, it may not be optimally or desirably successful. The purpose of getting a fee from patients for operations may fulfill a hospital's financial achievement but if the result in terms of patient satisfaction is sub-optimal, then the so-called 'satisfied customer' (here, patient) will remain sub optimally satisfied, deflating the entire purpose of this human-oriented service. The purpose of this case study was to introduce a QFD-based approach to select functional requirements for the purpose of evaluating service functions in operation theatres and providing guidelines for best-fit technique for providing services based on customers' voices.

Step 1: A customer is someone you have to satisfy to be successful, or else someone who can make you fail. Operation theatres in hospitals are a part of the chain of customers - surgeon who operates on the patient; the surgical team who helps the surgeon during the operation, supporting staff that is responsible for pre, per and post-operative management; attendants (caretaker, relatives) of the patient; and the patient himself. The first step is to uncover the "keystone customer". If the needs of the keystone customer are not satisfied, the whole service chain may collapse. In operation theatres, the keystone customer is the surgeon, although the patient is the beneficiary who gets the eventual result of the surgical procedure - good or bad. If the surgeon is dissatisfied or uncomfortable in the environment, that includes armamentarium, and facilities or services provided, and the interpersonal interaction among the team mates in operation theatres, he may long for a change in service functions, or else, he would not be able to work to his full potential. Since patients are usually unconscious under general anesthesia, they are unable to perceive what is going on around and inside them.

In QFD, it is important that the needs of the keystone customer be addressed first (figure 2), moreso since the procedures performed in the operation theatre are not akin to work upon machines with a defined tensile strength or fixed torque. It depends much upon the behavioural patterns among the surgical team that posi-

Table 1: Customer Segments Table

5 W 1 H Context					
Who	What	When	Where	Why	How
Surgeon	Operate	24/7, 365	O.T.	To aid patient	Define surgical procedure + innovative ideas
Surgical team	Assist surgeon	Pre, Per and post-operative	O.T.	To help surgeon in providing optimal/super-optimal results	Define job criteria for scrub nurse, circulating nurse, OT assistants and house keepers
Supporting staff	O.T sterilization, O.T. & instruments preparation	Pre, Per and post-operative	O.T.	For smooth conduction of operation; for trouble shooting during surgery	Define job criteria for scrub nurse, circulating nurse, OT assistants and house keepers
Attendants	Comfort patient, purchase and provide consumables, drugs, advocate for patient, pray	During entrance to O.T., and while the patient is in the theatre	Waiting lobby outside O.T.	Make decisions, assure patient's needs are met, moral support	Discuss with medical Staff, operation theatre personnel – surgical and non-surgical
Patient	Recover their health by getting operated	24/7, 365	O.T.	Ailments, accidents	Get operated upon

tively or negatively affect the entire surgical outcome and gain to the beneficiary. It must be kept in mind that biology and its integrated sub-disciplines are much more complicated, sensitive and abstract, than what can be comprehended through the principles of present day science. And also, the variables concerning living things cannot be defined in entirety by the principles of mathematics. Thus, the study will proceed with a view to satisfy primarily the keystone customer (here surgeon), although other customers are not left aside.

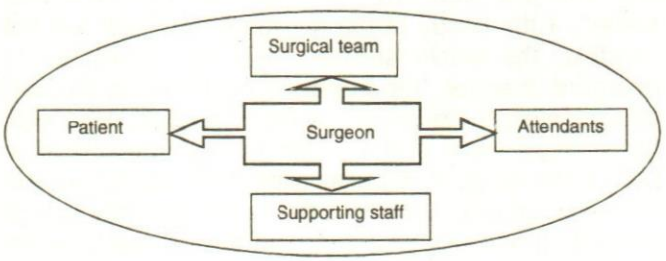


Fig. 2. The keystone customer

It is important to capture the "voice" of those customers that can directly and indirectly lead to success in satisfying them. In this respect it is important to look at all the customers, needs, how they are utilizing the system and for what the systems are used. A common way to describe the scenario of use is (five 'ws') who, what, when, where, why and (one 'h') how the product or service is used. These are laid out in a customer context table (Table 1) (Mazur, 1997; Mazur and Hearon, 2002).

To analyze the desires of customers, brainstorming sessions were conducted, which involved an individual team of surgeons, supporting staff, attendants/visitors and patients. The key question asked to all these teams was *'What are the shortcomings that are generally overlooked in operation theatres?'* Although it is important in conducting QFD study that verbatim be followed (Mazur, 1993, 1997; Mazur and Hearon, 2002) but in some cases responses are so vague, that verbatim cannot be followed, thus, while documenting the results, at some places results are modified keeping the context the same. The responses of all these discussions were documented and are compiled below.

A. Problems faced by surgeons:

1. Improper height of scrub station, which makes the scrubbing inconvenient and unhygienic.
2. Lack of shower system that is desired by surgeons for refreshment in lengthy procedures or in between two operations.
3. Scrub solution dispensers are cumbersome.
4. Seating arrangements for surgery (stools and operating chairs) are either uncomfortable, or unstable. Moreover, in prolonged operations they lead to sore back and bottoms.
5. Base of the operation table is very broad. Thus, a surgeon cannot come close to the patient while operating in a seated position, resulting in back problems.
6. Width of the table is not alterable. If two surgeons

are operating from opposite ends of the table upon a thin patient; then one of them will pull the patient to his end, thus, this results in the other surgeon leaning over, aggravating the problem of low back pain.

7. Incompatibility between tall surgeons and short assistants and vice versa, making it difficult to operate or to assist the operation.
8. Inadjustable length of segments of table.
9. Cumbersome mechanical mechanism of table that is also of poor ergonomic design.
10. Dangling O.T. lights, due to loose ceiling mounts with poor focus and illumination. Often, due to the dangling lights, the surgeon bangs his head against the light. Moreover, life of joints in these lights is less due to poor maintenance.
11. Bulky lights with poor illumination causing mobility problems for the surgeon and his team.
12. Soiling of feet and floor from the waste material and fluids falling from the O.T. table.
13. Monotonous atmosphere.
14. Difficult correlation between teaching and surgery, in case of a hospital associated with a medical college or research centre.
15. Clustered consumables in operation theatres (desired item cannot be found when needed).
16. Overloading.

B. Problems faced by surgical team & supporting staff

1. Monotonous atmosphere.
2. Irrational behaviour of surgeon, especially when he is not comfortable with the environment.
3. Lack of communication from surgeon about his requirements for an operation.
4. No technical person is available for routine maintenance of all the equipment leaving the responsibility of all equipment to us.
5. Lack of job distribution, i.e., job definition is unclear ("This is not my job").
6. Frequent change over of duty assignments from one specialty to the other. It takes me some time to get acquainted with the new type of job.
7. Poor quality instrumentation - non-efficient working, frequent breakdown.
8. Lack of cooperation from floor staff.
9. Overloading (lack of proper preparation time between two cases).
10. Soiling of feet and floor from the waste material falling from O.T. table.
11. Exposed to irradiation.
12. Ergonomic problems in O.T. ('One has to assist from a distance with poor visibility whereas surgeon expects that we should do the things in right fashion").
13. It takes me time to provide what the surgeon has asked for. But he gets impatient. I have been posted only two days ago in this specialty; let me identify the instrument you've asked for.
14. Lack of consumables.

C. Problems faced by attendants/visitors:

1. Lack of information exchange at O.T. entry.
2. Nauseating smell, mysterious and frightening environment.
3. While waiting during the operation we develop a vicious cycle of negative thoughts.
4. Lack of identification of surgeon, surgical team or supporting staff ("Who shall I ask about the health of my patient, all people here look the same").
5. Lack of identification by O.T. staff ("They don't care about me").
6. Uncomfortable waiting place.
7. What is being done on my patient inside the O.T. causes misery to me ("I want to accompany my patient").
8. Monotonous atmosphere.

D. Problems faced by patients:

1. Lack of communication, while waiting for operation. I develop a vicious cycle of negative thoughts. "I am fine, why have these people brought me here? What they will do to me? Will I survive this? Will I catch some infection? O my God, have mercy on me, please cure me."
2. Transportation on cold stretcher and then in operation theatre on cold O. T. table when patients are washed and are in thin O.T apparel.
3. Flimsy arm support, which is at a low level from the table, causes pain in arms.
4. Pressure sores in long operations. The patient

Table 2: Problems Faced by Customers (Grouped and with Headers)

What are shortcomings that are overlooked in Operation Theatres?		
Design/planning issues	**Problems in & around O.T. Table and seating**	
1. Clustered consumables in operation theatres	9. Seating arrangements for surgery (stoolsA) are either uncomfortable or unstable	12. Width of table is not alterable, if two surgeons are operating from opposite ends of table on a thin patient one of them will pull the patient to his end, this results in other surgeon leaving over, aggravating back pain problem.
2. Improper height of scrub station	10. Dangling O.T. lights, due to loose ceiling mounts with poor focus and illumination	13. Cumbersome mechanical mechanism of table that is of poor ergonomic design
3. Lack of shower system	11. Base of Operation table is very broad, resulting in back problems	14. Pressure sores
4. Scrub solution dispensers are cumbersome	15. Bulky lights causing mobility problems	
5. Poor quality instrumentation		
6. Lack of consumables		
7. Exposed to irradiation		
8. No technical person is available for routine maintenance of the equipments		
16. Ergonomic problems in O.T., One has to assist from a distance with poor visibility & awkward position where as surgeon expects perfect assistance	17. Non-adjustable length of portions of table	
	18. Cold stretcher and O.T. table when patients are washed and are in thin O.T. apparel	
19. Flimsy arm support, which is at low level from table, causes pain in arms	20. Soiling of floor	21. Soiling of feet

	Personal or individual problems	
22. Lack of desired support from supporting staff	23. Incompatibility between tall surgeons and short assistants and vice versa	24. Identification problems
25. Lack of job distribution, i.e., job definition is unclear	26. Overloading	27. Monotonous atmosphere

Communication related problems	
29. Patients don't understand what surgeon says	28. Irrational behaviour of surgeon
30. Lack of communication from surgeon about his requirements for a case	

has a fair risk of developing pressure sores over dependent pressure parts. Problem is aggravated because part is motionless for hours on O.T. table.

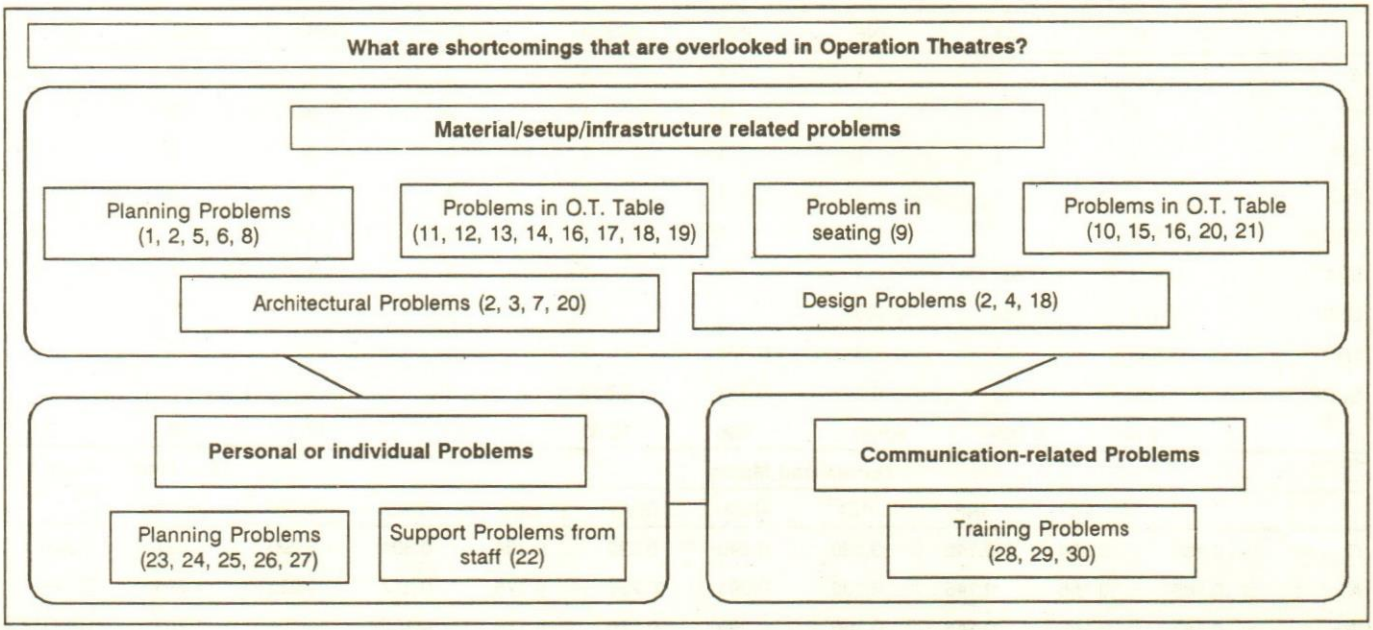
5. Lack of identification of surgeon/surgical team, so that I can address my needs.
6. Lack of privacy ("Am I an experimental object?").
7. Monotonous atmosphere.

All these responses were then grouped together using the KJ™ (Ulrich, 2002) method into an affinity diagram, which help structure the requirements from a customer's point of view. All the responses, from all the teams were combined and rearranged under headers with similar problems so as to achieve the technical solution of the above mentioned problems (table 2).

Stacking the facts underneath headers and arranging the headers/stacks into groups in order to reflect similarities among the headers. A concluding statement capturing the essential message of fact, header and group, is then written which provide clear direction for further problem solving efforts (table 3).

Are all problems equally important to the team? It is thus beneficial to prioritize problems so that the most attention or resources can be allocated to the most critical ones. But most critical is based on what criteria, the team's opinion, the customer's need or other needs? Depending on the stage of QFD, different prioritization methods may be used. If the problems already have a higher set of priorities, for example, customer needs, functions, or processes, a matrix can be created with these in the rows and the tasks in columns, and by examining the strength of relationships between rows

Table 3: Problems faced by Customers (Reflecting Similarities)



and columns, distribute the relative priorities across the tasks in the columns. The next step is to gather data from the customers about the priority of the service functions. To do this a number of votes along with customer priorities from brainstorming were used for prioritizing of service functions on a scale of 1–9 (table 4). Since the problems in operation theatre are real life situations, a more precise prioritization was required. Thus, Analytical Hierarchy Process (Saaty, 1990) is used here for pair-wise comparisons (table 5), which makes it clear that priorities given by customers are the same as analyzed by the Analytical Hierarchy Process.

Step 2: Hospital visits along with engineering and management knowledge gave ample data on the technical descriptors, which if used can fulfill the needs of surgeons, surgical team, attendants and patients regarding the service in operation theatres.

Step 3: Relationship matrix is used to represent graphically the degree of influence between each technical descriptor and each customer requirement. This data has been organized into a QFD matrix (table 6). At the top of the matrix ergonomical design, concurrent design, documentation, design for x, training, maintenance management, redesign, waste disposal, facility planning, group technology, acceptance sampling, inventory control, assignment, motivation, reliability, are either solution techniques or design considerations that will maximize the performance of operation theatre staff and satisfy patients. The symbol (●) with a strength of 9 indicates a strong relationship between the problem and solution. Similarly symbol (o) with strength of 6 and symbol (Δ) with strength of 3 represents moderate and weak relationships, respectively. These strengths are used to determine trade-off situations for conflicting characteristics and determine a relative/absolute weight at the bottom of the matrix. On the right side of the matrix "problems in table" has received a customer priority of 22.6 indicating it as a major problem area. Again "problem of desired support from staff" has received a priority of 4.1, which shows it is least important of all the problem areas. But this does not mean that the problem does not need to be resolved, what it means is, if problems with more priority will be solved prior to this problem it will either get solved automatically or diminish. Raw importance weight is calculated by product of priorities from Analytical Hierarchy Process and strength of relationship, between customer problem (WHATs) and technical descriptor (HOWs), and summing up all the products for

Table 4: Priorities of Problems faced by Customers.

Problems in Service function	Customer weighting	Abbreviation
Problems in O.T. table	9	IT
Problems around O.T. table	8	AT
Planning problems (infrastructure)	7	INF
Planning problems (individual)	6	IND
Architectural problem	5	ARCH
Problems in seating	4	SEAT
Design problems	3	DES
Training problems	2	TRG
Support problems from staff	1	SUPP

Table 5: Results of Analytical Hierarchy Process

	IT	AT	INF	IND	ARCH	SEAT	DES	TRG	SUPP
IT	1	1	1	1	3	3	5	7	9
AT	1	1	1	1	1	3	3	5	7
INF	1	1	1	1	1	1	3	3	5
IND	1	1	1	1	1	1	1	3	3
ARCH	0.333	1	1	1	1	1	1	1	3
SEAT	0.333	0.333	1	1	1	1	1	1	1
DES	0.2	0.333	0.333	1	1	1	1	1	1
TRG	0.333	0.2	0.333	0.333	1	1	1	1	1
SUPP	0.2	0.142	0.2	0.333	0.333	1	1	1	1
	5.4	6.009	6.866	7.666	10.33	13	17	23	31

Normalized Matrix										Row Total	Priority Weight
	IT	AT	INF	IND	ARCH	SEAT	DES	TRG	SUPP		
IT	0.185	0.166	0.145	0.130	0.290	0.230	0.294	0.304	0.290	2.037	0.226
AT	0.185	0.166	0.145	0.130	0.096	0.230	0.176	0.217	0.225	1.574	0.174
INF	0.185	0.166	0.145	0.130	0.096	0.076	0.176	0.130	0.161	1.269	0.141
IND	0.185	0.166	0.145	0.130	0.096	0.076	0.058	0.130	0.096	1.087	0.120
ARCH	0.061	0.166	0.145	0.130	0.096	0.076	0.058	0.043	0.096	0.876	0.097
SEAT	0.061	0.055	0.145	0.130	0.096	0.076	0.058	0.043	0.032	0.701	0.077
DES	0.037	0.055	0.048	0.130	0.096	0.076	0.058	0.043	0.032	0.579	0.064
TRG	0.061	0.033	0.048	0.043	0.096	0.076	0.058	0.043	0.032	0.495	0.055
SUPP	0.037	0.023	0.029	0.043	0.032	0.076	0.058	0.043	0.032	0.377	0.041
Consistency Index			0.095								
Consistency Ratio			0.065							Consistency ratio < 0.1 Therefore result is consistent	

a technical descriptor, which helps in evaluating the possible ways of solving the problem by means of relative weights.

Step 4: The triangular table on the top of the matrix representing the correlation matrix describes the direction of correlation. Although Taguchi methods can be implemented to develop an interrelationship matrix, here pure common sense has been used for developing interrelationships. For e.g. an ergonomical design has a strong relationship with a concurrent design, weak relationship with training and moderate with maintenance related problems. Symbols ●, o, Δ have been used here to indicate the type of relationship between pairs of technical descriptors.

QFD Matrix Checks

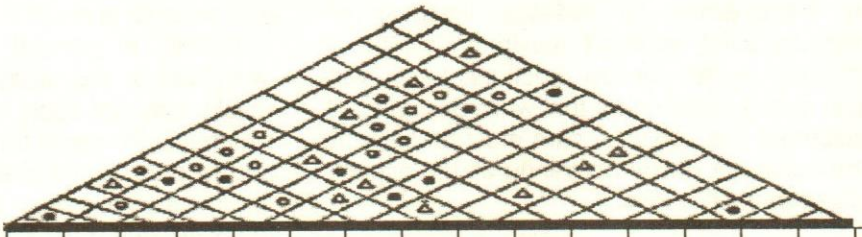
After building a QFD matrix it is necessary that it is checked for accuracy of results. The QFD matrix should not consist of any of the following (Nakui, 1991):

1. Empty rows
2. Empty columns
3. Rows with no strong relationships
4. Rows that repeat identical relationships
5. Cluster of relationships
6. Row with too many relationships
7. Columns with too many relationships.
8. Diagonal line across the matrix with few other relationships.
9. Too many weak relationships.

Result and Discussion

The results from QFD matrix make it clear that major problems in operation theaters are due to lack of insight of engineering and ergonomic know-how in the designing aspect and a human relations background which is generally overlooked in operation theatres. The results are presented as:

Table 6: QFD Matrix



Whats vs. Hows

Strong Relationship:	●	9
Medium Relationship:	○	3
Weak Relationship:	Δ	1

Service Design / Management Requirements

	Prob. No.	Ergonomical Design	Concurrent Design	Training	Redesign	Facility Planning	Maintenance Management	Waste Disposal	Assignment	Documentation	Motivation	Reliability	Design for X	Inventory Control	Acceptance Sampling	Group Technology	Priorities (AHP)
IT	11	●	○	Δ	○												22.6
	12	●	○														
	13	●	○	Δ					○								
	14	●					○										
	16	●	○										Δ				
	17	●															
	18	●	●	○													
	19	●		○													
AT	10		○		○			●	●								17.4
	15	Δ	Δ		●			○									
	16	●	○										Δ				
	20		Δ		Δ	○				●							
	21		Δ		Δ	○				●							
INF	1			●											●		14.1
	2	●	○			Δ											
	5						○									●	
	6						○							●			
	8			○			○	●									
IND	23			●			○				○	●					12.0
	24			●													
	25										●						
	26										●	○					
	27			○		●						●					
ARCH	2	●	●	Δ	●								○				9.7
	3				●	●											
	7		●			○			○				●				
	20		Δ		Δ	○				●							
SEAT	9	●	●			Δ		●	○				○				7.7
DES	2	●	○			Δ											6.4
	4	●	●		○												
	18	●	●	○									○				
TRG	28	●		●		○	○	Δ	○		●			○			5.5
	29			●			○					○					
	30			●		○	●							○			
SUPP	22			●		○					●	●					4.1
Raw Imp. weight		2307	1062	816	515	431	411	401	338	313	305	293	199	160	127	127	
Relative weight %		29.6	13.6	10.4	6.6	5.5	5.3	5.1	4.3	4.0	3.9	3.7	2.5	2.0	1.6	1.6	

- Design improvement or redesign keeping ergonomics in mind received maximum weight of around 30%. As all service functions begin with design in core it is important that while designing all the equipment and services, care must be taken to fulfill the customer desires covering all the aspects of its use and implications.
- A strong need is there to improve the training programme of the staff and also to build new training programmes for staff as well as patients and attendants through which problems related to communication will be rectified.
- Architects while planning the operation theatre should care for the average height of the user group and also for potential hazards in use of facility.
- Documentation of items in inventory, instructions and interactive training, and records of employees, is also of importance.
- Maintenance management, assignment, motivation and others are basically management skills which must be incorporated through human resource development, according to need of system and resources modified to meet the needs.

Conclusions

A QFD "decision machine" that incorporated the voices of surgeons, surgical team and supporting staff, attendants and visitors to patients as well as the patients themselves, was successfully built for the purpose of evaluating the service functions in operation theatres through the QFD-based procedure. The authors would like to present this approach to management, designers, architects,. to effectively plan and utilize operation theatres in hospitals with a view to fulfilling needs and desires of concerned customers, so as to improve the work environment. The results of this study on implementation will definitely improve the performance standards of O.T staff and hence fully satisfy the customers, i.e., patients, which will also in turn result in financial gains and social upliftment, as desired by the hospital management, in addition to facilitation of provision of better care to the human mind and body.

QFD is a very effective and efficient tool for the evaluation of service functions of all the service industries as well as product evaluation of manufacturing industries. In the future, the authors plan to implement the QFD theory to improve each individual service function in detail for quality improvement, such as design of O.T. table considering ergonomics, facility planning, design of training programmes, operations management programmes etc. The results presented above are mainly issued from the data collected, from the experiences of employees and patients in H.I.M.S and reflects the nature of similar problems, in general, of this region. Therefore, researchers in this study want to emphasize that these results may not apply evenly to all other similar looking situations. However, the purpose of presenting the idea and the approach of evaluating service functions in operation theatres has been served. (The authors do not wish to criticize the H.I.M.S. management in any sense, as the facilities provided by them are generally dependent upon the suppliers of service products and medical or other equipments, are independent bodies.)

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Feature

Remanufacturing – Issues & Current Indian Practices

Kampan Mukherjee & Sandeep Mondal

In this paper, the main focus is on the various issues relevant to the remanufacturing system. The system is classified into various areas of managerial activities such as remanufacturing operations, the reverse logistics, inventory control and marketing and sales. These issues need to be analyzed properly so as to eliminate bottlenecks, to understand critical activities and to find out the criteria for performance analysis and effectiveness.

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Product Recovery Management (PRM) is concerned with the recovery of the economic value of used and discarded products and components, leading to a reduction in waste and prevention of damage to the environment (Fleischmann et al., 2000; Dekker et al, 2000a; Thierry et al, 1995a; Guide et al, 2003a). The increasing concern for environmental issues, ban on disposal and the economic benefits of remanufacturing are the prime factors which have motivated industry towards the reuse of used and discarded products (Thierry et al, 1995b).

Various European countries and several states of the US have stringent laws on reuse. In their study report, Doppelt et al.(2001a), mention various take-back programmes in countries like Denmark, Germany, The Netherlands, Norway and Switzerland. The European Union Directive on Waste from Electrical and Electronic Equipment (WEEE) seeks to promote changes in the design of electrical products so that they consist of less toxic materials and can be more easily repaired, upgraded and reused, or at least disassembled and recycled in a safe manner. The directive has established compulsory targets for collection of returns by the year 2006 (Doppelt et al, 2001b). By then, as a result of take-back policies of Germany, Netherlands and France, automakers have agreed to collect and recycle used cars.

According to The Universal Waste Rule (1995) of North America it is mandatory that battery manufacturers collect rechargeable batteries at their own expense for disposal or recycling. The Batteries (Management and Handling) Rules, 2001, of India ensure that manufacturers collect the used batteries against new batteries. Japan has also enacted an Extended Producer Responsibility (EPR) law covering the four main electrical home appliances (television sets, refrigerators, air-conditioners and washing machines) (Spicer et al, 2004). The German Recycling and Waste Control Act requires that manufacturers should adopt techniques to avoid waste and reuse non-avoidable

wastes. Massachusetts prohibits land filling or incineration of cathode ray tubes (Guide et al., 2001). These laws made it mandatory for companies to adopt product recovery activities in order to continue their business in those countries. Many corporates have taken up voluntary take-back programmes, for example FujiFilm purchases its cameras back, Kodak has developed design-for-the-environment cameras and reuses 86% (by weight) of all the cameras.

Other than legislative compulsions, industries are motivated to take up product recovery activities as they see this to be economically more attractive than to dispose off used products, particularly in countries like US and EU (Mukherjee, 2002). It is estimated that product recovery activities can save 40 to 60% of the cost of manufacturing a completely new product, while requiring only 20% of the energy (Guide et al., 1997a). A remanufactured item is often cheaper than a new one as the processing and manufacturing expenditures (time, energy, cost, etc.) are avoided (Dekker et al., 2000b). Thus a remanufactured item with low prices can become popular, particularly in lesser-developed markets. For example, the cost of a bus reduces from $220,000 for a new one to $70,000 for a remanufactured one (Amezquita et al., 1995). Significant price differences like this can create a huge demand for the recovered or remanufactured products. Xerox estimates cost savings of $76 million in 1999 from its product recovery programme (Guide et al, 2003b). In US there are over 70,000 remanufacturing firms with total sales of $53 billion (Lund, 1998a). These firms directly employ 350,000 workers and their average profit margins exceed 20% (Nasr et al., 1998).

A "green" corporate image attracts environmentally conscious customers, contributing to sales growth. IBM Europe, Digital Europe and Xerox have found an improved customer image by PRM, resulting ultimately to better economic benefits (Guide et al., 2000b).

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Product Recovery Management broadly includes the management of recovery activities and reverse logistics. The former refers to various operations, which are directly applied on returned products so as to convert them into useable ones. On the other hand, the reverse logistics is the area that primarily focuses on inbound supply and distribution of used products and inventory management (Fleischmann et.al., 1997a). Thierry et.al., (1995c) have identified five types of product recovery options, namely repair, refurbishing, remanufacturing, cannibalization and recycling. Repair is basically done on the defective part of a used product to bring back to working condition. In refurbishing, the used products are disassembled to the level of modules and critical modules are inspected, fixed or replaced. In remanufacturing on the other hand, the used products are completely disassembled, the parts thoroughly inspected, repaired or replaced as required and then reassembled. In both refurbishing and remanufacturing technological upgradation of some parts or modules can be done. Cannibalization is done for the recovery of certain parts, for example, the retrieval of IC chips from used computers. Recycling is done for the recovery of materials and in this case, the product or parts lose their identity. This paper primarily focuses on the process of remanufacturing.

Issues Relating To Remanufacturing Activities

Remanufacturing begins with the reclamation of used products. Various operations then take place by which a remanufactured product is built using the recoverables with the same or similar performance characteristics and quality standards as the new units. Presently, a wide range of products are being remanufactured world-wide such as automotive parts, locomotives, aircrafts, engines, machine tools, electronic equipment, photocopiers, cellular phones, computers, etc. However, Lund (1998b) has presented seven criteria for a product to be remanufacturable. They are listed as:-

- that the product is a durable good
- it fails functionally
- the product is standardized and the parts are interchangeable
- the remaining value-added is high
- the cost to obtain the failed products is low compared to the remaining value-added
- the product technology is stable and
- the consumer is aware that remanufactured products are available

Giuntini et al. (2003) have classified remanufactured products into two classes: Capital goods and consumer durable goods. Capital goods can be anything from a complex military weapon systems to manufacturing,

mining and agricultural equipment to vending machines. Consumer durables can be automotive parts, computers, toner cartridges, cameras, refrigerators, etc.

A remanufacturing process does not operate under the same conditions as the traditional manufacturing process. There are a number of characteristics in the remanufacturing process which complicate the production planning and control activities. Guide (2000b) has identified seven unique characteristics relevant to remanufacturing, which make the process more complex compared to the manufacturing process.

- the uncertain timing and quality of returns,
- the need to balance returns with demands,
- the disassembly of returned products,
- the uncertainty in materials recovered from returned items,
- the requirement for a reverse logistics networks,
- the complication of material matching restrictions and
- the problems of stochastic routings of materials for remanufacturing operations and highly variable processing times.

These seven unique features distinguish management of remanufacturing as a distinct area of sectoral management. For a better understanding, the remanufacturing process, (see Fig. 1) may be broadly classified into the following areas of managerial activities:-

- The remanufacturing operation
- The acquisition of returns, incorporating the reverse logistics
- Inventory control
- Marketing and sales of remanufactured products

Remanufacturing Operations

The remanufacturing operations basically include all operational activities, which physically transform a return into a remanufactured unit. The operation mainly comprises of the following sequence of activities: (i) disassembly (ii) cleaning, (iii) sorting (iv) inspection (v) repair/ replacement and (vi) reassembly.

Disassembly

The disassembly process is a systematic method for separating a product into its constituent parts, components and subassemblies (Gungor et al., 1999). Even though it may sound reasonable that disassembly is a reverse of the assembly process, for complex products the operational characteristics of disassembly and assembly are quite different. The assembly planning knowledge may not be used 'as is' for disassembly planning issues. Hence it is required to know the operational implications as well as managerial and economical aspects of disassembly, so as to develop an effective disassembly schedule. This would not only avoid building up an excessive inventory of returns or parts/components, but also eliminate shortages of parts/components.

Such a schedule basically consists of an optimal sequence of the disassembly process, which shows the depth to which disassembly is to be carried out and the number of returns to be disassembled. One critical parameter which makes disassembly planning much more difficult is the stochastic behaviour of recovery rate. The recovery rate of the product is the proportion of content (parts/components) remaining healthy or in good condition or the proportion of parts/components that can be reused without repair/replacement/ modification. That is, the recovery rate is the proportion of the value of a used product, as compared to a new unit. This stochastic nature of recovery rate leads to a stochastic disassembly schedule. The quantity of parts/components recovered is only known after the disassembly operation is over, which makes the study of the recovery rate distribution essential.

The recovery rate is the proportion of the value of a used product, as compared to a new unit.

Guide and Srivastava (1997b) have commented on two different possibilities for the recovery of parts. Firstly, a homogeneous recovery rate, where units are subjected to same working environment and all the units have a fairly constant expected life and secondly, a heterogeneous material recovery, where units are subjected to radically different conditions, e.g., age, location of use and type of product. Beta-distributions may be used to model heterogeneous recovery rate, as it is a proper choice for modeling a distribution of random proportion. Uniform distribution, which is a special case of beta-distribution, can be used for homogeneous recovery rate. Thus the disassembly schedule incorporates the expected recovery rate, in place of exact rate of recovery.

