



Productivity

Vol. 38

April-June 1997

No. 1

Focus : Intellectual Property Rights



Intellectual Property and Technology Change

Biotechnology Development & IPR

Plant Variety Protection in India

Human Process Re-engineering

Leadership Style in Public Enterprises

Coping with Continuous Change

Taguchi Methodology

Crop Diversification

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<i>SAARC Countries</i>	:	Annual Airmail US \$ 40 Annual Surface Mail US \$ 30 Single Copy Airmail US \$ 10

Productivity will be sent to all subscribers within each quarter. The Journals Division, New Age International (P) Ltd., may be contacted in the event of non-receipt within one month from the quarter.

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**THE JOURNALS DIVISION,
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Telex : 031-66507 WEL IN

Cable : WILEY EAST

Phones : 3261487, 3278348, 3267996
3288149

ISSN 0032-9924

Productivity

A QUARTERLY JOURNAL OF THE NATIONAL PRODUCTIVITY COUNCIL

Vol. 38 • April–June 1997 • No. 1

PUBLISHING FOR ONE WORLD

NEW AGE INTERNATIONAL (P) LTD., PUBLISHERS

New Delhi • Bangalore • Calcutta • Chennai • Guwahati
Hyderabad • Lucknow • Mumbai • Pune

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NEW AGE INTERNATIONAL (P) LIMITED, PUBLISHERS

- NEW DELHI** : 4835/24, Ansari Road, Daryaganj, New Delhi 110 002
BANGALORE : No. 35, Annapurna Building, Basavangudi, Bangalore 560 004
CALCUTTA : 40/8, Ballygunge Circular Road, Calcutta 700 019
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ISSN 0032-9924

Published, on behalf of the National Productivity Council, by H.S. Poplai for New Age International (P) Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi 110 002. Typeset by Pagitek Graphics, 7F West Guru Angad Nagar, Laxmi Nagar, Delhi and printed at Kay Kay Offset Printers, D-197, Street No. 8, Laxmi Nagar, Delhi-110 092.

Printed in India.

Production: A. Chakraborty

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Intellectual Property & Technology Change

Subhash K. Bijlani

Industrial success is being increasingly attributed to technology, with the earlier success factors viz. labour and capital taking the back seat. In this emerging scenario a sound patent system is essential for creating a conducive environment for technology transfer. There is a pressing need for greater awareness about the patent information system and more importantly, how it can be accessed and used, according to the author.

There is overwhelming empirical evidence that innovation and creativity bring competitive advantage to nations. Per capita economic growth of countries is increasingly being driven by innovation, and not by aggregate capital investment *per se*. Economic progress requires a constant stream of new ideas and products to improve the quality of life, regardless of whether the innovation is a simple gadget or a sophisticated contraption.

Economic progress requires a constant stream of new ideas and products.

Technology & Economic Development

As new opportunities open up, the critical role of technology as a driver of economic growth has come to be acknowledged. Neo-classical economic theory attributed growth in output to increase in the factors of production, namely, labour and capital. However, recent experience of nations shows that the contribution of raw materials, and in many cases, that of labour, has steadily declined in providing competitive edge to the products: their percentage in overall costs has reduced. This is perhaps best reflected in micro-processor technology where the raw material content has steadily fallen to an insignificant proportion of its price. Increasingly, the speciality of most new products comes from value addition through technology.

The recent economic achievements of many countries have not sprung from their natural resources. Malaysia's prosperity, for example, is no longer based on tin and rubber. Countries rich in natural resources, on the other hand, for example, oil producing countries of Middle East, are not the great economic powers. With limited resources at the disposal of any one nation, it is logical to benefit from other strengths through technology transfer. We are witnessing an increased inter-dependence in global

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trade and technology as costs and risks of new products and process development increase.

Strategic alliances between companies such as licensing agreements, joint ventures, mergers, acquisitions and cooperative R&D agreements are proliferating, cutting across national borders and cultures. Alliances seek to learn and acquire from each other's technologies, products, skills, and knowledge that are not available to other competitors. New relationships between enterprises are setting new standards in making it easier to do business together.

The neo-classical economic theory assumed technology progress to be an essentially exogenous phenomenon. Current understanding of economic growth is at variance with this view which regards technology as a 'free good'. It is now widely acknowledged that technological progress occurs precisely as a result of entrepreneurial activities in anticipation of profits from innovations.

A sound patent system contributes to the transfer of technology by providing a legal environment which is conducive to encouragement of technology transfer.

Intellectual Property

It is useful at this stage to recapitulate some of the basic concepts of intellectual property:

Intellectual Property Rights are the exclusive rights granted to their holders as a reward to the inventor for his private initiative. Their origins go back to 18th and 19th century when the patent protection was first introduced. Under this system, in exchange of the grant of exclusive rights by the state, the inventor is obliged to make his invention known to public through the system of patent documentation. Creativity is accorded the status of 'property' because, like any commodity, it may be bought, sold, hired or licensed.

Intellectual Property Rights are the exclusive rights granted to their holders as a reward to the inventor for his private initiative. Creativity is accorded the status of 'property' because, like any commodity, it may be bought, sold, hired or licensed.

- *Movable property:* Here the owner has the legal and exclusive right to use his property. The

owner may authorize others to use his property but such authorization is legally necessary.

- *Immovable property:* such as land and buildings. There are limits to the use of such property, for example, the requirements to be fulfilled when constructing a building.
- *Intellectual property:* This is the creation of the human intellect. To put in simple terms, intellectual property relates to information which can be incorporated in tangible objects and reproduced in different locations. Like the movable and immovable properties, intellectual property is also characterized by limitations of law, for example, limited duration in the case of copyrights and patents.

If an invention cannot be protected against being copied or pirated, the scenario is hardly conducive for creativity. However, this is the dismal reality one encounters in most developing countries which have assumed that inventions are mostly done by 'outsiders'; that, on our own, we are incapable of innovation; what we do is not quite the international class. Therefore there exists the fear that foreigners will come from all over and register patents. This wrong notion that we are incapable of inventions and creativity has to be dispelled.

Inventions are characteristically protected by patents. Patents are used as devices to advance knowledge and bring new knowledge eventually into the public domain. But they are also used as instruments of competitiveness by the individual firm against potential or actual competitors or by Governments in their bid to strengthen their own countries against foreigners.

Patent System: Origin & Features

There is a mistaken belief that patents are only for major technological breakthroughs. There are millions of patents presently enforced around the world which are clearly not so. Most patents are granted for incremental inventions—those small improvements to products or process that make them more efficient or more marketable. What is more, patents cover every area of technology, from paper clips to computers. Each patent specification is a detailed disclosure of the invention and it is this aspect, which is particularly valuable as a rich source of technical information.

Generally, laws require that for an invention to be patentable, it must be new, it must involve an inventive step, that it must not be obvious and must be industrially applicable. In some countries, laws exclude certain

specific kinds of inventions from being patented, for example, inventions relating to nuclear transformation. It is also customary to distinguish between inventions of products and processes. An invention that consists of a new alloy, for example, is a product invention. A new method of making a known or new alloy is a process invention.

In India, the patent system was introduced by the British Government in 1856. The 1856 Act was replaced by the Industrial Patent and Design Act of 1911, based primarily on the model of British legislation. The 1911 Act was overhauled and a new Patent Act was passed in 1970 which came into operation in 1972. Since then more than 40,000 patents have been registered in India.

The history of industrial property licensing shows a definite correlation between economic development of a country and the patent protection granted by that country. In the early phases of industrial development, there is a weak system to protect intellectual property. As the technological advancement accelerates and industry grows, countries begin to strengthen their IPR base. The existence of the legislative framework to protect inventions provides a great spurt to inventiveness. A recent example is that of China where the Chinese Patent Law came into force in 1985. During the past 10 years since Chinese Patent Office was formed, the registrations in CPO has increased sharply at an average of 20 per cent per year. The filing number in 1992 was 67,135 and in 1993, it was 77,276.

The history of industrial property licensing shows a definite correlation between economic development of a country and the patent protection granted by that country.

Patent laws often provide for situations in which exploitation in public interest on behalf of the Government may be allowed on the basis of a compulsory license. A compulsory license is an authorization to exploit the invention given by the Government generally in very special cases defined in the law, e.g., public interest and only where the entity wishing to exploit the patented invention is unable to obtain the authorization of the owner of the patent for invention.

To provide a more complete backdrop of the intellectual property, it is also useful to make a reference to other linked areas:

- * *Utility models*: Certain countries provide protection to utility models which are inventions in the mechanical field. The inventive step in utility models is usually smaller than in the case of an invention. Also the maximum term of protection provided in the law for utility model is generally shorter than for an ordinary patent for invention.
- * *Industrial designs* are the ornamental or aesthetic aspects of a useful article. They depend on the shape, pattern or colour of the article. The design has to be appealing as well as be reproducible by industrial means.
- * The issue of the type of protection to be given to the layout design or the topography of the *integrated circuits* is a relatively new one. Although prefabricated components of electrical circuits have been used for a long time, large scale integration has become possible only over the last few years.
- * A *trade mark* is a sign used on or in connection with the marketing of goods. In general it performs four main functions: distinguishing the products or services of an enterprise from those of others, referring to a particular enterprise to give an indication as to the origin of the goods and services for which the mark is used, referring to a particular quality of products or services, promoting the marketing and sale of products/rendering of services.
- * Another category of objects of industrial property is *commercial names* and designations. In most countries, trade names are registered with the Government authority. Protection generally means that the trade name of one enterprise may not be used by another enterprise.
- * *Geographical indication*: is an indication of source showing that a product or service originates in a country, in a region or a specific place. As a general rule, the use of false or deceptive indication of source is unlawful.

A major step was taken when India signed the new GATT treaty and Government of India passed an Ordinance on 3 Dec., 1994, allowing 72 signatories to the World Trade Organisation Agreement to avail of the Indian Patents Act 1970, whether or not they have entered into any bilateral or multi-lateral agreement with India in respect of patent systems. The Government has also declared its intention eventually to align the Indian Patent System to suit the TRIPS provision of the new GATT treaty. There are several international treaties governing Intellectual Property Rights. A summary of various treaties is given in Annexure I.

Uses of Patent Information

Patent documents are extensively used as a source of technological information and related issues.

While the role of patents in granting monopolistic rights is well publicized, its usefulness in improving the competitive position of firms, and the important role it plays in the development of technology is not so well acknowledged. Some salient aspects of patents are as follows:

- * Patents deal with technology. They protect the most recent technology, namely inventions.
- * Inventions are not general ideas, they are solutions to technology problems and must be distinguished from general principles and theories without application and industrial production. They provide something that did not exist before which is different from a discovery of something which existed but was not known.
- * Inventions relate to products and processes. Their significance for technology users lies in the fact that inventions are disclosed in a well established documentation and eventually become generally available to anybody interested in using them.
- * Since patent documentation conveys the most recent information, applicants with new ideas ensure that their applications are filed without delay to gain legal means for the use of the invention to derive maximum benefit from protection and royalty on future sales. They are possibly the speediest form of technology disclosure.
- * Patent documentations have a fairly uniform structure. The claims give the essence of what is new, the description gives the background to the invention, that is, the situation before the invention, namely the 'prior art'. They define the difference between the existing technology and what the invention contributes as a step forward.
- * The uniform structure of patent documents makes their reading, generally easier, which is not the case with published articles where the reader has to familiarize himself with the style and mental process which differ from author to author.
- * Patent documents disclose technological information by describing the invention in accordance with the requirements of the law; they indicate the novelty claim and inventiveness by reference to the existing state of art. They are thus sources of information on only what is new but also on what is already known.
- * In many cases they furnish a history of the technological progress in the field to which they relate. Certain patent documents publish a search report showing a series of references found on the occasion of a document research made to establish the level of novelty of the claimed invention.
- * Patent documents cover most of what is new and most of what is worthwhile knowing about the technological advance. This is shown not only by the number of patents but also by the fact that they cover every branch, big or small, relatively simple or sophisticated technology.
- * Patent documents contain information which is not divulged in any other form of literature. A study in the USA Patent and Trade Mark Office shows that as much as 80 per cent of the technology disclosed in the US Patent Documents from 1967 to 1972 had not been disclosed in non-patent literature.
- * Many patent documents contain an abstract. One can get a general idea of the contents of the document in a few minutes without having to read the full text of the document.
- * In recent years, the emergence of the concept of an enhanced cover page for patent documents has been gaining acceptance. The purpose of such a page is to provide as much relevant and essential information to users as possible in a standard easily understandable format. Enhanced cover pages usually include bibliographic and legal data, such as the name of the inventor and owner, filing and issue dates as well as an abstract and a representative drawing of the invention. The enhanced cover page has become a powerful tool for patent searching.
- * Patent documents bear classification symbols. For the purposes of maintaining search files and performing searches for the state of art, patent offices classify patent documents according to the fields of technology to which their contents relate.
- * The international patent classification, IPC, has been established by Inter-Governmental Agreement and is now applicable in at least 50 Patent Offices. The IPC subdivides technology into 8 sections, 118 classes, 616 subclasses and more

than 64,000 fields called groups or sub-groups. Each group is described in a few words and identified by a classification symbol consisting of numbers and letters.

- * A major portion of the cost of processing and classifying patent documents to build search files and keep classification system up-to-date is borne directly by the Patent Office which publishes a large number of patent documents. Users have access to patent documentation without incurring the cost of maintaining, developing and classifying their own document collection.
- * Patent documents belonging to a given classification sub-division contain a highly concentrated supply of technically advanced information in a given technological field.
- * Patent documents bear a date from which conclusions can be drawn as to the age of an invention and to the question whether the invention they describe are still under legal protection.
- * Patent documents usually indicate the name and address of the applicant, the patentee and the inventor. These enable the potential licensee to the persons concerned to find out the conditions under which he may be authorized to exploit the invention.
- * Patent documents often disclose not only the concepts concerning the general utility of the invention but also give information on the possibility of its practical application in industry.
- * The technological information contained in patent document is not secret. It can be freely used to support research and development activities.

Patent documents often disclose not only the concepts concerning the general utility of the invention but also give information on the possibility of its practical application in industry.

- * Much of the information contained in the patents specification is often freely available for public use either because the owner has not paid the renewal fees or because the maximum term, usually 20 years, has expired. Patents contain information of great value; they can be used as a powerful marketing tool.

The available patent document collection comprises copies of patent specifications published in every country where patents are sought, making it world-wide in origin. To date, 37 million patents have been published world-wide. This collection is growing well over one million new publications each year. The number of new specifications published equals the rate of a new specification published every minute.

A special characteristic of patents is that an overwhelming majority of information they contain is unique—over 80 per cent of technical details found in patents is not published elsewhere. Many examples illustrate the fact that new technology is first published in a patent document rather than any other publication. A historic example concerns Hollerith punch card for computers. A patent was issued on this important invention in 1889, but no other publication told the story until 1940. If you do not use patents then clearly you are cutting yourself off from four fifths of this huge mass of information. Often a patent is the only publication of the detailed information.

The ways in which patent information can be used in technology development and transfer are as follows:

Commercial

- Locating business partners for collaboration
- Locating suppliers of equipment and materials
- Identifying products for marketing
- Avoiding possible infringement problems
- Locating area of investment
- Assessing technology related proposals for financial support
- Monitoring viability and progress of projects

Technical

- Avoiding duplication of research
- Assessing state of the art
- Finding ready solutions to technical problems
- Identifying and evaluating technology for transfer

Legal

- Assessing patentability of inventions
- Opposing grant of patents

- Moving for revocation of patents

This is only an indication of the broad range of opportunities provided by patent information.

Conclusion

There is a strong nexus between the legal framework of Intellectual Property Rights, technology change and economic development. The ultimate purpose of the IPR is economic in nature. The Patent Information System, in particular, encourages individuals and

organisations to develop and transfer technology.

There is a clear need for greater awareness on the availability of intellectual property protection, the main features of the different forms of protection, how to apply for and seek protection and, above all, how IPR information can be accessed and used.

If CEOs equip themselves with the knowledge of the search and access of intellectual property, the use of the electronic highway for exchange of intellectual property information world-wide will soon lead the industry on the road to prosperity.

Annexure I

Trade Liberalisation in Developing Countries

Country	Nature of Liberalisation
Algeria	Import licensing abolished in 1991
Argentina	Tariffs reduced in 1988; Import licensing relaxed in 1988 and 1990
Bangladesh	Import prohibition and tariffs reduced since 1985
Bolivia	Tariffs reduced in 1988 and 1990
Brazil	Tariffs reduced in 1988; 1989 and 1991; Import licensing eased since 1987
Cameroon	Tariffs and non-tariff barriers reduced in 1990
Central Africa	Import licensing and quantitative restrictions eliminated since 1986
Columbia	Tariffs reduced in 1989; Non-Tariff barriers reduced since 1990
Costa Rica	Tariffs reduced in three years
Egypt	Tariffs reduced in 1986 and 1989. Import prohibition eased in 1990
Ghana	Import licensing eliminated in 1989
Guyana	Import prohibitions removed in 1988
India	Delicensing and import liberalisation in 1991
Indonesia	Tariffs reductions since 1985; import licensing relaxed
Madagascar	Tariff structure simplified in 1988
Malawi	Import liberalised in 1988 and 1991
Mexico	Substantial reforms since 1985; tariffs reduced in 1986 and 1988; import licensing eased in 1990
Morocco	Import licensing eased since 1987
Nigeria	Import licensing eliminated in 1986
Nicaragua	Tariffs reduced in 1990
Pakistan	Reforms since 1988. Non-tariff barriers replaced by tariffs and tariffs reduced; Import licensing eased in 1991
Peru	Tariffs reduced in 1988 and 1991; Tariff structure simplified in 1990 and import licensing eased in 1989 and 1991
Philippines	Quantitative restrictions reduced in 1988 and 1990, import licensing eased in 1990
Sri Lanka	Tariffs reduced in 1988 and 1991
Thailand	Tariffs reduced in 1988 and 1991
Togo	Import and export licensing eased in 1988
Tunisia	Import liberalised in 1987, tariffs reduced in 1988
Turkey	Tariffs reduced in 1989; import licensing abolished in 1990
Venezuela	Tariffs reduced in 1989 and 1990

Source: Report by the Director General, GATT, International Trade & Trading Systems 1991.

Biotechnology Development & IPR: Issues in the Indian Context

P. Mohanan Pillai & V. Santa Kumar

This paper reviews the major issues arising from patenting of genetic materials and living organisms which is of crucial importance to developing countries. This is followed by a discussion of major strategies to deal with the changing situation. Two major strategies discussed in the Indian context are: taking appropriate measures to restrict access to biotechnology materials by a sui generis system and sharing the resources on mutually agreed terms to the benefit of the local community and strengthening the technology base.

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Issues relating to intellectual property in the area of biotechnology in developing countries remain largely controversial. This is because of the fear that the newly stipulated IPR (Intellectual Property Rights) is likely to adversely affect the farming communities in developing countries who constitute the majority of the population. It is argued that by granting intellectual property rights on plants and animals, the farmers of developing countries may be unable to exercise their inherited right on them and therefore bear adverse ethical, social and economic consequences. It is for the above reason that the GATT negotiations that established universal standards on patents have provided some scope for subsequent reviews in certain areas relating to living matter. Article 27:3 of the GATT agreement provides a five-year period for a more detailed examination of some issues before arriving at an agreement in the patentable subject matter of biotechnology (UNCTAD, 1994).

Uruguay Round Agreement

Chapter VIII of the document on Uruguay Round Agreement analyses the key features of the intellectual property rights. The agreement has introduced profound changes in the traditional standards of intellectual property rights. It establishes that all products and process in all fields of technology are patentable and calls on countries to make available under their law enforcement, procedures and remedies to take action against any infringement of intellectual property rights. In each category of intellectual property rights, the agreement builds upon and specifies a number of higher and additional standards for protection. In relation to biotechnology, GATT agreement demands bringing in all development based on cell manipulation and transfer of genes within the ambit of patent protection.

Fears of Developing Countries

Concern has been expressed by the developing

countries that the developed countries may use patents to extend rights on the use of the former's natural wealth. The following arguments have been put forward in various forums (Bush, 1995):

Concern has been expressed by the developing countries that the developed countries may use patents to extend rights on the use of the former's natural wealth.

There is no evidence to show that patents stimulate research. On the contrary patents are likely to restrain research by prohibiting the use of patented materials. Most often patents are used as a weapon to prevent competition from entering into the monopoly market. As a consequence of patents, the number of biotechnology based firms have come down drastically over a period of time. Developing countries in the process of industrialization have always limited the scope of patents to foreign firms. This is because these countries have weak technological capacity and are powerless to act against the abusive practices of foreign firms in the patented technology areas through strategies such as cross licensing arrangements or holding of multiple patents. Therefore the argument of equal treatment on the notion of equal ability to make use of patent system is built upon a wrong notion and understanding of relations.

Secondly, the biological materials which already exist in nature can not be considered an 'invention' and therefore are not patentable. It may be difficult to provide an appropriate criterion for determining novelty and non obviousness of the deposit and enforcement requirements and above all proper scope for patenting. Broad patents granted to procedures of genetic interventions are therefore highly questionable (Kollak, 1995).

Thirdly, patentability is generally excluded in public utilities and in areas like biotechnology where public interest dominates and public expenditure plays a major role in developing countries. Therefore, it is argued that it is not in the long run interest of society to allow private appropriation. In the same vein, it can be held that, for centuries, farmers in developing countries have played a crucial role in developing technologies of conservation, maintaining land races. These remain an inalienable part of the social heritage. Patenting may hinder this age old processes and make the farmers depend on multinational companies, spelling disaster

for the agrarian systems of developing countries. It is likely that the private seed companies in the developed world having free access to the plant genetic resources of developing countries, use them as raw materials for evolving improved varieties and later market them with intellectual property protection. In such a situation, the exchange of seeds and of germplasm would become totally dependent upon the patent holders on payment of huge royalties. Inspired by the new IPRs, multinational companies have already begun hunting for fresh genetic resources.

Patenting may hinder age old processes and make farmers depend on multinational companies, spelling disaster for the agrarian systems of developing countries.

Sui generis Protection

Those who are in favour of the new IPR in biotechnology point out that there is still provision to protect bio-diversity by a *sui generis* system, though the multi-lateral trade organisation at times has the power to override national laws (Reichman, 1993). By *sui generis* the scope exists for developing countries to formulate regulatory and legislative measures to achieve the desired objective of common heritage of genetic resources with the concept of national sovereign rights over genetic resources. Developing countries are therefore free to specify proprietary rights for advances in biotechnology so that their competitive status is enhanced. One such proprietary right in this field is plant breeding rights. On the strategy of restricted access, developing countries can sell protected products at higher prices to countries where the material is collected.

Control of Genetic Ownership

However, the appropriability issue is seen only in a legal framework conceived by the developed countries. There is no clarity regarding the respective rights of indigenous people, local communities and the 'global public' to biological diversity and local knowledge (Commandeur, 1994). There are no established institutions to determine the rights of indigenous and local communities and this clearly diminishes the local communities' ability to derive benefits from the conservation of biological diversity and assert their rights over genetic resources, knowledge and innovations. Even in a country like India, where some awareness of these issues exists, the proposed plant variety and biological

diversity conservation bill has generated a big controversy. Under the proposed bill, breeder gets the exclusive right to produce, sell in the market, export and import seeds. Needless to say, the above implies that the traditional right of the farmers to retain, save, exchange and sell seeds disappears. At the most, the bill stipulates only a compensation to communities while taking away their rights "to save, use, exchange, share and sell seeds from their harvest (Chaudhary, 1994) and transfers this right to the discretion of the government. Ironically enough, in India, farmers who conduct 80 per cent of seed trade will lose their right. It is also alleged that the proposed PVB will be a channel to transfer the genetic materials abroad, without complying with the reciprocal effect.

On the other hand, the possibility of linking the exchange of genetic resources for better technology from developed countries is unlikely as has been illustrated by the recent Indian experience. To cite one example, India wanted to enter into an agreement with a U.S. based agrochemical and biotechnology company for transgenic cotton. However, the license fee demanded by the foreign company had been so high that the government had to put off the deal.

Possibility of linking the exchange of genetic resources for better technology from developed countries is unlikely.

Resolving the Dilemma

It is difficult to resolve this dilemma of developing countries. In the days of active non aligned movement and G77, the leadership of Soviet Union served as a rallying point for developing countries to dispute with the west. The world is different today. The idea of collective bargaining or collective strength of developing countries is not going to work as in the past, for they do not have a collective identity and interest today. In an integrated world, compliance with W.T.O. appears inevitable to carry on production and trade and delinking may spell disaster. This does not mean that collective pressures are unimportant to safeguard the interests of the developing countries. It has its legitimate role where minds meet; however success is unpredictable as these countries have become GATT contracting parties, though there is some scope for negotiations which the developing countries should definitely take up in due course. Along with it, it is important that the countries make increasing use of other strategies as a means of dealing with the changing in-

ternational scenario, recognising one's strengths and weaknesses. In other words, specific characteristics of the country are to be considered while developing strategies.

Issues in the Indian Context

Indian scientific community and the political leadership have so far not developed an adequate awareness of the problems arising from IPR in the biotechnology area resulting in a lacuna in the legislation regarding the issues the farmers may confront in future. As stipulated in the *sui generis* system of the GATTs, the access to biotechnology materials has to be on the basis of mutually agreed terms. We have to assure that the local community has to benefit from this. As a first step towards this, the country has to take stock of its biotechnological resources which involves identification, collection and screening of resources to understand its worth and value. Such a national register of biological resources can establish the legal basis for ensuring the future collection of genetic materials. This has to be followed by recognition of the indigenous knowledge and innovation practices which should be protected by Trade Secret Act, if not by patents. It is pertinent to recall here the major recommendations of the Convention on Biodiversity (Biotechnology & Development Monitor, 1994). The Convention has called for establishing national agencies that serve as a focal point for defining the scope of prior informed consent for sharing arrangements of genetic resources of developing countries. As the biological convention asserted, "the countries providing genetic resources will have to improve the protection measures that are in place to prevent unlawful collection of genetic materials. Furthermore, they need to put in place, mechanisms for improved record keeping, linking collection with patents and for regulation and transfer of collected materials to the third parties (Mugabe & Onko, 1994). At the local level, active involvement of local governing institutes like *gramsabhas* may be necessary to arbitrate the sharing benefits with local communities. For gainful sharing and meaningful conservation of biomaterials in the new international context, India has to initiate steps in the above direction.

Indian scientific community and the political leadership have so far not developed an adequate awareness of the problems arising from IPR resulting in a lacuna in the legislation.

Recommendations

The most significant strategy in the Indian context is strengthening the technological capabilities so that India can take maximum advantage of the new global arrangements. India has a wide network of national research centres, she has also a large pool of trained scientific personnel. However, a patent culture is woefully lacking. Scientific worth has so far been evaluated on the basis of the number of papers published, in the new context, the number of patents should become the indicator. Needless to say, in some areas of agricultural research, we are far ahead of even some of the European countries. Indian hybrid is an illustrative example. In another instance, Europeans got rid of a wheat disease that induced a bad smell in the flour by using HD-29 species of IARI without any recognition. As S.K. Sinha, Director, Indian Agricultural Research Institute laments, no steps have been taken to protect the commercial importance of rice varieties like Basmati by patenting them to prevent others from doing so (Goswami, 1994). Since hybrid varieties need improvement in the specific context of agro-climatic conditions, our research institutes can develop a comparative technological advantage in this area. As a strategic measure, an extensive patent coverage of discoveries has to be undertaken. With adequate investment and right orientation, enough opportunities exist for India to develop technological capabilities in biotechnology research, with emphasis on the importance of 'right orientation'. Biotechnology research in India is still largely the preserve of public sector enterprises. Most of the R&D projects under public enterprises are not oriented towards commercial production (Mani, 1990) when the possibilities of closer link between R&D laboratories and production units are very high in the case of biotechnology than other kinds of technology. The entry of private sector in this area has been minimal. Since the potential in this field is very high, by establishing appropriate patent regime, India should encourage private investment and scientific entrepreneurship in this area to spin off the benefits of the already undertaken investment in R&D.

Government should also open up specific schemes for developing innovation-supporting financial mechanisms such as venture capital etc. Since the potential benefit of biotechnology research is very uncertain, innovative financial mechanisms to attract investment into this area assume importance.

Developing technical co-operation and information exchange among institutions in developing countries leading to collaboration venture is another strategy to promote research in this area. India can give leadership to third world countries because of the low cost re-

search personnel and infrastructure and particular comparative advantages in labour, land, energy etc.

Well established multilateral agreements between the institutions of developed and developing countries for transferring plant genetic resources and for sharing the potential benefits of research, can benefit countries like India. The agreements of bio-diversity prospecting prepared by National Cancer Institute and the institutions of Costa Rica point to this possibility (Baker et al., 1995). Given the scientific, legal and institutional capability of India, it can carry out bargaining in a much more gainful manner than other developing countries.

India should also try to document, patent and enhance the global production of the products of its natural and cultural heritage. The scientific, legal, industrial and the marketing facilities the country has at its command should be utilised for this purpose. The export of cultural products by other Asian countries like China and Japan may serve as a model, with the enhancement and preservation of this natural and cultural heritage depending on their global marketing at this juncture.

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Evolving Regime of IPRs: Implications on the Indian Patent System

Venkatachala G. Hegde

This paper seeks to examine the aspects which necessitated the evolution of a new regime on IPRs. While doing so, it presents the viewpoints of developing and the developed countries in the context of Uruguay Round of Multilateral Trade Negotiations. The author also outlines the implications flowing from the Agreement relating to Trade-related Aspects of Intellectual Property Rights, with particular reference to India, and identifies areas of patent regulation which need amendment in the Indian Patent System.

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The laws relating to intellectual property seek to regulate one of the intangible components of the economic system. Its evolution always had a close correlation with the aspects of technological development. The creation and the need for acquisition of new ideas and technological breakthroughs have played a crucial role in the evolution of intellectual property rights' (IPRs) regimes. For long, the belief that the acquisition of new and emerging technologies provided a competitive edge prevailed. Accordingly, many countries sought to formulate their intellectual property laws to facilitate not only the acquisition of technology, but also ways of putting them to use. Legal mechanisms to protect IPRs, therefore, were dependent on the socio-economic conditions and more importantly, on the industrial growth achieved in the various countries.

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IPR Regime: Evolution

The evolution of IPR regimes needs consideration at two different levels: The territorial application of IPRs formed the basic level of regulation. These applications, however, were regulated by the minimum standards prescribed by the international Conventions. This, in other words formed the general level of regulation. To put it differently, national laws play a central role in deciding the extent of protection to be granted to the new creations. On the other hand, international norms, as embodied in various Conventions outline the minimum standards which will eventually need incorporation in the national laws of respective Member States.

The rapid evolution of new technological developments in the decade of 1980s brought to forefront a new range of issues relating to IPRs. For the first time, industrialised countries realised the role of state-of-the-art technologies as a strategic element for achieving control of international markets. Therefore, in recent times, both economists and lawyers have been examining the crucial role of technology in shaping the pattern of international trade and determining how and to what extent each country participates in the global economic system.

Technological Development & IPRs

In view of the importance of technology to the economic development and its consequent effect on the operation of IPRs, it is necessary to examine, albeit briefly, their interrelationships. This interrelationship it may be noted, was cited as the primary reason for incorporating IPRs in the Uruguay Round negotiations and elaborate new principles. The technological growth towards more sophisticated and minute application of science and technology has generated certain problems. Internationalisation of high technology and its rapid diffusion create diverse conditions, as argued by some industrialised countries, necessitating its effective and adequate regulation. Easy copiability of the new technology has been stated to be one of the basic reasons for its rapid diffusion. This development in the area of high technology has two very important offshoots, namely, trade in counterfeit goods and possible distortions to international trade caused by the protection of IPRs.

Easy copiability of the new technology has been one of the basic reasons for its rapid diffusion.

The trade in counterfeit goods has acquired greater significance due to the following reasons: the accelerating rate of technological diffusion, increasing capacity to copy, imitate or differentiate products, and changes in production techniques. As regards the issue of trade-distorting effects of IPRs, the basic question was to consider whether or not IPRs constituted a non-tariff barrier. The concept of non-tariff barrier (NTB) is not clearcut and could be interpreted in different ways: for example, measures applied in such areas as environmental protection, public safety standards and norms may or may not be non-tariff barriers. Industrialised countries, in particular, the United States, sought the inclusion of IPRs in the framework of General Agreement on Tariffs and Trade (GATT) on the

ground that the failure to respect and enforce adequate IPRs was harmful to trade relations and amounted to permitting the existence of NTBs in this area.

Need for stronger regimes

The emerging new technological innovations posed a certain unique set of problems. These new innovations, carrying intensive scientific knowledge, made it easy to separate the form that a product took from the intellectual assets it embodied. Considering these features of the new and emerging technologies, it has been argued that "a legal system suited to conventional technological pattern of mechanical invention and printed forms of communication is not adequate for the new, scientifically based, technological innovation that permits a separation of the tangible from the intangible components, thereby facilitating the diffusion of the latter" (Bifani, 1990). For these reasons, countries which owned and worried about the international dimension of the appropriation of technological innovation sought to create strong IPR regimes. The strong IPR regimes, they argued, would facilitate maximum returns from the market in the shortest time. The life of the new and high technology was, it should be noted, shortened due to its faster diffusion rate and easy copiability. Diffusion and copiability allowed fairly easy operation of the process of "reverse engineering" in reconstructing the whole technological innovation. This, on the other hand, immensely favoured the developing countries. In sum, the international market for high technology is heavily dependent on IPRs to create barriers for new entrants in such a way as to protect the high technology industry.