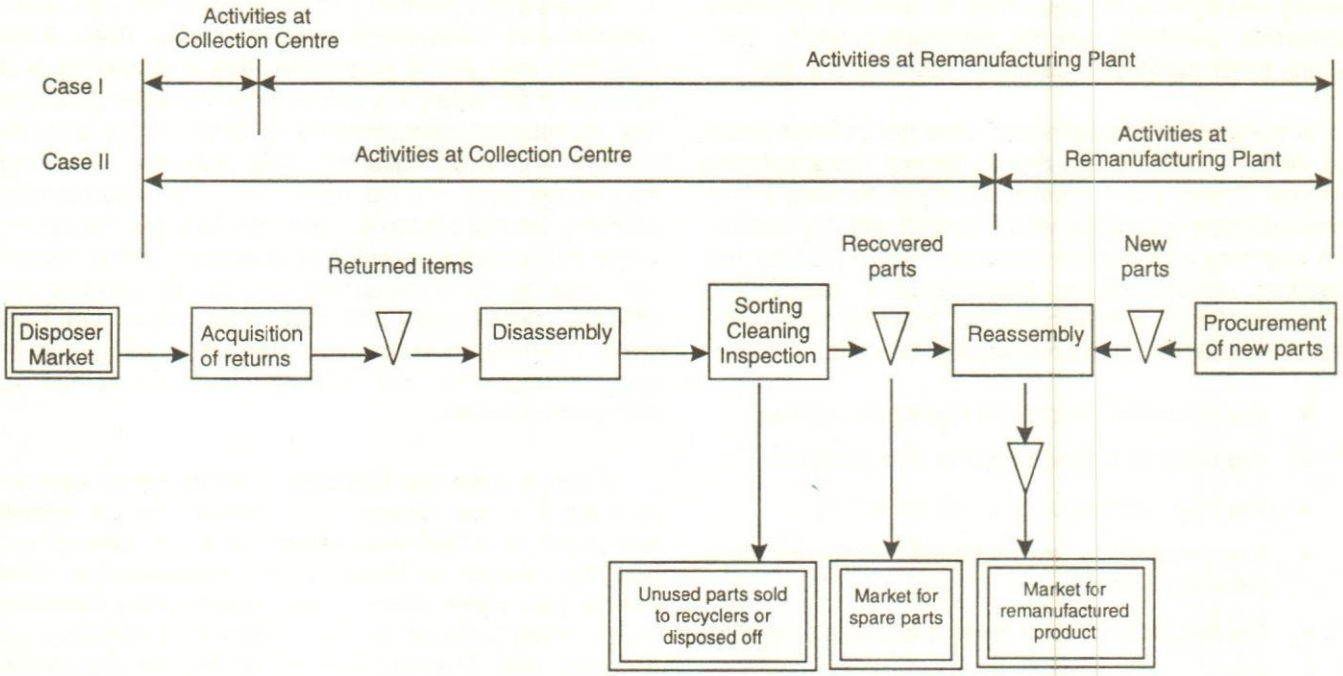

Fig. 1. The remanufacturing system

Disassembly planning is more or less centered on the following issues:-

- PUSH or PULL strategy: According to the PUSH strategy returns are disassembled as and when they arrive in the remanufacturing centre, and according to the PULL strategy disassembly is carried out based on the demand of remanufactured product.
- Disassembly technology: A good design for assembly is not necessarily a good design for disassembly. Thus remanufacturability is one of the key factors in product design of the original product, if the product is to be remanufactured in future. Reverse engineering is another area, which can be practiced to generate disassembly sequences.
- Homogeneity of the product range
- Disassembly of specific components rather than of all parts/components.
- Complexity in product design
- Tools required (any special tools, jigs, fixture etc.)
- It is required to have a detailed knowledge of the product, parts and modules and their joining process which may either be a permanent joining process such as welding, brazing, soldering, adhesive bonding or riveting or by semi-permanent joining process such as screws, bolts, nuts.
- Size of the product

Cleaning

A product is generally used in different working environments, which results in variable deposition of dirt, oil, debris, corrosion or rust. This makes the cleaning time a variable parameter. Moreover, factors like shape and size of parts, orifices, the material of the products and fragility of parts/components also affect the cleaning process. Proper selection of cleaning agents and special purpose tools and machines may be required in this process.

Sorting

Sorting basically requires identification of similar parts (parts of same family) and clustering them accordingly. Considerable attention is required for matching parts and retaining the serial number of specific parts/components.

Inspection

The inspection procedure of the remanufacturing operations is a critical stage, where, unlike the usual manufacturing process, the parts/components in this case undergo stringent inspection and test. Cent per

cent inspection is always recommended. Defining specifications and tolerances for parts/components are somewhat difficult in these cases. Inspection methods are mainly meant for judging whether a part/component can go for another product life cycle or not. These demand special instruments and test procedures for inspection and some extra expertise and training of inspectors.

Repair/replacement

There may be certain parts/components recovered from the returns, which may require some additional repair to bring it into working condition. The parts which cannot be repaired, should be replaced by procuring new ones from the market. But it may lead to another problem if these parts are not available in the market or if the product's life cycle has ended and it is no longer being manufactured.

Reassembly

The reassembly process in remanufacturing is almost similar to the assembly process of the manufacturing process. However, unlike, the assembly which involves new parts/components, reassembly may be carried out using a combination of used and new parts/components. This may lead to non-conformity of matching parts. Some special tooling may also be required sometimes. Reassembly of serial number specific parts/components requires special attention.

Acquisition of returns

Acquisition of returns for product recovery operations is one of the unique features of this business activity. Returns constitute the basic raw materials in the remanufacturing process. For a manufacturing process raw materials can be easily made available from the market, that is the source of supply of raw materials are easily identifiable. Moreover, the company can purchase any amount depending upon its requirement. In contrast to this, in a remanufacturing process the source of supply of returns are not easily identifiable and also the quantity and the quality level of returns received at the plant are very difficult to predict. These factors in the process of remanufacturing require special attention at the acquisition stage. Since the acquisition process forms the basic step for remanufacturing, improper planning can lead to creating bottlenecks and may result in heavy economic losses.

The acquisition or collection of returns from the market requires a well-planned reverse logistics network, an area that primarily focuses on inbound supply and distribution of used product (returns) (Fleischmann et al., 1997b). Reverse logistics encompasses the collection activities of the returns from the market and transporting them to the industry. Unlike the forward distribution networks, where the flow of goods is from the industry to the market, 'reverse' signifies the flow of goods from the market to the industry. Reverse logistics not only accounts for the movement of used products but also of certain activities like cleaning, testing, sorting and processing. A well-established reverse logistics network may carry out certain activities at the collection centre, which eliminates the transportation of useless parts/components. However, this may additionally require establishing testing facilities at every collection centre. On the other hand, if these activities are done at one centralized location, the total cost of testing would be less, but the transportation cost increases (Fleischmann et al., 1997c).

The acquisition or collection of returns from the market requires a well-planned reverse logistics network

Designing an effective reverse logistics network is not an easy task. As per literature, most of the networks designed are for the forward flow of goods but there are hardly any networks designed for reverse flow, or any such which is capable of combining both forward and reverse flow of goods. It is possible that reverse distribution can take place through original forward channels, through a separate reverse channel or through a combination of forward and reverse channel. However, according to the remanufacturing literature sources, depending upon the role of original equipment manufacturers (OEM) in this business activity, the reverse logistics network may be classified into three type as:-

- The OEM is managing all the activities relevant to remanufacturing process. Some OEMs like Xerox Corporation are directly involved in remanufacturing their own products (Amezquita et al., 1995b).
- The OEM is managing the basic remanufacturing operations, while acquisition of the used products, reverse logistics and/or some activities related to remanufacturing, like disassembly, cleaning and sorting are done by third party logistics providers (TPLPs). This makes the OEM outsource some of the recovery activities to outside agencies, although the OEM

controls the activities of remanufacturing. Many TPLPs like NetReturn, FedEx, ASTRA and GENCO are aiding reverse logistics process for remanufacturing (Krumwiede et al., 2002).

- OEM does not play any role in remanufacturing. Remanufacturing activities are done by Third Party Remanufacturers (TPRs), as OEMs do not consider it as a core business. Hence, there is the possibility of market competition among the manufactured products by OEM and remanufactured products by TPRs. Such type of remanufacturing is common for automotive parts (Amezquita et al., 1995c).

The analysis of reverse logistics network mainly involves the determination of optimal return and redistribution flows, locations and capacity of facilities, 'depth' and 'width' of distribution network and linking of forward and reverse flows as the key decision areas.

Some other issues that should be incorporated while transportation of returns to the remanufacturing facilities are as follows:-

- the size and condition of the product decides packing, storing and handling of the returns or recoverable. This process somewhat differs from usual regular products.
- whether transportation is done for the whole unit or only for the recoverables.
- whether arrival of returns to remanufacturing sites are in batches or in units.

One of the core activities of reverse logistics is proper planning of acquisition of returns. Acquisition planning is followed by other activities in reverse logistics. So the development of an efficient and effective acquisition plan naturally draws the interest of the management researchers. The complexity of the acquisition planning is primarily due to three factors – uncertainty in timing, quality and quality of returns, difficulty in searching for sources of returns, and lastly the balancing of returns with demands. Acquisition planning includes several decision-making phenomena as given below.

Who is responsible for collecting the returns?

Collection of returns may be either by the OEM himself, or through TPLPs or through take-back centres as mentioned above. This requires an appropriate planning and coordination of the collection points of the reverse logistics network. Cost-benefit analysis should be done before selecting a suitable network. As a simple case of study, an OEM in India remanufactures its own photocopier machines, has adopted a service policy according to which it provides free service and maintenance (excluding consumables) to every new photocopier sold to the customer, till its end-of-life. Thus, relevant information of all the customers is maintained through a strong network of service centres. The OEM manages all the activities of remanufacturing through this service network. This reduces the problem of tracing the returns. The returns are collected from the customers either by buying back or are replaced in exchange offer schemes at some cost, known as buy-back price. Acquisition is only made if the return is found to be suitable for remanufacturing. The returns are then transported to the remanufacturing site where they are disassembled, cleaned, sorted, inspected and repaired (if necessary). Subsequently, they are reassembled to build up a remanufactured product whose quality is 'as-good-as-new'. The parts/components that cannot be recovered from the returned unit are procured from outside. The unused parts/components are sold as scrap to the recyclers and finally, the remanufactured product is sold in the market.

What should the mode of collection be?

The various possible modes are explained below (Thierry et al., 1995d, De Brito et al., 2002).

- *Take-back*: Manufacturers are required to take-back used products either by law or by contract. For example, VW and Opel in Germany guarantee that they will take-back their products at the end of their lives at no charge to the customers.
- *Buy-back*: In buy-back the remanufacturers purchase the used products at a cost.
- *Off-lease/Off-rent*: Lease and rental contracts specify that manufacturers take back products upon contract expiry. In most cases, manufacturers are able to predict the quantities and timing of these return flows quite accurately.
- *Auction*: Many organizations sell off their scrap and used products through auctions.
- *Seed-stock*: Defective products at OEM's manufacturing plant are purchased by the remanufacturers.
- *Exchange offers*: Used products are also collected in exchange offers where old ones are replaced by the new model at a lower cost.
- *Warranty returns*: Due to technical failures

within the warranty period used products may be returned.

When to take back the returns?

The recovery rate decreases with the increase in the age of a product. The cost of remanufacturing increases if the recovery rate decreases or the product ages. Moreover, a higher price is to be paid for the units which are bought back earlier, so, the buy-back price decreases with the age of the product. The net benefit of the remanufacturing process is mainly controlled by these costs, which are in turn influenced by the age of the product. Thus, if the acquisition is made early, then perhaps, the purchase price of the used product may be very high, whereas, the remanufacturing cost will be low due to higher expected recovery. If acquisition is made too late, the remanufacturing cost may be high, but the used product will be purchased at a lower price. Hence, the optimal period of buy-back has to be found such that the net benefit is maximum.

The optimal period of buy-back has to be found such that the net benefit is maximum.

How much returns to be collected?

The amount of returns to be collected depends on the demand forecasted of the remanufactured products. This is where there is a need to balance returns with demand.

What should the buy-back price be?

Fixation of buy-back price for returns controls the profit margins from the remanufacturing process, and so should be decided accordingly. The buy-back price can be decided on the value of the product at a given age. According to Voutsinas et al. (2002), the value of products of high technology products such as personal computers (PCs), cars, etc. are characterized by rapid value decrease over time; hence exponential relations of the value-with-age can be used. Ferrer (1997) studies the value of PC components with time. The buy-back prices can also be fixed depending on the quality level of the return. In a case example mentioned in Guide et al. (2000c), ReCellular Inc., a TPR of mobile phones decides the buy-back price depending on nominal quality level. Each quality level is defined based on the condition of the return and for each level, the price offered varies accordingly.

However the buy-back price of the returns is decided on the following three factors:-

- *Reliability of the product*: Reliability of the product explains the failure pattern of the product with age and consequently explains the expected condition of the product at a given age. Buy-back price depends on this condition or use value of the product. Of course poor reliability lowers the buy-back price.
- *Market factor*: The pattern of a fall in buy-back price over time is also influenced by factors like technological obsolescence, market effect on product life cycle, availability of upgraded models and substitutes for the product in the market. Computer-related products undergo rapid changes in technology, resulting in fast obsolescence. It has been observed that the price of second-hand products or the buy-back price reduces drastically as new models with relatively cheaper and more efficient technology enter into the market. For cars and other products which often symbolize social status (as is quite evident in developing countries like India) the buy-back price reduces drastically within a few months of sales due to the label "second-hand".
- *Seller's mindset*: Factors like customer's willingness to sell his product, his readiness in opting for a change in model, emotional attachment to the product, etc. also influence the buy-back price of the product.

Inventory planning and control

The challenges that management scientists usually face while analyzing the inventory system of a product recovery situation are confined to integrating the uncertain return flow of used products into the producer's material planning which is further affected by the imbalance between returns and demand and also by the unknown product recovery rates. Thus, appropriate inventory control mechanisms are required to balance the demand of remanufactured products and the supply of returns. Any inventory analysis in a product recovery situation is more-or-less confined to the following issues:-

- The returns as received may be stored in units or they may be disassembled, cleaned and tested and the usable parts/components sorted out and kept in inventory. Thus there may be

inventory of return units and/or inventory of usable parts/components depending on the disassembly policy (PUSH or PULL policy). In PUSH policy, it will result in inventory of usable parts and in PULL policy, inventory of returns will be created.

- It is very often in remanufacturing that all the parts are not recovered from the returns, and are then procured from the outside market as new ones. Such parts are only known after the disassembly and testing operations are over. This leads to uncertainty in the procurement of these parts.
- There are some parts/components in a product like fasteners, adhesives, plastic parts, gears, etc. which cannot be reusable. Such parts/components will be required for any reassembled unit. These items form the mandatory category of items and are procured according to the existing inventory theory.
- Control of inventory of remanufactured product is almost similar to the normal manufactured products.
- Shortages are common, so the level of safety stock is judged accordingly.
- Special storage and handling equipment are required for the storage of recovered parts/components.
- Identification of commonality and the family of parts is required for an effective storage system. This is particularly important for proper reassembly.
- Due attention is required for serial number specific parts or matching parts.
- MRP based system can be used in this type of system, but may be in some modified form.
- The recovered parts can be used in a variety of application, such as, they may be used to build up a remanufactured product or they may be used as spare parts and sold to the secondary market, or a certain proportion may be used as spare parts and the rest used for the remanufactured product. This makes the control process more difficult.

Owing to these complexities and the substantial cost involved in this process, some of the remanufacturing operations are outsourced to TPLPs. Remanufacturers can easily purchase used parts/components from these sources and hence normal inventory control techniques may be applied in this situation.

Marketing and Sales of Remanufactured Products

The marketing and sales strategy depends on the type of product for sales, that is, whether the sales is for spare parts or for the remanufactured product. It is further dependent on whether the parts recovered are used by the company itself, or by other companies or suppliers in the business chain, or by companies outside the business chain (Thierry et al., 1995e). Market segmentation should clearly identify the potential customers. Since remanufactured products are cheaper than the new ones, lesser-developed market should be a good target. For example, remanufactured photocopiers are very common in small shops and business units, while transport and travel companies may be the target customers of remanufactured vehicles. One important element that is commonly used by many of the corporate business houses like Xerox, IBM Europe, etc. is the 'green image', which attracts the environmentally conscious customers.

The Indian Perspective on Remanufacturing

In India, unfortunately, remanufacturing is still not well accepted in the business sector and market. Although, environmental has concerns have become a serious issue in strategic plans for an Indian manufacturer, no organized effort has yet been seen in the recovery of used products or remanufacturing. Yet India, being a developing country, bears enough potential as a market for remanufactured products, which are cheaper than new ones and 'as-good-as-new'. Nevertheless, there are Indian companies which are engaged in remanufacturing activities. Xerox Modicorp Limited has been remanufacturing its own photocopier machines for quite a few years under the project name 'Asset Recovery Management'. United Van Der Horst Limited is engaged in the remanufacturing of marine, oilfield and industrial products. Many companies like Soft-AID Computers Private Limited, Mumbai, VV Printiand Services, Kores Printer Technology Limited and Transdot Electronic Private Limited, Trivandrum undertake repair and refurbishing of printerheads. Timkin India Limited has developed an in-house facility at Jamshedpur for refurbishing large industrial and rail bearings. In an article in *The Tribune* dated April 8, 2002, Chandigarh, Shveta Pathak has talked about the used car business where she mentions that Maruti Udyog Limited and Berkeley Auto Mall planning to buy old cars and sell them after remanufacturing. Another article in the *Times of India* dated December 31, 2002, is about the remanufacturing of computers. Rajesh Jain, founder of Netcore Solutions, India has suggested large-scale remanufacturing of computers discarded by developed countries.

Table 1: Various issues concerning remanufacturing operations

Disassembly	Cleaning	Sorting	Inspection	Repair/ Replacement	Reassembly	Disposal
Uncertain recovery rates	Excess Dirt/Oil/Debris	Identification of similar components	Inspector's knowledge	Difficulty in availability of new parts / components	Skill of employee	Environmental law for disposal
Homogeneity of product range	Corrosion/Rust	Expertise needed to recognize similar groups	Defining specifications		Complexity in design	
Disassembly sequence	Size and shape of parts/orifices		Identifying defects		Product diversity	
Depth of disassembly	Fragility of parts		Special instrument required for inspection		Fastening problem	
Lot-sizing	The type of material				Special tooling	
Permanent fastening			Product diversity		Lighter duty materials	
Corrosion/Rust			Tolerances for wear		Serial No. of specific parts/components	
Dirt/Oil					Uncertainty of demand of remanufactured products	
Complexity in product design					Feasibility of reassembly	
Special tools required						
Worn out fastener heads						
Size of products						
Availability of disassembly technology						
PUSH/PULL Strategy						
Source of disassembly technology						

Table 2: Issues relating to other remanufacturing activities

Modes to collect returns	Determination of the value of the return	Responsibility of the agents in logistics chain	Reverse distribution	Inventory control	Marketing of the remanufactured product
Exchange offer	Age of the product	Gathering of returns	Size and condition of the returns	Shortages of inventory	Recovered parts used to remanufacture a new product or used as spare parts
Buy-back	Usage of the product	Sorting of returns	Planning for material flow	Balancing demands with returns	Need for segmentation of the market
Off-lease	Any quality checking	Transportation of returns	Special methods to transport, handle or store returns	Special handling methods required	Green image used as marketing element
Take-back		Cleaning of returns			Cheaper price of remanufactured product
Auction centers		Disassembly of returns	High cost is associated with logistics,	MRP based	
Seed-stock					Secondhand market is thriving
Warranty returns					Customer's mindset that refurbished goods are inferior

In India, unfortunately, remanufacturing is still not well accepted in the business sector and market.

It is obvious that the issues discussed in the previous section are to be analyzed keeping in view the scenario of Indian industry setup. The bottlenecks in the remanufacturing process are to be clearly highlighted, the critical activities need to be made known and the criteria for performance analysis and effectiveness need to be identified. The outcome of this preliminary study has led to identification of the relevant issues and factors as given in tables 1 and 2.

Conclusion

In this paper an attempt has been made to explore the relevant issues in the area of remanufacturing. Apart from the specific issues discussed earlier, there exist some others issues which are more general in nature, but which demand attention for proper management of product recovery:

- Factors relating to remanufacturability or reusability of parts/components are to be incorporated while designing a new product (Johnson et al., 1995). Various technical factors, such as ease for disassembly, study of length of life cycles of all the modules/components/parts, etc. should be given due care during product design for making its future remanufacturing process effective and efficient.
- Proper remanufacturing technology should be made available. It may be obtained from the OEM or by reverse engineering (Voigt, 2001).
- Cost-benefit study should be conducted at the very outset so as to know whether remanufacturing is a viable proposition.
- Existence for market for remanufactured products should be assured before initiating this business endeavour.
- Product life cycle should be studied before remanufacturing a product. This will help in estimating the facts like when a used product should be collected or whether new parts and components are available for this model in the market or not.
- It is advisable to carry out a comparative study on the pricing and quality of a product as a new one, a remanufactured one and a second-hand one to explore sufficient information, particularly for pricing decision.

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Every country that has caught up has done it by copying.

– Lester C. Thurow

Feature

Self-Help Groups in Agency Areas of Andhra Pradesh

V.M. Rao

This paper tries to understand the working of self help groups in the tribal areas of Andhra Pradesh. The main focus of the paper was on the involvement of women in the activities of Girijan Cooperative Corporation. It was found during pre-testing that these members have also been associated with Self-help groups (SHGs). Issues relating to groups were then included in the questionnaire.

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Self-help groups (SHGs) comprise of 10 to 20 people, from poor financial backgrounds, who come together to address common problems. These like-minded individuals, representing a homogenous class, volunteer to save small amounts of money in a common pool. Need-based loans are provided to members from the pool for meeting emergent credit requirements, based on priorities decided by the group. The process helps imbibe essentials of financial intermediation including prioritization of needs, setting terms and conditions, and account keeping. Thus, SHGs can be referred to as a group of persons who own, manage, and control a micro bank of their own. As a result, members learn to handle resources of a size that is much beyond their individual capacity.

Banks are encouraged to provide loans in certain multiples of accumulated savings of SHGs without any collateral at market interest rates. Groups decide terms of loans to their members. Since group's own accumulated savings are part and parcel of aggregate loans made by groups to their members, peer pressure ensures timely repayments.

Essential features of a SHG are aptly provided in DWCD, 1999. They are:- a) group members come together voluntarily, b) basis of coming together is mutual help, c) homogenous group, d) regular interaction among group members, e) group independently takes decisions and manages its activities, f) basis of people's coming together is affinity, (g) all group members participate in the process, h) cooperation (not competition), and discussion (dialogue) are the cornerstone of its functioning, and i) group maintains its own accounts. SHGs have both qualitative and quantitative benefits (table 1). A succinct review of characteristics of various micro-finance delivery models are provided by Sinha (2003) (table 2), and a growth of these operations during 1993-02 is displayed in table 3. Cumulatively 4.61 lakh SHGs were organized, and a bank loan of Rs. 545.46 crores were provided to these groups.

Table 1: Overall benefits due to SHGs

Project component	Output and benefits
Capacity building of self-reliant women's groups	• Mutual support enabling women to manage their own affairs • Increased self-reliance and self confidence to address constraints faced by women • Framework for cost effective delivery of financial and technical services • Increased ability of women to mobilise public and private sector services for their benefit and • Improvement in social status of women in the family and community
Strengthen participating agencies to support women's development	• Improved orientation and attitude of support agencies, enabling them to be aware of women's priorities, and more proactive and effective in addressing women's specific needs, and • Improvement in levels of services received by women from banks and line departments
Mobilization of investment funds	• Inculcation of savings habit and development of credit management skills • Building a pool of creditworthy clients • Increased long-term access of women to credit through integration into mainstream delivery mechanisms for credit, and • Reduction in risks and transaction costs of banks as a result of high repayment rates of women's groups leading to greater willingness on the part of banks to lend to poor women
Provision of business management and technical support services to SHG members	• Increased income in the hands of women used for welfare of family, resulting in improved child health and nutrition and reduced poverty • Improved management and technical skills, and • Establishment of linkages of SHG members with service providers required to sustain and expand economic activities undertaken by women

Source: Swa-Shakti project (undated)

Objectives and methodology

Overall objective of this paper is to understand the working of self-help groups in the tribal areas of Andhra Pradesh. Specific objectives of the study are to document salient features of selected SHGs, and to analyse purpose-wise utilization of loans from SHGs. Out of the ten divisions of GCC, four were selected representing Andhra, Telangana, and Rayalaseema regions of Andhra Pradesh covering six districts. In all, 21 Girijan primary cooperative marketing societies (GPCMSs) were covered with a total sample size of 105 women. Data was collected from November 2003 to January 2004, and simple tabular analysis was followed (for more details on methodology, see Rao, 2004).

Table 2: Characteristics of micro-finance delivery models

Financial service	Characteristic	Description
Credit	Loan amount	Determined by the longevity of the client's association with the MFI. Not often directly related to the credit needs of the borrower
	Loan term	Usually 12 months, occasionally less, sometimes greater
	Repayment installments	Monthly or weekly - usually fixed, equal amounts
	Interest charges	Range of 24-36% usually levied as a flat charge, partly to simplify calculations for both the MFI and client. Some MFIs charge lower rates but suffer from poor sustainability as a result.
	Collateral	No physical collateral but often linked to some compulsory savings component which acts as financial collateral. Reinforced by joint liability with other clients or peer pressure arising from membership of a community/group revolving its own as well as borrowed funds. Some MFIs also create reserve funds to cover the risk of default.
Savings	Amount deposited	Grameen: compulsory - usually a fixed proportion of the repayment installment SHG: Compulsory - fixed amounts (weekly or monthly) per meeting to be deposited as part of the group fund; occasionally also voluntary. Some MFIs now offer long-term fixed deposits.
	Withdrawals	Compulsory savings cannot be withdrawn except when the client leaves the group. Voluntary savings often require some notice of withdrawal.
	Interest paid	Most programmes pay 4-6% interest (not consistent).
Insurance	Life	Some MFIs are starting to offer life insurance covering client loan repayments plus a small payment to the family in case of death of the client.
	Annual premium	Usually linked with a formal insurance company which obtains bulk business from MFI while the latter provides the service of premium collection; assists in the verification of claims.

Source: Sinha (2003).

Distribution of sample respondents

Socio-economic parameters of selected women

Table 3: Growth in micro-finance operations, 1993-02 (Rs. crores)

Year	No. of SHGs	Bank loan
1992-93	255	0.29
1993-94	620	0.65
1994-95	2112	2.44
1995-96	4757	6.06
1996-97	8598	11.84
1997-98	14317	23.76
1998-99	32995	57.07
1999-00	114775	192.87
2000-01	262825	480.87
2001-02	461478	545.46

Source: NABARD (various years)

are provided in table 4. Bhadrachalam region has 40 respondents while Srisailam has 15. The average age of respondents is 30 with a total family size of 5.3 persons. Family size is relatively high in Srisailam while it is lowest in Paderu. Tribals have both irrigated and *podu* lands. Titles are available in the case of irrigated lands, while *podu* lands are hill slopes, and unauthorized. Due to increase in population, *podu* land is declining, and yields are also minimal. Further, it is subject to vagaries of monsoon as also wild animals. Crops are grown without inorganic fertilizers on these *podu* lands.

Table 4: Socio-economic status of respondents

Indicator	Division				Overall (n = 105)
	Bhadrachalam (n = 40)	Chintapalli (n = 20)	Paderu (n = 30)	Srisailam (n = 15)	
Age	35.8	29.3	25.6	37.6	30.1
Size of family					
Adults	2.4	2.2	2.3	2.8	2.4
Sons	1.4	1.5	1.2	2.3	1.6
Daughters	1.3	1.7	0.9	1.1	1.3
Total	5.1	5.4	4.4	6.2	5.3
Land holding					
Irrigated	0.3	0.4	0.5	0.2	0.35
*Podu**	2.2	1.6	2.2	1.2	1.80
Total	2.5	2.0	2.7	1.4	2.15
Working persons	2.0	2.0	1.7	1.9	1.9
Percentage of illiterates	50.0	55.0	90.0	46.7	61.9
Average annual income (Rs.)	11619	9555	11638	10627	10860
Share of income from MFP (%)	35.5	18.0	20.0	26.0	25.2

* Hill slopes and terraces with no official titles

Source: Field visits

On an average, respondents have 2.15 acres of land of which 0.35 (16%) acre is irrigated. The situation is, nevertheless, same across all divisions. No respondent mentioned having land in her name in the entire sample. This is against the background that women put in as much as 730 minutes/day (12 hours and 10 minutes) on multiple activities including agriculture, and according to them they work longer hours compared to their counterparts (Rao, 2004). At the aggregate level, 62% of women respondents are illiterate while as many as 10% can only sign names. Thus, 72% of them had not been to their school during childhood. All the respondents are below the poverty line category, and average income ranged from between Rs. 9555/annum in Chintapalli to Rs. 11638/annum in Paderu. Of the total income, as much as 25% is contributed by minor forest produce. Here again the women's contribution is much greater than men.

Women put in as much as 730 minutes/ day (12 hours and 10 minutes) on multiple activities including agriculture.

Women and SHGs

The concept of SHG is not new in Andhra Pradesh. The awareness amongst women has considerably increased during the Telugu Desam Party period, and its efforts in sensitizing women needs appreciation. The party has been able to bring a revolution in awareness through the *janmabhumi* programme. Further, infrastructure facilities in the form of approach roads, protected drinking water, anganwadi centres, health care centres, free housing loans, ashram schools, food for work programme, etc. helped in improving the socio-

Table 5: Involvement of respondents in SHGs

Division	Yes	No	Total
Bhadrachalam	22 (55.0)	18 (45.0)	40 (100.00)
Chintapalli	13 (65.0)	7 (35.0)	20 (100.0)
Paderu	22 (73.3)	8 (26.7)	30 (100.0)
Srisailam	7 (46.7)	8 (53.3)	15 (100.0)
Overall	64 (61.0)	41 (39.0)	105 (100.0)

Source: Field visits

economic status of these tribals. A number of state departments, non-governmental organizations, and social workers have been promoting self help groups in these areas for the last 10 years. Around 61% of the respondents are involved in groups (table 5). Involvement of respondents in groups is relatively more (73%) in Paderu, and low (47%) in Srisailam.

Among various reasons identified for joining SHGs, vast majority (41%) of them indicated savings as the main purpose followed by self help, opportunity for availing loans, inculcation of discipline, and force by others. Across divisions, 46% from Bhadrachalam indicated savings as the main reason while reasons, are not uniform in other divisions (table 6).

Table 6: Reasons to join SHG

Reason	Division				Overall
	Bhadra-chalam	Chinta-palli	Paderu	Srisailam	
Savings	5 (45.5)	4 (40.00	7 (43.8)	2 (28.6)	18 (40.9)
Self help	3 (27.3)	2 (20.0)	3 (18.8)	1 (14.3)	9 (20.4)
Loans	2 (18.2)	3 (30.0)	2 (12.5)	2 (28.6)	9 (20.4)
Discipline	0 (0.0)	1 (10.0)	1 (6.2)	1 (14.3)	3 (6.8)
Force	1 (9.0)	0 (0.0)	2 (12.5)	1 (14.3)	4 (9.1)
Others	0 (0.0)	0 (0.0)	1 (6.2)	0 (0.0)	1 (2.3)
Total	11 (100.0)	10 (100.0)	16 (100.0)	7 (100.0)	44 (100.0)

Source: Field visits

Salient features of selected SHGs are provided in table 7. Average membership in these groups is 17 with a savings of Rs. 34/month. In terms of age of the group, it varied between 28 to 36 months. Thus, 31 months is the average age. Installments are to be paid on the second day of every month in Bhadrachalam, while it is 7th day in Paderu, and no definite time periods are agreed upon in both Chintapalli and Srisailam.

Forty four out of 64 (69%) respondents participating in SHGs availed of loans ranging between Rs. 1535/member in Srisailam to Rs. 2435/member in Bhadrachalam. Members agreed upon a minimum interest rate of 24%/annum to a maximum of 36%/annum. Repayment periods varied between 6-9 months in Bhadrachalam, 4-9 months in Chintapalli, and 6 months each in Paderu and Srisailam. Thus, the average repayment period is worked out as 6½ months. All the groups have been maintaining individual accounts, register for meetings, resolutions, and have opened accounts either in nationalized banks or regional rural banks. Majority of respondents are happy with the functioning of SHGs which is evident from the opinions provided in table 7.

Table 7: Salient features of selected SHGs

Content	Division				Overall (n = 64)
	Bhadra-chalam (n = 22)	Chinta-palli (n = 13)	Paderu (n = 22)	Sri-sailam (n = 7)	
Average members	18	18	16	17	17
Average savings/ month (rupees)	35	33	33	35	34
Age of SHGs (months)	36	32	30	28	31.5
Total savings/ member (rupees)	1260	1056	990	980	1072
Respondents availing loan	11	10	16	7	11
Average amount of loan (rupees)	2435	2130	1745	1534	1961
Rate of interest (%)	24	30	30	36	30
Repayment period (months)	6-9	4-9	6	6	6.5
Repayment (%)	92	87	90	82	88
Opinion about functioning of SHGs					
a. Not satisfactory	11	6	9	5	31
b. Satisfactory	7	3	6	0	16
c. Good	4	4	7	2	17

Source: Field visits

Purpose-wise utilization of loans

Loans availed from groups are further analyzed by purpose (table 8). These purposes are divided into production, and consumption. Loans for production purpose include cultivation of food crops, vegetable, and commercial crops, purchase of sheep and goats, petty shop, business, and others. These categories consumed as much as 65% of the total loans availed/member. Proportion of loan used for production purpose is relatively more in Paderu while it is less in Chintapalli. Across various production purposes, food crops consumed over a quarter of the total loans availed. Petty

trade is next important purpose for which loans are used.

Food crops consumed over a quarter of the total loans availed.

Table 8: Purpose-wise loans availed by respondents

Particulars		Division				Overall (n = 44)
		Bhadra-chalam (n = 11)	Chinta-palli (n = 10)	Paderu (n = 16)	Sri-sailam (n = 7)	
1. Production						
a.	Food crops	715 (29.4)	474 (22.2)	407 (23.3)	484 (31.5)	520 (26.5)
b.	Vegetable cultivation	333 (13.7)	122 (5.7)	259 (14.8)	0 (0.0)	179 (9.1)
c.	Commercial crops	0 (0.0)	208(9.8)	0(0.0)	0(0.0)	5292.7)
d.	Purchase of sheep and goat	74 (3.0)	120 (5.6)	145 (8.3)	246 (16.0)	146 (7.4)
e.	Petty shop	212 (8.7)	125 (5.9)	275 (15.8)	305 (19.9)	229 (11.7)
f.	Business	134 (5.5)	195 (9.2)	0 (0.0)	0 (0.0)	82 (4.2)
g.	Others	120 (4.9)	0 (0.0)	143 (8.3)	0 (0.0)	66 (3.4)
h.	Sub-total	1588 (65.2)	1244 (58.4)	1229 (70.4)	1035 (67.6)	1274 (65.0)
2. Consumption						
a.	Provisions*	356 (14.6)	506 (23.7)	302 (17.3)	276 (18.0)	360 (18.4)
b.	Social functions	372 (15.3)	225 (10.6)	186 (10.6)	185 (12.2)	242 (12.3)
c.	Arrack	119 (4.9)	155 (7.3)	28 (1.6)	38 (2.5)	85 (4.3)
d.	Sub-total	847 (34.8)	886 (41.6)	516 (29.6)	499 (32.5)	687 (35.0)
	Grand total	2435 (100.0)	2130 (100.0)	1745 (100.0)	1534 (100.0)	1961 (100.0)

* Includes expenditure on medicines

Source: Field visits

On the other hand, consumption purpose constituted 35% of the total loan availed. This category includes purchase of household provisions, social functions and arrack. Diversion of loan amounts for such non-productive purposes results in overdues and chokes the credit channel.