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Evolution of TRIPs Formulations

The Uruguay Round of Multilateral Trade Negotiations, 1986, included on its agenda, three new issues relating to services, investment measures and IPRs. The negotiating mandate on IPRs sought to "clarify and elaborate" existing GATT principles within the framework of "appropriate new rules and disciplines" to promote effective and adequate protection of IPRs. It should be noted that a powerful group of chemical, pharmaceutical, computer, entertainment, publishing and electronic corporations, mainly from the United States, lobbied to introduce intellectual property issues

into the multilateral trade negotiations under the GATT. An influential Advisory Committee for Trade Negotiations to shape the global trade policy was formed by the United States in 1981. This Committee played an active role in formulating overall agenda of the Uruguay Round, particularly concerning new issues.

Without waiting for the outcome of the negotiations in the GATT, some industrialised countries, in particular the United States and the European Community, resorted to bilateral handling of foreign trade difficulties. The central theme of the US law, entitled, "The Omnibus Trade and Competitiveness Act of 1988", for instance, was to promote US exports to reduce the US trade deficit. The key technique was reciprocity of market opportunity, which could be obtained either through multi-lateral or bilateral negotiations, or if necessary, through the use of Section 301 of the Trade Act of 1974. According to one dominant view, however, the reform of domestic intellectual property laws in responses to bilateral pressures hardly constituted a rational approach towards the practical economic needs (United Nations Conference on Trade and Development, 1991).

For developing countries, including India, the importance of creating comparative advantage and acquiring technological competitiveness was paramount. In such a scenario, the new technologies, notably in the areas of biotechnology and informatics sectors, provided the crucial technological leap with the possibilities of "reverse engineering". Realising the potential of these possibilities, developing countries had approached the Uruguay Round negotiations on IPRs with abundant caution. Their response to protection of IPRs was shaped on certain factors, such as, realization of the potentialities for a strong science and technology base, the narrowing and a more active participation in the process of technological change.

The fundamental differences at the negotiations on the Trade-Related Aspects of Intellectual Property Rights (TRIPs) as regards the level of protection pertained to:

- The lack of subject-matters protection in certain fields (primarily pharmaceutical products) and the uncertainty about the extent of protection concerning applications of the new technologies (software, integrated circuits, data banks and biotechnology)
- Limitations on patentee's rights (for example, as regards imports, forfeiture and compulsory licensing)
- Inadequate enforcement of conferred rights (lack of rapid administrative and judicial proce-

dures, questions about the applicable burden of proof etc.)

- Inadequate duration of protection.

The fundamental differences at the negotiations on TRIPs pertained to: The lack of subject-matters protection in certain fields, limitations on patentee's rights, inadequate enforcement of conferred rights and inadequate duration of protection.

The Agreement on TRIPs in addition to patents, seeks to regulate the following: Copyright and related rights; Trademarks; Geographical Indications; Industrial Designs, Lay-out Designs of Integrated Circuits; Protection of Undisclosed Information and Control of Anti-Competitive Practices. This study, however, proposes to limit the examination of TRIPs formulations to the issue of 'patents' only and with a particular reference to Indian Patents Act, 1970 (IPA). This has been necessitated for the following reasons: Firstly, the obligations under the TRIPs require some substantive changes in IPA. Secondly, IPA, reflecting socio-economic policies pursued by India, was adopted after extensive deliberations. And lastly, for this reason, substantive changes contemplated in the IPA have become a matter of intense debate within India.

Patentable subject matter

The Agreement on TRIPs, including Trade in Counterfeit goods which appear as Annexe III to the Final Act embodying the results of the Uruguay Round negotiations describes in Article 27, the scope of applicability of Patentable subject-matter. It deals with as many as five crucial components of patentability, namely, availability of patents for all kinds of inventions; patents granted in all fields of technology, whether products or processes; inventions to be patentable should fulfil the criteria of novelty, inventive step and industrial applicability; patents should be available and patent rights enjoyable without discrimination as to the place of invention, the field of technology; and patents granted irrespective of products' importation or local production.

The issue as regards the criteria actually constituting patentable subject-matter is generally left to be decided by the national legislations. These criteria are formulated by the countries taking into account their industrial and economic development. It was, however,

argued that rapid Internationalization of technological development and its use had necessitated a uniform criteria to conclusively decide the scope of patentable subject-matter. Industrialised countries viewed this deficiency from two angles, namely the denial of patent protection for technologies including pharmaceutical, agriculture chemicals, alloys, foodstuffs and even agricultural machinery; and the protection limited to the process of manufacture.

Rapid Internationalization of technological development necessitated a uniform criteria to decide the scope of patentable subject-matter.

India, however, did not concur with the rationale to stipulate any uniform criteria for patentable inventions applicable alike both to industrialised and developing countries or to restrict the freedom of countries to exclude any specific sector or product from patentability. In its view, every country should be free to determine both the general categories as well as the specific products or sectors that it wished to exclude from patentability under its national law taking into consideration its own socio-economic, developmental, technological and public interest needs. Further, it should be noted that in the critical phase of their industrial development, many of the industrialised countries had either "no-patent" or "weak patent" standards in vital sectors in order to strengthen their own industrial and technological capabilities.

Paragraphs 2 and 3 of Article 27 together stipulate exclusion of certain inventions from patentability, "to protect *ordere public* or morality, including to protect human, animal or plant life or health or to avoid serious prejudice to the environment". It is also provided that the plant varieties should be protected either by patents or by an effective *sui generis* system or by any combination thereof. The implications of these formulations need careful consideration. For instance, it is almost impossible to interpret the scope of *ordere public* or morality. This is not all. How to assess the elements of "serious prejudice to the environment" so as to justify exclusion of certain sectors from patentability? In other words, areas which may have to be excluded could be limitless. The issues relating to plant varieties' considering the phenomenal leaps made in the field of biotechnology and genetic engineering. Some of the frontier areas concerning life forms, computer software and integrated circuits have been seeking an acceptable for-

mulation of patentability criteria from the viewpoint of developing countries, including India. A thorough assessment of the consequences of granting protection for these frontier areas in a developing country like India is absolutely necessary.

Some of the frontier areas concerning life forms, computer software and integrated circuits have been seeking an acceptable formulation of patentability criteria from the view point of developing countries.

The increasing application of biotechnological inventions includes a wide range of biological substances, such as, animal and plant cells or cell lines, enzymes, micro-organisms, plasmids, replicons and viruses; the term "biological materials" encompasses organic and inorganic substances present in living systems. Certain claims made in these areas do not easily subscribe to the criteria of patentability. For instance, there are problems of attaining stability and homogeneity in biotechnologically evolved products. When such dissimilarities exist, the application of patentability criteria, such as, novelty, inventive step and distinctiveness becomes very difficult. In most cases, it may not stand the scrutiny.

In recent times, copyright protection of software has become more controversial than ever. At the international level, majority of the countries followed the initial United States position of recognising the copyright law as the primary vehicle for software protection. However, the trend in the United States now favours concurrent patent protection for those computer software that satisfy the requirements of patentability. The increasing technical application of software inventions has brought it under the ambit of patentable subject-matter. Copyright covers all "ordered expression of thought"; it protects "personal intellectual creations" which are aimed at "qualified human communication". For nearly a decade, the United States courts have been pointing out that although software engineers write their programmes instead of designing new hard-wiring, the main function of such works is to operate a machine rather than communicate with human beings. In other words, the patentability of computer software is dependent on the extent to which it exhibited the "technical character".

Limitations on patentee rights

The Agreement on TRIPs employs the term "Right Holder" to denote "patentee". Notably, the Agreement

discusses prominently the "Rights Conferred" on the Right Holder. Limitations, on the other hand, appear in the Agreement as mere "exceptions". Nowhere in the Agreement references could be found to "compulsory licensing or licences of right". These, it should be noted, formed one of the fundamental aspects of the Indian patent system. Instead, the phraseology employed to outline the limitations on so-called Right Holder, terms it as "Other Use Without authorization of the Right Holder" in Article 31 of the TRIPs Agreement.

Some form of limitations on the patentee's rights was considered necessary to meet certain public interest requirements. Article 31 of the TRIPs Agreement, makes no such references to public interest considerations or leaves no space for the national legislations to provide for the determination of 'public interest'. This provision, however, refers to public interest considerations as national emergency; circumstances of extreme urgency; and cases of public non-commercial use. The benefits of these considerations are subject to the proper notification made to the patentee. This Article even defines the content and scope of these notifications: that the scope and duration of "other use without authorization of the Right Holder" should be limited to the purpose for which it was authorised; and that the use should be non-exclusive, non-assignable in the usual circumstances and should be authorised predominantly for the supply of domestic market of the concerned State. It is also specified that the authorization for such use should be terminated if and when the circumstances cease to exist and were unlikely to recur. The continuation of the use, if found necessary, could be subjected to a review by a competent authority. Further, the patentee has to be adequately compensated taking into account the economic value of authorization. The legal validity of any decision relating to the authorization requires to be subjected to judicial review or other independent review by a distinct higher authority.

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Interestingly, Article 31 does not include the "failure to work" of the invention as a ground for authorising use of the patented invention. One of the basic objectives of the IPA, for example, relates to the working of the patented inventions in the host country on a commercial scale and to the fullest extent that is reasonably prac-

ticable without undue delay. The draft agreements circulated by a few industrialised countries at the negotiations had provided for the granting of compulsory licences on the grounds of non-working or insufficiency of local working justified by the existence of legal, technical or commercial reasons. The final agreement which was adopted in Marrakesh on 15 April 1994 did not incorporate these proposals.

The concerns of developing countries, particularly that of India need consideration. Firstly, foreign owners of inventions could, by refusing to exploit the patents prevent the development of national industries which might give employment to nationals and utilise national resources: Secondly, foreign patentees could, by excluding other producers of patented articles from the market monopolise the export of such articles to the country and thereby exact higher prices from domestic consumers.

Adequacy of enforcement measures

For the first time, procedures relating to civil and administrative remedies have been given due importance in the TRIPs Agreement while outlining enforcement measures. These procedures, however, need to be formulated within the domestic legal system. It is also true that without adequate provisions for the enforcement measures, the effectiveness of the substantive provisions may be nil. Even accepting this, the provisions concerning civil and administrative remedies should have been restricted to few areas. The existing structure in the Agreement creates mandatory obligations on the Members to make available to right holders civil judicial procedures concerning the enforcement of any IPR covered by the Agreement. The implications flowing from this structure could be briefly outlined.

In order to effectively check infringement, the Agreement places in the judicial authorities, the authority to order a party to desist from an infringement. It even provides for payment of damages which should be adequate to compensate for the injury the right holder had suffered because of an infringement. There are also a few remedies to create an effective deterrent to infringement, such as the disposal of infringing goods outside the channels of commerce or if legally permitted, to destroy such infringing goods. However, it is also provided that while considering such disposal methods, the need for proportionality between the seriousness of the infringement and the remedies ordered as well as the interests of third parties should be taken into account. While considering these procedural measures, care should be taken to examine the aspects which may require a State to put in place its limited financial resources to their effective operation. It

is also not easy to decide in a given situation, whether measures applied are adequate or not. In such cases, what could be the appropriate remedy? It appears that an affected Member is entitled to acquire all the information and can approach the Dispute Settlement Body (DSB) of the World Trade Organisation (WTO). The DSB will ultimately decide the feasibility of not only the domestic legislation concerning enforcement, but may also seek to comment on the customs and practices of the Member. The efficacy of these procedures, in any given situation, will depend largely on the interpretations accorded to the terminologies by the 'appropriate' Judicial authorities. These interpretations, however, are not necessarily final as these could be brought to DSB in accordance with the TRIPs Agreement.

Inadequate duration of protection

In the past, the term of protection for the intellectual property was left to the countries concerned to decide. Industrialised countries have been demanding a long term of protection. This, according to them, was necessary as the resources devoted to R&D required long periods of recovery, particularly to ensure the continuity and expansion of the innovative process. Many developing countries, including India, sought the freedom to set the duration at a level significantly lower than that of the industrialised countries in accordance with their own developmental, technological and public interest needs. They view twenty-year uniform period for patents as detrimental to their need to master new technologies and to expand their own industrial capacity needs that become all the more acute when the foreign technology has neither worked locally been nor effectively trans-

Industrialised countries have been demanding a long term of protection.

ferred by other means. Industrialised countries, on the other hand, placed emphasis on the encouragement to the extension of patent terms to compensate for delays in marketing occasioned by regulatory approval processes. According to them, the harmonisation of the various terms of protection should be achieved as the different lengths of protection in different countries created different markets which was in itself an obstacle to trade. The intricacies of duration of protection to intellectual property, however, should be viewed from the perspective of diffusion of high technology and its transferability. Fast rate of diffusion of high technology is essential as it reaches the optimum utilisation point at a

Developing countries, sought the freedom to set the duration at a level significantly lower in accordance with their own developmental, technological and public interest needs.

very short duration. So, a long duration of protection may not necessarily serve the purpose, particularly when the foreign technology has neither worked locally nor effectively transferred.

The intricacies of duration of protection to intellectual property should be viewed from the perspective of diffusion of high technology and its transferability.

Implications for the Indian Patent System

The basic principle which formulated the nature and scope of obligations under the TRIPs Agreement mandatorily confers an obligation on the Members to give effect to its provisions. It allows its Members to determine the appropriate method of implementing the provisions of the Agreement within their own legal system and practice. In other words, the standards and principles embodied in the TRIPs Agreement need to be incorporated in the internal legislations of Members. For India, the implications of this mandatory requirement is felt in the operation of its patent system, in particular the Indian Patents Act, 1970.

The basic objective of the IPA is unique in the sense that it was evolved after a long deliberation, keeping in view the national interest. It seeks to encourage inventions and to secure that the inventions are worked in India on a commercial scale to the fullest extent that is reasonably practicable without undue delay (Sec. 83, IPA). It also seeks to curtail the abuse of the patent monopoly. A patent monopoly is abused when the economic and social objectives of the patent system are jeopardised by the behaviour of the patentee. Although the TRIPs Agreement recognises the possibility of such abuses, nowhere have attempts been made to define or incorporate situations which may actually constitute such an act.

Nearly four decades ago, a US Senate Committee had authoritatively defined the abuse of a patent grant as "the temporal, functional or material limits of the

monopoly intended by the patent grant overstepped and the actually achieved monopolistic control extended in time, in scope, or in strength" (U.S. Senate Committee, 1958).

Although the structure of the IPA seeks to mitigate these abusive practices, its relevance in the context of TRIPs Agreement is minimal. To put it differently, the TRIPs Agreement makes no reference to the substantive aspects of abusive practices. Instead, it only seeks to define abuses of IPRs having an adverse effect on competition. Further, it seeks to specify only conditions that may in particular cases, constitute an abuse of IPRs.

The IPA, on the other hand, not only recognises the possibilities of abuses of patent grants, but also provides for certain legal safeguards against such abuses. These safeguards are—compulsory licensing, licences of right, and revocation of the patent grant in certain circumstances.

The IPA provision relating to compulsory licences allows any person to make an application to work the patented invention upon the expiration of three years from the date of sealing of a patent to a specified government authority on the grounds that the reasonable requirements of the public with respect to the patented invention had not been satisfied; or that the patented invention was not available to the public at a reasonable price. Further, Section 86 of the IPA authorizes the Central Government to make an application to the specified authority for endorsing the patent with the words "Licences of Rights". This application could be made on the same grounds as mentioned for the compulsory licences. In case of certain inventions relating to food, medicine and chemicals, the IPA deems patents to be endorsed with the words "Licences of Right". The effect of this deemed endorsement, as provided in the IPA, would be that any person who is interested in working the patented invention might require the patentee to grant him a licence for the purposes on such terms as may be mutually agreed upon.

As examined earlier, the TRIPs Agreement, particularly Article 31 allows no space for the introduction of any form of "non-voluntary" licensing. Both the "compulsory licensing" and "licences of right" are non-voluntary licences. The TRIPs Agreement, on the contrary, lays down detailed conditions which have to be respected while allowing other use of the subject matter of patent without the authorization of the "right holder", including use by the Government or third parties authorised by the Government.

Transitional arrangements

The patentability criteria as provided in the TRIPs Agreement in Article 27 seeks to grant patents "of any inventions, whether products or processes, in all fields of technology". The criteria provided in the IPA is different. It provides patents to all fields with exceptions, such as food, agriculture, medicine, chemicals and pharmaceuticals. In order to facilitate the transformation of some of the substantive aspects of the patent system, the "transitional arrangements" have been provided. In other words, it relates to the delayed time-frame structured for certain group of countries in matters concerning the applicability of the TRIPs Agreement. This timeframe is ten years and India is obligated to undertake the structural reform of its intellectual property system. Further, paragraph 8 of Article 70 of the TRIPs Agreement provides for what is termed as "pipeline protection". According to this provision, patent applications in the field of pharmaceutical and agricultural chemical products should be allowed to be filed as soon as the Agreement enters into force. In addition, while receiving these applications, the criteria of patentability as embodied in the Agreement should be considered.

The patentability criteria in TRIPs seeks to grant patents "of any inventions, whether products or processes, in all fields of technology". IPA provides patents to all fields with exceptions, such as food, agriculture, medicine, chemicals and pharmaceuticals.