Income-generating activities by SHGs

Sample respondents represent 12 SHGs of which four are maintaining daily requirement depots of GPCMSs, and two are pointed as implementing agencies under the mid-day-meal programme. These group members deposited a security amount of Rs. 25000 with the project officer (ITDA), and got permission to run a DR depot for which a monthly honorarium of Rs. 2000 is paid. As the women members are mostly illiterate, accounts and record-keeping was looked after by a male person who is paid a monthly salary, and the balance is distributed among 2-3 active members who are running the depots. In another case, a group got permission for running a depot while the deposit was paid by a third party paying Rs. 500/- month to the secretary and leader of the group. "Before involvement in SHG things got grimmer with every passing day, with rising mercury, water getting scarcer, and meagre savings vanishing. However, things changed favourably after joining SHG. There is no more wife beating in the area, and women have became pressure groups", beamed Kanthamma from Bhadrachalam division.

Kuchha Ramulamma hails from the Chintapalli division and belongs to the Nuka Dora tribe. The family has only an acre of *podu* land, and thus depended mainly on income from agriculture labour. She joined SHG with meagre savings and availed a loan to purchase a sewing machine. Ramulamma attends 6-7 shandies a month and earns Rs. 800 towards tailoring charges. Ramulamma repaid the loan, and is now planning to send her daughter to Waltair for further studies. So is the case with Kasulamma of Paderu division who belongs to the Konda Reddy tribe. Having studied up to the 5th standard, Kasulamma organized SHG in the village, took a loan and worked as a commission agent in minor forest produce. She purchases MFP by visiting door-to-door in the interior villages, selling the same at GPCMS. Thus, she has been earning Rs. 1100-1200/month, and is happy with the functioning of the SHG. However, such successful cases are not many. In the absence of income-generating activities, illiteracy, and locational disadvantages, most of these women are finding it difficult to find productive avenues.

Summary

Self help groups have become a movement in the country, more so in Andhra Pradesh. A host of governmental organizations and non-governmental organizations are involved in promoting these groups in the plains as also agency areas. A study conducted in four divisions of Girijan Cooperative Corporation revealed that about two-thirds of respondents are participating in the

groups, and savings is the main reason for joining such groups. On an average, these groups have a membership of 17 with a savings of Rs. 34/month. Forty four out of 64 respondents participating in SHGs availed loans to the tune of Rs. 1961/member. In most of the cases date of deposit, interest rates, and repayment schedules are clearly spelt out and have accounts in the nearby banks. About 65% of the loans so availed were used for production purpose, of which food crops accounted for as much as 27%. These groups are involved in managing daily requirement depots, and some of them benefited from loans availed from SHGs.

Lijjat papad has been providing gainful employment to women in low income societies. Material is supplied at the doorstep and women folk roll papads. The product is picked up by the organization for packaging marketing. It is possible to introduce such experiments in these hilly and tribal areas with other altruistic non-governmental organizations? Adult education is another area which needs the attention of these institutions. We need a blue print of what the exact needs of these hard working but innocent women are. The plan should supplement developmental programmes of the government. Thus, these efforts should be a joint venture between local women, NGOs, government departments, and social workers..

The paper is drawn from a research project "Integrating tribal women into cooperatives: An experience of Girijan Cooperative Corporation", and funded by the Department of Personnel and Training, Ministry of Personnel, Public Grievances and Pensions, Government of India, New Delhi

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The worse the news, the more effort should go into communicating it.

– Andrew S. Grove

Feature

Instability Analysis of Foodgrain Production Growth in Andhra Pradesh

I.V.Y. Rama Rao & V.T. Raju

In this paper an attempt has been made to analysis patterns of growth, magnitude of instability, and to decompose the change in production. Time series data from 1980-81 to 2001-02 regarding area, production and productivity of foodgrain was collected. Compound growth rate, Coefficient of Variation (C.V), Coppock's Instability Index (C.I.I) and decomposition analysis were the analytical tools used. Growth rates in production and productivity were significant and in area were non-significant. Besides recording medium degree of instability in area, production and productivity, yield effect was high on the production differential than by the area effect. These findings have an important bearing on policy implications.

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India is one of the leading foodgrain producing countries in the world with a cultivated area of 121.91 million hectares and a production of 212.03 million tonnes during 2001-02. In India, leading states in foodgrain production are Uttar Pradesh, Punjab, and West Bengal. Andhra Pradesh is ranked fifth, with a cultivated area of 7.04 million hectares and production of 14.84 million tonnes during 2001-02. Further in this region coastal Andhra, Telangana and Rayalaseema produce of 8.24, 6.46 and 1.33 million tonnes of foodgrains respectively. The low growth in production and productivity will adversely affect the prospective production employment and income both at micro and macro levels and as such hamper the economic growth of the country. Findings of the studies by Hazell (1984) Jayadevan (1991) revealed that the growth in crop production during the post-green revolution period has been accompanied with increased instability and yield fluctuation, which is a major source of production instability.

This necessitates the present study with the following specific objectives:

- To study growth rates in area, production and productivity.
- To examine the extent of instability in area, production and productivity.
- To identify the districts and regions having combinations of different degrees of growth and instability.
- To decompose the change in production.

Methodology

This study pertains to all the 23 districts in the three geographical regions of Andhra Pradesh, mainly, Coastal Andhra, Rayalaseema and Telangana, and the state as a whole. Time series data from 1980-81 to 2001-02 was collected from various sources published by the Bureau

of Economics and Statistics, Government of Andhra Pradesh. For the calculation of Compound Growth Rate (CGR), Coefficient of Variation (CV), Coppock's Instability Index (C.I.I) and decomposition of change in production the whole period was divided into two sub-periods resulting in the formation of three periods viz., period-1 (1980-81 to 1990-91), period-II (1991-92 to 2001-02) and overall period (1980-81 to 2001-02). Analysis was conducted separately for each period.

Analytical Tools

Estimation of Growth Rates

Compound growth rates of area, production and productivity for the periods mentioned earlier was estimated by fitting an exponential function of the following form:

$$Y = Ab^t$$

$$\text{Log } Y = \text{Log } A + t.\ \text{log } b$$

Where,

Y = Area/Production/Productivity

A = Constant

b = (1+r)

r = Compound Growth Rate

t = Time variable in years (1,2,3...n)

The standard error of growth rate was calculated by

$$SE\ (\log b) \sqrt{\frac{\sum(Y-\bar{Y})^2 - [(\log b)^2 - \sum(t-\bar{t})^2}{(N-2)\sum(t-t)^2}}$$

Student 't' test was used to test the significance of growth rates.

$$t = \frac{\log b}{SE\ (\log b)}$$

Estimation of extent of Instability:

1) **Coefficient of variation** (CV): This explains the fluctuations over the period.

$$CV = \frac{\left[1/N-1 \sum (X_t - \bar{X})^2\right]^{1/2}}{\bar{X}}$$

Where,

N = Number of years

X_t = Area/production/productivity in the year 't'

$\bar{X}$ = Mean of Area/production/productivity.

2) **Coppock's Instability Index (CII):** Coppock's Instability Index (CII) is a close approximation of the average year-to-year percentage variation adjusted for trend. In algebraic form:

$$C.I.I = [\text{Antilog } \sqrt{\log V} - 1] \times 100^*$$

$$\log V = \frac{[\log (X_{t+1}/X_t) - m]^2}{N-1}$$

Where,

log V = Logarithmic variance of the series.

X_t = Area/ production/ Productivity in the year 't'

N = Number of years

m = Arithmetic mean of the difference between the logs of X_{t+1} etc.,

Growth v/s Instability

The conjugation of growth rates and instability indices needs to be taken to identify whether the crop's performance is stabilized higher growth rate or instabilized lower growth rate. Accordingly, production in district(s) or region(s) was classified into four categories (as shown in table 3). So, this enables the development of district or region-specific strategies rather than old blanket strategy of the state as a whole. For rating the district(s) or region(s) as high or low growth rates and instability CGR and CII of state as a whole were taken as critical point.

Decomposition of Change in production

Decomposition of change in production will result into area effect, productivity effect and interaction effect of area and productivity. In formulae form:

$$\Delta P = Ao.\Delta Y + Yo.\Delta A + \Delta A.\Delta Y$$

Where,

ΔP = production difference

$Yo.\Delta A$ = Area effect

$Ao.\Delta Y$ = productivity effect

$\Delta A.\Delta Y$ = Interaction effect of area and productivity.

Results and Discussion

District Hyderabad was excluded from discussion, not from analysis, because of very less cropped area (32 ha) and production (78 tonnes) under foodgrains. The following discussion is level-wise, and at each level all the three periods are discussed.

Growth Rates

Among the districts during the overall period, three districts in area, ten districts in production and 19 districts in productivity have registered significant growth rates (table 1). Growth rates in area ranged between –2.3422 per cent (Ananthapur) and 0.5675 per cent (East Godavari). Further, all the districts in Rayalaseema and Telangana registered non-significant negative growth rates in area. Growth rates in production ranged from 0.7613 (Anathapur) to 1.3161 per cent (Karimnagar) and in productivity varied between 0.1467 per cent (Srikakulam) and 2.1895 per cent (Warangal). During period I for area, production and productivity, one, three and seven districts respectively registered significant growth rates. In this period, all the districts in Telangana region showed a non-significant negative growth rate in the area. During period II two districts, four districts and six districts recorded significant growth rates in area, production and productivity respectively.

Among the regions during the overall period, no region recorded significant growth rates in area, which were varied between -0.7523 per cent (Telangana) and 0.0149 per cent (coastal Andhra). In production coastal Andhra (0.7510%) and Telangana (0.8634%) registered significant growth rates, whereas Rayalaseema recorded a non-significant negative growth rate (-0.4661%). In productivity all the three regions registered significant growth rates, which, varied from 0.7360 per cent (coastal Andhra) to 1.6280 per cent (Telangana). During period I only productivity in Telangana (1.6562%) registered significant growth rate. During period II, production and productivity in coastal Andhra and Telangana registered significant growth rates. Further, during all the periods, except Rayalaseema in period II, growth in productivity has contributed more to the growth in production than by growth in area.

In the state as a whole, during the overall period significant growth rates were observed in production (0.6650%) and productivity (1.2178%) but, non significant negative growth rate was recorded in area (0.5462%). This indicates that growth in productivity has contributed more to production growth than by growth in area. During period I, productivity recorded a significant growth of 1.3402 per cent and non-significant growth rates were recorded in area (-0.8002%) and production (0.5292%). During period II growth rates were non-significant in area (0.1756%) and significant in production (1.2373%) and productivity (1.0599%). Inter period comparison between period I and period II has revealed that in area and production period II has performed better, while, there has been a decline in productivity growth rate during period II.

These results show that in almost all the districts, regions and state as a whole, growth in productivity has contributed more to the growth in production than by the growth in area. Further, area showed negative trend in period I and in the overall period. This conveys that farmers initially during period I had shifted their cultivation from foodgrain production to non-foodgrain agricultural production like oilseed, which boomed after the introduction of technology mission on oilseeds. This shift was mainly because of more remuneration for non-foodgrain crops.

Shah and Shah (1997) reported that foodgrain production during 1977-76 to 1990-91 has increased substantially but has brought in uneven development across the region and crops in India. This study reveals that during the overall period (1980-81 to 2001-02) production (0.6650%) and productivity (1.2178%) have shown significant growth rates, but non-significant negative growth rate (-0.5462%) was registered in area, whereas, in congruence with the above reference, there was uneven growth across regions, districts and among crops. For example, during period 1981/82 to 2000/01 all the districts in Rayalaseema and Telangana showed a negative growth rate, but it was positive in the coastal region. This conveys that improved technology and improved varieties are locally biased.

Extent of Instability

One should not be oblivious of instability by taking the growth rates only, because this will explain only rate of growth over the period, whereas instability will judge whether the growth performance is stable or unstable for the period for the pertinent variable.

Among the districts, during the overall period, the lowest and the highest instability in area, production and productivity were respectively recorded in West Godavari (4.51% CV and 1.94% CII) and Ananthapur (42.20% CV and 14.45% CII), Ranga Reddy (11.84% CV and 5.18% CII) and Warangal (30.58% CV and 14.47% CII); and in Guntur (10.87% CV and 4.42% CII) and Warangal (31.24% CV and 15.39% CII) (table 2). In total eighteen districts instability in productivity was higher than area, and likewise they contributed towards production variability.

Table 1: Compound Growth Rates for area, production and productivity of foodgrain during different periods.

Districts Regions & State		Overall Period			Period-I			Period-II		
		Area	Pro-duction	Producti-vity	Area	Pro-duction	Producti-vity	Area	Pro-duction	Producti-vity
Srikakulam	R	0.2647	0.4118	0.1467	-0.3329	-0.3051	0.0279	-0.9223	-1.7369	-0.8221
Vizianagaram	R	0.5650 *	1.3015 *	0.7323	0.3073	2.3126	1.9991	0.0566	-0.3770	-0.4334
Visakhapatnam	R	-0.0251	0.5870	0.6123	0.2709	1.8159	1.5409	-0.6334	-0.5579	0.0760
East Godavari	R	0.5675 * *	0.7897 * *	0.2210	0.9466 * *	0.3029	-0.6377	0.3337	1.3884	1.0512 *
West Godavari	R	0.0305	0.7264 * *	0.6957 *	0.3074	-0.3946	-0.6999	0.4274	1.5797	1.1474
Krishna	R	-0.2360	0.8870 * *	1.1256 * *	0.0617	1.3855 *	1.3229 *	-0.2090	1.3017	1.5138
Guntur	R	0.3062 * *	0.8603 * *	0.5525 * *	0.6145	1.9140 *	1.2916 *	0.1780	0.9508	0.7714
Prakasam	R	-0.9244	0.7251	1.6649 * *	-1.2166	0.5730	1.8116	0.4047	1.3080	0.8997
Nellore	R	-0.4655	0.8521 * *	1.3238 * *	-0.7224	1.4427 * *	2.1808	-0.2822	0.6547	0.9396
Coastal Andhra	R	0.0149	0.7510 * *	0.7360 * *	0.1057	0.8753	0.7687	0.0022	0.8152 *	0.8130 * *
	S.E	0.0008	0.0014	0.0010	0.0029	0.0050	0.0035	0.0013	0.0030	0.0024
Kurnool	R	-1.4361	-0.1559	1.2989 * *	-2.1322	-1.5824	0.5617	0.2953	0.9467	0.6494
Ananthapur	R	-2.3422	-0.7613	1.6187 * *	-4.3183	-2.1983	2.2157 * *	0.0151	1.1701	1.1548
Cuddapah	R	-1.8886	-0.7079	1.2034	-3.3052	-1.0102	2.3734 * *	1.3093	0.4305	-0.8674
Chittoor	R	-1.4525	-0.5209	0.9454 * *	-2.3029	-0.7356	1.6043	-1.2720	-0.5924	0.6883
Rayalaseema	R	-1.7308	-0.4661	1.2871 * *	-2.8904	-1.4174	1.5168	0.1091	0.5771	0.4675
	S.E	0.0020	0.0029	0.0021	0.0022	0.0083	0.0067	0.0025	0.0075	0.0054
Ranga Reddy	R	-0.5594	0.2768	0.8409 * *	-1.1460	0.5726	1.7385 * *	0.0503	0.6635	0.6128
Hyderabad	R	-4.9320	-3.7094	1.2860 *	-2.3966	0.2447	2.7061	-6.1886	-6.4832	-0.3141
Nizamabad	R	-0.3363	0.6493	0.9890 * *	-0.5045	0.0193	0.5265	1.1230 *	2.4537 *	1.3159
Medak	R	-0.2017	1.0402 *	1.2445 * *	-0.7510	0.4382	1.1981	0.9445 * *	2.5015 *	1.5425 *
Mahaboob Nagar	R	-1.0988	0.4040	1.5194 * *	-0.9883	0.4210	1.4233	0.5241	2.2230	1.6901 * *
Nalgonda	R	-1.0060	0.5695	1.5915 * *	-1.0204	1.1735	2.2165 * *	-0.0903	0.3725	0.4632
Warangal	R	-1.2103	0.9528	2.1895 * *	-2.0304	0.4594	2.5414	1.2404	3.0241 *	1.7619 * *
Khammam	R	-0.8897	1.0435 * *	1.9505 * *	-1.1091	0.7122	1.8417	-0.6262	1.2823	1.9206 * *
Karim Nagar	R	-0.5033	1.3161 * *	1.8286 * *	-0.5739	1.4467	2.0323 * *	0.9120	3.1320 * *	2.1999 * *
Adilabad	R	-0.7202	1.1373 * *	1.8710 * *	-0.6635	-0.5847	0.0793	-0.5358	2.0359	2.5856
TELANGANA	R	-0.7523	0.8634 * *	1.6280 * *	-0.9812	0.6588	1.6562 *	0.3885	2.0191 *	1.6243 * *
	S.E	0.0016	0.0029	0.0018	0.0030	0.0088	0.0062	0.0041	0.0078	0.0042
Andhra Pradesh	R	-0.5462	0.6650 * *	1.2178 * *	-0.8002	0.5292	1.3402 * *	0.1756	1.2373 *	1.0599 * *
	S.E	0.0010	0.0018	0.0011	0.0024	0.0059	0.0038	0.0024	0.0046	0.0028

* * 1% Level of significance
* 5% Level of significance
R = Compound Growth Rate (%)
SE = Standard Error of Coefficient B

Among the regions, during period I, the lowest instability in area (5.68% CV and 2.55% CII), production (11.93% CV and 5.04% CII) and productivity (8.96% CV and 3.60% CII) were recorded in Coastal Andhra. The highest in area (21.46% CV and 7.65% CII) and productivity (17.01% CV and 7.61% CII) were recorded in Rayalaseema, whereas, in production (17.20% CV and 7.98% CII) was registered in Telangana. Further, productivity variability was more in relation to instability in area in coastal Andhra and Telangana regions, whereas, in Rayalaseema it was the reverse. During period II, the lowest instability in area (2.59% CV and 1.13% CII), production (8.37% CV and 3.10% CII) and productivity (7.37% CV and 2.57% CII) were recorded in coastal Andhra, whereas, the highest in area (8.43% CV and 3.47% CII), production (21.49% CV and 9.34% CII) and productivity (14.34% CV and 5.77% CII) were noticed in Telangana. Further, in all the three regions productivity

Table 2: Coefficient of Variation (CV) and Coppock's Instability Indices (CII) of area, production and productivity of foodgrain among districts, regions and the state as a whole in Andhra Pradesh.

(Values in percentages)

Districts Regions & State	Overall period						Period-1						Period-II					
	Area		Production		Productivity		Area		Production		Productivity		Area		Production		Productivity	
	C.V	C.I.I	C.V	C.I.I	C.V	C.I.I	C.V	C.I.I	C.V	C.I.I	C.V	C.I.I	C.V	C.I.I	C.V	C.I.I	C.V	C.I.I
Srikakulam	14.62	8.63	24.10	16.77	16.11	8.35	18.13	11.13	29.77	22.35	20.84	11.06	8.99	3.83	17.34	6.61	10.64	3.85
Vizianagaram	12.56	6.51	28.55	17.92	21.65	11.41	14.36	7.47	36.72	22.90	28.06	14.68	5.42	2.38	16.42	7.54	13.48	6.02
Visakhapatnam	8.17	3.68	24.80	12.05	19.01	8.90	8.65	3.94	25.44	11.87	19.15	8.46	8.12	3.56	23.70	12.11	17.67	8.85
East Godavari	9.36	4.12	16.96	7.51	12.61	5.74	9.68	4.17	14.20	6.43	12.22	5.85	4.25	1.67	14.95	5.55	13.04	4.96
West Godavari	4.51	1.94	17.01	7.76	16.43	7.77	4.56	1.84	14.69	6.86	14.74	7.14	4.49	1.40	14.78	5.07	12.53	4.87
Krishna	4.67	2.04	14.46	5.47	16.69	6.56	3.43	1.45	13.02	4.21	12.06	3.94	3.04	1.06	11.11	4.94	11.65	3.69
Guntur	6.60	2.96	15.45	6.79	10.87	4.42	7.85	3.48	18.42	7.82	12.34	4.84	3.51	1.44	9.24	4.04	7.92	3.31
Prakasam	17.61	7.16	22.79	10.14	25.81	12.08	10.60	3.63	19.89	9.33	20.77	9.30	14.94	5.89	23.31	9.93	14.23	5.99
Nellore	9.00	3.46	16.61	7.86	19.77	9.11	8.96	3.49	16.12	7.81	16.70	7.73	4.52	1.68	12.88	5.27	12.15	4.38
Coastal Andhra	4.30	1.91	12.83	5.54	11.51	4.80	5.68	2.55	11.93	5.04	8.96	3.60	2.59	1.13	8.37	3.10	7.37	2.57
Kurnool	23.41	9.10	16.86	6.74	21.96	10.39	15.70	6.20	18.97	7.12	14.94	7.00	4.70	2.01	15.23	6.71	12.46	5.84
Ananthapur	42.20	14.45	25.70	9.18	25.24	11.47	33.07	12.26	26.86	9.04	21.27	8.95	4.18	1.81	18.51	8.45	15.72	7.09
Cuddapah	34.87	13.23	20.44	9.25	23.33	10.35	25.05	8.96	16.23	6.30	21.73	8.81	15.12	6.56	21.47	10.21	15.27	7.23
Chittoor	25.87	10.11	26.32	12.41	17.80	8.71	22.12	8.78	27.23	13.67	18.32	8.92	16.47	6.37	24.90	10.79	12.55	5.99
Rayalaseema	28.96	10.46	18.04	6.93	20.53	9.52	21.46	7.65	17.04	6.88	17.01	7.61	4.95	2.06	15.25	6.77	10.94	4.87
Rangareddy	10.69	4.11	11.84	5.18	29.33	6.09	9.82	3.76	13.35	5.76	16.01	6.42	6.29	2.50	10.63	4.46	7.58	3.32
Hyderabad	62.33	38.92	61.28	36.22	24.70	14.69	33.17	14.04	36.99	28.27	29.39	17.43	45.15	28.85	41.41	25.52	15.15	7.68
Nizamabad	10.81	4.79	22.06	9.59	18.32	8.22	6.60	2.88	15.72	7.03	13.56	6.00	11.40	4.94	25.41	11.31	14.60	6.39
Medak	9.27	3.74	26.37	12.15	23.02	10.51	9.06	3.65	24.78	12.13	22.45	10.01	8.46	3.49	24.84	9.54	16.60	6.20
Mahaboob Nagar	22.25	9.51	28.49	12.96	24.26	11.50	14.19	5.56	27.81	12.85	20.86	9.25	18.01	6.26	30.54	12.95	15.52	6.75
Nalgonda	16.67	6.99	19.13	8.49	23.90	10.76	9.93	3.99	18.71	8.33	20.37	8.35	9.41	3.53	18.62	8.26	11.38	4.98
Warangal	24.72	10.27	30.58	14.47	31.24	15.39	17.92	6.81	25.86	13.71	27.60	12.81	17.68	8.03	32.68	14.72	16.00	6.90
Khammam	14.00	5.72	20.76	9.58	28.25	13.09	10.02	4.00	16.61	7.90	20.14	9.20	7.95	3.23	17.21	7.79	16.03	6.56
KarimNagar	13.34	5.73	27.15	11.91	146.2	11.69	9.08	3.56	20.57	9.42	15.74	8.06	12.45	5.43	26.91	12.11	10.53	6.70
Adilabad	10.45	4.44	26.92	12.39	33.84	14.85	5.47	2.35	13.38	6.06	12.42	5.61	5.43	2.42	25.13	9.94	25.70	9.46
Telangana	13.79	5.58	21.18	9.35	24.05	10.77	9.22	3.45	17.20	7.98	16.39	7.47	8.43	3.47	21.49	9.34	14.34	5.77
Andhra Pradesh	9.78	3.73	14.29	6.22	17.68	7.61	7.54	2.68	12.02	5.42	12.34	5.15	4.79	1.98	13.14	5.45	9.48	3.53

variability has contributed more towards production fluctuations in relation to instability in area.

During the overall period, the lowest instability in area (4.30% CV and 1.91% CII), production (12.83% CV and 5.54% CII) and productivity (11.51% CV and 4.80% CII) were noticed in coastal Andhra. The highest instability in area (28.96% CV and 10.46% CII) was recorded in Rayalaseema, whereas, in production (21.18% CV and 9.35% CII) and productivity (24.05% CV and 10.77% CII) were noticed in Telangana. In similarity with period I, productivity variability was high in relation to instability in area in coastal Andhra and Telangana regions, whereas, the reverse was true for Rayalaseema, which contributed towards production fluctuations.

In the state as a whole during period II, production variability (13.14% CV and 5.45% CII) was higher than variability in productivity (9.48% CV and 3.53% CII), which in turn was higher than area variability (4.79% CV and 1.98% CII). Thus, instability in productivity in relation to instability in area has contributed more towards

Table 3: Districts and regions of Andhra Pradesh with combinations of different magnitudes of growth rates and instability indices in foodgrain

	High Growth rate and Low Instability		High Growth rate and High Instability		Low Growth rate and Low Instability		Low Growth rate and High Instability	
	District(s)	Region(s)	District(s)	Region(s)	District(s)	Region(s)	District(s)	Region(s)
	Krishna	**COASTAL ANDHRA**	Vizianagram East Godavari West Godavari Guntur Prakasam Nellore Warangal Medak Khammam Karim Nagar Adilabad	**TELANGANA**	Ranga Reddy	–	Srikakulam Visakhapatnam Kurnool Ananthapur Cuddapah Chittoor Hyderabad Nizamabad Nalgonda Mahaboobnagar	**RAYALA-SEEMA**
% to the State average production	**9.69**	**53.89**	**61.03**	**36.16**	**1.84**	--------	**28.94**	**9.79**

Note: 1. CGR for foodgrain production for state as a whole during the period 1980-81 to 2001-02 is 0.6650 % * *

2. CII for foodgrain production for state as a whole during the period 1980-81 to 2001-02 is 6.22 %

3. Total average foodgrain production for the period 1980-81 to 2001-02 is 11.99 million tonnes

production instability. During period II, instability in productivity (12.34% CV and 5.15% CII) has contributed more towards production instability (12.02% CV and 5.42% CII) than by instability in area (7.54% CV and 2.68% CII). During the overall period, variability in production (14.29% CV and 6.22% CII) has contributed more by variability in productivity (17.68% CV and 7.61% CII) than by variability in area (99.78% CV and 3.73% CII).

Inter-period comparison at the regional level, revealed that instability in productivity was more than instability in area in Coastal Andhra and Telangana in all the periods. In Rayalaseema it was similar in period II, whereas it was opposite during the period I and overall period. At state level during all the periods, variability in productivity was more than variability in area, and likewise, contribution towards production variability.

Growth v/s Instability

High growth rate and low instability (highly preferable): Only Krishna district and coastal Andhra region were in this category (table 3). They constitute 9.69% and 53.89% of total average state production respectively. So, region wise identification this category should be given prime importance.

High growth rate and high instability (This category is preferably based on the greatness of growth rate over instability index) : Telangana region and 11 districts were placed in this category. Separately, Telangana region and a total of 11 districts share 36.16% and 61.03% respectively of the state's average production. So, in district identification this category should be given prime importance. In this category even though growth rate is high, stability is low. This necessitates giving primary concern to production stabilization, because, higher production with uncertainty will not of much use to the farmers. Production fluctuation in foodgrain production was contributed to more by the yield variability than the area variability (table 2). So, this imperates the timely supply of required amount of inputs, and any breakthrough in production performance of a higher magnitude should come through varietal effect.

Low growth rate and low instability (less preferable): Only Ranga Reddy district with the production of 1.84% of total state average, was in this category. So, this category is negligible.

Low growth rate and high instability (not preferable): A total of 10 districts and Rayalaseema region, with a share of 28.93% and 9.79% respectively in the state average production, were constituted in this category. This means that more than a quarter of Foodgrain production was in a dismal situation of low growth rate and high variability condition. This requires strategies to increase the growth and decrease the instability. Production can be enhanced through higher input-use efficiency and development of farming system specific crop varieties. Providing the assured supply of inputs on time and the proper quantity can reduce instability.

Table 4: Components of change in production of foodgrain at district, region and state level during different periods.

(Values in percentage)

Districts Regions & State	Overall Period				Period-I				Period-II			
	Differential Production (Δp)	Area Effect (Δa)	Yield Effect (Δy)	Interaction Effect (Δa.Δp)	Differential Production (Δp)	Area Effect (Δa)	Yield Effect (Δy)	Interaction Effect (Δa.(Δp)	Differential Production (Δp)	Area Effect (Δa)	Yield Effect (Δy)	Interaction Effect (Δa.Δp)
Srikakulam	100.00	6.11	92.96	0.93	100.00	46.29	51.11	2.60	100.00	39.23	66.62	-5.85
Vizianagaram	100.00	10.03	86.63	3.34	100.00	12.47	80.20	7.33	100.00	24.36	80.07	-4.43
Visakhapatnam	100.00	-13.15	117.20	-4.05	100.00	31.88	60.85	7.28	100.00	-88.93	204.7	-15.74
East Godavari	100.00	40.79	48.53	10.68	100.00	-140.59	207.99	32.60	100.00	14.63	78.40	6.97
West Godavari	100.00	17.38	75.68	6.94	100.00	-5.43	104.82	0.60	100.00	23.51	65.79	10.70
Krishna	100.00	-4.54	108.31	-3.77	100.00	5.48	92.58	1.94	100.00	-11.30	116.4	-5.12
Guntur	100.00	26.29	64.02	9.69	100.00	24.68	67.73	7.59	100.00	23.51	73.14	3.35
Prakasam	100.00	-17.81	130.49	-12.69	100.00	-222.40	429.12	-106.72	100.00	47.74	40.73	11.53
Nellore	100.00	-126.01	284.86	-58.85	100.00	-55.21	176.47	-21.26	100.00	-70.60	188.6	-18.00
Coastal Andhra	100.00	5.39	92.12	2.48	100.00	9.49	89.16	1.35	100.00	10.82	86.10	3.08
Kurnool	100.00	1,161.73	-1,755	693.30	100.00	119.49	-29.23	9.74	100.00	31.99	60.76	7.25
Ananthapur	100.00	189.49	-255.98	166.49	100.00	117.31	-52.20	34.89	100.00	12.07	86.29	1.64
Cuddapah	100.00	300.21	-378.59	178.38	100.00	250.93	-306.62	155.69	100.00	204.76	-85.37	-19.40
Chittoor	100.00	134.75	-76.90	42.15	100.00	191.19	-151.05	59.85	100.00	110.04	-14.77	4.73
Rayalasema	100.00	239.57	-283.86	144.29	100.00	147.39	-89.85	42.47	100.00	17.50	80.92	1.58
Ranga Reddy	100.00	-84.25	226.37	-42.12	100.00	-75.36	211.94	-36.58	100.00	-16.22	118.6	-2.40
Nizamabad	100.00	6.59	90.70	2.71	100.00	-143.82	254.93	-11.11	100.00	34.82	53.81	11.37
Medak	100.00	-2.07	103.49	-1.41	100.00	-47.11	170.99	-23.89	100.00	27.97	57.53	14.50
Mahaboob nagar	100.00	-106.99	274.02	-67.04	100.00	292.91	-243.43	50.52	100.00	-15.69	121.6	-5.89
Nalgonda	100.00	-74.92	251.88	-76.96	100.00	-63.54	200.43	-36.89	100.00	-129.1	259.5	-30.43
Warangal	100.00	-40.84	194.52	-53.68	100.00	-319.69	630.51	-210.83	100.00	31.31	55.26	13.43
Khammam	100.00	-59.26	227.55	-68.29	100.00	-150.51	307.60	-57.09	100.00	-35.96	155.1	-19.16
Karimnagar	100.00	-12.59	125.15	-12.56	100.00	-50.99	170.93	-19.93	100.00	15.61	76.84	7.55
Adilabad	100.00	-39.81	187.52	-47.71	100.00	462.35	-430.71	68.36	100.00	-5.34	113.1	-7.72
Telangana	100.00	-37.64	171.56	-33.93	100.00	-131.15	282.03	-50.88	100.00	6.49	90.60	2.91
Andhra Pradesh	100.00	-41.56	170.13	-28.57	100.00	-197.49	353.44	-55.95	100.00	8.80	88.32	2.87

Decomposition of Change in production

Among the districts during period I, dominance of yield effect than other components of change in production was observed in sixteen districts (table 4). The lowest area effect (-319.69%) and interaction effect (-210.83%) and the highest yield effect (630.51%) were recorded in Warangal showing negative destabilizing effect of area and interaction of area and yield which was countered by yield effect. During period II, nineteen districts showed higher yield effect than other components of change. But, in Cuddapah, where the lowest yield effect (-85.37%) and the highest area effect (204.70%) were recorded, yield has caused negative instability. During the overall period, yield effect was higher than other components of change, as observed in 19 districts. In Nellore the lowest area effect (-126.01%) and the highest yield effect (284.86%) were observed. Thus, area has caused negative destabilization. Foodgrain consists of both total cereals and total pulses. In total cereals yield effect and in total cereals

and area effect in total pulses were dominant destabilizing factors. In foodgrain also, as with total cereals, the yield effect was higher showing total cereals dominance over total pulses in cultivation.

Among the regions, the dominant role of yield effect in coastal Andhra and Telangana and area effect in Rayalaseema was observed in period I and overall period, whereas, yield effect was dominant in all the regions during the overall period. Thus, as in districts, in regions the dominant role of yield effect was clearly felt.