In order to fulfil some of these obligations and to adopt measures consistent with the TRIPs Agreement, India promulgated The Patents (Amendments) Ordinance, 1994. Although this ordinance lapsed and subsequently the change in the IPA could not be effected due to consistent opposition, the changes proposed in the IPA are substantial. For example, it allowed product patenting in the sectors of medicine or drug. In recent times, the filing of number of patent applications seeking exclusive rights is increasing (Annual Report, 1994-95). The Indian Patent Office and its branches are not entirely equipped to deal with these changes promptly and effectively. So, there is a greater danger of misuse of "exclusive marketing rights", particularly when the patent examiners are not well trained to deal with some of the new and emerging technologies. The provision of "exclusive marketing rights" in Article 70 of the TRIPs Agreement and its incorporation in the Indian Patent

System itself could be far-reaching. The primary objective of these rights is to reserve the markets till the product patents are granted in the countries where product patent is not granted.

Structuring of Indian Patent Office

A responsive patent office is *sine qua non* for the effective application of patent law. A forward-looking and receptive patent office can encourage and motivate inventors. The increasing patent activity in Europe and the United States is primarily attributed to well-equipped patent offices. India, at least now, should devote its attention and divert considerable resources to reorienta-

A responsive patent office is *sine qua non* for the effective application of patent law.

tion of the Indian patent office staff and its structure is inevitable for various reasons; Firstly, the patent office will receive and may have to examine numerous novel patent specifications. Secondly, all the patent specifications received by the patent office may not disclose the inventions completely. Such partial non-disclosures may affect the long-term technological development. In order to identify such disclosures, the patent office should periodically train its patent examiners, particularly in the frontier areas of technology. Lastly, many patent applications may be filed by the multinational companies with the sole aim of reserving the markets for particular product varieties. Although it is extremely difficult to identify such patent grants, an alert and responsive patent office may succeed in minimising such abuses.

Many patent applications may be filed by the multinational companies with the sole aim of reserving the markets for particular product varieties. An alert and responsive patent office may succeed in minimising such abuses.

It may be worthwhile, albeit briefly, to outline some of the inherent problems in the operation of Indian Patent Office:

- The long delay in granting the patents due to many procedural hurdles should be minimised. Examination of the patent application itself has

been taking a long period. There are no fixed and bound timeframes for the process of examination. For example, Chapter IV of the IPA in Section 12 does not specify any timeframe for the Controller of Patents to submit the patent application for examination by a patent examiner. Although a patent examiner is bound to examine the application and ordinarily make a report to the Controller within eighteen months, there is no time limit within which a controller is bound to consider the patent examiner's report under Section 14. Even the procedures relating to amendment of the patent applications have been taking enormous time.

- Lack of adequate coordination between the Patent office and its branches. Patent applications are received in the branches within the specified territorial limits, namely, Bombay, Calcutta, Delhi and Madras. These territorial branches treat and process the applications separately. In order to have a better coordination, a centralised process of examination of patent application would be essential.
- Computerisation of all the patent offices is necessary so that information and materials received could be processed promptly. In other words, emphasis should be placed on the modernization of the patent offices.
- Incentives should be provided to the patent office staff, particularly patent examiners to undertake new responsibilities with a view to making the patent office more responsive to the industry. For this reason, they should be periodically exposed to new developments in the areas of law, science and technology through training and orientation programmes.

Conclusions

The essential features of the law of patents are territorial in nature. And these features are clearly reflected in the national patent legislations. Although the patent laws of various countries provide more or less uniform standards while defining the patentable subject matter, some degree of variation may arise in the emphasis accorded to each criterion of patentability involving considerable amount of subjectivity. For instance, it varies with the competence and effectiveness of patent agents who describe the invention in the patent specification, patent examiners who examine them, and finally the patent offices and Courts which look into the patent's legal validity. Despite this, the TRIPs Agreement seeks to outline a uniform criterion of patentability. The interests and priorities of India, a developing country, may be

The interests and priorities of India, may be severely affected if uniform criterion of patentability is accepted.

severely affected if the uniform criterion of patentability is accepted. If patents are not worked sufficiently within a reasonable stipulated period, the basic purpose of the patent system itself will be defeated. More significantly for developing countries, including India, the actual working of the patent grant is crucial for acquisition of the latest technological developments. When a patent is worked sufficiently, it adds value to the existing state of the art. A suitable amendment to the IPA should be made keeping in view some of the inherent problems of

the Indian Patent system. In this regard, a serious thought may be given to the complete restructuring of the IPA and the patent office without sacrificing in any way India's long term national interests.

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Plant Variety Protection in India: An Appraisal of the Proposed Legislation

Biswajit Dhar, Beena Pandey & Sachin Chaturvedi

In the course of the on-going debate on plant variety protection several issues have been raised in India. The present paper addresses some of the more pertinent of these issues by critically evaluating the Plant Varieties Act (PVA) which is proposed to be introduced in the country. The authors discuss the main features of the proposed PVA and critically evaluate it keeping in view the provisions of the Agreement on TRIPs from where the essentials of the framework of IPP in agriculture derived. They also analyse the response of the seed industry, the principal votaries of introducing plant variety protection in the country, to make an assessment of the future of the proposed PVA.

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The contours of agricultural development in developing countries are undergoing rapid changes as these countries prepare themselves to extend intellectual property protection (IPP) to this sector. This process has been set in motion following the commitments undertaken by the countries as a part of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs), formalised at the Uruguay Round of GATT negotiations. The Agreement on TRIPs proposes far reaching changes in the norms and standards of protection of intellectual property world-wide because developing countries have undertaken to amend their existing regimes and adopt ones which are quite akin to those prevailing in the industrialized countries. The harmonized system of intellectual property protection (IPP) that would thus come into existence has two major departures from the hitherto existing international system. One, the scope of protection afforded by the IPP regime would be considerably wider and, two, the rights of the owners of intellectual property would be stronger in the former instance, the most significant is the requirement to extend IPP to agriculture by protecting improved varieties of plants. However this manner of protection provides explicit recognition only to the rights of commercial plant breeders engaged in developing new plant varieties. For several developing countries like India where agricultural systems have been based almost exclusively on farming communities, this form of IPP raises several key issues.

The scope of protection afforded by the IPP regime provides explicit recognition only to the rights of commercial plant breeders. For several developing countries like India where agricultural systems have been based almost exclusively on farming communities, this form of IPP raises several key issues.

Legislation on Plant Varieties Protection: Features

The structure of the proposed PVA clearly reflects the twin pressures that the Government has had to contend with as it extends intellectual property rights to agriculture. On the one hand, there have been pressures from the world system to introduce IPP as a measure to recognise the contribution made by the commercial plant breeders in the development of new varieties of plants, and on the other there have been pressures from the farming communities opposed to the introduction of any form of IPRs in the agricultural sector. Complementing the former has been the part played by the emerging private seed industry in India.

Globally, the pressures to introduce IPP in agriculture have built up over the past few decades as private interests have expanded their operations in the area of plant breeding. In the process, production of superior varieties of planting material which had largely been carried out by the public sector in the past is being increasingly taken up by the private seed companies (Smith, 1996). The 1980s saw a further expansion of the private sector operations as major transnational corporations like Unilever, ICI, Monsanto and Rohm and Haas, involved in the agrochemical industry, entered the area of plant breeding (Sehgal, 1996). This took place primarily because these conglomerates were aiming at offering agricultural technology as an integrated package in which the improved varieties of planting material were the critical components. Extending of IPP was considered the most effective way in which the plant breeders could obtain returns on their investment in this activity.

The proposed PVA seems to address the mounting global pressures to extend IPP by tacitly accepting some of the features of the plant variety protection followed by the developed countries. These countries have, since 1961, adopted a framework of protection of all plant species through plant breeder's rights (PBRs) provided by the UPOV Convention. UPOV was amended in 1991¹ (henceforth UPOV '91) explicitly to strengthen the rights of the breeders and it is some of the features of UPOV '91 that have been incorporated in the proposed PVA.

The rights of the breeders recognised under the proposed legislation extends, in respect of seed and/or propagating material of the protected variety, to the following acts: production, offering for sale, marketing, export, and import. Further Clause 12 of the draft legislation specifies the domain of plant varieties over which the breeder can exercise his rights. The breeder can, accord-

ing to the provisions of this clause, exercise his rights over: any variety that is essentially derived from a protected variety, any variety that is not clearly distinguishable from a protected variety, and any variety whose production requires the repeated use of a protected variety. The concept of an "essentially derived variety" appearing in the proposed legislation is used in a manner identical to that provided in UPOV '91, the import of which is brought out in the following discussion.

Article 14(5) of UPOV '91, which provides for the inclusion of "essentially derived varieties" of the protected varieties within the scope of the rights of the breeder, constitutes a major element in this latest amendment to the UPOV. This provision expressly seeks to strengthen the rights of the breeder by bringing within the purview of protection "essentially derived and certain other varieties" of the protected varieties.

In introducing the above mentioned provision, the so-called "research exemption" available under UPOV '78, which allowed breeders to freely use other breeder's protected varieties for research purposes and for breeding new varieties, was sought to be excluded. It was argued that the benefits that a breeder could secure was limited since "research exemption" allowed creation of a new variety of plant by using protected varieties without authorization of the original breeder.² Article 14(5) was accordingly introduced to ensure that no new variety can be produced by using of the protected varieties by any means. An "essentially derived variety" has been defined by UPOV '91 thus:

- It is predominantly derived from the initial variety, or from a variety that is itself predominantly derived from the initial variety, while retaining the expression of the essential characteristics that result from the genotype or combination of genotypes of the initial variety.
- It is clearly distinguishable from the initial variety
- Except for the differences which result from the act of derivation, it conforms to the initial variety in the expression of the essential characteristics that result from the genotype or combination of genotypes of the initial variety.

This article further³ provides a non-exhaustive list of examples of acts that may result in the essential derivation, including the selection of a natural or induced mutant, or of a somaclonal variant, the selection of a variant individual from plants of an initial

1. The earlier amendments to the UPOV were in 1972 and 1978.

2. Articles 5(3) allowed use of a protected variety as an initial source of variation for the purposes of creating other varieties.

3. Article 14(5)(c).

variety, backcrossing or transformation by genetic engineering. This indicates that all acts of breeding, from the most conventional to the one involving use of modern techniques, would be taken into consideration while determining whether or not a new variety is "essentially derived".

Contentious Issues

The strengthening of the rights of the breeders took place despite the fact that several countries, more prominently Japan and Canada, had raised the issue in the Diplomatic Conference leading up to the adoption of the revised UPOV that identification of "essentially derived varieties" was a controversial issue. These countries had emphasised that prior to the assigning of rights for an essentially derived variety in line with the provisions of the article providing such protection, effective guidelines must be laid down for identifying such varieties. In this context it needs to be mentioned that while UPOV '91 took note of this observation through a decision to evolve the guidelines, the proposed PVA has shown no appreciation for such problems that may arise in extending the rights of the breeder.

Introducing the concept of essentially derived varieties raises several other contentious issues⁴. There is a view that determination of such derived varieties would not be made by an examining office as a part of the grant of PBRs, but between plant breeders either through a mutually arrived agreement or through litigation⁵. This implies that this critical issue would be settled by the relative strengths of the parties involved, and eventuality that would not favour developing countries like India which has long been involved in major programmes of plant breeding. An additional problem that India would face arises from the fact that there are no provisions in UPOV '91 which would ensure grant of a compulsory license to enable authorized use of the protected planting material⁶. The issue of granting compulsory licence was considered at the outset by the

revision conference held for adopting UPOV '91, but it was eventually rejected.

Determination of derived varieties would be settled by the relative strengths of the parties involved, and eventuality that would not favour developing countries long involved in major programmes of plant breeding.

However, alongside proposing breeder's rights that appear comprehensive in its coverage, the PVA also seeks to introduce contra influences on the breeders' exercise of their rights by explicit recognition rights of researchers, farmers and communities. A further abridgement of the rights of the breeders is seen to occur as the public interest at large gets precedence over the private interests of the breeders.

Protection of Rights

More particularly, the PVA makes an attempt to protect the interests of the farmers and researchers through recognising their rights to use the improved varieties. The farmers' rights defined in the draft PVA are akin to those recognised by the international community while interpreting the FAO Understanding on Plant Genetic Resources the process of which was initiated 1983.⁷ These two facets are reflected clearly in the objective of the PVA laid down in Clause 5 of the draft. According to this clause, the PVA "is to protect the rights of the developers of new varieties to stimulate investment in plant breeding and to generate competitiveness in the field of research and development both in the public and private sectors with the ultimate aim of facilitating access to newly developed varieties and maximising agricultural production and productivity in the country ...". the clause further states that protection of farmers' and researchers' rights will strive to balance the need for stimulation and incentive to R&D with welfare of the farmers."

The researchers' rights have been recognised by seeking to grant them "free and complete access to protected materials for research use for developing new varieties of plant". Clause 14 of the PVA in proposing these rights provides that "acts done for experimental and/or research purposes and for developing new varieties of plants shall not require authorization of the breeder".

4. For a discussion from the perspective of the seed industry see Smith (1996).

5. Greengrass (1993). In a subsequent personal communication, the author has reported that extension of the right to cover essentially derived varieties is expected to be limited to those varieties which take over virtually the whole of the genome of the protected variety. In matters of dispute this may therefore require scientific evidence (Cohen, et al forthcoming).

6. Although the UPOV '91 contains no provisions explicitly providing for compulsory licences, the Model Law on the Protection of New Varieties of Plants prepared by the UPOV does contain a provision on compulsory licences. This provision imposes conditions prior to the issue of the licences in much the same way in which it is provided in the TRIPS Agreement.

7. For a recent reiteration of this position see, Commission on Genetic Resources for Food and Agriculture (1996).

The researchers' rights have been recognised by seeking to grant them "free and complete access to protected materials for research use for developing new varieties of plant".

The rights that the PVA proposes for communities and farmers are presented in the form of an incentive mechanism in Clause 22. Thus, the "recognition of the contribution made by rural communities with sustained perseverance in development, on-farm innovations, enrichment and conservation of plant genetic resources" is to come through "rewards and/or compensation to such communities or clusters... such that rural communities may have a stake in and continue their efforts at preservation and improvement of land-races...". In a similar vein, in recognition of their contribution in ensuring conservation, improvement and availability of plant genetic resources" the farmers are proposed to be given the rights to "secure full benefits and support in continuation of their contribution".

The farmer's rights are spelt out quite unambiguously in this clause in a further elaboration to the relevant clause. A farmer is provided "... additional rights to dispose of his farm produce as he chooses which includes his right to save, use, exchange, share and sell propagating material or seed obtained or descended from seed obtained of protected variety except sale of branded seed/propagating material..." However, the last mentioned condition relating to branded seed/propagating material could imply a significant dilution of the rights in the light of the fact that the large TNCs and their branded seeds are making inroads into the seeds market.

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An important feature of the proposed PVA is the priority attached to public interest over the interests of the commercial breeder. In doing so, the legislation proposes to authorise granting of compulsory licenses to "ensure availability of seed plant or reproductive

material of the protected variety in reasonable quantity at reasonable price".

The grounds for the grant of compulsory licenses are elaborated thus: "The Authority may... on its own on being satisfied that the requirement of public with respect to a plant variety has not been, or is not being met, or where there is an overseas market for sale of seed, plant or reproductive material of the protected variety and the same is not being met by the breeder of the protected variety". Substantial grounds are thus covered as regards grant of compulsory licenses proposed in the PVA.

The recognition of farmers' and communities' rights came only after opposition by the farming communities in several parts of the country against the introduction of IPRs. Farmers' protests, that at times took violent forms, culminated in the inclusion of strong provisions in the draft legislation for the protection of the interests of the rural communities. The provisions in the draft directly address the main concerns of the farming communities—their rights to exchange and sell seeds of the protected varieties.

But despite its best efforts at balancing the contending interests while producing the draft legislation on PBRs, the Government faces two major challenges before it can see the regime of intellectual property protection in agriculture fructify. In the first place, the PVA has to be consistent with the provisions of the Agreement on TRIPs, and secondly, the draft legislation has to meet the strong reactions against several of its provisions by the growing private sector, and particularly foreign, interests in the seed industry in the country.

PVA Provisions: GATT Consistent

The major test of the system of PBR that is proposed to be introduced in India through the PVA would be the consistency of its clauses with the provisions of the Agreement on TRIPs. IPRs have been one of the major issues in the Uruguay Round negotiations and developments in this area would consequently be subjected to close scrutiny in the World Trade Organisation (WTO) as the Agreements formalised at the conclusion of the negotiations are implemented.

The norms for the protection of plant varieties are specified in the Agreement on TRIPs in Article 27.2(b), and although at first sight the scope of the relevant provision appears open to interpretation, in reality however it is quite well defined. Article 27.2(b) provides that "...Members shall provide for the protection of plant varieties either by patents or effective *sui generis*

system that is to be introduced as per the requirements of this Article holds the key to the adoption of the framework for the system. At present the only "effective" *sui generis* system existing for the protection of plant varieties is the PBRs defined by the UPOV Convention, i.e. UPOV '91. It can thus be said that only the UPOV framework can be considered to be in conformity with the provisions of Article 27.2(b).

The provisions of PVA that the Indian Government proposes to introduce should therefore be examined against the provisions of UPOV '91. Although some provisions of the PVA have been set in line with those of the UPOV, there are yet others on which there are major points of departure. Among these are provisions relating to farmers' and communities' rights, compulsory licensing and the term of protection of improved plant varieties.

Although some provisions of the PVA have been set in line with those of the UPOV, there are yet others on which there are major points of departure. Among these are provisions relating to farmers' and communities' rights, compulsory licensing and the term of protection of improved plant varieties.

One of the essential elements of UPOV '91 is that it seeks to severely restrict the freedom of the farmers to use propagating material hitherto provided under the earlier system, i.e. UPOV '78. The latter, in Article 5, provided that the breeder's rights extended to the following acts involving a protected plant variety: provision while indicating that the authorization of the breeder was required if production was undertaken for commercial marketing implied that the breeder's authorization was not necessary for using the seeds on the farm it was produced. The above interpretation gave rise to what has been commonly known as the "farmers' privilege" and taken to imply that the farmers were permitted to re-use the propagating material from the previous year's harvest.

UPOV '91, on the other hand, provides that the breeder's rights would be far more pervasive. Accordingly, the breeder's rights are to include the following acts: production or reproduction (multiplication), conditioning for the purposes of propagation, offering for sale, selling or other marketing, exporting, importing, stocking for any of the purposes referred above.

The rights of the breeder have been extended to cover all acts pertaining to production and reproduction

of the propagating material on which his rights have been established (Article 14(1) of UPOV 1991). The scope of protection thus leaves virtually no possibility of farmers re-using seeds without the authorization of the breeder as under UPOV '78. Nominal scope for exception to breeder's rights has however been provided under 15.2 as follows: "each Contracting Party (to UPOV '91) may, within reasonable limits and subject to the safeguarding of the legitimate interests of the breeder, restrict the breeder's right in relation to any variety in order to permit farmers to use for propagating purposes, on their own holdings, the product of the harvest which they have obtained by planting, on their own holdings, the protected variety..." (emphasis added)..

This is in sharp contrast to the earlier system under which the farmers were allowed re-use of protected material without paying any royalty to the commercial breeders. The new provisions thus allow the farmers to re-use the protected material only if the "legitimate interests of the breeder" are taken care of—the "legitimate interests" being the royalty that the breeder should be paid for re-using the seeds.

The new provisions allow the farmers to re-use the protected material only if the "legitimate interests of the breeder" are taken care of.

The recent amendment of the PBR system brought about by the US Congress after ratifying UPOV '91 pointedly indicates the restrictions that farmers could face in the new system of PBRs. Through this new legislation, the US Congress has put limits on the scope of "farmer's exemption" under the US Plant Variety Protection Act (the U.S. equivalent of PBRs). According to this legislation, farmers would be allowed to re-plant the seeds on their own farm but would be restricted from selling them for reproductive purposes to their farm neighbours without having to pay royalties or ask permission for the same.

Thus, while the UPOV Convention has sought to restrict the freedom that the farmers would enjoy, the PVA has drawn up an elaborate provision for recognising the farmers' rights. The concept of farmers' rights, although acknowledged by the FAO, suffers from the singular weakness in that there is no internationally accepted instrument through which it can be exercised. In the absence of such an instrument to put into operation the farmer's rights, it is the breeder's rights as defined by the PBRs which have come to be recognised as an intrinsic part of the *sui generis* system of protection

available for plant varieties worldwide. It is therefore the requirement of breeder's rights provided under UPOV '91 that the PVA would eventually have to meet in order to conform to the norms and standards proposed in the Agreement on TRIPs.

In the absence of an instrument to put into operation the farmer's rights, it is the breeder's rights as defined by the PBRs which have come to be recognised as an intrinsic part of the *sui generis* system of protection available for plant varieties worldwide.

The provisions relating to compulsory licensing appearing in the proposed PVA that give "over-riding priority" to public interest, are antithetical to the framework of intellectual property protection as proposed in the Agreement on TRIPs. In the latter, the rights of the owner of intellectual property are given primacy in no uncertain terms as is clear from Article 30 that relates to patents. According to this Article, "limited exception may be given in respect of the exclusive rights conferred by a patent, provided that such exceptions do not unreasonably conflict with a normal exploitation of a patent and do not unreasonably prejudice the legitimate interests of the patent owner, taking account of the legitimate interests of third parties".

Further, the provisions of the proposed PVA that lay down strict requirements for making available the protected material to the members of public at reasonable prices through the grant of compulsory licenses are diametrically opposite to the provisions of both the UPOV Convention (UPOV '91) as well as the TRIPs Agreement as both do not allow for the use of the mechanism of compulsory licensing to enable authorised use of the protected planting material. The issue of compulsory licensing was considered by the revision conference leading up to UPOV '91 at the outset, but was rejected eventually. In a similar vein, this issue of allowing the use of compulsory licenses was raised as one of the major areas of convention during the Uruguay Round negotiations particularly in relation to patents. However, it was eventually settled in favour of the patentee who now is free from undertaking any obligation to make his patented/protected material available to the public at reasonable prices.

The other point of difference between the PVA and UPOV '91 arises as regards the term of protection. The PVA, in providing a term of protection of 15 years for new varieties from the date of registration and 18 years

for trees and vines, provide a shorter term than stipulated under the UPOV where the corresponding terms are at least 20 years and 25 years respectively. There are, thus, several areas where the provisions of the proposed PVA appear inconsistent with those of the TRIPs Agreement, which, as discussed, require adoption of the UPOV Convention.

Domestic Pressures

Principal opposition to the draft legislation has come from the association of seed companies in India. The Seed Association of India (SAI) has made submissions seeking extensive changes in the proposed legislation. In its essentials, the proposals for revisions suggested by the SAI are aimed at establishing the pre-eminent position of the commercial breeder. The most significant of the suggestions made by the Association relates to the truncating of researchers' rights and an almost complete removal of the farmer's rights. It has been proposed that the rights of researchers provided in the draft PVA should be amended in a manner that the access of the researcher to the propagating material becomes possible only with the consent of the breeder. The farmer's rights of selling seeds has also been questioned. In the view of SAI, the very purpose of plant variety protection would be defeated if farmers start selling seeds of a protected variety.

As regards the strong compulsory licensing provisions provided in the draft legislation, the SAI has stated that licensing should be allowed only with the consent of the owner of the protected variety and compulsory licensing should only be resorted to in case of defined public interest after suitably compensating the breeder. The SAI has indicated that the rights of the breeder should be made stronger in the proposed regime. Apart from the rights provided in the draft legislation in Clause 12, the association has suggested that storage of planting material should also be included. Elaborating this point SAI proposes that the stocking of the varieties provided in the draft legislation should be permitted only with the consent of breeders. It further indicates that such stockings should be used only as reference material and for no other purpose. These suggestions made by the industry association portend a major problem that the Government could face while getting the legislation through.

Conclusions

Indian agriculture is at cross-roads as the Government prepares to bring forth a legislation for the introduction of intellectual property rights (IPRs) in this sector. Hitherto, India, like most developing countries

had kept the agricultural sector outside the domain of intellectual property protection. But this situation has changed following the commitment taken by the Government to extend the IPRs to encompass plants under the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs). The prospects of a rigid system of protection extending to the plant kingdom has generated considerable controversy in the country with farmers raising the issue of the loss of their traditional rights to make unfettered use of planting material of all hues. Government legislation has attempted to strike a balance between its commitments made in Geneva and the interests of the farmers opposed to the introduction of IPRs.

Although the Government has tried to address to the needs of the different interest groups in presenting a draft of the proposed legislation of plant varieties protection, little progress appears to have been made. Controversies have accompanied any reference made to the PBRs, the most vocal opposition coming from the farmers. Although this group has seemingly been placated with the promise that their interests would be protected in any regime that is introduced, such assurances may not eventually have much substance in view of the fact that domestic legislations have now come under the scrutiny of international organisations like the WTO. Thus, with the farmers' interest being put in sharp conflict with those

of the commercial breeders, trepidations facing Indian agriculture are far from being over.

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The New Patents Regime: Implications for India's Pharmaceutical Sector

H.A.C. Prasad

The paper examines the implications of the New Patents system as stated in the TRIPs agreement on India's pharmaceutical sector. It also examines, certain provisions which have not been included in the TRIPs agreement but have an important bearing on India's pharmaceutical sector. The study disproves many myths related to the impact of product patents on India's pharmaceuticals. While emphasising that the new patents system under WTO is not really adverse for India, the author underlines the need to take some immediate steps to reap the benefits of a strengthened patents regime, in the sphere of foreign investment and technology transfer.

The new patents system under the TRIPs agreement has important implications for India's pharmaceuticals. There are also some provisions related to patents which have not been included in the agreement but have an important bearing on India's pharmaceutical sector. The TRIPs agreement includes seven types of intellectual property, namely Patents, Copyrights, Trade Marks, Geographical indications, Industrial designs, lay-out-designs, integrated circuits and undisclosed information. The main features related to patents affecting India's pharmaceutical sector, which have either been covered or not covered in the TRIPs agreement are as follows:

Patents: Features Impacting Pharmaceuticals

Most Favoured Nation (MFN) & National Treatment

As with other IPRs, in the case of patents also, these two clauses are applicable. The MFN clause implies that any benefits of the provisions of the agreement extended to any WTO member or non-member have to be extended to all members without discrimination, though benefits extended to WTO members need not be extended to only one or few members. Thus no member can give preferential treatment to another member. This is however subject to the clauses which permit Regional Trading Blocks. The National Treatment principle implies that a member must not accord less favourable treatment to the nationals of other members than what it accords to its own nationals. This has a bearing on technological development in two ways. Since special protection cannot be given to domestic innovations over foreign innovations, the former may suffer. Alternatively foreign investments may take place as foreign investors can now use foreign innovations which enjoy equal treatment as domestic innovations. The domestic innovators devoid of the protection umbrella, may also become more competitive.

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Product patents vs process patents

The TRIPs agreement has an obligation on members to extend patents on both products and processes. Therefore for pharmaceutical items, India has to grant product patents, while under the Indian Patent Act (1970) only process patents were given. The switchover to the Product Patents Regime has been criticised in many quarters in India mainly due to the following myths.

- Drug prices will rise due to product patents
- Indian pharmaceutical industry will suffer due to product patents
- The common man will suffer due to higher drug prices caused by product patents

First myth

Let us now examine the first myth i.e. Drug prices will rise due to switchover to the Product Patents Regime. This in turn depends on the following.

- whether products patents as opposed to process patents can lead to rise in prices; and
- whether product patents are likely to lead to rise in prices in the near future in India.

Coming to the first question, while product patents can lead to a rise in prices as the competition prevailing in a process patents systems will be minimised, this actually depends on the *bandwidth* and substitutes available in the form of *non-patented* or *off-patent* items. The bandwidth of the patent is dependent on the determination of equivalents by the member country (UNCTAD, 1996). Thus if the patent equivalents are kept narrow by a country, then there will be more scope for competition. The TRIPs agreement would be applicable only to new patents—there are many non-patented products also. Besides, many patented drugs have become off patent and many are becoming off patent as the patent expires. Many of these may be substitutes for the new patented drugs. Infact the OPPI (1996) has given a list of patent expired therapeutic equivalents available for some new patented drugs.

The second question, whether product patents are likely to lead to rise in prices in the near future in India, depends on two sub-questions:

- To what extent are the drugs marketed in India covered by product patents abroad?
- Are drug prices in India market-driven or administered?

As regards the first sub-question, (Prasad & Bhat, 1993) as per minimum estimates, 5 per cent and as per maximum estimates, 21.5 per cent of the drugs and medicines marketed in India are product patented abroad. There are about 30 internationally patented drugs in the Indian market with a turnover of less than 10 per cent of the total sales (OPPI, 1996). Only 2 drugs out of more than 250 drugs listed in the WHO list of essential drugs would be patented today, if India had an existing patent law for pharmaceuticals covering product patents (OPPI, 1996). Of these 2, the patent for one expires in 1997 and the other in 1998. Only one is marketed at present in India and has a sale of Rs. 6-7 crores against a total pharmaceutical turnover of approximately Rs. 8000 crores.

Coming to the second sub-question, one of the important factors influencing prices of pharmaceuticals is the Drug Price Control Order (DPCO) and the GATT agreement is not against price controls (Prasad & Bhat, 1993). Earlier, the number of drugs under price control was reduced from 375 to 145 with only a marginal decline in the span of control from around 79 per cent to around 70-74 per cent; under the 1994 Drug Policy, the number of drugs under price control was reduced from 142 to 73, with the span of control reduced from 70 per cent to 50 per cent. Thus, despite a judicious policy of deregulation, the DPCO is still an important player in determining drug prices in India.

Despite a judicious policy of deregulation, the DPCO is still an important player in determining drug prices in India.

The above facts show that pharmaceutical prices are not likely to increase in India in the near future due to the switchover from process to product patent system. Thus the first myth is disproved in the Indian case.

Second myth

The second myth is that the Indian pharmaceutical industry will suffer due to Product Patents. This is also

Pharmaceutical prices are not likely to increase in India in the near future due to the switchover from process to product patent system.

dependent on the results of the earlier analysis. Firstly, product patented pharmaceuticals form a small percentage in India. Secondly there are a host of off-patent items which the Indian pharmaceutical industry is focusing upon. Thirdly, as studies (Prasad & Bhat 1993) have shown, India's Revealed Comparative Advantage (RCA) in Pharmaceuticals has improved over the years even when compared to other developed countries. India has in fact become a net exporter of pharmaceuticals. While technology transfer may receive a setback as imitative research will not be possible in the new system, India is likely to receive real and value added technology along with foreign investment by strengthening its patents regime. Thus there is no need for the Indian pharmaceutical industry to get worried due to Product Patents.

Third myth

The third myth, that the common man will suffer due to higher drug prices caused by product patents depends on the first myth which has now been disproved. Further as pointed out in studies (Prasad & Bhat, 1993) and also by Exim Bank (EXIM Bank, 1994), the chances of the common man being affected by rise in drug prices caused by product patents is very unlikely for the following reasons:

- * Product patents would form a small percentage of total marketed drugs in India.
- * If, by the common man, we mean the people below the poverty line or even the middle class, then the percentage of patented drugs consumed by them would still be less. Besides there are many substitutes.
- * The per capita consumption of drugs in India is very low compared to many developing countries. OPPI estimates (OPPI, 1996) show that the annual per capita drug expenditure in India in 1990 was \$3 compared to \$412 in Japan, \$222 in Germany, \$191 in USA, \$30 in Chile, \$28 in Mexico, \$7 in China and Pakistan.
- * Expenditure on drugs is generally less than 10 per cent of total medical care
- * Diagnostic, therapeutic and surgical methods which form a substantial portion of medical expenditure may be excluded from patentability under GATT agreement.
- * Medical care expenditure forms around 2.6 per cent of total expenditure in India and medical treatment in India is also in the form of Ayurvedic Treatment, Unani, Homeopathy, etc. In the case of medicines for such treatment, India can get patents rather than granting patents to others.

- * Only 2 items in the WHO list of essential drugs are under product patents in the world.
- * The New Drug Policy imposes price control on drugs with a turnover of Rs. 4 crores and above.

Thus the third myth also stands disproved. There is no valid reason for India to postpone the implementation of the new patents regime on the grounds of product patents except that it has a 10 years transition period under the GATT accord to make the necessary provisions for product patents.

Imports allowed

One controversial issue in the case of the new Patents System is that imports are tantamount to working the patents. If today one were to search for any valid, argument for postponing the implementation of the TRIPs agreement, this could be one. If the objective of strengthening the patents regime is to get more foreign investment, particularly in R&D in pharmaceuticals, then this clause can be tricky. As pointed out in earlier studies (Prasad & Bhat, 1993) the pharmaceutical sector has high backward linkages and the high backward linkages may be reaped outside the country instead of within the country due to the clause 'importation is tantamount to working the patents'. The possible danger of an adverse effect on balance of payments due to imports of patented items may not be real, as the decision to manufacture or import depends on many factors like cost of raw materials, labour etc; newly patented items each year are small in number; some items become off patent each year and there are many therapeutic substitutes for patented items. But the promise of greater foreign investment inflows in a strengthened patent protection regime and the resultant greater transfer of latest technology may not be a reality if deliberate importation of patented items take place. Since it may not be possible to renegotiate on this issue, in cases where patented items are deliberately imported despite definite cost advantages to work the patents in India, India should at least explore the possibility of resorting to some sort of emergency safeguard measure or of declaring such practice as anti-competitive by a judicial or administrative process. Then compulsory licensing can be applied as a remedy. The importation clause may also hinder technology transfer. However other clauses like the need to supply clear and complete information of technology can help in technology transfer. Here, there is one issue which is not quite clear. Article 27 of the TRIPs agreement says that patents shall be available and patent rights enjoyable without discrimination as to whether products are imported or locally produced (GATT, 1995). The word 'discrimination' used here is quite tricky as it implies that

patented goods may not be subject to EXIM Policy Clauses which prohibit and restrict items. Even an import duty can be considered as a discrimination!