In the state as a whole, change in yield has a higher effect on production differential than the other components of change as noticed in period I (353.94%), period II (88.32%) and the overall period (10.13%), and that too, change in area caused negative destabilizing effect during the period I (-197.49%) and overall period (-41.56%).

Policy Implications

1. Production increased due to productivity in foodgrain which indicates that growth in production should come from yield attributing factors like development of high yielding farming system specific varieties and improvement in input use efficiency.
2. Production was stagnant, which necessitates a thorough yield-gap analysis.
3. Yield stabilisation efforts should be given prime importance, like assured supply of farm in-puts and providing remunerative prices.
4. Identified high and low growth rate districts and regions for rice will be better utilized in the local specific and crop specific research schemes and growth-oriented development programmes.
5. Though area has less effect on foodgrain production, but for overall improvement in foodgrain production for supplying staple food to people, the area attributing factors like adequate supply of farm inputs for area expansion should also be given importance.

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The world hates changes, yet it is the only thing that has brought progress.

– Charles F. Kettering

Feature

Indian Meat Industry: Potential, Constraints and Policy Interventions

Jabir Ali, Shamim Ahmad & Pratap S. Birthal

The present paper highlights the potential, constraints and policy changes in relation to the meat industry in India. India has immense potential for production and export of meat due to sufficient resources, available markets and a huge livestock population. The new market-oriented policy is aimed at the modernization of slaughterhouses in order to encash on emerging export opportunities. These reforms have contributed significantly towards the development of an organized meat industry. As a result, private investment in meat processing has been increasing gradually. But still it is dominated by the unorganized sector, which sells the produce in the local market. A very small quantity of the total meat produced is further processed for value addition. The change in tastes and preferences towards branded products due to increase in income level has provided a new opportunity for the meat processing industry to launch its brands in the domestic market also. India is reasonably competitive in the production and export of meat.

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Meat is one of the important and fast growing industries within the livestock economy, with an annual growth of over 5 per cent. The structure of the meat industry is highly unorganized and only a meagre amount of meat is further processed for value addition. There is tremendous growth potential in terms of production and export due to huge livestock population, available markets and other resources. The contribution of meat in total livestock output has significantly increased over time. The unproductive and non-milch livestock population constitutes a vital stock of national wealth, which is mostly unexploited. Due to mechanization of the farming system, use of animal labour has also declined steeply, rendering the male livestock population useless. The maintenance of a productive herd size is one of the basic problems of livestock farmers as there is no market to dispose of the unproductive animals. The utilization of unproductive animals for meat production is one of the potential options but due to social constraints and lack of policy interventions, it is not being utilized. The meat industry is also having very strong forward linkages and is the major supplier of raw material to the leather processing industry. Due to deficient domestic supply of raw hides and skins to utilize the existing capacity of the leather processing industry, the country has to depend upon imports.

In India, most of the slaughterhouses are old, unhygienic and lack basic facilities like water, light, ventilation, drainage, waste disposal and effluent treatment. Traditional slaughtering practices contribute to poor meat quality and low recovery of various by-products such as hides, blood, bonemeal, internal organs and trimmings. These by-products, separated from carcasses are used to make clothes, medicines, sports goods, animal feed and food products. A large share of blood and other by-products from unorganized slaughter is wasted. But the new market-oriented policy is aimed at modernization of slaughterhouses in order to encash on emerging export opportunities and realization of its by-

products for value additions. These reforms have contributed significantly towards the private investment in meat processing and development of modern integrated meat processing plants, which utilizes every part of the carcass efficiently.

The major portion of the meat produced is consumed domestically. Yet, per capita consumption of meat and meat products is extremely low because of socio-cultural and religious factors. Besides, demand for meat is also constrained due to high price and low income of the majority of the population (Ravishankar and Birthal, 1999). But in recent years, change in the consumption pattern has been seen with rising per capita income, urbanization and taste. Considering its nutritional value, meat and meat products are becoming a part of the food basket of millions of people. Indian meat is also reasonably price competitive in the international market (World Bank, 1999; Kumar *et al*, 2001; Ali and Ahmad, 2002). Meat is also the major contributor in export earnings from livestock products and accounts for more than 90 per cent of total livestock export from India.

The study has been undertaken to assess the existing potential for meat production and export from India; the growth pattern and composition of production, consumption and export of different kinds of meat; to assess major constraints affecting the performance of the meat industry; and to analyze the possible policy measures to capture the potential of the meat industry.

Potential of the meat industry

Livestock population dynamics

India has a huge livestock population of about 175 million cattle, 84 million buffalo, 55 million sheep, 102 million goat and 12 million pigs. The number of all categories of livestock has increased from 1982 to 1992. But during 1997 the population came down for all kind of animals except sheep and buffalo. Out of the total livestock population, bovines constitute the major share followed by ovines and pigs. In the bovine population, cattle outnumber buffaloes, which makes the Indian livestock economy a cow economy. However, over the years there has been a slow but perceptible change in favour of buffaloes. The above pattern of population statistics clearly reveals that cattle rearing still dominates the livestock sector and that the importance of the buffalo, goat and poultry, is increasing gradually.

There are significant variations in the nature and magnitude of growth rates in the population of different species of livestock. For instance, buffalo population in the country recorded a faster growth rate than that of cattle. Similarly, goats grew at a faster rate than sheep during the above period. Poultry witnessed spectacular growth and its number has increased over fourfold. The faster growth in poultry farming may be attributed to the fact that amongst farm animals, poultry is one of the quickest and most efficient converters of plant products into food of high biological value.

Table 1: Trends in livestock population in India, 1982 to 1997

Species	Population in million numbers			ACGR (%)		
	1982	1992	1997	1982-1992	1992-97	1982-97
Cattle	192.45	204.58	174.97	0.61	-3.08	-0.63
Buffalo	69.78	84.21	84.03	1.90	-0.04	1.25
Sheep	48.80	50.78	55.31	0.40	1.72	0.84
Goats	95.20	115.28	102.26	1.93	-2.37	0.48
Pigs	10.10	12.79	12.37	2.39	-0.67	1.36
Poultry	207.70	120.29	402.61	-5.32	27.33	3.97

Source: Livestock census (various issues)

Livestock is considered to be a secondary agricultural activity in India, which supports the farming community by disposal of agricultural by-products, supply of animal labour, food products, fuels etc. It also provides additional income, employment and manages risk during natural calamities. But economic and productive holding of livestock is the present day need because of scarcity of feed and fodder. In India, cattle and buffalo are reared for milk purpose only but livestock farmers are bound to maintain unproductive animals also, resulting in the increase in the cost of production of milk. Table 2 shows the slaughter rate of different species of animals for meat production. The slaughter rate for bovine animals is quite low and only 6 per cent of cattle and 10 percent of buffaloes are used for meat production. In case of ovine animals this rate is high and 25 per cent of sheep and 28 percent of goats are used for meat, which is considered to be the full off-take under the present production technology. The slaughter rate for pigs is quite high i.e. 49 per cent.

Table 2: Slaughter rates of different types of animal (%)

Species	1980-82	1990-92	1999-2001
Cattle	5.1	5.8	6.0
Buffalo	8.6	9.8	9.9
Sheep	23.6	23.6	24.8
Goat	25.5	27.5	27.5
Pig	45.6	49.8	49.3

Source: Calculated from FAO database

Trends in meat production

The meat production in India has increased significantly over the last two decades in absolute terms. However, growth in production of different species of meat has declined over time, except sheep meat. Buffalo meat production has experienced an almost constant growth rate. It is also clear from table 3 that annual growth in meat production was higher during the 1980s when compared to the 1990s. The decline in growth is evident by a decrease in number of animals slaughtered. The reason for decline in slaughter rate varies with the species. In case of bovine animals, there is sufficient stock of animals for meat production but stringent control on slaughter due to socio-religious constraints, which does not allow exploitation of the available potential. In case of ovine meat, we are utilizing nearly the full capacity and increase in production is possible only by technological interventions. The production of meat from pig and poultry has also shown significant growth. The production of processed meat has increased over time, which shows the increasing importance of the meat processing industry in India. Though its contribution in total meat production is very small, a favourable policy for processed meat products and increasing demands for packaged products may induce private investment in this sector.

Table 3: Trends in meat production in India, species-wise

Species	Triennium Average (000' MT)			Compound Growth Rate (%)		
	1980-1982	1990-1992	1997-1999	1980-1990	1990-1999	1980-1999
Beef and Veal	883	1277	1400	3.95	1.20	2.98
Buffalo Meat	871	1186	1398	2.57	2.50	2.98
Goat Meat	313	434	462	4.01	0.90	2.31
Mutton and Lamb	167	185	225	0.75	2.87	1.75
Pig Meat	279	432	545	4.75	3.36	4.04
Poultry Meat	121	369	542	11.09	5.45	10.04
Processed Meat	107	129	136	2.02	0.80	1.41
Meat Total	2741	4011	4709	3.79	2.28	3.41

Source: FAO Production Yearbook (various issues)

The share in production of different species of meat showed a significant change over the time period. Bovine meat constitutes more than half the portion of total meat production in the country. But the share has slightly come down from 64 per cent from 1980-82 to 59 percent during 1997-99. The share of ovine meat has declined from 17 per cent to 15 per cent from the same period. Share of pig meat has also increased slightly from 10 per cent to 12 per cent and that of poultry meat which has experienced highest growth, of only 4 per cent from 1980-82 to 12 per cent from 1997-99.

Value of meat output

Livestock contributes about 25 per cent of agricultural sector output, and has been rising continuously (table 4). The contribution of meat output to total agricultural and livestock output was about 3 and 13 percent respectively from 1980-1982, which has increased to 4 and 15 percent from 1997-1999. During 1980s the livestock sector grew at an annual rate of 4.8 per cent, compared to 2.7 per cent of crop sector. But it witnessed a deceleration during the 1990s.

Table 4: Share of livestock and meat output in total agricultural output

(per cent)

Year	1980-82	1990-92	1997-99
Share of livestock in total agricultural output	20.92	24.08	25.04
Share of meat in total agricultural output	2.79	3.78	3.75
Share of meat in total livestock output	13.32	15.71	14.97

Source: National Account Statistics (various issues), CSO, Ministry of Statistics and Programme Implementation, GOI.

Table 5: Trends in value of meat output at 1993-94 prices

Products	Triennium Average (Rs. in crores)			Compound Growth Rate (%)		
	1980-1982	1990-1992	1997-1999	1980-1990	1990-1999	1980-1999
Meat Group	6333	10986	13695	5.50	3.23	4.73
Meat	5166	9617	11959	6.46	3.18	5.13
Beef/ buffalo meat	769	1253	1313	4.94	0.67	3.31
Mutton/ goat meat	2111	3819	4439	5.24	2.30	4.81
Pork	266	548	817	8.15	5.76	6.54
Poultry meat	2020	3997	5390	7.91	4.33	5.79
Meat Products	245	341	437	1.98	3.81	3.63
By-products	922	1029	1299	-0.07	3.48	2.09
Hides	539	476	586	-2.51	2.95	0.27
Skins	249	394	502	3.52	3.84	4.65
Other by-products	134	159	211	0.17	4.28	2.86
Total livestock	38787	61228	79889	4.84	3.87	4.26

Source: National Account Statistics (various issues), CSO, Ministry of Statistics and Programme Implementation, GOI.

The value of output from the meat group has increased from Rs. 6333 crores from 1980-1982 to Rs. 13695 crores from 1997-1999, with an annual growth of 4.73 per cent (Table 5). The annual growth in main meat products has come down during the decades of 1980s and 1990s, whereas increased growth has been experienced in the case of processed meat and its by-products. The growth in processed meat output was 1.98 per cent from 1980-1990, which has increased to 3.81 per cent from 1990-1999, whereas the growth in its by-products has increased from a negative growth to the extent of 0.07 percent to 3.48 per cent. The by-products from meat constitute hides & skins, blood, offals, trimmings etc. The output from hides has increased from a negative growth of 2.51 per cent per annum from 1980-1990 to 2.95 per cent from 1990-1999. The growth in skin output is very small due to full utilization of existing potential for small ruminant. It shows that proper utilization of by-products has increased over time due to improvement in processing technology and emergence of markets.

Export of meat and meat products

Export of meat and meat products has showed a promising performance over the last two decades. The meat export from India was 49.33 thousand metric tonnes during the triennium ending 1980-82, which has increased to 178.62 thousand metric tonnes during the triennium ending 1996-99 (Table 6). It has experienced significant annual growth of 6.65 percent over the period 1980-99. The meat products' export has witnessed significant annual growth during the post-liberalized period and increased at the rate of 7.92 percent during 1990-99. However, species-wise growth in export varies over the period. Annual growth of bovine meat export was 5.62 percent during 1980-90, which has increased to 8.61 percent during 1990-99. On the other hand growth, in ovine meat export was 3.43 percent during 1980-90, which has substantially declined and has become negative to the extent of 2.41 percent during 1990-99. The scope for export of sheep, goat and poultry meat is constrained by high domestic demand and prices (Ravishankar and Birthal, 1999). The pig meat export has increased significantly over the period due to increase in piggery farming and processing as pig slaughter is not subjected to slaughter ban. The poultry meat export has declined because of less export price competitiveness due to high cost of production. The cost of poultry farming in India is high mainly due to higher feed cost and lack of efficient technology.

The export earnings from meat export have been given in Table 7, which reveals that the same have increased from 58 million US dollars during the triennium ending 1980-82 to 201 million US dollars during the triennium ending 1997-99. The annual growth in value of export from meat and meat products has increased from 4.43 percent during the 1980s to 8.50 percent during the 1990s, which is higher than the quantity growth during the same period. It shows that India has received higher export prices of meat during the 1990s.

Table 6: Trends in quantity of meat export from India, species wise

Products	Triennium Average (metric tonnes)			Compound Growth Rate (%)		
	1980-1982	1990-1992	1997-1999	1980-1990	1990-1999	1980-1999
Bovine Meat	43701	75478	172334	5.62	8.61	7.10
Beef and Veal	807	9603	12572	28.10	2.73	14.72
Buffalo Meat	42894	65875	159762	4.38	9.26	6.80
Ovine Meat	5593	7836	6139	3.43	-2.41	0.47
Sheep Meat	5569	7768	5848	3.38	-2.80	0.24
Goat Meat	24	68	291	10.98	15.65	13.29
Pig Meat	4	7	103	5.76	30.85	17.64
Poultry Meat	30	51	45	5.45	-1.24	2.05
Total Meat	49328	83372	178621	5.39	7.92	6.65

Source: FAO Trade Yearbook (various issues)

Table 7: Trends in value of meat export from India, species wise

Products	Triennium Average ('000 USD)			Compound Growth Rate (%)		
	1980-1982	1990-1992	1997-1999	1980-1990	1990-1999	1980-1999
Bovine	47059	72922	184508	4.48	9.73	7.07
Beef & Veal	836	8840	11975	26.60	3.08	14.24
Buffalo Meat	46223	64082	172534	3.32	10.41	6.81
Ovine	10640	15748	16766	4.00	0.63	2.30
Sheep Meat	10543	15613	16212	4.00	0.38	2.17
Goat Meat	97	136	554	3.37	15.10	9.08
Pig Meat	7	371	105	48.03	-11.88	14.22
Poultry Meat	40	76	32	6.78	-8.34	-1.07
Total	57746	89117	201411	4.43	8.50	6.45

Source: FAO Trade Yearbook (various issues)

Share of different species in total meat export in terms of quantity reveals that bovine meat account for 96.48 per cent of total meat export followed by sheep (32.7 per cent), goat (0.16 per cent) and pig (0.06 per cent). Out of ovine meat export 98.51 per cent is contributed by buffalo meat. Buffalo meat export recorded a rapid increase in recent years mainly because of its price competitiveness. India lacks price competitiveness in case of poultry meat, as it is over 50 per cent costlier

than the world price. Export of Indian meat products is concentrated in Asian countries, which accounts for 92.52 per cent of total meat export. Among the Asian countries it is again mainly confined to the Middle East countries. The main importers of Indian meat and meat products are UAE (25 per cent), Malaysia (23 per cent), Philippines (15 per cent) and Iran (7 per cent). Besides, small quantities are exported to a number of countries. Country-wise trade shows there is year to year variation in the volume of trade with the Indian trading partners.

Domestic consumption

The major opportunity for growth of the livestock sector lies in the increasing demand for animal food products. Per capita consumption of meat and meat products in India is extremely low. However, demand for meat is expected to grow faster with sustained economic growth, rising per capita income, strengthening urbanization trends and increasing awareness of the nutritive value of meat and meat products (Kumar and Mathur, 1996; Bhalla and Hazell, 1998; Kumar, 1998). But it is not only the income factor which affects its consumption level in the country, it is also the social and religious factors which play a crucial role in the consumption of meat and meat products. Around 60 per cent of the total population in India is non-vegetarian which also indicates a good potential for meat and meat products. During 1983 per capita consumption of meat products were 2.38 kg/ annum, which has increased to 3.10 kg from 1999-2000 (table 8). The consumption of buffalo, pig and poultry meat has increased over time, whereas the consumption of goat and sheep meat has come down due to increase in domestic prices.

Table 8: Change in consumption of meat and meat products, all India

(kg/capita/annum)

Product	1983	1987-88	1993-94	1999-00
Goat meat/ mutton	1.09	1.10	0.97	0.96
Beef/ buffalo meat	0.62	0.71	0.69	0.85
Pork	0.16	0.19	0.26	0.24
Chicken	0.32	0.37	0.39	0.71
Total	2.38	2.49	2.39	3.10

Source: Consumption of Some Important Commodities in India (various issues), NSSO, GOI.

The domestic consumption of meat was 2692 thousand metric tonnes from 1980-82, which has increased to 4530 thousand metric tonnes from 1997-99. Out of the total meat produced in the country, 96 per cent is domestically consumed. The consumption of goat, pig and poultry meat accounts for nearly the total meat production of these species.

Table 9: Trends in domestic consumption of meat, species-wise

Items	Triennium Average ('000 metric tonnes)			Compound Growth Rate (%)		
	1980-1982	1990-1992	1997-1999	1980-1990	1990-1999	1980-1999
Bovine Meat	1710	2389	2626	3.39	0.96	2.17
Beef and Veal	882	1267	1387	3.69	0.91	2.29
Buffalo Meat	828	1121	1238	3.07	1.01	2.03
Ovine Meat	474	611	681	2.57	1.09	1.82
Sheep Meat	307	426	456	3.32	0.68	1.99
Goat Meat	167	185	225	1.03	1.97	1.50
Pig Meat	279	432	545	4.47	2.35	3.40
Poultry Meat	121	369	542	11.80	3.92	7.79
Total Meat	2692	3929	4530	3.85	1.44	2.64

Source: Calculated from Table 3 & 6 with import adjustment
Note: Consumption = Production – Net Export (Export – Import)

The compound growth of meat consumption has been 2.64 per cent per annum during 1980-99 (table 9). The highest growth in meat consumption has been recorded by poultry meat (7.79%) followed by pig meat (3.40%), bovine meat (2.17%) and ovine meat (1.82%). There was higher growth in the consumption of all species of meat from 1980-90 which substantially slowed down from 1990-98.

Constraints for the meat industry

The feed fodder for the huge livestock population has been a real limiting constraint to the livestock production system. Average size of land holding is small, which has been declining with the increasing population, causing pressure on land and other natural resources. The livestock is mainly reared by marginal and small farmers who do not have much agricultural land to grow fodder on and who largely depend on common grazing lands for green fodder. Common grazing lands have been deteriorating quantitatively as well qualitatively due to excess pressure of livestock population and the distributive policy of the government (Jodha, 1992). Animals rely on crop residues and forages from road sides and other marginal lands. Feeding of grains and other concentrates is inadequate and the competition for grains will intensify with the increasing human and livestock population. The inadequate availability of health and veterinary services are also imposing constraints on the livestock sector development in the country.

Meat production in India is mainly constrained by the social factor, poor meat yield per animal and lack of modern processing facilities. The industry has to face

challenges from social organizations and NGOs demanding a ban on animal slaughter. But for sustainable development of agriculture as well as of the livestock sector, proper disposal of unproductive livestock population is desirable. The extra population which can not be used for milk production, should be utilized for meat production. The slaughtering should be done without hurting religious sentiments. The gap between the existing slaughter rate and the potential offtake for different species of animals should be minimized for better utilization of livestock resources.

Meat yield per animal in India is low compared to other countries for all the species, mainly because animals are not reared especially for meat. Moreover, only unproductive and old animals are used for meat production, which have normally not been given proper feed and fodder and other nutritional requirements for increasing their body weight. Besides, most of the meat in India is produced with traditional slaughter practices, contributing to poor meat quality and low recovery of main and various by-products such as hides, blood, bonemeal, internal organs and trimmings.

The poor sanitary and phyto-sanitary conditions are also considered to be one of the major constrains in realizing export potential. The quality standards for production of meat and meat products set by the Government of India are not comprehensive enough to match with international standards. The quality of meat for export should meet the quality standards of importing countries. As these standards vary with countries, it imposes a lot of constraints in strengthening the meat export from India. Injudicious use of pesticides in the agriculture sector and outbreaks of various animal diseases in the country, encourage the different importing countries to reject or even ban Indian meat import on the ground of health.

The domestic market for meat and meat products is unorganized. Animals are slaughtered by local butchers without any prior health treatment and sold at local meat shops, which do not have proper hygienic and refrigeration facilities. Non-availability of refrigeration facilities at retail shops of meat in the domestic market leads to deterioration in the quality of the product which ultimately affects consumer health. The market segment that consumes unprocessed meat in India basically belongs to the low and middle income groups. The market for processed meat properly packed and branded is confined to the high income group. Liberalization of meat and meat products import under the new trade policy may induce the meat processing plant owners to launch their products in the domestic market. This may bring various alternatives for consumers and stiff competition in the market for producers. With increased health awareness among the consumers and a rise in their living standard, the domestic market for processed and canned meat may be strengthened in the coming decades.

Policy intervention

Meat production and processing in India are critical activities which need much policy intervention from the government side. There is still a question mark on whether meat can be considered as a potential industry. The slaughtering of animals for meat production is a state subject and, therefore, the extent of control varies from state to state. Generally local slaughterhouses are controlled and managed by local authorities. The government provides different kind of supports for better and hygienic conditions of slaughterhouses. After the liberalization of the economy and emergence of modern export-oriented meat processing plants in the country, more attention from the government side is needed. APEDA provides some support for the modernization of slaughterhouses to improve the quality of meat production but this assistance is limited to a few export based slaughterhouses only. The following two regulations directly related to the meat industry need better implementation and revision to make the meat industry viable in India:-

1) The Meat Food Product Order, 1973

The Essential Commodities Act, 1955, is the principal act which controls the production, supply and distribution, trade and commerce, of a large number of agricultural commodities. The Act is now covered by liberalized trade agreements with respect to which non-tariff barriers have been removed for all agricultural commodities over time. Under the Essential Commodities Act, the Meat Food Product Order, 1973, has been introduced and came into force with effect from July 15, 1975, to control meat production and supply. This is the first order issued by the Government of India containing definitions, constitution of meat products advisory committee and licensing and control of meat manufacturing. The Agricultural Marketing Advisor to the Government of India is the licensing authority, who grants a license for production, packing, repacking and relabelling relabelling meat products for sale. As per the order, meat manufacturers have been classified into three categories (table 10).

The meat production in the country is regulated by this Act and every licensee has to comply with the provisions and guidelines laid down in different

schedules. The licensing authority or any officer from the Directorate of Marketing and Inspection, authorised by the Agricultural Marketing Advisor on his behalf, may check to secure the compliance of the order.

Table 10: Categories of meat manufacturers and license fee

Category	Details of manufacturers	License fee (Annual)
Category "A"	Manufacturer who makes meat food products exclusively from meat of animal(s) slaughtered and dressed in his factory	
	• If the quantity of meat products manufactured is more than 150 tonnes per annum.	Rs. 5000
	• If the quantity of meat products manufactured is less than 150 tonnes per annum.	Rs. 2500
Category "B"	Manufacturer who makes meat food products exclusively from meat of animal(s) slaughtered and dressed in a recognized slaughter house and whose factory is situated in close	
	• If the quantity of meat products manufactured is more than 150 tonnes per annum.	Rs. 2500
	• If the quantity of meat products manufactured is less than 150 tonnes per annum.	Rs. 1000
Category "C"	Manufacturer who makes meat food products exclusively from poultry and/or pig meat at places where authorised slaughter houses do not exist and the total quantity manufactured is less than 30 tonnes per annum.	Rs. 1000

Source: The Gazette of India (various issues)

The order also describes the details of sanitary and hygienic condition in slaughterhouses, ante and post-mortem inspection and humane slaughter of animals. To control and maintain the quality of meat food products, the quality norms with permissible limits related with poisonous metals, preservatives, insecticides, sequestering and buffering agents and mono-sodium glutamate, have been laid down in the order.

2) Export of Raw Meat (Frozen/ Chilled) (Quality Control and Inspection) Rules, 1992

This rule has been incorporated under the Export (Quality Control and Inspection) Act, 1963, to check and maintain the quality standard of meat exported to other countries. The rule includes definitions, details of layout *and management of slaughterhouses, sampling methods for quality* checking, quality specifications of *different species of meat, storage and procedures of* inspection and certification. The central government recognizes the Directorate of Animal Husbandry of all state governments, as an agency for the inspection of meat quality prior to export. The export of raw meat is not possible without a mark or seal recognized by the Central Government on the packages or containers, indicating that it conforms to the standard specifications defined under the rules and is export worthy.

The schedule-I of the rule state that all abattoirs/ slaughterhouses shall have the basic essential facilities like a resting place for animals before slaughtering, adequate facilities for ante-mortem inspection, carrying out humane slaughter, facilities for washing the carcasses, hanging carcasses and edible offals, handling by-products, disposal of waste, separate wards for diseased animals and adequate water supply. They shall also have reception area, lairages, slaughter halls, ancillary accommodation and refrigerated rooms.

Table 11: Minimum number of cartons to be selected from each lot

No. of cartons in the lot	No. of cartons to be selected in routine inspection	No. of cartons to be selected in re-inspection
Up to 100	4	8
101 to 200	5	10
201 to 500	6	12
501 to 800	7	14
801 to 1200	8	16
1201 to 3200	9	18
3201 to 8000	10	20
8001 and above	12	24

Source: The Gazette of India (various issues)

The Rules describe the details of sample size and method selection in schedule-II. Each type of meat produced for export shall be kept in separate lots. Samples shall be tested from each lot ascertaining the conformity of material with the requirement laid down in schedule-II to VII. Table 11 shows the number of cartons to be selected for inspection randomly from a specified lot and minimum sample weight per carton shall be 50 gms. The sample from the carcasses or quarters shall be taken from the back muscle, shoulders, eye muscle, hind quarters and back, and care shall be taken during inspection. Minimum weight per sample/ carcass shall be 100 gms.

As per the guidelines of the Rules, two samples shall be drawn, one for the analytical laboratory and the other sample shall be sealed by the inspecting officer and deposited for safe custody in the meat plant under

proper refrigeration. The sample shall be examined by the inspecting officer to ensure conformity with prescribed standards which include the internal temperature of meat, no ragged edges, off-colour, flabby or watery nature, pieces of bones, hair, excessive connective tissues, blood clots, excessive trimmings, excessive fat, greasy, fungus, bad odour, souring, freezer burn, parasitic cysts, firmness.

The inspection of raw meat intended for export shall be carried out which conforms to the specifications recognized by the Central Government. A meat exporter shall submit an application for inspection in prescribed proforma giving particulars of consignment to the nearest office of agency for quality control not less than five days before the anticipated date of dispatch. A Veterinary Health Certificate is issued by the agency declaring the raw meat (chilled/ frozen) as fit for human consumption and export-worthy. If the agency is not satisfied with the quality standard of meat, it shall within a period of five days refuse to issue such certificate and communicate such refusal to the exporter along with the reasons thereof. The agency shall also have the right to reassess the quality of consignment in storage, transit or at the ports and at any stage if it is found not conforming to the standards, the certificate originally issued shall be withdrawn. The validity of inspection certificate shall be five days for chilled meat and ninety days for frozen meat. If the consignment is not shipped within the period of validity of a certificate, the exporter shall be permitted to present the consignment for revalidation. In such cases, the validity shall be extended for a further period of three days for chilled meat and thirty days for frozen meat.

The inspection fee shall be paid by the exporters/ processors to the agency as here under:

- For export under consignment, a fee at the rate of 0.4 per cent of the F.O.B. value, subject to a minimum of Rs. 50 per consignment.
- For export under the in-process quality control system, a fee at the rate of 0.2 per cent of the F.O.B. value, subject to a minimum of Rs. 50 per consignment.
- For export under the self-certification system, a fee at the rate of 0.1 per cent of the F.O.B. value, subject to a minimum of Rs. 2500 and a maximum of Rs. 1 lakh only in a year.

To maintain the quality of meat for export, the rules have also provided proper guidelines for handling the carcass during transportation. The specifications of transport requirements have been given in table 12.

Table 12: Specification for transportation of meat

Type of meat	Specification for transport
Fresh	Vehicles fully covered with impervious flooring and side walls in case of transport over distance exceeding 100 kms., suitable arrangement shall be made to maintain a temperature not exceeding 6°C
Chilled	Transported in refrigerated/ insulated vans, in case of transport over distance exceeding 100 kms, suitable arrangement shall be made to maintain a temperature not exceeding 6°C
Frozen	Transported in refrigerated/ insulated vans. The temperature of the carcass meat shall not go above minus 8°C

Source: The Gazette of India (various issues)

Conclusions

India has good potential for production and export of meat and meat products. The meat production is mainly constrained due to socio-religious factors. It has been seen that uneconomic holdings of herd size leads to addition in cost of milk production as livestock is usually reared for milk purposes. Besides, meat yield per animal in India is extremely low due to use of old and unproductive animals for meat production. There is a serious need for a technological breakthrough in breed improvement especially for meat production. An alternative option to sustain output growth is to affect changes in the structure of meat production. As the potential off-take for small ruminants is nearly fully utilised, we should utilise the potential of large ruminants, whose slaughter rate has been low. This has to take place through policy intervention and public awareness. Though buffalo is not subject to a slaughter ban, its potential should be utilised as buffalo meat also has enough price competitiveness for export.

Therefore, to improve the quality of meat we have to improve the quality of animals for slaughter by giving them quality feed, health treatment, proper cattle yard, proper cattle management, water and drainage facilities etc., on one hand, and improve the processing technology, on the other. Since common farmers are unable to provide these facilities to animals, therefore, meat processors should adopt backward integration to produce quality animals for international quality meat production. For the producers, supply controls and contract growing arrangements will provide an assured market for slaughter at a reasonable price. This will also improve quality, reliability of supply and timeliness of delivery, which in turn improves cost efficiency, planning and the utilization capacity of plants.

This paper has largely been drawn from the ongoing doctoral research of the first author on "Growth and Efficiency in the Indian Meat Processing Industry" at the Department of Agricultural Economics and Business Management, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh.

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The victors of the battles of tomorrow will be those who can best harness thought to action.

– B.C. Forbes

Feature

Technical Efficiency of Paddy Farmers in Haryana

S.K. Goyal, K.S. Suhag & U.K. Pandey

This paper estimates farm-level technical inefficiency on paddy farms in Haryana, by applying translog stochastic frontier production function using unbalanced panel data for three years from 1996-97 to 1998-99. The data was collected from 93 farmers for each year, forming 231 total observations. The results showed that the null hypothesis of absence of technical inefficiency effects was rejected indicating that the traditional average response function was not an adequate representation of the data. Once the factors for increasing inefficiency effects are identified, policies can be formulated which could deal with bridging the gap between potential and actual yield through improving the extension advice, farmers' training and research.

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Agriculture is the mainstay of livelihood of the Indian people. About 65 per cent of the total working force is engaged in agriculture, a sector which accounts for only about 25 per cent of the gross domestic product (GDP), whereas the non-agriculture sector employs only about 35 per cent of total workers but accounts for about 75 per cent of the gross domestic product. The availability of land is the most critically limiting factor of production in farming.

Rice is the most important cereal crop grown in India constituting about 42 per cent of the total foodgrain production and accounting for about 24 per cent of the total cropped area. In Haryana State, rice covers about 17 per cent of the total cropped area and contributes about 22 per cent to the total foodgrain production of the state. The rice production in Haryana had increased from 223,000 tonnes in 1966-67 to 2,695,000 tonnes in 2001-02, registering an increase of about 32 per cent per annum. The share of paddy area in the total cropped area showed a consistent increase in Haryana. It was only about 5 per cent in 1996-67 and reached to 17 per cent in 2001. Paddy is an irrigation intensive crop. Because of urbanization and limitation on irrigation potential, cultivating more area under the crop is not possible. The increase in production is possible only through improvement in productivity of the crop. Productivity can be increased through one or a combination of its determinants - the technology, the quantities and types of resources used and the efficiency with which the resources are used. Of the various determinants, improvement in the efficiency of the resources already at the disposal of the farmers is of great concern.

In this context technical efficiency in production of a crop becomes of paramount importance. As far as technical efficiency in production is concerned, there are two possibilities. The policy makers can either attempt to enhance the uptake of improved technologies relevant particularly to small-scale agricultural production by im-

proving the Research and Development (R&D) processes, or they can take steps, which enable the farmers to improve technical efficiency in production. While the former probably requires a long time, considerable funds and effort, it is likely to yield long-term benefits. Else, raising technical efficiency offers more immediate goals at modest costs, if it can be shown that substantial inefficiencies are present in agricultural production. This research is based on an analysis of technical inefficiencies in the production of paddy crop by farmers. Therefore, an attempt has been made in this paper to investigate farm specific technical efficiency for paddy in Haryana. In the present study, we employ the stochastic frontier approach for panel data developed by Battese and Coelli, 1992, to estimate the technical efficiency of paddy farmers. This approach allows us to predict the technical efficiency and also to test whether the technical efficiency increases, decreases or remains constant over time. Such information may help the policy makers/planners to formulate appropriate policies to improve technical efficiency of paddy cultivation.

Analytical Tools

Stochastic frontier production function

A measure of technical efficiency was first introduced by Farrell (1957) for a cross section of firms by using a deterministic approach. This approach ignores any random factors that can influence the efficiency of a firm. Later on, a more satisfactory means of estimating technical efficiency viz., stochastic frontier model was independently developed by Aiger et. al.(1977) and Meeusen and van den Broeck (1977). Jondrow et. al. (1982) made it possible to estimate technical efficiency for each firm. Stochastic production function have two error terms, one to account for the existence of technical inefficiency of production and the other to account for factors such as measurement error in the output variable, weather, etc. and the combined effects of unknown inputs on production. The technical efficiency of individual sample farms can be predicted on the basis of cross-section or panel data. Cross-sectional data provides an insight to producers and their efficiency.

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The studies such as Pit and Lee, (1981); Kumbhakar, (1990), Mythili and Shanmugan, (2000), etc have made use of panel data. Reviews on models for stochastic frontier production function and application to agricultural sector are given by Forsund et.al (1980), Bauer (1990), Greene (1993), Bravo-Ureta and Pinheiro (1993), Coelli (1995) and Kumbhakar et.al. (1997). Stochastic frontier models have been widely applied in the analysis of the efficiency of rice farming, especially in developing countries. For India, such studies include Battese, Coelli & Colby (1989) and Kalirajan (1991).

The present study uses the stochastic frontier production function approach for panel data to measure the technical efficiency in paddy production. The production process is modelled with a single-output production frontier. In the analysis of farmers' efficiency/ inefficiency, it is not the average of observed relationships between farmers' inputs and outputs that is of interest but the maximum possible output that is obtainable from a given combination of inputs. Thus, Frontier production function can be defined as the maximum feasible, or potential output that can be produced by a firm with a given level of inputs and technology.

The general specification of frontier production function considered is defined by

$$Y_{ht} = \exp (X_{ht}\beta + V_{ht} - U_{ht}) \qquad (1)$$

Where: Y_{ht} represents the output for the h-th firm in the t-th time period; X_{ht} is a (1xK) vector of inputs for the h-th firm in the t-th time period; β is a (Kx1) vector of parameters that describe the transformation process,

the V_{ht} are assumed to be independent and identically distributed random error which have normal distribution with mean zero and unknown variance σ_v^2 2v; and

the U_{ht} are non-negative unobservable random variables associated with the technical inefficiency of production, such that, for the given technology and levels of inputs, the observed output falls short of its potential output. The U_{ht} is zero when the farm produces the potential output (full TE) and is greater then zero when production is below the frontier (less then full TE)

The model developed by Battese and Coelli (1992) has been employed as it can accommodate unbalanced

panel data associated with a sample of 'H' firms over 'T' time periods. Also it provides a measure of technical efficiency for the same farm, in each time periods considered. Following the model, U_{ht} can be defined as:

$$U_{ht} = \{\exp [-\eta (t-T)]\} U_h, \quad \ldots(2)$$

Where: η is an unknown parameter to be estimated; and U_h, h = 1,2....N, are non-negative random variables that are assumed to be independently and identically distributed obtained by truncation of the normal distribution with unknown mean, μ, and unknown variance σ_u^2.

U_{ht} decreases, remains constant or increases as 't' increases depending upon whether $\eta > 0$, $\eta = 0$ or $\eta < 0$, respectively.

The parameters of stochastic frontier production function model are estimated by maximum likelihood (ML) method using the computer programme, FRONTIER 4.1 (See Coelli, 1994).

Model specification

For empirical analysis, a translog stochastic frontier production function is specified as given below:

$$\text{Ln}(Y_{ht}) = \beta_0 + \sum_{i=1}^{6} \beta_i X_{iht} + \sum_{i \geq k}^{6} \sum_{i=1}^{6} \beta_{ij} X_{iht} X_{jht} + V_{ht} - U_{ht} \quad \ldots(3)$$

Where: the subscripts 'h' and 't' refer to the h-th farmer and t-th year of observation, respectively.

Ln represents the natural logarithm (i.e. to base e)

Y represents the quantity of paddy (in kg)

X_1 represents the total human labour (in hours). Human labour includes both family as well as hired labour. Labour mandays were converted to male equivalent units by treating female and child hours equivalent to 0.67 and 0.50 male hours, respectively.

X_2 represents the quantity of fertilizer (kg of NPK)

X_3 represents irrigation expenditure (in Rs.)

X_4 represents land area (in hectares)

X_5 represents expenditure on plant protection measures (in Rs.)

X_6 represents the year of observation where X_6 = 1, 2 and 3 for the years, 1996-97, 1997-98 and 1998-99.

V_{ht} -Uht is the random variables defined above.

The technical efficiency of production of the h-th farm in the appropriate data set, given the levels of his inputs is defined as the ratio of the observed output to the frontier output which could be produced by a fully-efficient firm, in which the inefficiency effect is zero. The technical efficiency of the h-th farmer in the t-th year of observation can be calculated as:

$$TE_{ht} = \exp(-\mu_{ht}) \quad \ldots(4)$$

The technical efficiency of a farmer is between zero and one and is inversely related to the level of the technical inefficiency effect. The technical efficiency can be predicted using the Frontier programme (FRONTIER 4.1).

Testing whether technical inefficiency effects are not present in the model is of great interest. This is expressed by H_0: $\gamma = 0$, where the parameter, γ is defined by $\gamma = \sigma^2/(\sigma_v^2 + \sigma^2)$ and $\sigma_s^2 = \sigma_v^2 + \sigma^2$

The γ-parameter has value between zero and one. The γ is zero when U_{ht} equals to zero (full TE). If this is the case, the Ordinary Least Square (OLS) estimates are also ML estimates. The null hypotheses that the technical inefficiency effects are time invariant and that they have half normal distribution are defined by H_0: $\eta = 0$ and H_0: $\mu = 0$, respectively. If parameter (is positive, the technical efficiency of the sample farm increases over time and vice versa. However, if η is zero, then the farm effect will be constant over time. Similarly, if parameter (were zero, then farm effect would have a half normal distribution instead of a truncated normal distribution. The Cobb-Douglas production frontier is adequate in describing the production of the data if the coefficients of the second order terms are zero, i.e. $H_0 = \beta_{ij} = 0, i \leq j = 1, 2.... 6$. There will be no technical change if the coefficients of all variables involving years of observation are zero, i.e. $H_0 = \beta_6 = \beta_{i6} = 0$, i = 1, 2...6. Further, the hypothesis that neutral technical change is present is defined by $H_0 = \beta_{i6} = 0$, i = 1, 2, 3, 4, 5 i.e. if the coefficients of the interaction between year of observation and the input variables are zero. The hypotheses are tested using the generalized likelihood-ratio test statistic. The decision whether to accept the corresponding null hypothesis depends upon the value of the test statistic obtained using generalized likelihood-ratio statistic which is defined by:

$$\lambda = -2 \text{Ln}(L(H_0) (L(H_1)$$

Where: $L(H_0)$ and $L(H_1)$ are the values of the likelihood function for the frontier model under the specification of null and alternative hypotheses, H_0 and H_1, respectively.

If the null hypothesis is true, then (has approximately chi-square (or mixed chi-square) distribution with degrees of freedom equal to the difference between the parameters estimated under H_1 and H_0, respectively.

The Data

The data used are compiled under the comprehensive scheme on "Cost of Cultivation of Principal Crops" in Haryana, India. The farm level panel data for the years 1996-97, 1997-98 and 1998-99 are used for the estimation of the model. The survey on cost of cultivation of principal crops is undertaken under the auspices of the Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India. In Haryana, the scheme is being implemented by the CCS Haryana Agricultural University, Hisar. The farm level data is collected by adopting multi-stage stratified random sampling techniques. Under this scheme, the Haryana state has been classified into three zones according to the agro-climatic factors such as rainfall, irrigation pattern, soil characteristics, etc. The selection of tehsils, cluster of villages and farm households from each zone form the first, second and third stage of sampling units, respectively. The data is collected from 10 farms each from 30 clusters of villages from all the three zones, which form a total sample of 300 farms each year. For the present study, 70 per cent of the total clusters from each zone have been selected. In totality 20 clusters, which constitute 200 farms, formed the total sample in each year for compilation of the required information. As the present study is confined to paddy crop, there were only 93 farmers who cultivated the said crop. For some years, a few observations did not undertake paddy cultivation or were non-existent. Therefore, the data set consists of 93 farm units constituting 231 total observations for all the three years. The required information on physical input-output data, factor-product prices and other related variables were collected from the scheme for arriving at the objectives of the study.

Results

A basic summary of the values of the key variables, defined in the model is presented in Table 1.

The figures are for a per farm basis. The average paddy production per farm was 108 qt. which ranged from 6.00 to 410 qt. On an average 1217 hours of human labour per farm were used by the farmers for paddy cultivation. The average area under paddy was 2.57 hectares on the sample farms but the size varied from a very small farm of 0.2 hectare to a large farm of 11.20 hectares. The cost incurred on plant protection measures was Rs. 2111 per farm. On an average, the sample farmers used 442 kg of fertilizers (NPK). The average expenditure per farm on irrigation incurred was Rs. 7854. However, expenditure on irrigation ranged from merely Rs.80 to Rs. 40900 per farm.

Table 1: Summary statistics of study variables in the stochastic frontier model for paddy farmers in Haryana: 1996-99

Variable	Mean	Standard deviation	Minimum	Maximum
Output (qt)	108.00	93.50	6.00	410.00
Human labour (hours)	1217.05	1016.65	106.33	5334.00
Fertilizers (NPK) kg	441.82	418.27	23.00	2339.70
Irrigation expenditure (Rs)	7854.49	7411.08	80.00	40900
Land (ha)	2.57	2.16	0.20	11.20
Plant protection measures (Rs.)	2111.05	3392.20	0	24780

The maximum-likelihood estimates of the parameters in the translog stochastic frontier production function are presented in Table 2. Besides estimating the general form in conjunction with the panel data, some restricted forms were also estimated and tested.

The estimates for parameters of the time varying inefficiency model indicate that the technical inefficiency effects tend to increase over time since the parameter η is estimated to be negative (–0.74). For deciding the most appropriate model, various hypotheses were tested using likelihood-ratio (LR) statistic. The tests of various null hypotheses associated with the models were carried out and the results are presented in Table 3. The first null hypothesis, that there are no technical inefficiency effects, is rejected i.e. the likelihood-ratio test rejects the null hypothesis that $\mu = \gamma = \eta = 0$. The LR test statistic (λ) is 56.75 which is significant at 5 per cent probability level, implying thereby that traditional average response function was not an adequate representation for the data given the specification of the stochastic frontier with time varying farm effects. Thus, inefficiencies of production can not be assumed to be absent from the stochastic frontier production function for the given level of technology used by farmers.

If the null hypothesis is true, there are no frontier parameters in the regression equation, and the estimation becomes an ordinary least square estimates. The null hypothesis that H_0: ($4 = \eta = 0$, the technical inefficiency effects are time invariant and have half normal distribution are also rejected. However, the asymptotic t-value on the estimated value of μ is not statistically significant at 5 per cent indicating that μ follows half

Table 2: Estimates of stochastic frontier production function with time varying inefficiency effects for paddy farms in Haryana

Variable	Parameter	General Model	Preferred Model
Stochastic Frontier			
Constant	β_0	5.7293 (7.2927)	5.2585 (8.2930)
Labour	β_1	-3.9816* (1.7330)	-3.7313** (2.0342)
Fertilizer	β_2	2.3266* (1.0364)	2.1805** (1.1066)
Irrigation	β_3	0.9630 (0.9055)	0.9830 (0.9367)
Land	β_4	1.9783 (2.1629)	1.8582 (2.4337)
Insecticides	β_5	-0.0351 (0.1513)	-0.0410 (0.1516)
Year	β_6	-0.9467 (0.7216)	-0.9498*** (0.7292)
Labour x Labour	β_{11}	0.4793* (0.1607)	0.4726* (0.1749)
Fertilizer x Fertilizer	β_{22}	0.0602 (0.0831)	0.0716 (0.0842)
Irrigation x Irrigation	β_{33}	0.0464 (0.0337)	0.0488*** (0.0331)
Land x Land	β_{44}	0.1444 (0.1700)	0.1387 (0.1874)
Insecticides x Insecticides	β_{55}	0.0176* (0.0043)	0.0176* (0.0042)
Year x Year	β_{66}	0.0624* (0.0360)	0.0704** (0.0372)
Labour x Fertilizer	β_{12}	-0.2454* (0.1636)	-0.2514*** (0.1688)
Labour x Irrigation	β_{13}	-0.0479 (0.1359)	-0.0667 (0.1360)
Labour x Land	β_{14}	-0.5351* (0.2798)	-0.4944*** (0.3226)
Labour x Insecticides	β_{15}	-0.0360* (0.0209)	-0.0358** (0.0212)
Labour x Year	β_{16}	-0.1080 (0.0911)	-0.1061 (0.0916)
Fertilizer x Irrigation	β_{23}	-0.2202* (0.1038)	-0.2093** (0.1068)
Fertilizer x Land	β_{24}	0.1376 (0.1855)	0.1061 (0.1946)
Fertilizer x Insecticides	β_{25}	0.0496* (0.0157)	0.0508* (0.0159)
Fertilizer x Year	β_{26}	0.2124* (0.0664)	0.2043* (0.0658)
Irrigation x Land	β_{34}	0.1876 (0.1504)	0.1892 (0.1560)
Irrigation x Insecticides	β_{35}	-0.0215* (0.0121)	-0.0216** (0.0123)
Irrigation x Year	β_{36}	0.0188 (0.0429)	0.0216 (0.0421)
Land x Insecticides	β_{45}	-0.0172 (0.0254)	-0.0174 (0.0255)
Land x Year	β_{46}	-0.1667 (0.1135)	-0.1585*** (0.1136)
Insecticides x Year	β_{56}	0.0213* (0.0105)	0.0208** (0.0105)
Variance Parameters			
	σ_s^2	0.7096* (0.3458)	0.2397* (0.0537)
	γ	0.9551* (0.0249)	0.8683* (0.0352)
	μ	-1.6465 (1.1267)	0.
	η	-0.7490* (0.1625)	-0.7700* (0.1741)
Loglikelihood Function		16.759	15.2686

1. Figures in the parentheses indicate standard errors.
2. *, ** and *** Significant at 1, 5 and 10 per cent probability level, respectively

normal distribution. The equation was re-estimated by imposing restrictions $\mu = 0$ and $\eta = 0$. The hypothesis that $\eta = 0$, the technical inefficiency effects are time invariant is rejected but the hypothesis, $\mu = 0$, the technical inefficiency effects have half normal distribution is accepted. The next null hypothesis, H_0: $\beta_{ij} = 0$, $i \leq j = 1, 2...6$, that the Cobb-Douglas frontier is an adequate representation of the data for rice production is strongly rejected. The hypothesis, H_0: $\beta_6 = \beta i_6 = 0$, $i = 1, 2...5$, that there is no technical change is rejected by the data. Also, the null hypothesis of neutral technical change (i.e. interaction of year of observation with input variables in the model is zero), H_0: $\beta i_6 = 0$, $i = 1, 2...5$, is rejected. Thus, given the specification of translog frontier produc-

tion function, the above tests of hypotheses indicate that the preferred model is the model with time varying inefficiency effects (or technical efficiencies) and have half normal distribution of farm effects. The parameter estimates are presented in Table 2.

The parameter σ and γ terms are positive and statistically significant at the 5 per cent level again indicating that the observed output significantly differed from frontier output due to factors which are within the control of farmers. This implies that, the average production function estimated using OLS was not the right estimate of the production function in the present case. The variance ratio was significant at the 5 per cent level which indicates that the variation in output of individual farms from its maximum possible frontier output arises mainly from technical inefficiency rather than random variabilities. The variance ratio showed that about 87 per cent of the differences between the observed output and the frontier level of output was caused by differences in firm's technical efficiencies, while the remaining variation is due to factors out of the control of farm households.

Elasticities

The individual coefficients of the explanatory variables in the translog frontier are not directly interpretable. The estimates of elasticities of the mean output with respect to various inputs, which are functions of the second order coefficients of the translog frontier and the levels of inputs are very important. Therefore, the elasticities of mean production with respect to kth inputs i.e. human labour, fertilizer, irrigation expenditure, land area and expenditure on plant protection measures (insecticides) for the translog stochastic frontier production function are calculated as a second stage after the parameters are estimated at the mean values of the different inputs, using the maximum likelihood estimates of the parameters in the preferred model. The elasticities are calculated using the following expression:

$$\frac{\partial \text{LnE(Y)}}{\partial \text{Ln(Labour)}} = \beta_1 + 2\beta_{11}\,\text{Ln(Labour)} + \beta_{12}\,\text{Ln(Fertilizer)} + \beta_{13}\,\text{Ln(Irrigation)} + \beta_{14}\,\text{Ln(Land)} + \beta_{15}\,\text{Ln (Insecticides)} + \beta_{16}\,\text{ln (Year)} \quad \ldots(5)$$

$$\frac{\partial \text{LnE(Y)}}{\partial \text{Ln(Fertilizer)}} = \beta_2 + 2\beta_{22}\,\text{Ln(Fertilizer)} + \beta_{12}\,\text{Ln(Labour)} + \beta_{23}\,\text{Ln(Irrigation)} + \beta_{24}\,\text{Ln(Land)} + \beta_{25}\,\text{Ln (Insecticides)} + \beta_{26}\,\text{ln (Year)} \quad \ldots(6)$$

$$\frac{\partial \text{LnE(Y)}}{\partial \text{Ln(Irrigation)}} = \beta_3 + 2\beta_{33}\,\text{Ln(Irrigation)} + \beta_{13}\,\text{Ln(Labour)} + \beta_{23}\,\text{Ln(Fertilizer)} + \beta_{34}\,\text{Ln(Land)} + \beta_{35}\,\text{Ln (Insecticides)} + \beta_{36}\,\text{ln (Year)} \quad \ldots(7)$$

$$\frac{\partial \text{LnE(Y)}}{\partial \text{Ln(Labour)}} = \beta_4 + 2\beta_{44}\,\text{Ln(Land)} + \beta_{14}\,\text{Ln(Labour)} + \beta_{24}\,\text{Ln(Fertilizer)} + \beta_{34}\,\text{Ln(Irrigation)} + \beta_{45}\,\text{Ln (Insecticides)} + \beta_{46}\,\text{ln (Year)} \quad \ldots(8)$$

$$\frac{\partial \text{LnE(Y)}}{\partial \text{Ln(Insecticides)}} = \beta_5 + 2\beta_{55}\,\text{Ln(Insecticides)} + \beta_{15}\,\text{Ln(Labour)} + \beta_{25}\,\text{Ln(Fertilizer)} + \beta_{35}\,\text{Ln(Irrigation)} + \beta_{45}\,\text{Ln (Land)} + \beta_{56}\,\text{ln (Year)} \quad \ldots(9)$$

Table 3: Likelihood-ratio tests of hypotheses for parameters of the stochastic frontier production function for paddy farms in Haryana

Null Hypothesis	Loglikelihood	λ	Critical value	Decision
Given Model	16.759			
$\mu = \gamma = \eta = 0$	-11.618	56.75	10.50*	Reject
$\mu = \eta = 0$	0.499	34.52	5.99*	Reject
$\mu = 0$	15.268	2.98	3.84	Accept
$\eta = 0$	2.451	28.62	3.84	Reject
$H_0 = \beta_{ij} = 0, i \leq j = 1,2...6$	-15.835	65.19	32.67	Reject
$H_0 = \beta_6 = \beta i_6 =, i = 1,2...6$	6.119	21.28	14.07	Reject
$H_0 = \beta i_6 = 0, i = 0, i = 1,2...5$	6.694	20.13	11.09	Reject

* The critical value for this test involving gamma = 0 is obtained from Table of Kodde and Palm (1986, p1246)

The elasticities of mean paddy output and their estimated standard error are presented in Table 4. The estimated elasticity of mean paddy output with respect to human labour is estimated to be negative. However, the elasticity is not statistically different from zero. The negative elasticity of frontier output for human labour indicates that labour use is not optimal. The frontier elasticity for labour estimated should not be referred to as being associated with 'best practice' paddy production in Haryana. The empirical results in Table 4 indicated that the land had the major influence on output. The elasticity of frontier (best practice) production with respect to land under paddy was estimated to be 0.49. This indicated that, if area under paddy were to be increased by 1 per cent, then the total paddy production were estimated to increase by 0.49 per cent. Further, the elasticity of fertilizer was estimated to be 0.30. Thus, if fertilizer use were to increase by 1 per cent, then the mean production of paddy was estimated to increase by

about 0.30 per cent for the best practice paddy production. The results also show that the elasticity of output with respect to human labour is estimated to be an increasing function of human labour, but it is estimated to be an decreasing function of fertilizer, irrigation, land and insecticides. The elasticity of farm output with respect to fertilizer is estimated to be an increasing function of fertilizer, land and insecticides but decreasing function of human labour and irrigation expenditure. It is also observed that the elasticity of output with respect to irrigation expenditure is estimated to be an increasing function of irrigation expenditure and land but decreasing function of human labour, fertilizer and insecticides. The elasticity of output with respect to insecticides is estimated to be an increasing function of insecticides and fertilizer but the decreasing function of human labour, irrigation and land. The returns to scale parameter is estimated to be 0.85 which indicates that there are decreasing returns to scale at the mean values of the variables.

Table 4: Elasticities of mean output under MLE specification

Elasticity with respect to	Elasticity	Standard Error
Human labour	-0.1050	0.1858]
Fertilizer	0.2989	0.0725
Irrigation expenditure	0.1667	0.0484
Land	0.4914	0.0873
Plant protection measures	0.0003	0.0304

Technical inefficiencies

A production process is technically inefficient if the maximum output is not produced from a given bundle of inputs. The technical efficiency of each farm was predicted and found to be time varying. It implies that farm specific technical efficiency varies over time. Because of the large number of observations involved, the individual technical efficiency values were not presented. For better indication of the distribution of individual efficiencies, a frequency distribution of predicted technical efficiencies within ranges of 0.05 for each year are presented in Table 5 and also depicted in Fig.1.

The farm specific technical efficiency showed very wide variations. The predicted technical efficiencies for paddy farmers ranged from 0.72 to 0.98, with mean technical efficiency estimated to be 0.93 in the first year (1996-97); from 0.50 to 0.96, with mean technical efficiency estimated at 0.86 in the 2nd year (1997-98) and from 0.22 to 0.91, with mean technical efficiency estimated at 0.73 in the 3rd year (1998-99) of study data. The estimated mean technical efficiencies are an

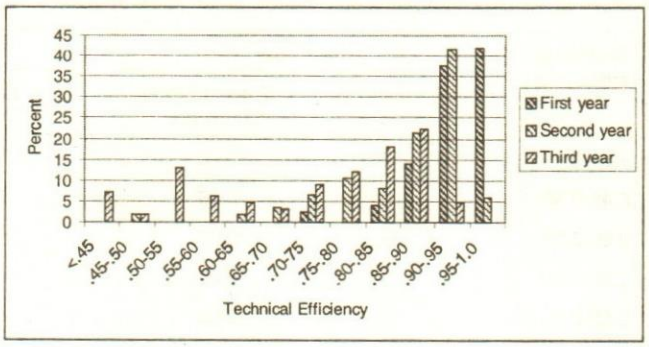

Fig. 1. Distribution of technical efficiency of paddy farmers in Haryana

indication of increasing inefficiency effects over the years. An examination of technical efficiency of individual farmers also revealed that a downward trend in the level of technical efficiency is observed over years. The negative value of η (-0.77) further confirmed that the technical efficiency tends to decline over the years.

There were about 80 per cent of paddy farmers who had technical efficiency greater than 0.90 in the first year observed. This percentage reduced to 47 in the second year and in the third year, only about 5 per cent of paddy farmers had technical efficiency above 0.90. Also, there were some farmers (about 6 per cent) who were quite poor in their technical efficiency performance (less than 0.45) in that year. In the first year, no sample farmer operated below 0.7 level of technical efficiency and in the second year, 6.50 per cent of sample farmers pushed to that level. In the third year, there was a quantum jump in this figure and about 33 per cent of the sample farmers operated below 0.7 level of technical efficiency. The main reason for downward trend in technical efficiency level may be attributed mainly to untimely rainfall, which resulted in decline in production of paddy in the state. It is evinced from the fact that the average yield of paddy was 30 qt./hectare in 1996-97 in Haryana which slightly declined to 28 qt /hectare in the next year. The average yield of paddy further declined to 22 qt/hectare in 1998-99. Maximum numbers of farmers (53 per cent) were concentrated between 0.75 to 0.90 level of technical efficiency and about 1/3rd per cent of sample households operated at technical efficiency level of up to 0.70 in third year. This indicates that it would be possible to increase paddy production with the given level of inputs and technology of the farmers who operated below the frontier level of production. The operation level of such type of farmers is very important because any attempt to bring this group to the frontier production will increase paddy production at the household's level and will add to the aggregate state production as well.

Table 5: Relative frequency distribution of technical efficiency of paddy farmers in Haryana

Technical efficiency	First year		Second year		Third year	
	Frequency	% age to total farm ers	Frequency	% age to total farmers	Frequency	% age to total farmers
≤0.45	0	0	0	0.00	5	5.88
0.45-0.50	0	0.00	1	1.30	1	1.18
0.50-0.55	0	0.00	0	0.00	10	11.76
0.55-0.60	0	0.00	0	0.00	5	5.88
0.60-0.65	0	0.00	1	1.30	4	4.71
0.65-0.70	0	0.00	3	3.90	3	3.53
0.70-0.75	1	1.45	5	6.49	8	9.41
0.75-0.80	0	0.00	8	10.39	10	11.76
0.80-0.85	3	4.35	7	9.09	16	18.82
0.85-0.90	10	14.49	16	20.78	19	22.35
0.90-0.95	26	37.68	32	41.56	4	4.71
0.95-0.99	29	42.03	4	5.19	0	0.00
Mean	0.9306		0.8597		0.7293	
Minimum	0.7242		0.4988	,0.2239		
Maximum	0.9795		0.9565		0.9098	
Total number of sample farmers	69		77		85	

Conclusion

The estimated translog stochastic frontier production function for paddy farmers in Haryana using unbalanced panel data for three years showed that the traditional average response function, which does not account for technical inefficiency of production, was not an adequate representation of the data. Further, it was found that the Cobb-Douglas functional form is not an adequate representation of the data. The farm-specific technical efficiencies estimated were time varying and tend to decline over time. The mean technical efficiency declined from 0.93 in first year to 0.73 in third year which indicates that average technical efficiency deteriorated through the years in paddy production. The mean level of technical efficiency further implies that the realized output could have been increased by about 27 per cent without any additional resources. However, the technical efficiency showed wide variation across sample farms ranging from 0.22 to 0.91 in the 3rd year of the study period. Further, the results show that about 80 per cent of the total sample farmers had technical efficiency above 0.90 in the first year observed. In the last year of study, only about 5 per cent of sample farmers operated above 0.9 level of technical efficiency. At the same time about 6 per cent of the sample farmers were quite poor in their technical efficiency (equal or less than 0.45) performance.

The results show that about 80 per cent of the total sample farmers had technical efficiency above 0.90 in the first year observed. In the last year of study, only about 5 per cent of sample farmers operated above 0.9 level of technical efficiency.

Various socio-economic, technological factors and natural factors may be responsible for the observed inefficiency in paddy production. It is a matter of great concern to identify those factors which resulted in increasing inefficiency effects in paddy production. Once the factors are identified, the policies can be formulated which could deal with bridging the gap between potential and actual yield through improving the extension advice, farmers' training and research.

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No institution which does not continually test its ideals, techniques, and measure of accomplishment can claim real vitality.

– John Milton

Feature

Marketing Efficiency of Potato – A Micro Level Analysis in Assam

C. Hazarika, A. Gogoi & J.P. Hazarika

The potato is one of the most important and widely cultivated field crops of Assam. However, major marketing channels are deficient and potato production does not meet its full potential in this state. The present study was conducted in Jorhat district of Assam to identify the major marketing channels and price spread analysis. Four major marketing channels of potato in Jorhat district of Assam were identified, their price spreads were studied through the mode method and the marketing margins were calculated for different intermediaries at various levels of marketing. It was observed that the total marketing cost was directly related to the number of intermediaries involved in that channel. The study revealed that the channel-I, i.e., producer – consumer was an effective and efficient channel among the four marketing channels for the potato.

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The potato occupies a place of prominence on the commercial crop map of India. Although the potato is cultivated on 0.70 per cent of the total cropped area, it contributes over 2.00 per cent of the aggregate value output from the agriculture sector in India. India ranks fourth both in terms of area and production of potato. In 1999-2000, the country produced 25 million tonnes of potato from an area of 1.34 million hectares with an average yield of 18.6 million tonnes per ha (Khurana and Naik, 2002a).

A majority of the area under potato crop in Assam falls under flood-affected areas of the state. But the crop growing season coincides with the flood-free period and hence farmers take the advantage of residual soil moisture and grow crop under rainfed condition. Further, these soils are light in texture with good aeration status and therefore suitable for successful potato cultivation. However, productivity of potato in Assam was 89.27 quintal per ha during 1997-98 which is much below than the national average, (167.10 q/ha). It is quite disappointing considering that Assam has good potential in all aspects, including suitable agro-climatic conditions, which vary from the tropical type to the temperate type, and light texture soil with good aeration status.

Potential potato growing areas of the state are normally located in remote places. Markets are generally located far away from these places and due to bad roads, transportation of inputs such as seeds, fertilizers, implements and also outputs is very difficult. Farmers have to sell their produce in local weekly markets just after harvest. They do not have any facility to store the potatoes. The basic needs like proper road communication, transport facilities, markets and cold storage are lacking in the areas where the crop is grown. The potato produce in Assam is used as ware potato. No seed production programme has been implemented in the state. Again, there is no processing unit. Because of these reasons, farmers are reluctant to take up the crop on a commercial basis.

Assam is deficit in potato production. Every year a sizeable amount of potato comes to the state from the other parts of the country. To increase the productivity of potato in Assam and to meet the growing demand, it is essential to make an in-depth analysis of the marketing of this crop. The present study was conducted in Jorhat district of Assam to identify the major marketing channels and price spread analysis.

To increase the productivity of potato in Assam and to meet the growing demand, it is essential to make an in-depth analysis of the marketing of this crop.

Methodology

The study was conducted in Jorhat district of Assam. The required information was collected through a pre-tested structured schedule. The primary data was collected from the sample respondents in a face-to-face situation and the editing of the complete schedule was done by none other than the interviewer himself.

Tabular and percentage analysis were undertaken according to the needs of the objective of the study. The price spreads for different channels were studied through the mode method and the marketing margins were calculated for different intermediaries at various levels of marketing. The total marketing costs, marketing margins and producer's share in consumers rupee were also examined separately for each channel and were presented in tabular form along with the respective percentage share. The marketing cost was calculated by estimating the cost incurred in the process of the marketing of the potato. The cost incurred after the harvesting of the crop until it reaches the consumer, generally constitutes the marketing cost. It includes transportation cost, handling cost, storage cost, market fees, weighing charges and labour charges for packing, loading and unloading. The marketing cost was calculated at various stages and finally the total marketing costs were computed. Marketing margin at any stage of marketing was calculated as follows.

$$MMi = SPi - (PPi + MCi)$$

Where,

MMi = Marketing margin of the i-th middleman

SPi = Selling price of the i-th middle man

PPi = Purchasing price of the i-th middle man

MCi = Marketing costs incurred by the i-th middle man

After calculating the marketing margins at different stages, finally the total marketing margins were calculated. The price spread is the difference between the price paid by the consumer and the price received by the producer. It mainly consists of marketing costs and margins. The price spread analysis was carried out as follows.

Producer's share in consumer's rupee =

$$\frac{\text{Producer's price}}{\text{Consumer's price}} \times 100$$

Similarly, the share of total marketing costs and the total marketing margins were also estimated to analyse the price spread. To determine the marketing efficiency a composite index of marketing efficiency for each channel was calculated. Here different marketing channels were identified and marketing efficiency (R) in the alternate marketing channels was computed by ranking different performance indicators. The indicators included were the producer's share in the consumer's rupee, marketing costs of intermediaries, marketing margins of intermediaries and return per rupee of investment. Ranks were attached to each performance indicator. By pooling all the indicators, the marketing efficiency was calculated.

$$R = \frac{R_i}{N_i}$$

Where,

Ri = Sum of ranks in each channel

Ni = Number of performance indicators

The channel with the lowest composite index is the most efficient channel.

Results and Discussion

Marketing channels are the paths through which goods move from the hands of producers to the hands of ultimate consumers. It involves various middlemen who facilitate the flow of goods and services from the points of production to the points of ultimate consumption. The channels are also the chains of intermediaries involved in the smooth distribution of products from producers to consumers. The length of the channel varies from commodity to commodity, depending on the quantity to be moved, and the nature and degree of regional specialization in production.

Table 1: Effectiveness of various marketing channels of potato for different size groups

Channels	Small		Medium		Large		All farms	
	Qnty. (qt)	per cent	Qnty. (qt)	per cent	Qnty. (qt)	per cent	Qnty. (qt)	per cent
I	176.43	65.20	231.81	54.44	127.43	25.28	535.67	44.62
II	81.99	30.30	150.10	35.25	190.85	37.86	422.94	35.23
III	12.18	4.50	43.91	10.31	185.81	36.86	80.55	6.71
IV							161.35	13.44
Total	270.60	100.00	425.82	100.00	504.09	100.00	1200.51	100.00

In this study, four major marketing channels of potato in Jorhat district of Assam were identified. The four channels are as follows.

Channel I : Producer – Consumer

Channel II : Producer – Retailer – Consumer

Channel III : Producer – Village trader – Consumer

Channel IV : Producer – Village trader – Retailer – Consumer

No wholesaler was found in the marketing channels transacting locally-produced potato. The wholesalers that exist in the district deal in potatoes which are coming from the other states of the country.

The amount of quantity sold through different channels is presented in table I.