Newly patented items each year are small in number; some items become off patent each year and there are many therapeutic substitutes for patented items.

Non exclusive compulsory licensing

The TRIPs agreement does not specify the grounds for compulsory licensing or non-voluntary licensing and also does not require a member to justify the grounds on which it is resorted to. While under Paris convention, non-working of the patents could invite compulsory licensing, under TRIPs agreement this does not hold good as there shall be no discrimination between imports and locally produced products. Further there is the need to make efforts to get authorization from patent holder and compulsory licensing can be resorted to only if authorization could not be obtained, within a 'reasonable period' and this 'reasonable period' is not specified in the agreement. The grounds on which compulsory licensing can be resorted to, may be, if the non-utilization of the patents causes scarcity, resulting in unduly high prices, or it may be to protect public health and nutrition or promote public interest in the context of socio-economic and technological development. If higher imports which may also be costly is considered as a case of public interest, there is also the clause that there should be no discrimination against imports. Thus there is a lot of ambiguity in the case of compulsory licensing. Among the specific limitations, there is the issue of non-exclusivity which means that the patentee should not be excluded from utilising the patent when a compulsory license is issued. This will of course automatically deny monopoly powers to the license holder. Another specific limitation of interest is that the compulsory license must be predominantly for the supply of resultant products to the domestic market, which implies that this cannot be used for the purpose of exports. But since the issue of exhaustion of the patent is not mentioned in the TRIPs agreement, the patent holder can possibly not take any action if the patented items are eventually exported after the initial sale in the domestic market.

Reversal of the burden of proof in process patents

In the case of process patents, the burden of proof has been reversed and the defender has to supply the

evidence. However, the judicial authorities have the power to order the infringer to inform the right holder of the identity of third persons involved in the production and distribution of the infringing goods or services and of their channels of distribution. This would mean that the burden of proof will also be on the third party. This can lead to a lot of mud slinging by the competing pharmaceutical producers.

Pipeline protection exclusive marketing rights

The TRIPs accord has been criticised particularly in the case of pharmaceutical sector as it has an obligation on members to grant exclusive marketing rights for pharmaceutical products during the transition period of 10 years, for 5 years after obtaining marketing approval in that country for the product for which applications for patents has been filed, even though patents will not be given till the member applies the relevant provisions of the agreement. This is however subject to the condition that this is applicable only for new products for which patents have been granted and marketing rights obtained in any one of the member countries. Though this is considered to give some right to the innovator, there is also the disadvantage for him as the duration of the patents of 20 years will be from the date of filing the application, though actual patents may be given from the date when the relevant provisions of the agreement are applied which may even be the last day of the 10 year transition period. Further the exclusive marketing rights being not equivalent to that of a patent, action cannot be taken against copying such innovations. Further, the government can intervene in the case of public interest or extreme emergency. Compulsory licensing is also applicable on such products. As examined earlier, while there is no need to fear any adverse fallout due to adopting product patents even before the 10 years transition period for pharmaceuticals there is definitely no need to fear its weakened shadow in the form of exclusive marketing rights for five years during the transition period.

Duration of the patent

Under Indian Patents Act, the duration of patents for pharmaceuticals was seven years from the date of application or five years from the date of grant whichever was shorter, while it is 14 years in other sectors. The modal years for granting patents from the date of application in India is 4 years (Prasad & Bhat, 1993). This means that only 3 years are left to use the patent before it expires. Under TRIPs, patents are for 20 years from the date of filing the patent. Given the delays in granting the patents and the time taken for clinical trials, the effective period of patents is quite moderate.

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Exhaustion of the patent

The issue of exhaustion of the patent is not covered in the TRIPs agreement, but is very important from the point of view of pharmaceuticals. As per the principle of exhaustion, once the patent holder has sold his patented product, he cannot exercise any control on the later stages of the marketing of the product. The patent is deemed to have been exhausted after the first sale. Each nation can have its own provisions regarding exhaustion of patents. If the patented product is costly in one country, it would be beneficial to import the patented item sold in another country (UNCTAD, 1996). Since this is not covered under TRIPs, this cannot be brought under the Dispute Settlement Mechanism.

Exceptions

The TRIPs agreement provides for limited exceptions to the rights of the patent holder, which implies that exceptions can be applied in the case of further scientific development. This coupled with the obligation on patent holders to disclose fully the invention sought to be patented so that an expert in the field can carry out the same invention and the obligation to indicate the best mode for carrying out the invention as known to the inventor, can help further scientific development.

Dependent patent

In the case of dependent patents, if a second patent cannot be exploited without infringing the first patent, cross-licenses have to be given. This provision will also help further scientific development and research in pharmaceuticals.

Enforcement of patents

The enforcement under TRIPs has been made tighter and both civil and criminal procedures have been allowed. Under the dispute settlement process, cross-retaliation in other areas like goods or services are allowed in the case of grievance in the area of TRIPs. But similar cross-retaliation in TRIPs for grievances in goods or services sector is not allowed. This imbalance has to be set right in future negotiations. Under the TRIPs agreement, the judicial authorities can order prompt

and effective provisional measures to prevent an infringement of any IPR from occurring, and in particular to prevent the entry into the channels of commerce in their jurisdiction of goods, including imported goods immediately after customs clearance (GATT, 1995).

Unilateralism

Added to the enforcement mechanism under TRIPs, there are the unilateral threats by countries like USA which fall outside the WTO mechanism. Infact the US has passed a law under which it can renegotiate or even come out of the WTO if the decisions of the dispute settlement body are found to be inappropriate by a US commission in atleast three cases. While India is not in a position to exercise such powers, there is no harm in India setting up such a commission to explore issues for future negotiations. Meanwhile pressure should be applied against the use of unilateral measures.

Conclusion

The above analysis shows that the new patents system, under WTO will not really have an adverse impact on India's pharmaceutical sector, though it may not also be very rosy in terms of foreign investment and technology transfer, unless India makes some intelligent moves. There are also many clauses within and outside the TRIPs agreement which can be used to India's advantage. Finally, India should also invest in R&D which is at an abysmally low level, to get more foreign patents for Indian products.

There are many clauses within and outside the TRIPs agreement which can be used to India's advantage.

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Intellectual Property Right Laws: A Historical Perspective

Gayatree Siddhanta Sarma & Chandrasekhar Sarma

Despite a long historical background, Intellectual Property Laws have had a chequered evolution. And the necessity for IPR with scientific and economic development has not been adequately tested and established. However, it is being increasingly accepted that IPR Laws act as agents of innovation, which is the key to the economic superiority of a country. This paper traces the evolution of the two major components of IPR Laws, the Patents and the Copyright Laws. It makes a quick overview of the major arguments for and against IPR Laws. It also takes stock of the IPR Laws in India and presses the argument to further strengthen the present IPR Laws in India in order to become globally attractive and competitive.

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In an essay on *Literary Larceny*, the English copyright scholar Augustine Berrill (Goldstein, 1994) observed that " 'a particular leg of mutton is mine' is capable of easy proof or disproof but 'How much of a book is mine?' is a good question". Though Intellectual properties have the attributes of regular property in the sense that they can be bought, sold or licensed, there has been controversy surrounding the various rights that protect them. Despite the activities carried out globally or by the nations individually – confusion is still abound regarding this issue.

Intellectual Property: Attributes

Intellectual property is information that has commercial value and derives its intrinsic value from creative ideas (Besen, 1987). Intellectual property is an archetype of the economist's public good. According to Samuelson (1976), a public good has the attribute that "each individual's consumption of such a good leads to no subtraction from any other individual's consumption of that good..."

Where the consumption of private good requires as many units to be produced as are demanded by all consumers combined, the same amount of public good that is produced is simultaneously available for the consumption of all consumers. Thus, the use of a song, a computer program or a journal article by one person does not diminish the availability of that good for the use of others. This characteristic of public good¹ is known as "jointness or non-rivalry in consumption". The corollary of the fact that a simultaneous use of the same public good does not diminish the availability for others is that the cost per user declines as the number of users increases.

1. One significant point to be noted is that we are distinguishing here between intellectual property such as songs, computer programmes, novels and scientific articles etc. and their physical embodiment in video tapes or records, computer disks, books or journals. Only the former in reality are public goods.

Intellectual property can be classified into two streams: industrial property and copyright. Industrial property includes inventions, Trademarks and industrial designs.

Patents

Inventions are novel ideas that provide in practice, the solution of specific technological problems. To qualify as an invention the idea has to be new, non-obvious and must possess immediate applicability to industry. Patents legally protect the inventions – usually granting the patentee exclusive right for a limited period over the exploitation of the invention. Trade secret also protects an invention, but it relies exclusively on private matters.

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The history of patent is a chequered one. Government grants of exclusive rights to inventors date back to the 14th century. But the purpose behind such rights has not always remained the same. Law in the 15th century Venice as well as 16th century Germany and England conferred patent rights on the inventors of “new arts” and machines; both utility and novelty were taken into account. Ironically some evidences suggest that these were awarded to free the inventors from the stifling constraints imposed by the Guilds.

In USA, the early laws encouraged foreign investors to invest in industries and guaranteed them a protected local market. By the late fifteen hundreds, English monarchy increasingly used monopoly privileges not to encourage inventions but to reward court favourites, to secure loyalty and to earn money. Opposition to this unethical practice precipitated the creation of the “statute of monopolies” in 1625 by the English parliament. This generally is considered as the model of most modern patent laws. The statute outlawed monopoly privileges for anybody but for the “first and true inventor” of the new product. Similar laws were passed throughout Europe and north America between mid seventeenth and mid nineteenth centuries.

Traditionally four arguments have been formulated by economists in favour of a patent system as has been discovered by Fritz Machlup and Edith Penrose (Benko, 1992) in two independent studies:

- The “natural rights argument” extends the philosophical and moral arguments for individual property rights to intellectual property. This argument gained immense popularity in nineteenth century France.
- The second argument-labelled by Machlup (Benko, 1992) as “reward by monopoly” was seriously considered by English economists. This thesis maintains that society imperatively owes rewards to the inventions that are beneficial to it. Natural rights and moral imperatives have mainly influenced this argument as well.
- The third, “the monopoly profit incentives” thesis stressed that monopoly privileges or patent rights, whether just or not, are needed as economic incentives to encourage inventive activities and its financial support.

Monopoly privileges are needed as economic incentives to encourage inventive activities and its financial support.

- The final argument asserts that whether it works as a social incentive to invent or not, monopolistic property rights were necessary to disclose their secrets to society. Patents were, therefore, essential for diffusion of technology.

The modern argument for patent relies heavily on the last two arguments. It is conceded by all economists that knowledge goods have awkward properties which differentiate them from the standard goods in neo-classical economic theory. The price mechanism of the market completely fails to operate efficiently in the case of inventions. The problem stems from the public nature of inventions as well as the cost structure underlying the production and distribution.

Public goods vs knowledge goods

Inventions are public goods characterised by difficulty of exclusion or the so-called ‘free rider’ problems. It is often difficult or prohibitively expensive to exclude those who do not want to pay for the benefit the goods provided to them. If the public goods is accessible to all, it is near to impossible to exclude the free riders who do not wish to pay for the access to the goods. If the ‘public goods’ in discussion is knowledge, the exclusion problem becomes more severe, since one may have to reveal to the potential buyer, the nature of the goods to get them to purchase it. And once they know the nature,

they may have no need to purchase it. This characteristic is known as non-exclusion.

In the case of intellectual property, the patent and copyright systems are designed to deny access to those who do not pay for the use of the fruits of others' intellectual efforts. If owners of intellectual property are unable to exclude non-payers, their revenues will decline and their willingness and ability to produce new types of intellectual goods will diminish.

Furthermore, although the initial production cost may be significant, the subsequent distribution cost of the knowledge or ideas or invention is zero or near zero. The distribution of additional unit of knowledge-good would not deplete the stock. According to the static economic criteria, optimum price for knowledge or invention, once produced, would be roughly zero. At a normal selling price of near zero, there is no incentive to produce knowledge goods. This is the problem of appropriability. Hence, pressures to keep new discoveries as secrets mount high. Patent ensures that the invention is disclosed to the general public and thereby promotes diffusion of technology.

Copyright

Copyright was technology's child from the beginning. There was barely any need for copyright protection before the invention of the printing press. But as movable type brought literature within the reach of everyone and demands of mass consumer supplanted the demand of select few, a legal mechanism was needed to connect consumers to authors and publishers commercially. Copyright was the answer to that. What distinguishes copyright from patent is the fact that in case of patent, the invention and the novel idea are inextricable. They are one and the same. But the copyrighted work and the information it contains are separable. The novelty of idea here is irrelevant. It is the expression of the idea that makes the intellectual product original and herein lies its consumer value. Copyright protects the expression and not the idea. This is a traditional distinction—but the practical and analytic usefulness of the distinction between copyright and inventions has been gradually challenged by the revolution in modern technology.

Since invention is embodied in a product that is required to have immediate applicability—the debate over patent rights is not tainted much by cultural views. For example, European, Asian and Latin American copyright laws look and work in many respects as the American copyright law. But their copyright laws are based on the natural right philosophy (Scheuer, 1980).

To these countries an author's work is not only his property but the very embodiment of his personality. Copyright, just like patent, protects the products of human mind, but since they are intangible in character, it is difficult to draw a boundary around such "fugitive" properties.

Arguments against IPR Laws

The antipatent argument

A strong antipatent movement, particularly during the period between 1850-1870, kept the patent law debate alive. The antipatent movement eventually led to the abolition of patent laws in Holland. Economic depression in the 1870s, rise of nationalism and protectionism and willingness to compromise on the part of patent lawyers brought back on its feet, a near collapsed patent system. Economists unanimously agree that inventions do create problem of market failure, appropriability and externality. But they are not unequivocal in the view that a patent system alone would provide solution to this problem. Their hesitation to endorse a patent system wholeheartedly is attributed to various factors. There is the question whether innovative activities fare in a different way in a patent free environment. Another classic qualitative question is: "Do patents encourage only the innovation of certain kinds and discourage others?"

Yet another question often raised by the antipatent lobby is whether they generate the actual benefits in terms of an increased inventive activity. It is also argued that the pure joy of invention can not be directly correlated to monetary rewards. But what prompts invention is still an unsettled question. The oft quoted story of the classic inventor of yesteryears-fiddling alone in his attic and chancing upon an invention does not have much relevance in today's corporate and economic system. The technological inventions which revolutionised the world might have been rewards in themselves but what is relevant today is concerted research and large investments. All these depend on the expected return on investment.

Patent, it has also been argued is not necessary to stimulate invention. Competition in itself is incentive enough, and in most cases works as a sufficient agent to encourage disclosure. If it is so, patents bring no new benefits to society but add cost. But there is no empirical proof of that.

Moreover, even if patents clearly encourage the development of new technological knowledge, it is not clear whether this kind of knowledge generates more

benefit than the unpatentable knowledge which the system discourages. It is an ironical criticism of the patent system and is quite an implausible one. No system can discourage development of knowledge. and even if it is not patentable, the other kinds of knowledge generated and developed, say, by a historian or sociologist, bring great benefits to the society. They are also protected by copyright laws. Patent system is required not to prove the superiority of scientific and technical knowledge but to encourage inventions.

On the cost side, patents generate the inefficiencies associated with monopoly—such as higher prices, restricted supply and inefficient allocation of resources. Patents lead to waste of scarce resources and this is the final argument to discourage patents. As Edith Penrose (Benko, 1992) points out: "It seems that the argument that patents are necessary to induce inventions and to encourage the exploitation of inventions is difficult to evaluate and impossible to test adequately." Although it is hard to establish a foolproof argument for patent, it has been revealed historically that technological changes do occur under this system.

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The anti-copyright argument

Just like the case of patent, copyright's foundation is also split by a debate. On one side are lawyers who assert that copyright is rooted in natural justice—entitling the authors to every rupee they earn from the books that are sold. These are copyright optimists: to them copyright's cup of entitlement is always half full—waiting to be filled further. On the other side of the debate are copyright pessimists who view copyright's cup as half empty: they accept that copyright owners should get some measure of control over copies as an incentive to produce creative works, but treat anything further as an encroachment.

In 1971, Harvard law Professor Stephen Breyer—a copyright pessimist wrote an article (Goldstein, 1994) which was nothing less than an attempt to dismantle the moral and economic claims of the pro-copyright group. In the first part of his essay Breyer attacked the natural right supporters and then he undertook the task of refuting the economist's foundation—the one that claims that copyright is needed as an incentive to produce and

distribute creative works. The most prominent of his arguments are:

- * Even without copyright, an author can ward off unauthorized copies by threatening to issue a "fighting edition," priced even lower than the pirate's.
- * And that, although it costs a pirate less to publish a book than it costs the original publisher, the latter has a lead-time advantage that enables it to recoup its costs.

The onus of defending copyright fell on Berry Tyerman. In Tyerman's view (Goldstein, 1994), a publisher can not sell drastically below his cost to drive out copiers and still remain financially solvent. According to him, "there would be no safe haven in which the publisher could produce a book free from competition in that title and make the profits necessary to finance the production and sales of fighting editions of other titles".

Tyerman's response to Breyer's theory of lead-time advantage was also simple and factual. Why should one assume that the copier's unauthorized edition would be a paperback rather than a more expensive hardcover one? and, in any event, the competing illicit copy would reach the market sooner than an authorised cheaper edition, which publishers intentionally delay. Eventually Breyer also came out of the radical camp and admitted that instead of abolishing copyright, the debate should be over a modified stricture of copyright.

IPR Laws: The Indian Scenario

Theoretical arguments against patents become more complicated once it is extended to the international area. Philosophical and practical differences between the industrialised nations in the northern hemisphere and the developing world of the South lead to another set of arguments over the intellectual property right issue. The less developed countries (LDC) maintain that western technology is unjustifiably expensive. India being an LDC also seems to have a strong anti patent lobby. It is not our intention here to question the sincerity of the issues they raise but to establish that intellectual property right system is not detrimental to a nation's progress nor does it rob a nation of its dignity and pride and its indigenous methods of creation and preservation. The opposition argues that intellectual property rights give inventors a monopoly over a particular information. They in turn charge an unreasonably high price for their knowledge and impose unwarranted restrictions on its use. These restrictions hinder progress in LDCs and widen the gap between the haves and the have-nots i.e., the developed and the develop-

ing nations. Moreover, knowledge is the common heritage of mankind and should be available at minimum cost. But by its very nature, technology is private property in creation and public property in productive use or consumption. If it were made free, who would bear the cost of its creation? Agreed that it is not justifiable for poor nations to bear the cost while others reap the benefit. But instead of lamenting we should shed our fears and get rid of protectionism; by ensuring a strong intellectual property right we should encourage our brilliant scientists to do more applied research so that gradually procuring technology from the western world would not be a pre-requisite for our progress.

The industrialised nations have their own counter arguments. Monopoly rights ensure proper compensation for the private inventor. It is the best interests of the LDCs that they realise that IPR holds the key to an indigenous technology development and foreign technology transfer. The USA is the benchmark for almost the whole world in technological development. But early colonial America granted monopoly rights to encourage foreign investments. There is always a first step and however shaky it might be, India should take it towards a scientific and technological renaissance.

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More often than not, it is argued that what the developing countries lack are the basic pre-requisites for fundamental research and development and not intellectual property rights protection. Without proper funds, research facilities and scientific and technical personnel, intellectual property rights make little difference. India does not lack fund or research facilities, let alone technically and scientifically competent personnel. After the liberalisation of economy, there is a distinct effort from all quarters toward achieving a rapport between the industries and scientists in various laboratories and academic institutions. Technology transfer is the main thrust here. But studies reveal that there exists an atmosphere of mistrust and lack of co-operation and unwillingness for a synergistic relationship. But once that bridge is built, corporate funded innovative research will come into vogue. Until now, sadly, the underlying assumption in the Indian technological scenario has been that western scientists alone are capable of revolutionary inventions, This is an old colonial hangover that wrongly assumes that we are second class, incapable of invention and creativity. But

once the concept of technology transfer turns into a reality, intellectual property right protection will play a major role in India too.

Without proper funds, research facilities and scientific and technical personnel, intellectual property rights make little difference.

One major complaint against the multi-national companies in India is that they are bringing in obsolete technologies and are not yet ready to invest in R&D. This allegation ironically reflects why technological achievement bypasses nations which lack ample protection for intellectual property rights. Companies do not hesitate to set up plants in costlier places if they have a strong patent protection system. The argument that the kind of innovative knowledge which is encouraged by intellectual property rights should not be the key issue in economic development, does not hold much water. A third world country's current mixture of capital, skilled labour and existing market would only encourage them to adopt less advanced, more labour oriented old technologies than those in the developed nations. This would widen the gap between North and South. The primary social benefit associated with patent is technological innovation. It plays a key role in the development of a nation by reducing cost, increasing creativity and creating new markets (Bijlani, 1990). History stands witness to the fact that most of the economic growth around the world since the industrial revolution has been fuelled by technological inventions. Today, a country's economic superiority in the global standing depends mostly on its innovative capacity.

The current patent laws in India are rather weak. For example, Indian patent Act 1970 does not grant product patents in drug and pharmaceutical & chemical sectors. To develop a drug from laboratory stage to marketing for use requires 10-12 years work and an investment of US \$ 200 million. In the absence of patent protection,

The current patent laws in India are rather weak. In the absence of patent protection, there will be no incentives for companies to invest in R&D. And this has a detrimental effect on the long-term economic development of the country.

there will be no incentives for companies to invest in R&D. And this has a detrimental effect on the long-term economic development of the country. History repeatedly shows how adequate protection an IPR encourages the inventive activity of a country.

Conclusion

From an ethical point of view a strong IPR regime is warranted. In addition, history is replete with instances of adequate production of Intellectual properties spurring inventions and creating wealth. One of the components of sustaining economic development is strong IPR laws. For India to be globally competitive in all arenas, a strong IPR regime is a must.

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Bartering Baubles for Books: A Way to Increase Productivity

Albert A. Blum

Students world over aspire to study in American Universities, the move being welcome on the part of the latter too, in view of their pressing financial needs. However, the lack of dollars stands in the way as developing countries do not possess the necessary 'green notes'. They do possess other items which may be bartered to finance their students' education, suggests the author.

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When one walks around any American campus, one hears students speaking a babel of languages. Besides the students native to the country, there are many present from all over the globe. This polyglot conglomeration owes its existence to American educators who have ideological commitments to help the young from elsewhere to learn skills to increase productivity at home as well as to appreciate the benefits of democracy and become sympathetic to American foreign policy. These commitments, whatever be their actual impact on students are now being merged with a more pragmatic concern: the pressing financial needs of many universities, particularly private ones, which are being met by the tuition dollars from abroad. For example, Nigerians, once so abundant on American campuses, are now rare since Nigeria's economy has gone downhill and no longer has as many dollars to pay for tuitions. In their place, one often finds Malaysians because Malaysia has an affirmative action program under which it pays for the education abroad of its Malay residents so that they can catch up with their fellow-Chinese and Indian citizens.

Towering Aspirations & Too Few Dollars

To attract foreign students with dollars to United States, there are now four groups organized, with American college recruiters travelling abroad to induce students to come to their college. These travelling college salesmen are however, not going to countries where there are very few dollars available. The idealistic rhetoric about the value of having foreign students come to the United States to learn to appreciate the benefits of democracy has often been replaced by the attraction of tuition dollars and therefore the foreign students tend to come increasingly from affluent foreign countries or supported by parents who have hard currency, rather than from the poorer countries around the world where the need for better education is so pressing.

The idealistic rhetoric about the value of having foreign students to learn to appreciate the benefits of democracy has often been replaced by the attraction of tuition dollars.

Counter Trade

Unfortunately for the recruiting colleges, there are not enough countries—rich or poor—willing to spend their short supply of dollars to pay for students to study abroad. There has been no decline in interest on the part of students from abroad to study in the U.S. Any American university administrator or professor knows how many foreign students (or their parents) continue to write to them, pleading for scholarship money so that they can study in the States. But an important barrier to their coming to the United States is the lack of hard currency or dollars. American business leaders faced with a similar problem learned what to do when a potential customer does not have enough dollars. They often practise countertrade—more popularly known as barter. If Americans can learn to countertrade a popularly known as barter if Americans can learn to countertrade a popular soft drink for one of Russia's popular hard drinks, why cannot we learn to countertrade so that foreign students can pursue American education?

Nigeria, as mentioned earlier, used to send many students abroad to study. A drop in oil prices resulted in a drop of dollars available in Nigeria to pay for tuitions. But the United States does import oil; it can import other products also from Nigeria. Why not countertrade the oil and the other products for the tuition payments? Other countries can also barter their products. What some African countries, suffering from potential and actual starvation, need is not only grants of food but assistance so that some students can attend, for example, schools of agriculture so that upon graduation they can return to help make their lands more productive. And one way to pay for this education is countertrade—our taking some products from these countries which would be sold for the hard currency needed to pay for the tuitions.

Modalities

How can universities handle this arrangement? At the minimum, it requires that a group or a consortium of colleges (and there are many already in existence) work out an arrangement with a specialist in countertrade who, in turn, negotiates with a given country for a countertrade agreement—so many barrels of oil, so

many gross of baubles, so many yards of textiles, and so forth, to pay for so many student tuitions. The countertrader sells the jewellery or textiles for dollars (or for other items which he feels he can eventually sell for dollars), keeps for himself a percentage of the selling price, and makes available to the consortium dollars to cover the tuition and living expenses for a number of foreign students. The countertrade specialist or facilitator would be the middleman: he will secure the products from the foreign country; and he will transmit the dollars to the consortium or college for it to disburse to cover the tuition and the living expenses of the foreign students. The foreign students will apply to the colleges in the consortium. No college would have to accept unqualified students, (One of the perennial handicaps of many foreign students is their inability to speak and write English adequately. This problem could be handled through the money from the countertrade being used to pay for improved training in English.) The counter trade specialist would benefit since, although there is a risk, he should be able to make a profit from the exchange. Such a programme could also be organized on an international basis by UNESCO if it spent more time on facilitating educational change than on political manoeuvring.

The need—both idealistic and economic—of American universities for foreign student enrolments and the need of foreign students for American education should prompt college administrators to use their initiative to develop a system.

Countertrade is not as easy as trade with dollars. But the need—both idealistic and economic—of American universities for foreign student enrolments and the need of foreign students for American education should prompt our college administrators to start to use their imagination and initiative to develop a system to attract students from abroad without being limited by the number of dollars available in the foreign countries or in Washington or London—although both countries' bureaucrats could well play an important role in educating our educators about countertrade and in providing some funds for the initial attempts to develop such a programme. Of course, university administrators could also learn about countertrade from a course increasingly being taught in their own schools—namely, international business. What they may learn is that countertrade does work in business, and can work in education too. □

Re-engineering Human Resource Function

J.L. Rastogi

The role of the human element of work has greatly increased in recent years particularly in the context of the ever increasing competition both in national and international markets. Being the only active resource, workers are the real strength of any organisation, and it is their competence, commitment and contribution which account for its success. The author delineates the need and methodology for re-engineering the human resource function to suit the current scenario.

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The failure of strategies adopted by Indian organisations in the wake of the recent economic liberalization has been because these have not been backed by appropriate human resource strategies. Every strategy, irrespective of its nature—whether individual like expansion and integration, diversification, R&D, aggressive advertising and marketing or exploration of new markets; or collaborative leading to strategic alliances through mergers or amalgamation, market segmentation, increase in foreign equity and/or permission to use internal marketing infrastructure—has a human content, and unless it is accorded due importance, unlikely to succeed.

Work Relationships: Existing Scenario

Although most of the Indian organisations are conscious of the significance of human resources and have adopted HRD as a major strategy, the incompatibility between the needs, interests and aspirations of the employees, and the organisational policies and practices has been continuously growing.

Besides significant variations in the economic environment due to reduction in bureaucratic control, encouragement to private initiative and entrepreneurship and the opening of Indian economy to foreign investment and participation, drastic changes have taken place in the contexts of industry and work, on the one hand, and in the profile of employees, on the other. Industry is no longer regarded as a venture of the owners of capital alone, but as a systematic activity carried on by cooperation between an employer and his workmen for the production, supply or distribution of goods or services with a view to satisfying human wants or wishes. Similarly work is no more a mere means of living, but also an end in itself. While facilitating satisfaction of lower level needs, viz., physiological/economic, security and social, it provides people status, prestige, self-respect, and a sense of accomplishment, satisfaction and personal worth. Thus people today are not interested in just any work, but in such work which is recognizable, meaningful and challenging.

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The change in the employees' profile has been even more marked. The industrial and commercial employees in India are no longer a mass of illiterate or ignorant people connected with the soil ready to take up any job on any terms and conditions of employment. In many cases we now have, particularly in the organized sector, third or even fourth generation of employees who are fully committed to the industrial way of life, much more educated, skilled and mobile, and conscious of their role, responsibilities and rights. They are in no mood to be exploited by any quarters, be it employers or even trade unions. Rather they are adequately equipped and motivated to take the initiative, assume responsibility and bring about positive results, if provided with adequate support, resources and trust.

Unfortunately organisations in India have failed to adapt themselves to the changing needs. Except in a few establishments which have progressive CEOs, or have foreign collaboration or are in hi-tech industries, managerial approach towards human resources continues to be traditional, based on McGregor's Theory 'X' assumptions about human nature. Thus the human side of the enterprise remains neglected in most of the Indian organisations, or at the most given only lip service. The employees, instead of being recognized as a resource, are regarded as a factor of production, an item of cost to be shown on the Profit and Loss Account of the organisation, with the result that human resources in India remain largely under-developed and under-utilized.

Need for Re-engineering

One of the means to take care of this discrepancy is re-engineering human resource function (HRF). HRF is concerned with all such activities and relationships which are relevant to or account for human resource (HR) optimization. In the context of business processes, re-engineering is 'the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service and speed' (Hammer & Champy, 1995). It is different from restructuring in the sense that while the latter means re-arranging the parts, elements or components to make a system viable and may imply inclusion of missing links or strengthening of weaker limbs, re-engineering implies looking at the

system afresh, beginning on a clean slate and re-designing the job from beginning to the end.

Although a positive approach towards human resources is a vital constituent of re-engineering of processes as contemplated by Hammer and Champy, in the present Indian situation, re-engineering of human resources may itself be adopted as an independent and basic strategy to optimize the resources of any organisation. In the context of human resources, thus, re-engineering may mean a total re-designing of HRF taking into account the needs of the environment, on the one hand, and the changes in the concepts of industry and work and in the profile of the employees, on the other, with a view to improving their attitude, behaviour and performance at work as an aid to total organisational proactivity. Because of the continuing and ever enlarging gaps in organisational policies and practices, and the employees' needs and aspirations, mere re-structuring of HRF would not be enough. Although even re-structuring of HRF involves many of the imperatives of its re-engineering, e.g., organisation/work re-structuring, employee development, involvement and participation, a strong HR information system, etc., their respective focus varies. While HRF re-structuring is an extension/adaptation of the present set up and practices to suit the needs of the changing environment, its re-engineering implies a complete break from the past and present, assimilation of the changed context, complete re-design of the roles and relationships, and implementation of these with full commitment and vigour.

While HRF re-structuring is an extension/adaptation of the present set up and practices, its re-engineering implies a complete break from the past and present, and complete re-design of the roles and relationships.

The traditional approach to wards employees has not only failed to remove the scars inflicted on them since the beginning of modern industrialization in terms of exploitation, but also perpetrated adversarial pressures between the employers and employees. It has resulted in mutual distrust, often so intense that even the good intentions on the part of employers are suspect and interpreted as a means of manipulation/exploitation.

Role of the CEO

HRF being a vital aspect in organisational working, its re-engineering has to be initiated with adequate

caution, commitment and determination, and implemented in a planned and phased manner. In our context the CEO has to play an important role in this regard. It's he, whatever his title, who is normally the key influence within the enterprise and sets the organisational climate, because:

- He is the only person in the organisation, including members of the Board of Directors, who is continuously involved with the operation of the enterprise as a whole;
- He is vested with hierarchical, and often legal authority;
- He represents the enterprise both to the outside world and to his employees;
- To his subordinates, whether managerial or technical staff or workers, he is generally, the ultimate court of appeal within the organisation, and a key factor in their personal careers and economic success (ILO, 1972).

However, his success in re-engineering HRF would depend on the institutional power he enjoys and his competence to foresee and interpret the ensuing changes, make sound future oriented decisions and persuade others to accept and implement them.

Positive presumptions about people

In the outset the CEO must be personally convinced of the increasing role of the employees in the effective working of the organisation, and of the need for re-engineering HRF. He has to redefine his presumptions about people and adopt an attitude which is not only positive and based on human dignity, but also more realistic considering the prevailing environment and the changed profile of employees. Some such presumptions are:

People are the only active resources of the organisation. With their needs and emotions to be satisfied, interests to be protected and aspirations to be promoted, they also have the competence and potential to grow, achieve and excel.

Being fully committed to the industrial way of life, people, particularly in the organized employment sector, are conscious of their roles and responsibilities.

People's needs, interests and aspirations are not necessarily opposed to the organisational goals; these are rather complementary and/or interdependent.

People are not only flexible and adaptable, but also

forward looking; and willing to predict changes, anticipate opportunities and challenges and optimize them.