From the table, it is evident that channel I was the most effective channel through which small, medium and large farmers transacted 65.20, 54.44 and 25.28 per cent of their marketed surplus, respectively. For the all farms group 44.62 per cent was sold through this channel. The next effective channel was channel II through which 35.23 per cent of the total marketed surplus was transacted. Small, medium and large farmers transacted 30.30, 35.25 and 37.86 per cent, respectively, through this channel. Through channel IV and channel III, 13.44 per cent and 6.71 per cent, respectively, of the total marketed surplus was sold. Therefore, channel III was the least effective channel among the four. Category wise, i.e., small, medium and large groups of farmers, flow of commodity through channel III and channel IV could not be traced out. Therefore, only pooled estimates were considered. The pattern of disposal revealed that small and medium farmers sold the majority of their marketed surplus through channel I. The next effective channel for them was channel II. Only 4.50 per cent and 10.31 per cent of the marketed surplus were transacted through channel III and channel IV by the small and medium groups of farmers, respectively. For a large group of farmers channel I was the least effective channel. They sold a maximum amount of their marketed surplus through channel II. The next effective channel for them was channel III and channel IV through which 36.86 per cent of their marketed surplus was transacted. The marketing channels of potato in Jorhat district are also presented in a flow chart in Fig. 1.

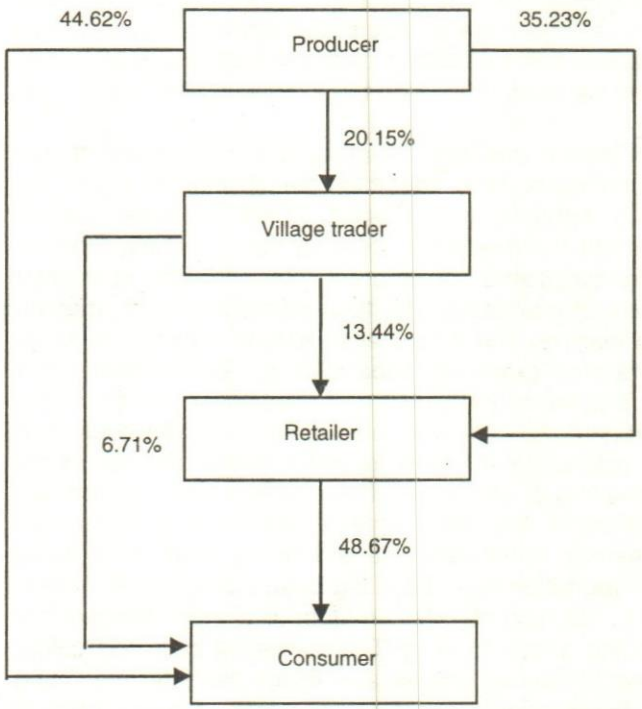

Fig. 1. Flow Chart showing Channels of Distribution of Potato

The small and medium groups of farmers mostly preferred to sell their products through channel I than the other channels. This might be due to the fact that they had a small amount of marketed surplus. Channel I fetched more price and they preferred to sell directly to the consumer through this channel. On the other hand, the large group of farmers had a comparatively large amount of marketed surplus. They could not take the

Table 2: Area, production, marketable and marketed surplus of potato for different size groups

Size groups	Area under potato (ha)	Production (q)	Average area under potato (ha)	Per ha production (q)	Requirement for family consumption (q)	Retained for seed (q)	Non market transactions			Total (q)	Marketable surplus (q)	Marketed surplus (q)	Per ha marketed surplus (q)	Per farm marketed surplus (q)
							Presented to others (q)	Wastage (q)	Paid to labour in kind (q)					
Small	3.65	329.33	0.09	90.23	93.28 (28.32)	27.68 (8.40)	1.95 (0.59)	4.90 (1.51)	1.20 (0.36)	129.01 (39.17)	200.32 (60.83)	270.60 (82.17)	74.14	6.94
Medium	5.28	497.64	0.12	94.25	128.97 (25.92)	24.30 (4.88)	3.95 (0.79)	9.25 (1.85)	2.52 (0.51)	168.99 (33.96)	328.65 (66.04)	425.82 (85.57)	80.65	9.68
Large	6.17	575.72	0.17	93.31	108.20 (18.79)	25.80 (4.48)	4.40 (0.76)	11.00 (1.91)	3.75 (0.65)	153.15 (26.60)	422.57 (73.40)	504.09 (87.56)	81.70	13.62

Figures in parentheses indicate percentage to production

burden of selling the majority of their produce through channel I. Therefore, they sold most of their produce to retailers and village traders, which would ultimately be consumed by distant consumers.

Marketed and marketable surplus

"Marketed surplus" is the actual amount of produce which the producer-grower sold out of the year's production irrespective of his requirements, family consumption, wastage and other payments. On the other hand, "marketable surplus" is that quantity which is left with the producer after meeting his consumption and other farm requirements. It is the residual left with the producer after meeting his requirements for family consumption and other non-market transactions like seeds, wastage, feed, presentation to relatives, payments to labour and also the customary payments in kind. Theoretically these two words are often used interchangeably. For perishable commodities marketed surplus may be equal to the marketable surplus when the farmer retains more or less than his requirements (Acharya and Agarwal, 1978a).

Table 2 represents the area, production, non-market transaction, marketable and marketed surplus of the potato. The analysis was carried out for different categories of farmers. The table revealed that the average size of operational holding under potato was 0.09 ha, 0.12 ha and 0.17 ha for small, medium and large groups of farmers, respectively. The average yield per ha was highest in the medium group of farmers followed by large and small groups, the amount being 94.25q, 93.31q and 90.23q, respectively. 8.40 per cent of the total produce of small group of farmers was used for seed purpose. The medium group of farmers stored 4.88 per cent and the large group of farmers stored 4.48 per cent of their total produce for seed. The per ha marketed surplus was highest for the large group, the amount being 81.70 q followed by 80.65 q and 74.14 q, respectively, for medium and small groups of farmers.

The per farm marketed surplus was found to be 6.94q, 9.68q and 13.62 q for small, medium and large farmers, respectively. This shows that per ha marketed surplus and per farm marked surplus were directly related to farm size. From the table it is seen that marketed surplus was much higher than the marketable surplus for all groups of farmers. This is due to the fact that potato is a voluminous and semi-perishable item with seasonal production, which is demanded throughout the year for consumption. To maintain its regular supply, it is necessary to store it in cold storages. Due to lack of cold storage facilities in the study area, the sample farmers had to sell their produce within three months of the harvest. Thus, distress sale was observed and marketed surplus became higher than the marketable surplus. Kumar *et al.* (1997) also reported that almost all the potato producer-sellers of Allahabad district of Uttar Pradesh sell their total marketable surplus either just after the harvest or within three months of the harvest. Saha and Mukhopadhaya (1997) observed the same situation in Burdwan district of West Bengal.

It was observed that per capita consumption by surveyed farmers was 10 kg for three months. This was much higher than the national per capita consumption of about 14 kg per year (Khurana and Naik, 2002b). It was also observed that the potato consumption decreases after home stored potatoes are used up.

Marketing Costs, Margins and Price Spreads

The term 'price spread' has been variously defined and understood according to its usage. Generally, it refers to the difference between the two prices, i.e., the

price paid by the consumer and the price received by the producer. A study of the price spread involves not only ascertaining the actual prices at various stages of marketing channel, but also the costs incurred in the process of the movement of the produce from the farm to the consumer via the various intermediaries (Acharya and Agarwal, 1978b). The greater the number of intermediaries, the higher is the value of gross margins and the higher the value of price spread. This lowers the marketing efficiency as the producers' share in the consumers' rupee becomes lower.

Table 3: Channel-wise marketing cost and marketing margin (Rs/q)

Particulars	Ch I	Ch II	Ch III	Ch IV
Price received by producer	400.00	350.00	300.00	300.00
Charges borne by producer	29.50	23.50	7.50	7.50
Price paid by village trader	-	-	300.00	300.00
Charges borne by village trader	-	-	30.00	35.00
Village trader's margin	-	-	120.00	55.00
Price paid by retailer	-	350.00	-	390.00
Charges borne by retailer	-	31.00	-	19.00
Retailer's margin	-	119.00	-	91.00
Price paid by consumer	400.00	500.00	450.00	500.000

Table 3 represents the channel-wise marketing costs and margins of different functionaries involved in the marketing of the potato. It shows that the price paid by the consumer was lowest in channel I and highest in channel II and channel III. Again the price received by the producer was highest in channel I and lowest in channel III and channel IV.

Table 4: Marketing costs of intermediaries in different marketing channels (Rs/q)

Intermediaries	Ch I	Ch II	Ch III	Ch IV
Producer	29.50 (100.00)	23.50 (43.12)	7.50 (20.00)	7.50 (12.20)
Village trader	-	-	30.00 (80.00)	35.00 (56.91)
Retailer	-	31.00 (56.88)	-	19.00 (30.89)
Total marketing costs	29.50 (100.00)	54.50 (100.00)	37.50 (100.00)	61.50 (100.00)

Figures in parentheses indicate percentage to total

Table 5: Marketing cost incurred by various middlemen in Channel-I (Producer – Consumer)

Name of functionary/ item cost	Rs. per q.	Percentage share in consumer rupee
Cost incurred by producer:		
Gross price to producer:	400.00	
1. Transportation cost	14.00	3.5
2. Market fee	5.00	1.25
3. Cleaning/grading	7.50	1.86
4. Loading/ unloading	3.00	0.75
Total charges borne by producer	29.50	
Net price received by producer	370.50	92.63
Consumers purchase price	400.00	100.00

Table 6: Marketing cost incurred by various middlemen in Channel – II (Producer – Retailer - Consumer)

Name of functionary/ item cost	Rs. per q.	Percentage share in consumer rupee
Cost incurred by producer:		
Gross price to producer/ Retailers purchase price	350.00	70.00
1. Transportation cost	8.00	1.60
2. Market fee	5.00	1.00
3. Cleaning/grading	7.50	1.50
4. Loading/ unloading	3.00	0.60
Total charges borne by producer	23.50	
Net price received by producer	326.50	65.30
Cost incurred by retailer:		
1. Transportation cost	15.00	3.00
2. Market fee	5.00	1.00
3. Cleaning/grading	5.00	1.00
4. Storage/ shop rent	6.00	1.20
Total charges borne by retailer	31.00	
Retailer margin	119.00	23.80
Retailer's sale price/ Consumer's purchase price	500.00	100.00

The marketing costs incurred by different intermediaries in different marketing channels are shown in Table 4. From the table, the highest marketing cost was observed in channel IV, the amount being Rs. 61.50 per q, mainly due to the presence of more intermediaries involved in that channel. The lowest marketing cost of Rs. 29.50 per q was observed in channel I, where

producers directly sold their produce to the consumers. The marketing cost in channel III was 37.50 per q followed by channel II where marketing cost was Rs. 54.50 per q. The cost incurred by intermediaries ranged from 30.89 per cent to 80.00 per cent of total marketing costs in various marketing channels. The item wise marketing cost incurred by different middlemen in various marketing channels are presented in tables 5 to 8.

Table 7: Marketing cost incurred by various middlemen in Channel – III (Producer – Village trader - Consumer)

Name of functionary/ item cost	Rs. per q.	Percentage share in consumer rupee
Cost incurred by producer:		
Gross price to producer/ village trader's purchase price	300.00	66.67
1. Cleaning/grading cost	7.50	1.67
Net price received by producer	292.50	65.00
Cost incurred by village trader:		
1. Transportation cost	20.00	4.44
2. Market fee	5.00	1.11
3. Loading/unloading	5.00	1.11
Total charges borne by village trader	30.00	
Village trader's margin	120.00	26.67
Village trader's sale price/consumer's purchase price	450.00	100.00

Table 9 shows the marketing margins earned by different intermediaries in different marketing channels. The village traders earned Rs. 120.00 per q in channel II where they directly sold to the consumer and Rs. 55.00 per q in channel IV where they sold to retailers. Retailers on the other hand earned Rs. 91.00 per q in channel IV where they purchased from village traders and Rs. 119.00 per q in channel II where they purchased directly from producers. The table also shows that the total marketing margins was highest in channel IV (Rs. 146.00 per q). This might be due to the greater number of intermediaries associated with this channel.

The price spread analysis of different marketing channels of potato is presented in Table 10. This table shows that the producer's share in the consumer's rupee was the highest (92.63 per cent) in channel I where no intermediaries were involved. This indicated that out of the total money paid by the consumer the producer in channel-I received 92.63 per cent. The lowest amount of producer's share in the consumer's rupee (58.50 per cent), was observed in channel IV where maximum number of intermediaries were involved. In channels II and III, the producer's share in the consumer's rupee was found to be 65.30 per cent and

Table 8: Marketing cost incurred by various middlemen in Channel – IV (Producer – Village trader - Retailer - Consumer)

Name of functionary/ item cost	Rs. per q.	Percentage share in consumer rupee
Cost incurred by producer:		
Gross price received by producer/ village trader's purchase price	300.00	60.00
1. Cleaning/grading cost	7.50	1.50
Net price received by producer	292.50	58.50
Cost incurred by village trader:		
1. Transportation cost	30.00	6.00
2. Loading / unloading	5.00	1.00
Total charges borne by village trader	35.00	
Village trader's margin	55.00	11.00
Cost incurred by retailer:		
1. Transportation /loading/unloading	8.00	1.60
2. Market fee	5.00	1.00
3. Storage/shop rent	6.00	1.20
Total cost borne by retailer	19.00	
Retailer's margin	91.00	18.20
Retailer's sale price/consumer's purchase price	500.00	100.00

Table 9: Marketing margins of intermediaries in different marketing channels (Rs./q)

Particulars	Ch II	Ch III	Ch IV
Village trader	-	120 (100.00)	55.00 (37.67)
Retailer	119.00 (100.00)	-	91.00 (62.33)
Total marketing margins	119.00 (100.00)	120.00 (100.00)	146.00 (100.00)

Figures in parentheses indicate percentage to total

Table 10: Price spread analysis for different marketing channels

Items	Ch I	Ch II	Ch III	Ch IV
Consumer's price (Rs/q)	400.00	500.00	450.00	500.00
Total marketing cost (Rs/q)	29.50	54.50	37.50	61.50
Total marketing margins (Rs/q)	-	119.00	120.00	146.00
Producer's share in consumer's rupee (per cent)	92.63	65.30	65.00	58.50

65.00 per cent, respectively. Similar results were also obtained by Yadav *et al.* (2000).

From the above analysis it was observed that the total marketing costs were directly related to the number of intermediaries involved in that channel. The more the number the higher the cost. The marketing margin was also found to have a direct relationship with the number of intermediaries.

Marketing efficiency

Marketing efficiency essentially represents the degree of market performance. It is defined as having the following two major components:- (i) the effectiveness with which a marketing service is performed and (ii) the effect on the cost and the method of performing the service on production and consumption. These are most important because the satisfaction of the consumer at the lowest possible cost must go hand in hand with the maintenance of a high volume of farm output. These could also be a differentiation of the technical and economic notions of marketing efficiency. Technical efficiency denotes the efficiency in the physical handling of the product that is a matter of procedure, technique and scale of operation. Economic efficiency should ensure that the improvement in technical efficiency is passed on to the producers and consumers in the form of reduction in money costs (Subbarao, 1991). The movement of goods from the producers to the ultimate users at the lowest possible cost and margins, consistent with the provision of services desired by the consumer, may be termed as efficient marketing.

Table 11 presents the estimates of marketing efficiency in different marketing channels. The table shows that channel I had the lowest composite index 1.0. Channel II and III had composite index 2.5 and 3.0, respectively. Channel IV had the highest composite index of 3.5. The results indicated that the channel I was the most efficient channel and channel IV was the least efficient. This might be due to the absence of intermediaries in channel I and the greater number of intermediaries associated with channel IV.

Thus, the study revealed that channel I, i.e., producer – consumer, was the most effective and efficient channel among the four marketing channels.

Table 11: Estimates of marketing efficiency in different marketing channels

Components of composite index	Ch I	Ch II	Ch III	Ch IV
Consumers share in final price (per cent)	92.63	65.30	65.00	58.50
Rank	1	2	3	4
Marketing cost	29.50	54.50	37.50	61.50
Rank	1	3	2	4
Marketing margin	0	119.00	120.00	146.00
Rank	1	2	3	4
Rate of return (marketing margin/ marketing cost)	0	2.18	3.20	2.04
Rank	1	3	4	2
Total score	4	10	12	14
Mean score	1.0	2.5	3.0	3.5

Policy Implications

From these findings, the study following policy implications are drawn. To remove the distress sale by the producer, storage facilities should be created either in the public sector or at community level. This will help in maintaining a steady supply of potatoes throughout the year and will stabilize the price. Better transport facilities should be provided to the farmers for efficient marketing. If possible, subsidized transport facilities should be made available. To reduce the price uncertainty, support price for potato should be announced. As the popularity of different forms of processed potato is increasing day by day, a potato processing unit may be established in the study area, which will help the farmers to gain more profit.

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Feature

Production Behaviour of Tea in India: An Aggregative Analysis

Rabindra N. Bhattacharya, Krishna Das Sarkar & Shyamal Paul

This paper examines the structure of the functional relationship between output and inputs of the tea industry in India. Our study is of the industry behaviour in terms of aggregate production and efficiency and the extent to which relevant factors influence production. Both the Cobb–Douglas (CD) functional form and the Transcendental Logarithmic (Translog) functional form are used for estimation of production function. The results indicate that in this labour-intensive industry the role of labour in productivity growth has not been significant, while the contribution of capital has. In this context the industry may have to tap labour-saving technology for a brighter future.

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The year 1938 may be treated as a landmark for the tea industry in India, as the first consignment of tea produced in the country was shipped to London. The total consignment was 1899 kgs. Since then, the wheels of production have never stopped. In 1950, as per official statistics (Tea Statistics, Tea Board, Govt. of India), the recorded production was 278 mill. kg. The year 1997 ended with a production of 811 mill. kg out of the world production of 2701 mill. kg (India's share being 29.8%). Thus grew the importance of tea in the Indian economy over the last 50 years.

Production of tea started in Assam followed by the then Bengal in undivided India. Over a period of time it spread in some other north Indian States like Uttar Pradesh, Punjab and Himachal Pradesh, as also in the south Indian states of Kerala, Tamil Nadu and Karnataka. Production behaviour and the relationships between production and inputs are, thus, important in the context of understanding India's tea economy.

Tea is distinct from many other agricultural products. Up to the stage of plucking the leaves, almost all tea-related operations are extremely land and labour-intensive. It is only in the recent past that mechanised water sprinkling was introduced as part of the irrigation system in tea gardens. Mechanisation starts after the plucking is over and extends up to the processing stage of the finished tea and further to packaging and transportation.

Various theoretical and empirical issues in the context of the production function and productivity studies for Indian industries have been discussed in Banerji (1975), Hashim and Dadi (1973), Dholakia (1977), Goldar (1986, 1999) and Ahluwalia (1991). In the context to tea, Misra (1986), taking Terai-Dooars region of West Bengal as the base of his study, covers the period 1956-1982 to estimate a production function for tea (Cobb-Douglas) with labour, capital are intermediate inputs as independent variables. Dwivedi (1999) has carried out a

study of the trend of production, yield and planted area under tea in the Dooars region of West Bengal for the period 1961 to 1993.

We have chosen to examine the structure of our functional relationship between the output and inputs of the tea industry. Our study is of industry behaviour in terms of aggregate production and efficiency and the extent to which relevant factors influence production. It needs to be noted that not much significant technological change has taken place in the manufacturing of tea since 1954 when the CTC (crush, tear, curl) technique of tea production emerged as a special category of finished tea product.

We thought it prudent to formulate and estimate a production function for the tea industry initially following the Cobb-Douglas model. We utilised the data provided by the Annual Survey of Industries (ASI) for the period 1973-74 to 1997-98 for the tea industry as a whole. For data relating to various states, the reference period used is 1973-74 through to 1994-95. The source of this time series data for the states is the various issues of tea statistics published by the Tea Board, Government of India.

The Annual Survey of Industries (ASI) of the Central Statistical Organisation (CSO), Government of India, has been compiling basic data pertaining to fixed capital, working capital, employment, value of output etc. since 1970 in respect to industrial products including tea. Tea Statistics (the Tea Board) compiles data relating to plantation area, production of tea in terms quantity, yield in kg/hectare, size of plantation, age-group of tea bushes and various other relevant variables on an annual basis. In our study, data pertaining to output of tea and capital are expressed in terms of values at constant prices with 1980-81 as the base year, area of plantation in hectare and employment in terms of daily average number of workforce of all categories at the end of each year.

Most of the studies on production function have generally used a two-input framework, taking value-added as output and labour and capital as the two inputs. However, in econometric literature, it has been shown that the use of value-added form is justifiable only under certain very restrictive conditions (Goldar 1999a). In our study, instead of taking value-added as output, we have taken actual production data and labour and capital as inputs in our production function.

Like many other studies, we have used the number of employees as a measure of labour input. This suffers from the limitation of variations in age, sex, education and skill. Variations in hours of work are also not reflected in such a measure of labour input (Goldar, 1999b). It needs to be pointed out that published data on fixed capital are the book values of fixed assets at the end of reference years net of cumulative depreciation. The reported figures on capital understate the market value of the capital stock because the reported figures are at historical prices, and the depreciation allowed by the income tax authorities are much higher than true capital consumption.

In our estimation of production function, we have used the published data directly without making any price corrections. We are aware of the fact that this is not quite appropriate for a study based on time-series data or pooled cross-section and time-series data. Because of the fact that the choice of deflator for price correction has its own problems, we depend on the published data directly.

Functional Forms of Production

As noted, most of the studies on production function estimation for Indian industries (and tea in particular) have used the Cobb-Douglas (CD) functional form. We have made use of both the CD functional form and the Transcendental Logarithmic (Translog) functional form for estimation of production function.

(a) The Cobb–Douglas functional form

Allowing for technological change, the CD function for the two-input case (labour and capital) with output as the dependent variable may be written as:

$$Y = A\, e^{\lambda T} E^{\alpha} K^{\beta} \qquad ...(1)$$

where Y = output, E = employment, K = capital and T = time representing technology), α and β are the elasticities of output with regard to labour and capital respectively, and λ is the exponential rate of technological progress. The sum of α and β gives the returns to scale. The CD function implicitly assumes the elasticity of substitution between capital and labour to be unity.

The logarithmic transformation of the CD function yields an equation linear in parameters. Thus, taking logarithms and adding an error term u, the CD function to be estimated may be written as

$$\ln Y = a + \alpha \ln E + \beta \ln K + \lambda T + u, \qquad ...(2)$$

where $a = \ln A$.

This may be estimated by the Ordinary Least Square (OLS) technique. We use cross-section time

series panel data for seven states, viz. Assam, West Bengal, U.P. and Tripura of north India and Kerala, Tamil Nadu and Karnataka of south India for the period 1973-74 to 1994-95. Thus we have 154 observations. The results of the estimated equation are shown below:

$$\ln Y = 1.2608 - 0.0977 \ln E + 1.0671 \ln K + 0.0070 T \quad ...(3)$$

(3.0674)* (-1.4637) (14.5359)* (0.8655)

n = 154

$R^2 = 0.8794$; $\bar{R}^2 = 0.8794$; F - statistic F(3, 150) 364.7227*

DW statistic 0.8263

Figures in parentheses indicate t-ratios.

* indicates significant at 1% level.

The estimated equation (2) seems to fit the data well as indicated by R^2, $\bar{R}^2$ and F-statistic. The co-efficient of labour E is, however, negative though not statistically significant. The co-efficient of capital K is positive and statistically significant. Again, the positive coefficient of T is not significant and thus does not indicate any upward trend in total factor productivity (TFP).

To test whether the estimated CD equation exhibits constant returns to scale (CRS) or not, we run the Wald test of restriction imposed on parameters. The restriction that we impose here is $\alpha + \beta = 1$. The Wald statistic with restriction is CHSQ (l) = 1.0317. Since this is not statistically significant, we have no reason to reject the null hypothesis. This implies that the estimated production function exhibits constant returns to scale.

However, it has been a common practice among studies based on CD function to interpret sum of labour and capital coefficients as a measure of returns to scale. This interpretation can be questioned for studies based on aggregated data, especially time series data (Goldar, 1999c). Goldar argues that the concept of returns to scale can be given an unambiguous meaning only at the micro-level. The relationship is supposed to hold at a point of time and apply to a situation in which the character of inputs does not change. But when the analysis is carried at the aggregate level using time series data, the above interpretation of returns to scale turns out to be very different. Aggregate data tend to combine economies of plant-size the economies of the size of the market. Thus it is absolutely necessary to be very cautious in drawing inferences about returns to scale based on such estimates of the production function.

Again in many studies based on aggregate time series data, estimates of the CD function have been found to be poor (Goldar, 1999d). This happens mainly due to the problem of multi-collinearity that occurs in studies using a time-trend variable to capture technological progress. The problem is accentuated by the inclusion of a time variable, because this eliminates the trend components from various series. Considering these, we have opted for a panel data which is likely to reduce the above problems to some extent.

(b) The Translog Production Function

The translog production function avoids many of the above problems. The functional form of translog is more general. In its most general form, translog function provides a second order approximation to any twice-differentiable function. The known limitations of CD specification led to studies employing a generalised translog function developed by Christensen, Jorgensen and Lau (1973). The translog function has a very flexible form, imposing relatively few apriori restrictions on the properties of the underlying production technology. It allows for variable elasticity of substitution and non-neutral technological change. It allows also for variable scale elasticity (returns to scale). The function, thus, is capable of approximating a wide variety of functional forms (Johnston, 1985).

Let us consider the general case of a translog production function with n inputs. Let Q denote output and $x_1, x_2, ...x_n$ be the n inputs. Then, the translog production function may be written as:

$$\ln Q = \alpha_0 + \sum \alpha_i \ln x_i + [1/2] \sum \beta_{ij} (\ln x_i) (\ln x_j) \quad ...(4)$$

where, $\beta_{ij} = \beta_{ji}$ (symmetry condition)

It can be shown that this function allows for variable scale elasticity and elasticity of substitution. The production function is homothetic if the following restrictions are satisfied:

$$\sum_i \beta_{ij} = 0 \text{ for } j = 1, ...n$$

A production function is homothetic if the marginal rate of substitution between any pair of inputs is constant at constant relative levels of factor intensity. In the context of a two-input production function, this implies that along a ray from the origin all isoquants have the same slope.

The production function is linear homogeneous (constant returns to scale) if along with the above restrictions, the following one is satisfied:

$$\sum \alpha_i = 1$$

The translog production function reduces to Cobb-Douglas function, if

$$\beta_{ij} = 0 \text{ for all i, j}$$

All these restrictions can be tested using the estimated parameters of the production function.

For a two-input case (labour and capital being the two inputs considered here), allowing for technological change, the translog function may be written as:

$$\ln Y = \alpha_0 + \alpha_E \ln E + \alpha_k \ln K + \alpha_T T + (1/2)\beta_{EE} (\ln E)^2 + (1/2)\beta_{kk} (\ln K)^2 + \beta_{EK} (\ln E)(\ln K) + \beta_{ET} (\ln E) T + (1/2)\beta_{TT} T \quad ...(5)$$

where Y is output, E labour, K capital and T time. The conditions for constant returns to scale are $\alpha_E + \alpha_K = 1$; $\beta_{EK} = 0$; and $\beta_{ET} + \beta_{KT} = 0$. Technological progress is Hicks-neutral if β_{ET} and β_{KT} are zero. Using the estimates of parameters, these restrictions can be tested.

We now turn to estimate the translog production (output) function for tea in India using cross-section time series panel data for seven states over the period 1973-74 to 1994-95. We use the specification given in (5) above. The results of the estimated equations are shown below:

$$\ln Y = -11.8511 - 1.2817 \ln E + 4.4387 \ln K - 0.1614T - 0.0768 (\ln E)^2 - 0.2589 (\ln K)^2$$
$$(-3.7700)^* \quad (-1.7842)^{***} \quad (4.6694)^* \quad (-2.3490)^{**}$$
$$(1.2764) \quad (-4.0376)^*$$

$$-0.0020 T^2 + 0.2501 (\ln E)(\ln k) + 0.0341 (\ln K) T - 0.0221 (\ln E) T \quad ...(6)$$
$$(-1.4565) \quad (2.7856)^{***} \quad (2.6707)^{***} \quad (-1.9241)^{***}$$

$n = 154$

$R^2 = 0.90427$; $\bar{R}^2 = = 0.89828$; F – statistic F (9, 144) 151.1292*

DW statistic 1.1927

Figures in parentheses indicate t-ratios.

*indicates significant at 1%

**indicates significant at 5% and

***indicates significant at 10% level.

In this estimated equation (6), most of the coefficients are found to be statistically significant. However, like CD specification, here also the co-efficient of labour turns out to be negative but unlike CD specification this negative co-efficient is statistically significant at 10% level. We need to see whether we can infer from this that the elasticity of output with respect to labour is really negative or not. In the translog model, the output elasticity of labour is:

$$M_E = \delta \ln Y / \delta \ln E = \alpha_E + \beta_{KE} \ln K + \beta_{EE} \ln E ...(7)$$

where M_E stands for output-elasticity of labour.

If we insert in equation (7) the estimated coefficients and the mean values for ln K and ln E of 11.8495 and 8.3516 respectively, then the result is (1.0405) which is positive and is in line with our expectations.

We have also tested this translog form for constant returns to scale by imposing the restrictions.

$$\alpha_E + \alpha_K = 1; \beta_{EE} + \beta_{EK} = 0; \beta_{KK} + \beta_{EK} = 0; \text{ and } \beta_{ET} + \beta_{KT} = 0$$

The resulting Wald statistic is CHSQ (4) = 34.2902. The statistic being highly significant, we cannot accept the constraints as constraints as valid. This implies that our estimated translog production function does not exhibit constant returns to scale.

The coefficients of ln KT is positive while that of ln ET is negative. However, both the estimated co-efficients are statistically significant. This suggests a labour-saving bias of technological progress. This result is also implied by the estimated CD model (3).

We have also carried out the Ramsay RESET test (1969) comparing the translog specification with the CD specification which is more restrictive. From the resulting F-statistic the hypothesis of the production technology being characterized by the CD function is not rejected in the test. However, it needs to be noted that knowing that a model (translog in this case) is misspecified by the Ramsay RESET test, does not necessarily help us in choosing a better alternative (Gujarati, 1995), in this case, the CD function.

Conclusion

The results that we obtained indicate that in this labour-intensive industry the role of labour in productivity growth has not been significant. The contribution of capital, on the other hand, has been significant. So to attain scale economies the industry may have to look for labour-saving technology in the future. One important implication that transpires from both the CD and the Translog models is that there is a serious inefficiency

problem associated with labour use. It seems (at least from the translog model) that employers are also becoming aware of this problem and consequently have been opting for labour-saving technological options. The recent downswing of the tea industry in India may be explained, along with other factors, by this problem of labour use inefficiency.

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Teamwork is a make or break situation. Either you help make it or the lack of it will break you.

– Kris A. Hiatt

Feature

Employment of Farm Resources in Punjab Agriculture

Tejpal Singh & V.K. Sharma

This study was undertaken with a two-fold aim: (1) To estimate the use of human resource on farms (2) To estimate to what extent capital such as tractors, electric motors and diesel engines are used. The study was conducted on 120 farm holdings – small, medium and large – at Rampuraphul and Nathana blocks of Bathinda district, Punjab. This paper suggests that avenues of employment outside agriculture are required for the surplus farm family labour, and that measures need to be taken to curb over-capitalization.

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The green revolution of the mid-1960s led to a dramatic change in agricultural production within India, and the state of Punjab proved to be the star performer. It was the first state to widely adopt the modern high-yielding varieties of rice and wheat and subsequently contribute 40-50 per cent of rice and 50-70 per cent of wheat to the central pool.

These notable achievements took place due to two innovations, namely bio-chemical and mechanical. The adoption of these technologies was facilitated by the existing canal irrigation infrastructure and strongly supported by a spurt in a rapid energization of tubewells. The net area irrigated increased from 57.33 per cent during 1967-68 to 96.00 per cent during 2000-01 and the fertilizer consumption per hectare rose from 96.50 kg to 177 kg for the same period. (Statistical Abstracts, Punjab).

The rapid adoption of seed and fertilizer technology was facilitated by mechanical innovations. The number of tractors per thousand hectare of net sown area increased from 10.10 in 1971-72 to 96.00 during 2000-01, and the number of tubewells per thousand hectare of gross cropped area increased from 8.27 during 1967-68 to 119.00 during 2000-01.

In this context there is a need to analyse the trends in the use of resources such as electric motor, diesel engines and human labour in the state. This study set out to work out the availability, utilization and excess capacity in costly capital like tractors electric motors, diesel engines and human labour available on the farm and to spell out the policy implications of the analysis.

Methods and material

This study pertains to the Bathinda District of Punjab during the kharif season of 2001-02. A three-stage sampling technique, with block as the first stage, village

Table 1: Availability and utilization of family labour over different size categories in the study area, 2001-02

(Man Days - Kharif season)

Blocks Enterprises	Rampuraphul				Nathana				Overall			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Crops	175 (62.27)	122 (37.54)	105 (27.78)	134 (40.85)	111 (37.63)	147 (42.24)	127 (32.90)	128 (37.32)	143 (49.65)	135 (40.06)	1116 (30.36)	131 (38.99)
Animal husbandry	78 (27.76)	105 (32.31)	88 (23.28)	90 (27.44)	97 (32.88)	80 (22.99)	71 (18.39)	83 (24.20)	88 (30.56)	93 (27.60)	80 (20.94)	87 (25.89)
Total labour employed	253 (90.03)	227 (69.85)	193 (51.06)	224 (68.29)	208 (70.51)	227 (65.23)	198 (51.30)	211 (61.52)	231 (80.21)	228 (67.66)	196 (51.30)	218 (64.88)
Available family labour during kharif season	281 (100.0)	325 (100.0)	378 (100.0)	328 (100.0)	295 (100.0)	348 (100.0)	386 (100.0)	343 (100.0)	288 (100.0)	337 (100.0)	382 (100.0)	336 (100.0)
Family labour unutilized	28 (9.97)	98 (30.15)	185 (48.94)	104 (31.71)	87 (29.49)	121 (34.77)	188 (48.70)	132 (38.48)	57 (19.79)	109 (32.34)	186 (48.70)	118 (35.12)

(Availability of family labour was worked out for half the year.)

as the second and respondent as the third stage, was adopted for farm holdings of three sizes—small, medium and large. In all 120 farm holdings were used for the study and data was collected by the personal survey method.

The sum of the hour-use of the capital equipment in question for all the sampled holdings represents the magnitude of use of that piece of equipment. The left-out magnitude after utilization percentage reflects the excess capacity of the capital equipment in question. So far as the technique of analysis is concerned, the available horsepower of tractor, electric motor and diesel engines was calculated by making use of the formulas given below:

Availability of tractor power

$$\text{Horse power hour of tractor} = 1000 \sum nj\ Hj$$

$$(j = 1, 2, 3.....n)$$

Where nj = the number of sample horse power tractors available in the study sample

Hj = the horse power of tractor in question

1000 indicates the total recommended hours to be used annually assuming the expected life of tractor as 10 year.

Utilization of tractor power

$$\text{Horse power hours of tractor used} = 1000 \sum hj\ Hj$$

$$(j = 1, 2, 3.....n)$$

Where hj = hours used of same horse power of tractors

Hj = horse power of tractors in question

Similarly the availability and utilization of electric motor and diesel engines have been worked out assuming the expected life of diesel engine as 10 years and that of electric motor as 15 years.

Family labour use

The detailed picture of family labour use in agriculture revealed that out of the total farm family labour available on the farm, only 64.88 per cent has been utilized (see table 1). Of this, 38.99 per cent was employed in crop farming and 25.89 per cent in animal husbandry, which indicated that 35.12 per cent of the family labour available remained unutilized during the kharif season.

Analysis further revealed that in the case of Rampuraphul block, 40.85 per cent of the available family labour was employed for crop farming and 27.44 per cent for animal husbandry. Thus 68.29 per cent of available family labour was utilized and 31.71 per cent unutilized. At Nathana block 68.52 per cent of the total family labour available was utilized, 37.32 per cent on crop farming and 38.48 per cent for animal husbandry, while 24.20 per cent of the family labour remained unutilized.

At Rampuraphul block the highest employment of family labour was on small farms (90.03 per cent) which was followed by medium and large farms (69.85 and 51.06 per cent respectively). This indicates that the highest percentage of the unutilized family labour was 48.94 per cent on large farms, 30.15 on medium and

Table 2: Availability and utilization of tractor horse power on sampled farms (owing tractors) with different size categories.

(Hours - Kharif season)

Blocks Size categories	Rampuraphul			Nathana			Overall		
	Availability	Utilized	Unutilized	Availability	Utilized	Unutilized	Availability	Utilized	Unutilized
Small	8760 (100.00)	2217 (25.31)	6543 (74.69)	10768 (100.00)	2183 (20.27)	8585 (79.73)	19528 (100.00)	4400 (22.53)	15128 (77.47)
Medium	75920 (100.00)	38876 (51.21)	37044 (48.79)	82855 (100.00)	39603 (47.80)	43252 (52.20)	158775 (100.00)	78479 (49.43)	80296 (50.57)
Large	88768 (100.00)	59014 (66.48)	29754 (33.52)	85958 (100.00)	58566 (68.13)	27392 (31.87)	174726 (100.00)	117580 (67.29)	57146 (32.71)
Overall	173448 (100.00)	100107 (57.72)	73341 (42.28)	179581 (100.00)	100352 (55.88)	79229 (44.12)	353029 (100.00)	200459 (56.78)	152570 (43.22)

(Figures in parentheses are percentages worked out in relation to total availability of tractor horsepower hours during the Kharif season for respective size categories in the study area. Availability of tractor horsepower hours have been worked out for half the year.)

9.97 per cent on small farms. At Nathana block, the use of family labour was the lowest on large farms with 51.30 per cent, which increased to 65.23 and 70.51 per cent on medium and small farms respectively.

This indicates that the unutilized family labour in the block was highest on large farms at 48.70 per cent, followed by medium and small farms at 34.77 and 29.49 per cent respectively. The casual labour demand for per hectare in the state has increased by 54 per cent from 1971-72 to 1991-92 whereas the demand for family labour has decreased by nearly 10 per cent during the same period (Kaur and Singh, 1998). There is thus an inverse relationship of family labour use with farm size in the study area.

Tractor power use

The availability and utilization of tractor power worked out on sampled farm families given in table II, reveals that the average farm utilized 56.78 per cent of the available tractor horse power hour during the kharif season in 2001-02. The size-wise analysis revealed that small farms utilized only 22.53 per cent of the total available tractor power followed by medium and large farms with 49.93 and 67.29 per cent respectively. This showed that on small farms more than 77 per cent tractor power remains unutilized, whereas on medium and large farms it was 50.57 and 32.71 per cent respectively at the district level. Thus the percentage use of tractor was much lower on small farms compared to medium and large farms, showing over-capitalization of small farms in the study area. The fixed cost in the crop sector have been estimated to have gone up due to over-tractorisation (Ray and Johl, 2002).

At Rampuraphul block 57.52 per cent of the available tractor power was employed, and 42.28 per cent of unutilized. At Nathana block only 55.88 per cent of the tractor power available on sampled farms was utilized. The highest employment of tractor power took place on large farms with 66.48 per cent, followed by medium and small farms with 51.21 and 25.31 per cent, respectively. This show that the highest unutilized tractor power on small farms was 74.69 per cent followed by medium and large farms with 48.79 and 33.52 per cent respectively. In case of Nathana block, the maximum use of tractor was on large farms with 68.13 per cent followed by medium and small farms with 47.80 and 20.27 per cent respectively. This showed that 31.87, 52.20 and 79.73 per cent tractor power on large, medium and small farms remain unutilized in Nathana block. By and large, it depicted a direct relationship between farm size and tractor utilization, which is obvious, as the magnitude of work increases with the farm size.

Electric motor use

Electric motors are the major source of power used to run tubewells. The changed cropping pattern in the district leading to wheat paddy rotation puts more pressure on running tubewells constantly. Therefore, it is imperative to examine the magnitude of the electric motor use in the study area.

The table revealed that an average farm in the study area utilized the electric motor to the extent of 104.6 per cent of its normal use, which showed excess utilization of 4.66 per cent. The size-wise picture revealed the lowest use of 83.42 per cent on small farms, followed by medium and large farms with 110.98 and 111.26 per cent respectively. This trend showed that excess use of electric motor has taken place on medium and large farms in the study area.

The block-wise analysis showed that in Ram-

Table 3: Availability and utilization of electric motors on sampled farms (owing electric motors) with different size categories

(Hours - Kharif season)

Blocks / Size categories	Rampuraphul			Nathana			Overall		
	Availability	Utilized	Under-utilized/ over-utilized	Availability	Utilized	Under-utilized/ over-utilized	Availability	Utilized	Under-utilized/ over-utilized
Small	10494 (100.00)	8487 (80.87)	2007 (19.13)	3194 (100.00)	2931 (91.77)	263 (8.23)	13688 (100.00)	11418 (83.42)	2270 (16.58)
Medium	28287 (100.00)	30998 (109.58)	-2711 (-9.58)	30113 (100.00)	33814 (112.29)	-3701 (-12.29)	58400 (100.00)	64812 (110.98)	-6412 (-10.98)
Large	26463 (100.00)	30168 (114.00)	-3705 (-14.00)	29900 (100.00)	32544 (108.84)	-2644 (-8.84)	56363 (100.00)	62712 (111.26)	-6349 (-11.26)
Overall	65244 (100.00)	69653 (106.73)	-4409 (-6.76)	58207 (100.00)	59549 (102.31)	-1342 (-231)	123451 (100.00)	129202 (104.66)	-5751 (-4.66)

(Figures in parentheses are percentages worked out in relation to total availability of electric motor hours during the Kharif season for respective size categories. Availability of electric motor hours have been worked out for half the year.)

Table 4: Availability and utilization of diesel engine horsepower hours on sampled farms (owing diesel engines) with different size categories.

(Hours - Kharif season)

Blocks / Size categories	Rampuraphul			Nathana			Overall		
	Availability	Utilized	Under-utilized/ over-utilized	Availability	Utilized	Under-utilized/ over-utilized	Availability	Utilized	Under-utilized/ over-utilized
Small	9490 (100.00)	1482 (80.87)	8008 (84.38)	13505 (100.00)	2224 (16.47)	11281 (83.53)	22995 (100.00)	3706 (16.12)	19289 (83.88)
Medium	25550 (100.00)	7826 (30.63)	17724 (69.37)	10255 (100.00)	4032 (39.32)	6223 (60.68)	35805 (100.00)	11858 (33.12)	23947 (66.88)
Large	18615 (100.00)	10736 (57.67)	7879 (42.33)	20075 (100.00)	13248 (65.99)	6827 (34.01)	38690 (100.00)	23984 (61.99)	14706 (38.01)
Overall	53655 (100.00)	20044 (37.36)	33611 (62.64)	43835 (100.00)	19504 (44.49)	24331 (55.51)	97490 (100.00)	39548 (40.57)	57942 (59.43)

(Figures in parentheses are percentages worked out in relation to total availability of diesel engine horsepower hours during the Kharif season for respective size categories in the study area. Availability of diesel engine horsepower hours motor hours has been worked out for half the year.)

puraphul, an average farm recorded the highest motor use of 106.76 per cent of its normal requirement. With respect to Nathana block, an average farm used the electric motor to the extent of 102.31 per cent of its normal used, which is a negligible excess used of the motor.

The size-wise analysis in case of Rampuraphul block revealed the highest use of 114 per cent on large farms, followed by medium farms with 9.58 per cent and that it was underutilized on small farms with 19.13 per cent. At Nathana block the table revealed the highest use of 112.29 per cent on medium farms, followed by 108.84 per cent on large farms and 91.77 per cent on small farms. This trend showed that there was an excess use of the electric motor on medium and large farms by 12.29 and 8.84 per cent respectively.

On the whole, the results revealed the underutilization of electric motors on small farms against the overuse on medium and large farms. The small size of holdings and shift in the cropping pattern favouring paddy on large farms may explain this result.

Diesel engine use

Diesel engine, used as a standby arrangement to irrigate paddy in case of electricity failure, assumed a significant role. The results of table IV reveal that an average farm holding in the district used diesel engine for 40.57 per cent of its normal use. The utilization of this capital equipment across size groups work 61.99 per cent on large farms, followed by medium and small farms at 33.12 and 16.12 per cent respectively.

The block-wise analysis in Rampuraphul block reveals that an average farm used diesel engine to the extent of 37.36 per cent of normal requirement, which means an underutilization of 62.64 per cent. The sizewise results revealed the highest use of 57.67 per cent on large farms followed by medium and small farms at 30.63 and 15.62 per cent, respectively. Thus the diesel engine remained unutilized at 84.38 per cent on small farms and 69.37 and 42.33 per cent on medium and large farms, respectively.

In Nathana block, an average farm used diesel engine to the extent of 44.49 per cent during the study period. The highest use of this power was on large farms at 65.99 per cent followed by medium and small farms at 39.32 and 16.47 per cent respectively. Thus, the underuse of this power equipment on large farms was at 34.01 per cent followed by medium and small farms at 60.68 and 83.53 per cent respectively. The results depict a direct relationship between diesel engine use and farm size. No doubt the capacity-utilization increased with the increase in farm size, yet it was far below the requirement.

The small magnitude of work on small holdings on the one hand and less proportion of area under paddy on these farms may be responsible for the underutilization of diesel engines. Overall, diesel engines are kept as a standby arrangement as this is a costly capital.

Conclusions and policy implications

Overall unutilized family labour constituted about 35 per cent and was largely found on the large farms. Tractor power was underutilized in all farms to the extent of 43.22 per cent. It is clear that there is significant overcapitalization in the study area. Electric motors are overutilized on large and medium farms and slightly under used on small farms in the study area. The average farm in the study area utilized the electric motor to the tune of 104.66 per cent of its normal requirement. Different size groups of farms showed that an average farm at district level utilized diesel engine at 40.57 per cent of its normal use. There is thus overcapitalization in the state agriculture. The implications of the analysis suggest that avenues of employment ought to be explored outside agriculture for employing the surplus farm family labour in the state. Furthermore the underutilisation of tractors needs to be linked with loan availability consistent with its utilization.

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If you don't ask, you don't get.

– Mahatma Gandhi

Feature

Input Use Productivity of Cotton Crop in South-Western Zone of Punjab

N.S. Dhaliwal, R.S. Bawa & D.K. Grover

The present study attempts to examine the economics of cotton and marginal value productivity of various inputs used for cotton cultivation in the south-western district of Punjab. The analysis highlights the scope of increasing the investment on seed, machine, nitrogen and plant protection measures and cut down phosphatic fertilizer. The study reveals that the gross returns as well as returns over total costs, excluding land rent in the least developed block, was more as compared to the highly developed block. The study also brought out that returns over total costs excluding land rent on all the categories of farms was observed to be negative. The study also reveals that the inputs of human labour on hoeing and phosphatic fertilizer was overutilized. The economic losses due to non-adoption of recommended technology was observed to be 1547 kg per hectare in cotton (1697 kg per hectare on small farms).

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Cotton occupies around 14 per cent of the total cultivated area in the Kharif season in Punjab. The large productivity differentials in cotton have been observed in the south western zone of Punjab, varying between 243 and 394 kg lint per hectare. It is also felt that some of the crucial inputs are either underutilized or overutilized in the production process. The inefficiencies of resources affect the productivity of the crop resulting in an unfavourable cost/returns structure and producers' incentives as well. Over the years, yield deceleration in cotton has also taken place i.e. 3.24 (1975-76 to 1989-90) to 2.95 (1990-91 to 2001-02). In view of the urgency and importance of increasing cotton production, the resources have to be utilized properly and efficiently. Increasing efficiency of resource use through appropriate allocation not only increases the productivity but also profitability on the farms.

The present study has been undertaken with the following specific objectives:

- To study the economics of cotton cultivation in the south-western zone of Punjab.
- To examine the various factors affecting the productivity of cotton and marginal value productivity thereof in the south-western zone of Punjab.
- To estimate the economic losses and identify the reasons for such losses.
- To suggest an efficient policy measure to improve the existing resource use pattern in cotton cultivation in the state.

Methodology

In order to study the input-use productivity of cotton crop in the south-western zone of Punjab, Muktsar district was randomly selected. Block-wise area, yield and

production of principal crops in the selected Muktsar district was collected for calculating weighted average productivity. On the basis of weighted average productivity, two blocks from the district, i.e. Muktsar block with the highest productivity (highly developed block) and Lambi block with the lowest productivity (least developed block) were selected. Thereafter, two villages from each block were randomly chosen.

The present study on cotton is part of a bigger study in which adoption gaps in recommended technology were also examined in the south-western zone of Punjab. For comprehensive investigation, a sample of 29 farmers was selected from each block in Muktsar district of Punjab, respectively. All the operational holdings of selected villages were arranged in ascending order. The farmers were stratified in three categories, viz., small, medium and large farmers, using the cube root frequency technique. The primary information regarding output of cotton and various cost components such as seed, weedicides, fertilizers, plant protection measures, human labour and machine labour were collected from these 58 farmers for the year 2001-02. The required information on all these aspects were systematically recorded in the schedule especially designed for the purpose, so that it could be logically transformed into different variables.

Functional analysis

To accomplish the objectives of the study both functional and tabular techniques were used. Economics of cotton cultivation was examined by working out the total cost excluding the land rent on a per hectare basis.

To examine the factors affecting value productivity of the cotton crop in the south western zone of the state, both linear as well as log linear production function was fitted. The best-fit function i.e. Cobb-Douglas production function was determined on the basis of the level of significance of the explanatory variable, the value of coefficient of multiple determination (R^2) and the logical signs of the explanatory variable. The following form of the Cobb-Douglas function was followed:

$$Y = A \sum_{i=1}^{n} X_i^{bi} U_i$$

where, Y represented value productivity per hectare of cotton, X_i the selected explanatory variables (per hectare), A the technical efficiency parameter and b_i the coefficient of production elasticity of the respective variable X_i at the mean level of input used and output obtained. The U_i is an error term.

The functions were fitted for both highly/least developed blocks, for different farm size categories and for the overall study.

Y: Value productivity per hectare of cotton crop (Rs.)

X1: Value of seed (Rs.)

X2: Plant Protection measures (Rs.)

X3: Nitrogenous fertilizers (Rs.)

X4: Phosphatic fertilizers (Rs.)

X5: Machine labour (Rs.)

X6: Human labour (Rs.)

X7: Irrigation (No.)

X8: Hoeing/Triphali (No.)

X9: Education (No.)

X10: Operational holding (ha)

X11: Interaction with agricultural related departments (dummy)

The marginal value productivity represents the estimated change in gross returns per hectare consequent upon a unit change in the variable under consideration while the level of use of other variables are held constant. Marginal value productivity in the present study was estimated directly from the regression estimates at arithmetic mean level of input and output used as following:

$$MVP_{(xi)} = b_i \left(\frac{\bar{Y}}{\bar{X}_i}\right)$$

where, b_i is the output elasticity of variable xi and $\bar{X}$ and $\bar{Y}$ are the arithmetic means of the concerned variables.

In the long run, economic losses can be minimized if we reduce the gap between experimental plots and actual farm situations. It is also called as yield gap-I. We can overcome this difficulty only by adopting suitable long term policy decisions. In the short run, an effort can be made to minimize economic losses only by reducing the yield gap II, which was studied by estimating the gap between the highest yield and average yield of crops attained in the particular vicinity. Index of yield gap I was estimated by dividing yield gap I with the potential yield of cotton.

Results and Discussion

The results have been explained under the following heads:

I Economics of Cotton

II Determinant and Marginal Value Productivities thereof

III Economic Losses and Reasons thereof

IV Suggestions for Input-use-Efficiency Enhancement in Cotton Cultivation

Economics of Cotton

An attempt has been made to evaluate the expenditure on different inputs in highly developed block/least developed block, on small, medium and large farm size categories of farm and overall. Per hectare expenditure on different inputs along with their proportionate share in the total costs, excluding land rent, was calculated.

Highly vs least developed block

Table 1 reveals that the total cost, excluding land rent per hectare in cotton, was observed to be Rs. 18212 and Rs. 21581 in the highly and least developed block, respectively. The share of major costs of plant protection, human labour and machine labour were found to be 50.31, 18.53 per cent of the total cost, excluding land rent respectively, in the highly developed block in comparison to 48.23, 22.00 and 16.70 per cent in the least developed block. The table further reveals that the overall costs of plant protection, human labour and machine labour were found to be 49.18, 20.48 and 17.54 per cent, which constitutes 87.20 per cent of the total operational cost, excluding the land rent.

The gross returns per hectare from cotton came to be Rs. 10164 and Rs. 25587.84 in the highly developed block and least developed block, respectively. Respective net returns, excluding land rent per hectare, were Rs. 7535 and Rs. 4693. The study reveals that the gross returns as well as net returns, excluding land rent, in the least developed block was higher as compared to the highly developed block due to the higher yield of cotton.

The relative economics of cotton cultivation in the highly developed block and least developed block showed that in absolute terms the expenditure on human labour, machine labour, seed, plant protection and fertilizer was more in the least developed block as compared to the highly developed block. But in relative terms the expenditure on machine labour, seed and plant protection was higher in the highly developed block in comparison to the least developed block.

Different size categories

Table 1 reveals that the highest share of expenditure on plant protection was observed to be Rs. 8781, Rs. 10718 and Rs. 10450 per hectare on small, medium and large farms, respectively, forming 49.51, 49.88, and 47.81 per cent of respective total cost, excluding land. The study also reveals that the expenditure on human labour in relative terms varied inversely with the size of the farm. The study concludes that use of machine, fertilizer in absolute as well as in relative terms varied directly with the farm size. The study also reveals that in absolute terms the expenditure on seed varied directly with the size of the farm. The overall expenditure on plant protection, human labour, machine labour, seed, fertilizer and interest on working capital was found to be 49.18, 20.48, 17.54, 5.88, 4.41 and 5.54 per cent of the total cost, excluding land.

The gross returns per hectare from cotton came out to be Rs. 15631, Rs. 20688 and Rs. 20916 on small, medium and large farms, respectively. The net returns excluding land rent per hectare were found to be negative on all categories of farms and in the overall study due to high cost of plant protection measures and low yield of cotton.

Determinant and marginal value productivities

Highly vs least developed block

The value of R^2 (the co-efficient of multiple determination) for highly developed block came out to be 0.5035 indicating that about 50 per cent of variation in value of cotton crop yield was explained by the explanatory variables included in the study (table 2). The highly significant regression co-efficient of plant protection measures turned out to be 4.559 at 1 per cent level of significance, indicates that with 1 per cent increase in expenditure on plant protection measures, resultant value of yield would increase by 4.56 per cent in the highly developed block. The co-efficient of machine labour came out to be 2.128 at 5 per cent level of significance, which shows that with 1 per cent increase in expenditure on machine, the resultant value of yield would increase by 2.13 per cent in the least developed block.

The marginal value productivity of plant protection measures were found to be 2.55 and 2.22 in the highly and least developed block, respectively, indicating

Table 1: Economics of cotton cultivation in south-western zone of Punjab, 2001-02 (Rs. per hectare)

	HDB	LDB	Small farmer	Medium farmer	Large farmer	Overall
Total cost excluding land	18211.74	21581.04	17736.09	21488.36	21856.59	19896.06
Human labour						
Family labour	1984.74 (10.90)	2772.59 (12.85)	3117.50 (17.58)	2194.58 (10.21)	1243.21 (5.69)	2378.66 (11.96)
Hired labour	1416.29 (7.78)	1974.31 (9.15)	881.92 (4.97)	2051.25 (9.55)	2748.21 (12.57)	1695.30 (8.52)
Total	3401.03 (18.67)	4746.90 (22.00)	3999.42 (22.55)	4245.83 (19.76)	3991.43 (18.26)	4073.97 (20.48)
Machine labour	3374.58 (18.53)	3604.23 (16.70)	2755.30 (15.53)	3764.18 (17.52)	449.48 (20.59)	3489.40 (17.54)
Seed	385.78 (2.12)	422.16 (1.96)	377.40 (2.13)	420.28 (1.96)	432.33 (1.98)	403.97 (2.03)
Weedicide	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Fertilizer						
Nitrogen	295.17 (1.62)	598.88 (2.78)	386.92 (2.18)	460.14 (2.14)	541.79 (2.48)	447.03 (2.25)
Phosphorus	488.97 (2.68)	371.81 (1.72)	351.92 (1.98)	485.14 (2.26)	505.71 (2.31)	430.39 (2.16)
Total	784.14 (4.31)	970.69 (4.50)	738.85 (4.17)	945.28 (4.40)	1047.50 (4.79)	877.41 (4.41)
Manuring	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Micro-nutrients	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Plant protection	9161.90 (50.31)	10408.20 (48.23)	8780.68 (49.51)	10718.48 (49.88)	10450.18 (47.81)	9785.04 (49.18)
Irrigation	33.03 (0.18)	159.40 (0.74)	41.15 (0.23)	130.28 (0.61)	150.00 (0.69)	95.93 (0.48)
Interest on working capital	1071.28 (5.88)	1269.47 (5.88)	1043.30 (5.88)	1264.02 (5.88)	1285.68 (5.88)	1170.36 (5.88)
Yield value of main product	10163.71	25587.84	15044.13	20062.78	20322.68	17875.78
Value of by product	512.93	687.07	586.54	625.00	592.86	600.00
Gross Income	10676.64	26274.91	15630.67	20687.78	20915.54	18475.78
Return over total cost excluding land	-7535.10	4693.87	-2105.42	-800.55	-941.05	-1420.29

Figures in parenthesis indicate the per cent to total cost, excluding land

HDB: Highly developed block LDB: Least developed block

scope for increasing value productivity in cotton. The study reveals that an additional expenditure of one rupee on plant protection measures would increase the value productivity of cotton by Rs. 2.55 and Rs. 2.22, respectively, in the highly developed block and least developed block. The study reveals contradictory results were found in irrigation in both the highly and least developed block. The study reveals that one additional irrigation would increase the value productivity of cotton by Rs. 947.93 in the highly developed block but this variable is overutilized in the least developed block. Similarly, an increase of rupee one on machine labour would increase the value productivity of cotton by Rs. 1.65 and Rs. 8.89, respectively, in the highly and least developed block (table 3).

Different size categories

Table 2 reveals that the co-efficient of multiple determination (R^2) came out to be 0.591, which indicates that

Table 2: Regression coefficients of Cobb-Douglas type functions for cotton crop in south-western zone of Punjab, 2001-02

	Highly developed block	Least developed block	Small farmer	Medium farmer	Large farmer	Overall
Intercept	2.142 (6.125)	1.024 (7.005)	2.758 (6.853)	2.073 (7.437)	1.114 (20.39)	3.675 (4.175)
Value of seed	0.712ns (0.526)	1.105ns (0.710)	0.039ns(0.732)	0.379ns (0.780)	0.271ns (1.286)	0.509ns (0.376)
Plant protection measures (Rs.)	4.559*** (0.481)	1.719* (0.514)	5.217*** (0.528)	0.374ns (0.716)	0.760ns (1.309)	5.374*** (0.343)
Nitrogen fertilizer (Rs.)	0.361ns (0.048)	1676ns (0.443)	0.289ns (0.059)	1.509ns (0.087)	0.649ns (0.748)	0.926ns (0.041)
Phosphatic fertilizers (Rs.)	0.456ns (0.052)	1.181ns (0.040)	0.172ns (0.052)	0.424ns (0.057)	0.542ns (0.073)	0.393ns (0.027)
Machine labour (Rs.)	0.663ns (0.779)	2.128** (0.571)	0.857ns (0.685)	2.081* (1.342)	1.337ns (2.007)	1.843* (0.486)
Operation holding (Ha)	0.191ns (0.277)	0.969ns (0.282)	0.508ns (0.452)	0.585ns (0.932)	0.517ns (0.638)	0.959ns (0.184)
Education	0.659ns (0.075)	0.207ns (0.067)	0.188ns (0.080)	1.025ns (0.210)	0.47ns (0.139)	0.236ns (0.051)
Interaction	0.282ns (0.134)	0.136ns (0.087)	1.014ns (0.256)	1.007ns (0.138)	1.111ns (0.106)	0.503ns (0.073)
Hoeing/triphali (No.)	0.366ns (0.724)	0.680ns (0.676)	0.567ns (0.728)	0.673ns (0.971)	0.071ns (2.217)	1.142ns (0.419)
No. of irrigation	0.296ns (0.652)	1.169ns (1.048)	1.058ns(0.698)	0.614ns (1.072)	0.580ns (1.239)	1.106ns (0.475)
R^2	0.5035	-0.279	0.591	0.5803	0.4453	0.4444

Note: ns denote non-significant at 10 per cent level of significance

*, **, *** denote significant at 10, 5 and 1 per cent level of significance

Figures in parenthesis represent standard error of the estimates

about 59 per cent of variation in the value yield of cotton was explained by the explanatory variables on small farms. The highly significant regression co-efficient of plant protection measures turned out to be 5.217 which indicates that with 1 per cent increase in expenditure on plant protection measures, resultant value of yield would increase by 5.22 per cent. In case of medium farms the regression co-efficient of machine came out to be 2.081 at 10 per cent level of significance, which shows that with 1 per cent increase in machine, the resultant value of yield would increase by 2.08 per cent.

The table also reveals that the regression co-efficients of all the explanatory variables turned out to be non-significant on large farms due to a very small degree of freedom.

The marginal value productivity of the size of holding and use of hoeing turned out to be negative on all categories of farms indicating diseconomy of scale. The marginal value productivity of machine labour was found to be positive on all categories of farms indicating great scope for increasing productivity by using this variable. The study concludes that mechanization is the only way for enhancing productivity of cotton.

The marginal value productivity coefficient of plant protection was found to be 4.91, 0.52 and 1.98 on small, medium and large farms, respectively, showing that an increase of rupee one on plant protection would increase the value productivity by Rs. 4.91, Rs. 0.52 and Rs. 1.98 in cotton. The marginal value productivity of phosphatic fertilizer reveals that excess use of this fertilizer was observed on all categories of farms (table 3). The study concludes that the excess use of phosphorus fertilizer should be discouraged.

The overall study reveals that highly significant regression co-efficient of plant protection measures turned out to be 5.374 which indicates that with 1 per cent increase in expenditure on plant protection measures, the resultant value of yield would increase by 5.37 per cent. The co-efficient of machine came out to be 1.842 at 10 per cent level of significance which indicates that with 1 per cent increase in expenditure on machine, the resultant value of yield would increase by 1.84 per cent.

The marginal value productivity of seed, plant protection, nitrogenous, machine labour and irrigation in cotton was found to be positive which indicates that with an

increase of rupee one/unit on these variables the value productivity of cotton would increase by Rs. 8.69, Rs. 3.47, Rs. 15.71, Rs. 4.77 and Rs. 3810.18, respectively. The negative sign of phosphatic fertilizer and hoeing coefficient reveals excess use of these variables.

Table 3: Marginal Value Productivity of Inputs for cotton crop in the South-Western zone of Punjab, 2001-02

Inputs	HDB	LDB	Small farmer	Medium farmer	Large farmer	Over all
Seed	–10.24	–48.55	–12.01	14.77	–16.93	8.69
Plant protection measures	2.55	2.22	4.91	0.52	1.98	3.47
Nitrogenous fertilizer	–6.15	32.47	–6.87	5.84	18.92	15.71
Phosphatic fertilizer	5.24	33.92	-39.97	–10.23	-16.54	-4.72
Machine labour	1.65	8.89	3.35	15.33	12.46	4.77
Operational holding	943.10	-1496.67	-2090.15	- 24.07.63	-526,88	-619.30
Hoeing/triphali (no.)	-482.86	2486.93	-1321.36	2283.30	-571.07	-1639.26
No. of irrigation	947.93	-10772.71	4922.00	-5231.39	5139.65	3810.18

HDB: Highly developed block

LDB: Least developed block

Economic losses – reasons

An attempt has also been made to compare the potential and realized yields and hence estimate the yield gaps in highly developed block/least developed block, on small, medium and large farm size categories of farms and overall. Yield gap I (gap between potential yield and average actual yield of crop in the particular vicinity) has been estimated for this purpose.

A wide yield gap existed in cotton productivity between potential yield and sample farms' average yield. The magnitude of yield gap II was found to be more (i.e. 817 kg per hectare) in the highly developed block. The higher yield gap implies that greater amount of highest yield was left untapped on actual average yields. The highest index of realised potential was worked out to be 54 per cent in the least developed block. The lowest estimated index of realised potential was worked out to be 22 per cent in the highly developed block. This was because area under cotton was sown at the recommended period of time in the least developed block in comparison to the highly developed block. The study observed that the augmentation of canal water lifting facility allowed by the Badal government has played an important role in the enhancement of value productivity of cotton in the least developed block. Singh and Jain (1985) also clearly underlines the scope for increasing agricultural production along with the nature of shifts in inputs and output for different size categories of farms consequent upon the augmentation of basic crucial water input. The study reveals tremendous scope to improve cotton production in the study area. The overall economic losses due to non-adoption of the recommended technology was observed to be 1547 kg per hectare (table 4).

Table 4: Per cent yield realization of cotton crop in the south-western zone of Punjab, 2001-02

	Highly developed block	Least developed block	Small farmer	Medium farmer	Large farmer	Overall
	Kg/ha	Kg/ha	Kg/ha	Kg/ha	Kg/ha	Kg/ha
Potential yield	2500	2500	2500	2500	2500	2500
Actual average yield	551	1355	803	1065	1086	953
Highest yield	1368	2000	1600	2000	1562	2000
Yield gap I	1949	1145	1697	1435	1414	1547
Yield gap II	817	645	797	935	476	1047
Index of yield gap I	0.78	0.46	0.68	0.57	0.57	0.62
Index of realised potential	0.22	0.54	0.32	0.43	0.43	0.38

The major reason responsible for such gaps as identified in the study are non-adoption of seed treatment, late sowing of cotton, underdose application of nitrogenous fertilizer, over-adoption of pesticides and brackish nature of underground water in the south-western zone of Punjab.

Suggestions for input-use-efficiency enhancement in cotton cultivation

The study brought out that the gross returns as well as returns over total costs, excluding land in the least developed block, was more compared to the highly developed block. The study concludes that the contribution of plant protection measures and machine was positive and significant in the highly developed block and least developed block, respectively, and in the overall study.

The coefficients of phosphatic fertilizer, nitrogenous fertilizer, machine and plant protection measures in cotton in the least developed block shows that there was

great scope for increasing investment on these variables. The marginal value productivity of phosphatic fertilizer was higher in the least developed block in comparison to the highly developed block. The analysis brought out the need to increase the expenditure on seed, plant protection measures, nitrogenous fertilizer, machine and number of irrigations in the overall study. The study also reveals that the inputs of human labour on hoeing and phosphatic fertilizer was overutilized in the overall study. The overall economic losses due to non-adoption of recommended technology was observed to be 1547 kg per hectare.

On the basis of the above discussion the following suggestions are put forward:-

1. Overdose of phosphatic fertilizer application should be avoided.
2. The recommended quantities of various brands of pesticides should be used and it should be applied at the recommended time.
3. The number of pesticides sprayed should be reduced.
4. The cotton should be sown at the recommended time i.e. up to 15 May.
5. The application of nitrogen fertilizer should be at the recommended time.
6. Use of insecticide with tractor mounted sprayer should be encouraged. □

Business has only two functionns—marketing and innovation.

— Peter Drucker

Book Reviews

Energy Environment and Sustainable Development *by Pradeep Chaturvedi*, Concept Publishing Company, p. 404, Rs. 750.

This book is an excellent effort towards compiling informative and valuable papers on energy and environment.

It includes a Platinum Jubilee Lecture by Mr. Gerald Doucet, Secretary General, World Energy Council on the topic 'Energy for People, Energy for Peace – Markets Sustainability and Drivers'.

The book has been divided into two parts dealing with energy and environment. Part I covers various issues in sustainable energy supply areas including hydro, thermal and nuclear energy sources. Foreign and private investment in the energy sector and characteristics of energy sector growth since the introduction of reforms in 1992 have been elaborated. That quality power distribution can be achieved through private companies with the help of IT intervention has also been highlighted. It is worth noting that this concept is already under implementation in various parts of the country.

In this part of the book, various initiatives taken by the Government of India and the thrust placed on modernization of power plants has also been discussed along with the strategic and energy challenges for nuclear power, renewable energy and alternative fuels.

Chapter 6 outlines the vision on research and development in the power sector and highlights technical issues which need to be tackled for ensuring quality power. Relatively new areas like nuclear power development and CNG for transport have also been covered. The author also focuses on the role of energy in rural development and agriculture and offers future direction in rural electrification. In order to promote renewable energy, an assessment of rural energy needs in South Asia has been made and also the networking of non-government organisations (NGOs) has been emphasised with the aim of achieving regional cooperation for sustainable energy supply. The author has made extraordinary efforts to review major hydroelectric power projects in countries like Nepal, Myanmar, Malaysia, Lao PDR, Thailand, Indonesia, China etc. and emphasis has been placed on building synergy for energy use in the Asian region.

Part II of the book covers a wide range of environmental issues with stress on sustainable development, environmental governance, quality of life through environment management and socio-aspects. This part starts with a discussion on environmental issues in the capital city, covering air quality, water quality and waste disposal. The sustainable development-related issues have been linked with the Johannesburg, World Summit on Sustainable Development, broadly encompassing five major areas i.e. water, energy, health, agriculture and bio-diversity. The author then goes into details of global overview of population, water quality, air quality, poverty, unemployment and on technologies for ensuring sustainable economic development. Three mutual reinforcing pillars of sustainable developments i.e. economic growth, social development and environmental protection have been elaborated and the need for environmental governance has been emphasised.

The author emphasises the need for globalization with a human face, ensuring environmental security. In chapter 24 corporatisation and sustainability have been linked with institution and observation. The environmental concerns like the use of environmental sound technologies, environment-based corporate decision-making, market-based instruments for environmental management and natural resource accounting, have been elaborated for effective corporate planning. Various awards initiatives for motivating Indian industries to lead in environment protection are discussed in chapter 26, with linkage to ISO 9000 and ISO 14000. Mention of disaster mitigation in the South Asia region context and the UN effort for natural disaster reduction has also been covered.

The author has made useful recommendations for capacity-building towards disaster management and sustainable water supply with a focus on the role of engineers in it. The author has not forgotten the importance of plant maintenance and related environmental issues. The last but not the least, is a very important chapter on Ensuring Public Acceptability of Hydro Projects, covering resettlement and rehabilitation of oustees from the project site and the role of stakeholders and NGOs.

The annexures include a detailed account of the growth of the power sector in India, energy reforms and plan of implementation of the World Summit on Sustainable Development, Johannesburg.

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Dairy Development in India (An appraisal of Challenges and Achievements): *by V. Venkatasubramanian, A.K. Singh and S.V.N. Rao,* Concept Publishing Company, Rs. 400.

Though the Indian dairy sector has been making inroads into the social and economic development of rural farmers since the implementation of the much acclaimed Operation Flood Programme in the early seventies (bringing the nation to the forefront as a global milk producer), it gained widespread attention only since the industrial delicensing in the early 90s, which was a part of the broad economic reforms and globalization of the national economy. If the cooperatives and the government dairies have established infrastructure at village-level for milk procurement and at the urban centres for milk sales, synchronizing the welfare maximization criterion at both ends during the protective era, the delicensing of the sector paved way for the private sector to have a slice of the cake.

Such a move has brought about a kind of internal competition between the cooperative and the private sectors in milk procurement, and marketing in the domestic markets, with global players also involved. There is wide speculation on the short-term and long-term implications of such competition on the domestic dairy sector and the industry. A decade has however, been passed off in this speculative competitive ambience, for the sectoral constituents to determine their competence and measure their confidence to face the internal and international competition in the framework of competitive advantage.

Given this background, this book holds great significance in identifying the operational modalities that have prevailed in the sector, and weighing up the pros and cons viz-a-viz the scope for the future. The book is a balanced, mature and in-depth analysis of the developments in the sector, presented in a sequential order. It highlights the repercussions of the different phases of dairy development of the past to determine the future scope for the sector. Towards this objective it adopted a scanning approach, starting with an in-depth review of the key village and intensive cattle development project, upto the cross breeding technology and technological intervention in breed upgradation at various stages of dairy activities under Operation Flood over the last three decades, and up to the emerging scenarios in the post Operation Flood era. It reveals the rapid development made during each of these phases in the respective fields, to impact the national economy at a comparatively low cost to the government. To implicate the development phases to business prospects, the authors have resorted to a SWOT analysis and identified the critical intervention areas for improving the competitiveness of the domestic dairy sector from a global economy perspective.

Part one of the book elaborates on the issues in dairy development programmes and attempts to establish the agenda for the course of action to match with the emerging market environment. It essentially acts as a foundation for the sector to build its future on a pragmatic and realistic manner. The technological interventions made in the rural dairy sector over the last three decades have been thoroughly evaluated for effectiveness and for the scope of sustained improvements in the sector for the future.

Part two of the book is an insight into the management and professional orientation of the dairy sector. It looks into the planning and evaluation of human resource requirements and the productivity in various spheres of dairy activities. It identifies the problems of bureaucracy and motivational problems among human resources and also highlights the probable consequences. The book has a separate section on the performance of dairy cooperatives and analyses the success and failures. As this section is based on a primary study, its credibility in the contemporary world seems to be high.

The book hints at the need to look at the dairy sector as more of an economic and commercial activity than just a developmental initiative. Hence, it gets into the need of evaluating the costs and benefits of various extension activities initiated at various stages of dairy development. It suggests a cost advantage approach for development programmes to enable commercial and market sustainability.

Overall, the book provides an insight into the future requirements of the dairy sector, for it to balance its development commitments and ensure viability and sustainability from a commercial viewpoint, as against the development criterion used in the past. It is essential reading for practicing managers in the sector, students, professionals and academicians.

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Bioinformatics-concepts, skills and applications *by S.C Rastogi, Namita Mendiratta and Parag Rastogi,* CBS Publishers and Distributors, p. 365, Rs. 320, Paperback, Rs. 1195 (Hard bound).

In the last few decades, advances in molecular biology and the equipment available for research in this field, have led to the increasingly rapid sequencing of large portions of the genomes of several species. In fact to date, several bacterial genomes, as well as those of some simple eukaryotes (e.g., *Saccharomyces cerevisiae*, or baker's yeast) have been sequenced in full. The Human Genome Project, designed to sequence all 23 point of the human chromosomes, is also underway.

This deluge of information has necessitated the careful storage, organization and indexing of sequence information. Information science has been applied to biology to produce the field of bioinformatics which is a fast emerging and dynamic field and is an interdisciplinary approach requiring sophisticated computer science, mathematics and statistical methods. It also needs a functional understanding of the biological and chemical context at the molecular level. Bioinformatics provides new opportunities in skills like manipulation, control and modification of the interface at the molecular level, which have broad applications in disease gene discovery, molecular diagnostics, drug design, metabolic engineering, bioconversion and biosynthesis.

This book is written primarily as an introduction to bioinformatics. It tackles the challenge of understanding bioinformatics head-on by discussing the current approaches and variety of systems available to help bioinformatic professionals with this increasingly complex issue. The heart of the book lies in efforts to describe approaches to data integration and interoperability, presented in a unique style. This book provides important criteria for evaluating these systems, that bioinformatic professionals will find valuable. The book aims to provide a systematic overview of bioinformatics for biological students, healthcare professionals and for students of computer science. It attempts to simplify the concepts and skills required for understanding bioinformatics and illustrates the principal applications involved.

The book is conveniently divided into 10 sections. Section one deals with the basic overview of bioinformatics. Section 2 covers chapters 2, 3 & 4 and deals with the basis of all cell information i.e. structure and function of DNA and proteins and the relationship between molecular biology and bioinformatics. Section 3 deals with the Linux operating system, which also includes writing shell programmes.

Section 4 is Programming with Perl. Many biologists have a difficult time learning how to apply the language to bioinformatics. The most popular Perl programming books are often too theoretical and too focused on computer science for a non-programming biologist. This section deals with the basics as well as the applications.

Section 5 deals with the understanding and applications of biological databases and gives a good idea about the types of databases and networks. A biological database is a large, organized body of persistent data, usually associated with computerized software designed to update, query, and retrieve components of the data stored within the system. A simple database might be a single file containing many records, each of which includes the same set of information. This chapter also introduces the concept of biostatistics.

Section 6 deals with chapters 8, 9, 10 and 11. These chapters deal comprehensively with sequence analysis like alignment of pairs of sequence, tools for sequence alignment, alignment of multiple sequences and phylogentic analysis. The chapter on sequence analysis forms the basis for this section and provides fundamental details of sequence analysis of biological data, models for the same and their biological motivation and methods of alignment. The chapter ends with illustrative examples, which are useful in understanding the basic concept of this very important topic. The various tools for sequence alignment like BLAST, FASTA etc are detailed in the chapter titled the same. The alignment of multiple sequences is given in the next chapter. It also gives details related to the tools for multiple sequences alignment, its applications and also explains about measures for efficient sequence detection.

The concept of phylogenetic analysis and trees is explained along with the various methods like distance matrix and character-based methods in the next chapter. Methods of evaluating phylogenies and a summary

of the methods are also elucidated in the chapter. An illustration showing work with phylogenetic trees provides the reader with a good understanding of this topic.

The next section deals with the prediction methods related to genes and proteins and covers chapters 12 and 13. The chapter on gene prediction methods deals with the use of patterns, methods and tools for gene prediction. A summary of tools for the structure and function analysis for DNA/RNA gives the reader an in-depth analysis of the topic. The chapter on visualization and prediction of protein structure gives an overview of the protein structure, different structural proteins, and some in-depth knowledge about the databases and visualization tools relating to proteins. The chapter also deals with the accuracy of protein function and methods for predicting the same.

The next section deals with gene mapping, its application and also gives an idea about DNA microarray with an insight into experimental design and data analysis. The chapter on proteomics deals with a brief introduction to the topic, analysis and tools for proteome analysis, metabolic pathways and complete pathway simulations.

The last section in the book deals with an important aspects in Bioinformatics, with topics like genomic analysis for DNA and protein sequences, strategies and options related to similarity search and practical considerations in sequence analysis along with flowchart for protein structure prediction. The last portion of this informative book ends with illustrations with good examples of problems and solutions.

There is also a good and comprehensive glossary, which will be helpful to students.

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We cannot become what we want to be by remaining what we are.

– Max Depree

News & Notes

Economic Security exceeds Income Share

The region encompassing South Asia and South-East Asia has a higher share of economic security than its share of the worlds income. This is a notable conclusion of a new ILO report on economic security around the world, which draws on a comprehensive database for more than 100 countries, as well as on special workplace and household surveys looking at the insecurities experienced by workers and their families.

Among the findings in the report that relate specifically to Asian countries are the following:

- The pattern and trends in national economic security in Asia is affected by the differential experience of the two mega-countries, China and India, both of which have experienced higher economic growth in the globalization period and a decline in economic instability. Other countries have experienced lower growth rates, but unlike the rest of the world they have not experienced a great deal more economic instability, even taking account of the Asian crisis of 1997-98.
- The extent of labour market insecurity – lack of employment opportunities – is underestimated in Asia, primarily because a large part of the labour slack that exists in China is unmeasured, consisting of large numbers of workers put on long-term lay-off. Such workers are gradually entering the pool of open unemployed.
- Surplus labour abounds in Chinese enterprises. The situation is particularly pressing in State-owned and collective enterprises. In the ELFS, over two-thirds of such establishments indicated that they did not have enough work for their workforce.
- While women all over the world experience more income insecurity than men, their relative position in Asia is more disadvantaged. Among the main reasons for this is that they often lose a large part of their earnings, taken by relatives, middlemen and others. They are also more likely to experience irregular payments and fluctuating incomes.
- Women in Asian countries are concentrated in some form of informal economic activity – in itself an indicator of various forms of insecurity documented in the report. It also seems that when men move into more formal (protected) jobs they gain more than women making similar moves, implying that formalization of jobs could widen the inequalities between men and women.
- In terms of relative performance in economic security, as measured by the Economic Security Index, a high proportion of Asian countries are in the Much-to-be-Done cluster, that is, having relatively undeveloped policies to promote economic security, having weak institutions to put such policies into effect and having relatively poor outcomes. This is the case even though the region has achieved higher levels of economic security than income, as noted earlier.
- In Asian countries, workers in general lack representation security, that is, they do not have access to collective representation and bargaining to protect them in the workplace and in the labour market. In this respect, they are worse off than their counterparts in many other parts of the world. No country in Asia has high representation security, as measured by a national index of representation, and 9 out of the 16 countries surveyed fall into the Much-to-be-Done cluster of countries.
- Women are less likely to occupy senior positions in trade unions in Asian countries than in most other regions of the world, according to evidence from a review of 61 countries. Thus, women only have 10% of top union managerial positions in Asia, compared with 26% in OECD countries.

- Workers in Asian countries are more inclined to be passive or fatalistic when confronted by labour difficulties than in many other parts of the world. For instance, in China over a third of workers (35%) said they would do nothing if they did not receive their wages, whereas only 14% said they would appeal to a union to take action. In Indonesia, only 21% of workers thought they would be prepared to go on strike in pursuit of their interests.
- Unions in the Philippines, according to a survey of 1,300 industrial enterprises, have been effective in increasing workers income security. Average wages in unionized firms were three times the level in non-union firms.
- In Bangladesh and Indonesia, women were more likely than men to express a positive attitude to trade unions, and this seemed to apply in the Indian state of Gujarat as well.
- In Asian countries, as shown from the survey data from China and Indonesia, women with higher levels of schooling and in higher-income jobs are much less likely than other women to lose their jobs on becoming pregnant. This is a form of insecurity that is not taken into account in standard measures of inequality. Overall, in China 18% of all women thought a woman would lose her job on becoming pregnant.
- In Asian countries such as China and the Philippines, managers of small-scale firms are more likely than their counterparts in large firms to admit discriminating against women because of the prospect of women taking maternity leave.
- Small is also not necessarily beautiful when it comes to the promotion of skill formation. In Indonesia, in a survey of 2,000 firms, it was found that small firms were less likely to give workers any training. Foreign firms, there and in the Philippines, were the most likely to provide training.
- A phenomenon that is strongly observable in Asian countries covered by the ILO analysis is the non-use of available skills. Given the widespread belief that there is a need for more investment in skills and training, it is notable that large numbers of workers report that they do not use the skills and qualifications in their work. This is more common among women than among men.

Indonesia: Income-earners believing they use their qualifications or skills in their main work, by area, establishment size and work status, by gender (percentage responding Yes)

	Using qualifications		Using skills	
	Male	Female	Male	Female
Type of area				
Urban	62.1	41.7	79.6	76.6
Rural	49.2	42.3	68.8	63.6
Establishment size				
1-5	48.0	37.9	68.9	66.5
6-10	69.7	73.3	79.5	75.0
11-20	79.3	54.5	75.4	81.3
21-50	79.1	55.6	83.7	73.9
51+	76.5	75.0	84.6	87.5
Work status				
Own account	46.9	34.8	69.0	62.5
Wage				
Private (employees)	43.5	34.1	61.1	66.2
Private (5+ employees)	70.8	58.7	86.7	65.0
Public	80.6	81.0	81.7	96.0
Cooperative	(100.0)	(100.0)	(100.0)	(100.0)

Note: Figures in parentheses are based on fewer than 10 observations.

Source: Indonesia PSS 2001.

- In South Asian countries, workers in wage jobs are relatively unlikely to be working without any form of employment contract. China is a striking exception, since over two-thirds of workers, both men and women, have long-term employment contracts. By contrast, in Bangladesh, only a little over a third of men in wage jobs have such contracts and in Gujarat only a little over 1% of both men and women do so.

Source: ILO Socio-Economic Security Programme Economic Security for a better world. Fact Sheet No. 6: South and South-East Asia.

Why Neither Formal nor Informal may be Best for Workers

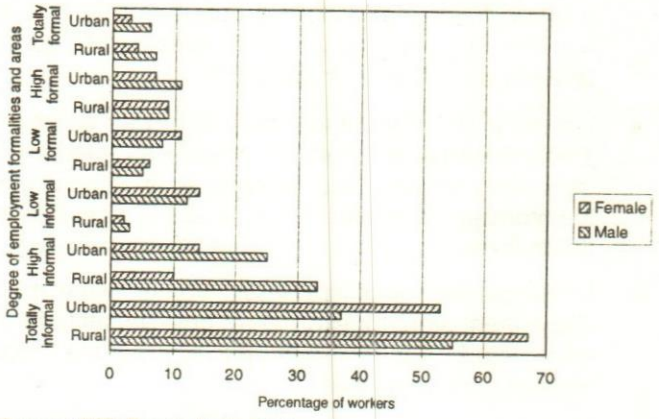
The worlds economy is being steadily informalized, with more and more workers finding themselves outside standard employment relationships. The notion of strong employment security is increasingly a mirage, according to an ILO report that has traced developments in various aspects of social and economic insecurity around the world.

- The analysis shows that non-wage forms of labour force work have been spreading, and that own-ac-

count activity has grown particularly fast in Latin America, where it now accounts for more than 40% of all non-agricultural labour force work.

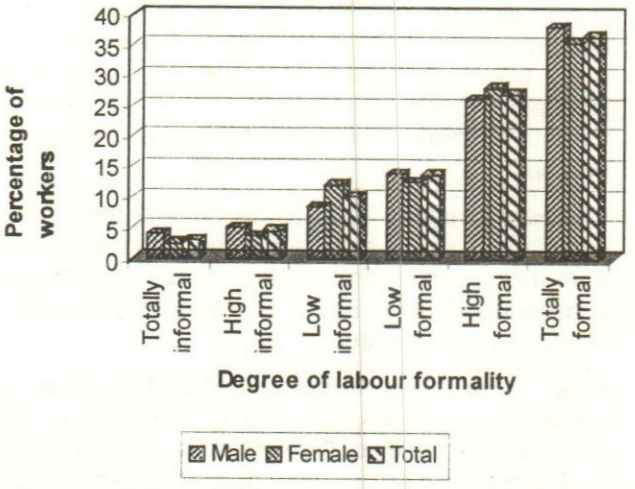
- The report warns that it is incorrect to see the international trends in terms of a dualism of an informal sector growing alongside a formal sector. Rather there is a wide spectrum of work statuses, and it should not be presumed that being highly formal is better than being less formal.
- Indeed, according to statistics on working patterns from the ILOs Peoples Security Surveys, covering 48,000 households in 15 countries, increasing the formality of jobs may result in a widening of income differences between men and women and between younger and older workers.
- The existence of a large informal economy and the informal support networks that tend to accompany this, as found in south-east Asian economies, may actually act as a buffer in times of economic shock. By contrast, where labour markets are highly formal, and individualistic, economic shocks can cause devastating consequences for those adversely affected. This is not to romanticize the informal economy, but merely to show that formalization is not a panacea of economic insecurity.
- Labour informality does not map neatly onto the enterprise-based concept so widely used in reports and by analysts. Chile, where the PSS data show that 38% of workers in so-called informal enterprises are actually in highly formal labour relations, while 62% of all workers are both in informal enterprises (so-called) and in informal labour as defined in the PSS. Moreover, 42% of workers in so-called formal enterprises (with more than 10 workers) are not in formal labour. In Bangladesh too, only 47% of workers in large firms with more than 500 workers are highly formal, and 27% are low in the scale of formality. Even in China, only 54% of workers in such firms are formal, while 17% of workers in establishments of less then seven workers are formal.
- In Bangladesh or in India (Gujarat), most workers stand at the low end of the continuum, with women overwhelmingly so. There is a tremendous contrast with the situation in China, where the PSS in three provinces showed a picture of most workers being at the upper end of the spectrum, and with women actually being more likely to be highly formalized.
- In Argentina the relatively informalized workers are more likely to have experienced a spell of unemployment lasting a month or more in the past two years 57% of the most informalized, compared with 12% of those in highly formalized statuses. A roughly similar pattern emerges in Brazil and Chile. What characterizes them most is that they are in constant search for other things to do.

Bangladesh: Degree of labour informality, by gender



Source: PSS Bangladesh, 2001

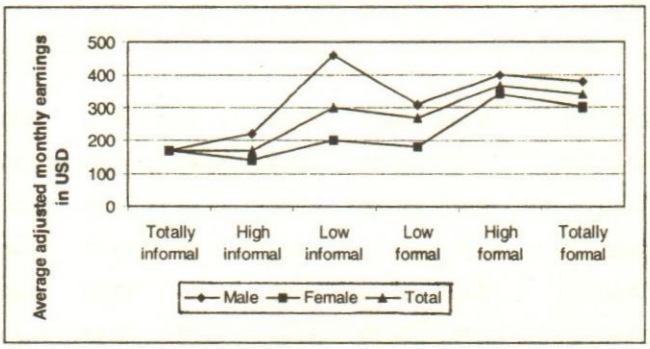
China: Degree of labour informality, by gender



Source: PSS China, 2001

- In Gujarat, India, about three-quarters of the highly informal do not have any skills security, compared with 13% of those in highly formal labour statuses.
- In Ethiopia, as expected, the less educated are concentrated in the more informal work statuses, and the vast majority of them do not meet any of the five criteria used to define formality. Much the same emerges in the very different economy of China, where those in relatively informal labour statuses are far less likely to have access to training.
- Workers in higher degrees of informality may have earnings equivalent to those in formal jobs. As for income security, it is too simplistic to equate informality with poverty, even though more of the relatively informal have low incomes.

- Income advantage comes with more increase in formality, but it is by no means always the case that a high degree of formal employment yields much higher income [or skills security, as shown in Fact Sheet 13].

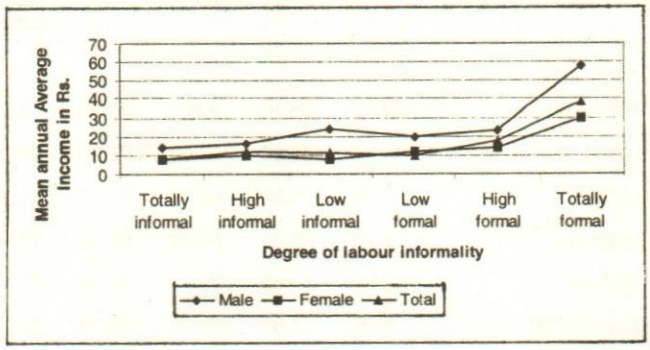


Source: Chile PSS 2001.

What seems to be the case is that formality gives greater protection for men than for women. The benefit of formality – in terms of income - is gained by men to a greater extent, though worsening gender based income inequality.

Being in an informal labour status means a greater likelihood of income variability and decline.

Workers in highly informal work statuses experience a higher incidence of financial crisis in Gujarat 13% of those in the most informal status went hungry in the past year, against 6% of those with highly formal status.



Source: PSS Gujarat India, 2000.

Conscious of their general insecurity, those in highly informal work statuses worry more than others about what will happen in their old age when they are unable to work.

Source: ILO Socio-Economic Security Programme Economic Security for a better world. Fact Sheet No. 12: Employment insecurity.

Strength does not come from physical capacity. It comes from an indomitable will.

– Mahatma Gandhi

Labour participation rates in India

Table 1: Age specific labour force participation rates[1] for each sex in India

Year	Male						Female					
	Age-group (in years)						Age-group (in years)					
	5-14	15-29	30-44	45-59	60 & above	Total	5-14	15-29	30- 44	45-59	60 & above	Total
						Rural						
1977-78	13.10	86.10	99.00	95.90	64.60	63.70	9.10	39.70	49.20	41.10	16.00	30.50
1983	11.60	82.80	98.60	95.20	64.20	62.60	9.00	37.20	46.00	40.80	15.60	29.10
1987-88	7.40	79.70	98.70	95.70	64.90	61.40	6.30	36.90	47.60	42.20	16.30	29.20
1989-90	7.70	80.30	97.50	96.90	70.40	54.60	7.10	35.70	43.70	42.10	18.00	25.40
1990-91	8.30	74.50	98.10	95.90	71.10	54.90	5.10	37.70	39.90	40.40	12.50	24.30
July-Dec. 91	8.00	77.30	98.40	96.70	72.70	54.80	7.50	34.60	42.80	40.70	17.40	24.70
1992	7.30	77.40	98.80	97.50	72.70	55.00	6.30	35.00	45.40	43.50	18.20	25.30
Jan-June 93	6.50	76.60	98.40	96.70	71.00	61.70	5.00	33.80	43.90	42.20	19.70	27.90
1993-94	5.90	77.70	98.80	96.40	60.30	63.00	5.50	32.20	42.70	43.10	17.30	27.20
1994-95	5.80	77.00	98.40	96.60	72.10	55.30	5.30	31.20	43.20	39.60	19.60	23.80
July 95 June 96[a]	6.20	78.10	98.70	97.10	69.90	55.00	4.30	32.20	43.50	40.00	17.80	23.60
Jan-Dec 97[a]	5.80	77.00	98.80	97.20	67.30	55.00	4.30	30.00	40.40	38.50	18.00	22.40
Jan-June 1998[a]	4.60	74.90	98.30	96.20	70.70	54.30	3.40	28.40	38.40	37.50	17.50	21.20
1999-2000	4.31	75.94	98.38	95.37	62.40	53.30	3.83	31.61	44.52	40.75	17.40	23.50
July 2000-June 2001	3.62	75.25	98.72	96.40	68.20	54.08	2.94	28.51	43.31	41.31	15.30	22.25
						Urban						
1977-78	5.80	73.60	98.90	93.60	50.50	60.10	3.80	21.90	27.20	24.10	10.50	17.10
1983	5.60	72.90	98.60	92.80	48.80	60.30	3.00	17.20	23.90	23.00	11.60	14.80
1987-88	4.20	69.70	98.70	93.10	46.60	59.60	2.40	17.20	23.90	22.40	9.30	14.60
1989-90	4.10	66.20	98.00	92.90	44.90	52.40	2.40	16.70	23.80	22.70	10.40	12.90
1990-91	3.90	64.90	98.50	94.90	44.80	53.20	2.30	16.00	24.10	23.50	8.90	13.00
July-Dec. 91	4.70	66.20	98.20	93.40	50.50	53.50	2.60	16.00	22.60	21.40	8.50	12.70
1992	4.50	65.30	97.80	90.60	47.90	52.60	2.70	17.00	22.20	25.40	9.90	13.40
Jan-June 93	4.20	65.70	97.80	93.00	45.90	59.00	1.40	14.50	21.40	21.50	8.20	13.30
1993-94	3.30	67.40	98.40	93.40	43.00	60.10	1.90	16.50	23.60	23.20	9.20	14.50
1994-95	3.70	64.50	98.40	92.80	43.70	53.40	1.90	14.80	20.50	19.60	6.80	11.70
July 95 June 96[a]	3.90	67.30	98.60	92.30	40.40	54.40	1.50	13.60	19.80	19.50	7.40	11.10
Jan-Dec 97[a]	3.60	66.40	97.10	92.50	41.50	53.70	1.70	14.30	21.40	19.30	7.70	11.70
Jan-June 1998[a]	4.20	64.00	97.80	92.00	41.70	53.40	1.60	12.40	19.90	19.20	6.40	10.80
1999-2000	2.73	65.88	98.14	92.26	38.60	53.90	1.53	14.92	22.93	21.96	8.20	12.60
July 2000-June 2001	3.03	64.88	98.28	92.65	39.10	58.80	1.49	13.07	22.68	21.32	7.50	12.05

Source: National Sample Survey Organisation

Note: The figures of different rounds relate to the usual principal status.

a. The results are based on thin samples.

1. Percentage of labour force in the population.

Table 2: Age specific unemployment rates[1] by sex for India

Year	Male						Female					
	Age-group (in years)						Age-group (in years)					
	5-14	15-29	30-44	45-59	60 & above	Total	5-14	15-29	30- 44	45-59	60 & above	Total
						Rural						
1983	2.80	4.70	0.50	0.20	0.20	2.10	1.20	2.80	0.50	0.40	0.60	1.40
1987-88	3.20	6.20	0.90	0.50	0.50	2.80	2.90	5.40	2.40	1.90	1.80	3.50
1989-90	1.90	3.60	0.50	0.04	0.60	1.60	1.40	1.50	0.40	0.60	NA	0.80
1990-91	0.60	3.20	0.30	0.30	0.20	1.30	NA	1.00	0.30	NA	NA	0.40
July-Dec. 91	3.70	4.30	0.40	0.20	0.20	1.80	2.70	2.00	0.60	0.50	0.60	1.20
1992	1.30	3.80	0.30	0.20	0.30	1.60	1.60	2.10	0.30	0.30	NA	1.20
Jan-June 93	3.70	3.70	0.20	0.20	0.10	1.60	2.10	2.00	0.30	0.20	0.50	1.00
1993-94	1.60	4.90	0.40	0.10	NA	2.00	0.80	3.20	0.40	0.20	NA	1.40
1994-95	0.80	3.10	0.30	0.00	0.00	1.30	0.00	1.50	0.00	0.10	0.00	0.40
July 95 June 96[a]	1.60	3.60	0.60	0.20	0.10	1.40	0.00	1.60	0.30	0.10	0.00	0.80
Jan-Dec 97[a]	3.30	3.80	0.30	0.00	0.00	1.60	1.20	2.10	0.30	0.00	0.00	0.90
Jan-June 1998[a]	2.10	5.00	1.10	0.80	0.60	2.40	4.40	4.10	1.00	0.70	0.60	1.90
July 99- June 2000	2.20	5.10	0.60	0.10	0.20	2.10	1.20	3.70	0.40	0.20	0.40	1.70
July 2000-June 2001	2.74	4.16	0.14	0.04	0.00	1.58	1.69	1.52	0.17	0.20	0.00	0.61
						Urban						
1983	10.60	12.20	1.40	0.70	0.60	5.90	2.30	15.50	2.10	0.70	9.10	6.90
1987-88	9.30	13.60	1.20	0.70	1.10	6.10	4.10	18.80	3.50	1.10	1.10	8.50
1989-90	11.10	9.70	0.90	0.90	1.80	4.40	NA	7.90	1.10	0.50	NA	3.90
1990-91	9.00	11.30	0.80	0.30	0.90	4.50	NA	13.20	1.40	0.40	NA	5.40
July-Dec. 91	12.00	9.60	1.00	0.60	0.20	4.50	3.90	11.20	2.50	NA	NA	5.50
1992	14.80	10.20	1.30	0.40	2.10	4.60	17.20	13.80	1.80	0.30	1.00	6.70
Jan-June 93	7.20	9.20	0.80	0.40	0.20	3.80	NA	8.60	2.60	0.50	NA	4.30
1993-94	4.50	10.80	1.10	0.40	0.30	4.50	2.60	19.60	2.80	0.40	NA	8.20
1994-95	6.80	8.50	1.10	0.20	NA	3.70	2.70	10.00	0.30	0.00	NA	4.30
July 95 June 96[a]	7.90	9.90	1.00	0.30	0.20	4.00	0.00	0.80	0.30	0.30	0.00	3.60
Jan-Dec 97[a]	4.30	10.00	0.90	0.30	0.20	3.90	3.10	13.20	1.70	0.00	0.00	5.10
Jan-June 1998[a]	18.80	11.50	1.90	1.20	1.40	5.20	38.80	16.60	2.40	1.70	4.70	8.30
July 99-June 2000	5.70	11.50	1.40	0.40	0.00	4.80	3.30	16.60	2.80	0.50	0.00	7.10
July 2000-June 2001	5.21	9.84	1.26	0.39	0.51	4.17	0.00	11.05	0.64	0.00	0.00	3.82

Original Source: National Sample Survey Organisation

Note: The figures of different rounds relate to the usual principal status.

0.0 : Negligible

NA : Not available

1. The percentage of unemployed in labour force.

a. The results are based on thin sample.

Source: Socio-economic Statistics 2002. CSO, GOI

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Book Review

"Geography of Transport Development in India" Edited by Vaidya. B.C: Concept Publishing Company New Delhi-110059, 2003; pp.465, Price Rs.800. Reviewer: K.P. Sunny, Deputy Director, National Productivity Council, Vol. 44 No. 2 July–Sept, 2003 P. 338-339

"Solid Waste Management" by Iqbal H. Khan and Naved Ahsan, CBS Publishers & Distributors, p.238 Price Rs. 175. Reviewer: Yogesh Gupta, Dy Director (Environment) National productivity Council, Productivity Vol. 44 No. 3 Oct–Dec 2003 P.512

"State-level Reforms in India : Towards more Effective Government" by (Ed) Stephen Howes, Ashok K. Lahiri and Nicholas Stern, Macmillan India, 2003, p325. Price: 450 Reviewer: Utpal Chattopadhyay Dy. Director (Economic Services) NPC Vol 44 No.4, Jan –March,2004 P.692

"The Dynamics of Technology Creation and Diffusion of Skills and Knowledge", edited by Roddam Narashima, J. Srinivasan and S.K. Biswas, Sage Publication, New Delhi, 2003, Hard Cover, p.301. Price: 506/- Reviewer: S.K. Gupta, Management Consultant D-4, Green Park Main New Delhi-16. Vol. 44 No.4, Jan-March, 2004 P .690.

"Water Perspective, Issued & Concerns" by Ramaswamy R. Lyer, 2003, Sage Publications India Pvt Ltd;p.368,Rs.550 Reviewer: Rajesh Sund, Asstt.Director, NPC, Vol. 44 No.3 Oct Dec-2003 P.512.

"Water Resources Sustainable livelihoods and Eco-Systems Services", edited by Kanchan Chopra,C.H. Hanumantha Rao& Ramprasad Sengupta, Concept Publishing Company, 2003, p.450, price: 575/- Reviewer: Rajesh Sund, Asstt. Director NPC Vol. 44 No. 4,Jan-March, 2004 P. 688-689.

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Don't forget that it (your product or service) is not differentiated until the customer understands the difference.

– Tom Peters

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