Conducive Organisational Climate

Re-engineering of HRF being virtually re-writing such a function on a clean slate, before any such programme is initiated and/or executed, the necessary pre-conditions have to be created. The first task before the CEO in this direction would be creating a climate of trust and confidence. It calls for total commitment and support on his part, which are to be translated into deeds and actions. The following are some of the universally recognized pre-conditions for any such move which must be initiated immediately as a part of strategic planning towards re-engineering HRF:

An Egalitarian Environment: In order to implement the concept, it is essential to dismantle status/social barriers. The authority and reporting relationships should be redefined. Not only should the superior-subordinate relationships be replaced by *Sempai-Kohai* (Senior-Junior) relationships, but organisational hierarchy should also be re-interpreted as a hierarchy of expertise and support rather than that of command and control. Implementation of the concepts of open work area, common canteen and parking places as well as a common dress code would go a long way in this regard.

An Integrated Communication Network: Communication is perhaps the most important variable in organisational/work relationships. An integrated communication network would not only help integrate the various shades of employees with one another and with the organisation as a whole, and attain organisational goals more effectively and efficiently, but also optimize people's creativity, ingenuity and satisfaction by keeping them informed of their performance and also of the needs and developments and opportunities and challenges in the organization, and transmitting upward their views, reactions and suggestions regarding various aspects of organisational working.

Transparency: To be effective the communication network has to be supported by transparency in all aspects of organisational working. It calls for development of and accessibility to a Management Information System (MIS) providing for collection, compilation, analysis and dissemination of information relating to organisational working. It would not only take away much of people's distrust in organisational information, but would also foster better understanding for the need for action, and participation in decision making and problem solving on a more realistic/factual basis.

Fairness and Equity: No amount of efforts to re-engineer HRF is likely to succeed unless these are accompanied by perceived fairness on the part of the employees. With growing consciousness amongst employees of their roles, responsibilities and rights, they are not only interested in work which is remunerative, interesting, meaningful and challenging, but one which also provides for equity in emoluments, benefits, facilities and amenities, on the one hand, and opportunities for development and growth, on the other. These can, however, be only assured through the free flow of information and employee involvement in planning and administration of such benefits, facilities and opportunities.

Organisation/Work Re-structuring

An equally important pre-requisite for re-engineering HRF is organisation/work re-structuring. It has to be redesigned in a manner that it is not only flexible, adaptive and pro-active, but also facilitates optimization of human talents, creativity and ingenuity, and provides people an opportunity for growth, achievement and excellence.

Being compatible with the general distribution of people's capabilities, organisational hierarchy cannot be totally eliminated. It can certainly be adapted to the changing needs, and its role re-defined accordingly. Thus depending on the nature of the business/industry and other associated factors, the number of organisational levels may be appropriately reduced to facilitate better communication and co-ordination, on the one hand, and provide a greater degree of discretion to the people, on the other. Again the organisational hierarchy may be interpreted as hierarchy of expertise and support rather than that of command and control.

At the operative level, the organisation may be creatively decentralized making use of group dynamics to optimise results. In this context the concept of autonomous work groups/teams may be explored. Regarding their role in modern organisations, Edgar Schein (1980; p.143) observes:

"Instead of assigning work to individuals, rewarding or punishing individuals and holding individuals responsible for output, it is possible to conceive of organisations in which an entire group is assigned a task, made responsible for it and paid as a group. ...Such autonomous work groups are then made responsible for producing an entire product such as a radio, an engine or some total component of a large machine".

Autonomous work groups/teams are being deployed by more and more organisations in the West

to improve performance and competitive position. The moving forces behind such groups/teams are autonomy, self-regulation and inner motivation. They enjoy a high degree of autonomy in internal working—they not only decide their members' work assignment within the limits of the primary task allocated and the technology, but also establish their own work standards and quality control. Again besides higher financial rewards facilitated by the improvement in productivity, the members are provided with a sense of importance, achievement and personal worth associated with meaningful and challenging tasks, and greater control over their own fate.

In the context of such groups/teams, the role of supervision also changes from direction, surveillance and control to that of guidance, support and assistance. In many organisations a visible shift is being noticed from superior-subordinate relationships to Sempai-Kohai (Senior-Junior) relationships on the job.

The role of supervision also changes from direction, surveillance and control to that of guidance, support and assistance.

Similar organisation/work restructuring would certainly help HRF re-engineering in our country by creating amongst people a feeling of completion of the whole task; a sense of responsibility, achievement and satisfaction; better and satisfying inter-personal relations on the job; and a high degree of commitment, leading to all round improvement in performance.

People's Development

While initiating actions to promote conducive organisational climate and organisation/work re-structuring, simultaneous efforts have to be made to prepare and equip people—both managerial and non-managerial for their new and more active roles in a competitive environment. It calls for knowledge and skills over and above the requirements of their present assignments. The development programmes may be so organized that they are not only provided with a broader perspective and insight into the organisational working, but also a global context of their work. Besides, they should be helped to develop the capability of handling data, identifying the need for action, participating in decision making and taking risk in trying new ideas leading to organisational renewal, growth and excellence.

Employee Empowerment

In the present Indian situation, re-engineering of HRF would be nothing short of a complete transition to people's empowerment. It is the authority to make decisions within one's area of operations without having to get approval from any one else. While this process is similar to that of delegated authority, there are two characteristics which make empowerment unique—One is that the personnel are encouraged to use their initiative. The second is that the employees are given not just authority but resources as well, so that they are able to make a decision and see that it is implemented (Luthans, 1995).

India still being at a rudimentary stage of HRF, a sudden/overnight leap to empowerment may not be feasible. Thus after steps have been initiated for creating a conducive organisational climate, organisation/work re-structuring and employee development, the task of empowerment has to be taken up and implemented cautiously and gradually in stages. Each stage in the process would serve as a prelude to the next successive stage equipping the employees for a still higher degree of involvement in organisational working.

The first stage in this phase of HRF re-engineering would be information sharing. The concept has to be initiated by strengthening the internal communication network, say by starting a regular internal information bulletin, and feeding it with the information of mutual interest, e.g., information relating to organisational policies and procedures, benefits, facilities and amenities, organisational/personal achievements and rewards, and opportunities and challenges in the organisation. The employees may also be provided access to data through a well designed MIS.

At the second stage, besides initiating the concept of autonomous work groups/teams at the operative levels, joint forums consisting of representatives of employers and employees at various levels may be introduced to encourage face to face interactions between them. Depending on the maturity of interactions, these may be used besides information sharing, for inviting employees' views, reactions, criticisms and suggestions regarding various aspects of organisational working, on the one hand, and for improvement in productivity, quality, cost and customer service, on the other.

In the third phase, besides planned transition to increased autonomy to work groups/teams in internal working at the operative level, efforts may be made to promote employees' gradual involvement in the decision making function/process starting with consult-

ation through joint forums. In the last stage of the exercise, the work groups/teams would not only be granted autonomy, but also encouraged to take initiative and allowed to try new ideas for improvement in products/services, processes and other aspects of organisational working by committing resources within prescribed limits. An appropriate support system to monitor and assist efforts to innovate and improve may be established to facilitate optimization of human resources. At the macro-level, employees may be provided representation on top management bodies as equal partners alongwith other stakeholders. Each subsequent stage of empowerment would help in:

- Increasing autonomy to employees and their greater involvement in total working of the organisation
- Increasing the use of information technology by employees
- Better utilization of resources, and employees' talents, creativity and ingenuity
- Continuous improvement in performance in terms of variety, quality, cost and customer service and
- Improved customer satisfaction, market position, organisational image, and benefits to the various stakeholders including the employees.

HRF Re-engineering & HR Professionals

Although the major initiative, support and resources towards HRF re-engineering have to come from the CEO, the real challenge in this regard has to be faced by the HR professionals. It is the latter who make any such programme a success by advising the top echelon on HRF re-engineering, helping create conducive organisational climate, designing and implementing the appropriate organisation/work structure and developing people for their new role and responsibilities, on the one hand, and by pushing forward the transition to employee empowerment on the other.

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Human Process Engineering for Growth in Small Organisations

P. Sethumadhavan & Susanna Rajaratnam

The paper gives a picture of entrepreneurship in the Indian scenario as observed by the authors. It deals with the blocks that hamper individual and organisational development in small organisations, suggests the need for a paradigm shift in orientations and presents implications for human process engineering in small organisations.

Indian entrepreneurship has finally got unleashed – the change in the policies of the Government and financing institutions, new opportunities thrown up by the open market, increased need for autonomy and income among the new generation of Indians, and increasing trend among the manufacturers to depend on external suppliers and dealers, among others, have been the catalysts. Small scale organisations are emerging as the backbone of the modern Indian economy. Apart from their direct contribution in terms of products, services and employment generation (Pillai, 1994), they also play, rather are forced to play, a very important role in developing and utilizing the underdeveloped human resources of the country. While availability of excess human resource becomes an excuse and reason for the under-utilization of people in large organisations, small organisations due to their resource constraints are forced to employ, and utilize people who are not adequately trained. Thus small organisations provide the learning ground for a large number of people and uplift them from the 'unemployable' to the 'employable' category.

The future of the economy will depend to a great extent on the development of small entrepreneurial organisations in the country (McClelland, 1962, Rao, 1996). Hence the need to focus on the small entrepreneurial organisations in the country. The typical problems encountered by the entrepreneurs need to be addressed and we need to come out with creative solutions and intervention plans which are relevant and useful.

Though the country is witnessing the emergence of the small scale sector in a big way, only a handful of these organisations may break the 'small scale cocoon' and metamorphose into large scale organisations in future. Many of them may either remain as small organisations serving as 'cash cows' for the owner or may encounter market deaths due to their failure to cope with the continuously emerging challenges and

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problems (Khanka, 1993). However, some small entrepreneurs operating in relatively less competitive sectors such as trading may survive without adopting modern management technology as they are not directly hit by any shock from the market.

The Second All India Census of Small Industries revealed that more than 99.13 per cent of the sick units in the country are in the small scale sector (Pillai, 1994). This paper presents some of the factors which block the growth of Indian entrepreneurial organisations, as observed by the authors. Most of the problems identified in this paper are based on real life caselets collected by the authors, during their personal and professional interactions with different types of entrepreneurs as well as their employees.

Blocks to Development in Small Organisations

Fear of growth

Perhaps the most painful dilemma for an owner boss is to decide whether to grow or not. Having started as a tightly controlled and small organisation, any thoughts or even pressures to grow in size or operations makes many owner-bosses insecure. In fact, one of the dealers of a very profitable heavy equipment, declined to accept the offer given by the manufacturing organisation to open a branch in a near by city due to this fear. Despite the fact that it was a business which could have been controlled easily from a distance, he declined the offer because he did not trust others to take charge of the new branch of his business. Many successful entrepreneurs who have grown into large organisations are those who have got over this fear. As one such successful entrepreneur puts it, "there was a time when I was the only person signing a cheque in this company. During that time the cash transactions were typically below Rs. 25,000. But now there are so many people signing cheques and many of those transactions are above a lakh!"

Rewards for not growing

Another block to the growth of small scale organisations is the 'rewards' offered by the government as well as the various entrepreneurship development agencies, 'for not growing'! To avail the subsidies, tax exemptions and other concessions offered to the small scale industries, the entrepreneurs decide to keep their organisations 'small'. In some cases where time is the criteria for obtaining the concessions (e.g., five year tax holidays), the small organisations decide to go willingly 'sick' and 'die' after five years, to be reborn again with some new name. The tendency of small enterprises to

look for subsidized credit rather than timely credit has been identified as one important reason for their failure (Pillai, 1994). While these 'tactics' help owners of small organisations to extract some cash out of the system, it is clear that they also block the development of the organisation into a large institution.

To avail the subsidies, tax exemptions and other concessions offered to the small scale industries, the entrepreneurs decide to keep their organisations 'small'.

Alice Syndrome

Small organisations especially, entrepreneurial setups, remind one of Alice in the Wonderland:

- Alice : Would you tell me, please, which way I ought to go from here?
Cat : That depends on where you want to get to.
Alice : I don't much care where....
Cat : Then it doesn't matter which way you go.

Like Alice, many entrepreneurs lack direction and do not have any long term objectives. They are even afraid to think big. In the absence of vision and clear objectives, they tend to drift rather than surge ahead.

Spider in the web syndrome

Compared to the chief executives of established organisations, entrepreneurs enjoy considerable power over their employees. In the early stages of growth, most people report to the owner directly. However, the same system continues even after the organisation achieves a certain level of growth. As a result, the new employees who join in the different hierarchical levels of the organisation do not have any control over their subordinates as all the power is concentrated in the hands of the owner. The fact that some of the older employees may be 'close' to the owner makes life difficult for the new employees. The consequence is that either the new employees fall in line or fall apart with the setup. Many an entrepreneur fail to recognize the growth of their own firms and the fact that planned decentralization, internal capability development, delegation, and structural changes will be imperative for achieving growth and excellence if not for survival. They fail to understand that the 'spider web structure' will collapse when the external

and internal demands on the organisation arising out of growth and competition cross certain limits (Byars, 1987).

Informer trap

Some entrepreneurs assumed that, the ones who keep them informed about other employees are the best and most loyal employees. But, many cases collected from small organisations indicate that often this may not be true. As a matter of fact, informers can be manipulative. Good performers will be less political compared to poor performers as they have more conviction that through performance they will be able to win the heart of the boss. In the absence of any clear measures of performance, an 'informer culture' harms the sincere employees as the credit for the work done by the performers is often grabbed by the informers who have direct access to the owner.

Some owner bosses admit that they have grown out of the informer trap after going through the bitter experience of being deceived. As one of them put it, 'acting trust worthy to the boss has become an art now, among the employees, especially the manipulative and disloyal ones!'

Boss tag

Entrepreneurs tend to derive their sense of power by constantly reminding themselves that they are the bosses. The need for power is often satisfied through expressing their power unnecessarily on the employees, thus alienating them from the organisation. Sometimes the need for power is so high that the boss looks for red areas for catching the employees on wrong foot. The employees get a clear message that they are only mercenaries meant for slogging and that any missionary zeal or tendency to psychologically own the work or work place will be seen as an invasion into the territory of the boss-owner. Many boss-owners are also often influenced by the cheap books on power and influence which give tips such as 'one should walk half a meter ahead of others to prove that s/he is the leader' and so on.

Value obsolescence

Obsolescence of values of the owner-boss and the resulting generation gap between the owner and employees is a major reason for high employee turnover in small organisations. Entrepreneurs who have grown through hard work and struggle often forget the fact that the new world is offering better comforts to its people. Some owner-bosses refuse to give faster modes of transport to their service engineers, bound by the fact that

they used to go on a bicycle attending on their customers ten years ago. Similarly, using telephones for communication is a way of life for most of the new employees whereas it is perceived as an avoidable expense and luxury by the owners. Forgetting about the fast changes in values and perceptions that have occurred in the society, the owner-bosses complain that, the employees belonging to the new generation are greedy about money, they are rolling stones with no commitment, thinking 'too high' of themselves and so forth. Owners feel proud of their own children who think big, but get threatened by employees who do so. This happens when the owners lack a nurturing spirit in their relationship with their employees. These owner-bosses have become obsolete in their values and the solution is to learn to cope with the fast changes arising out of the changes in the larger social system, rather than complaining.

Knowledge and skill obsolescence

Owners of small organisations do not take much interest in updating their knowledge and skills and tend to ignore the need for modern management methods and techniques. As a result they not only fail to utilize, motivate and retain their employees but also fail to think strategically and plan pro-actively. This problem hampers the growth of small organisations in the long run.

Owners of small organisations do not take much interest in updating their knowledge and skills and tend to ignore the need for modern management methods and techniques.

Pseudo mentor/developer trap

Some entrepreneurs find the terms—development, learning etc.,—a good justification for exploitation. They believe that they are developing their subordinates by providing them with learning opportunities. However, those subordinates who take interest in learning, develop faster and start demanding higher levels of job as well as pay. The entrepreneurs start realizing the 'merits' of underdeveloped human resources, when some of the developed employees start creating problems for them. Based on such experiences, some of them start preferring committed non-performers than disloyal performers. However, the disloyalty of the employees is often a consequence of the pseudo developer style of the owners. The pseudo mentors start getting threatened when they see employees taking up their roles or jobs. Unless the owners get over their own

insecurity in relation to their employees, achieving growth and excellence is not possible.

Human resource under-development

Some owner bosses find it difficult to delegate important jobs to their employees, even if the employees are capable of learning them. As a result, the employees are often not able to grow beyond a certain level in their career as well as capabilities. The under-development of employees caused by poor delegation becomes an excuse for not delegating. Caught in this vicious cycle, the owner-bosses continue to believe that they are the only people 'capable' of doing those important jobs on this earth (Hagemann, 1994). They keep complaining about the poor capabilities of their employees. By the principle of 'Pygmalion' or self fulfilling prophecy (Livingston, 1988), eventually these complaints come true and become the permanent features of the work place.

Style creates the situation

Most popular management books teach the entrepreneurs that their leadership style should match the nature and the level of maturity of the subordinates. An autocratic style may be necessary for a group of underdeveloped and immature employees! Either by nature or driven by the conviction that all the employees are useless and incapable, some entrepreneurs adopt an autocratic style of leadership. However they forget that employees will never mature under an autocratic leader (Wheatley, 1993). A closer look at the complaints made by the entrepreneurs will indicate that most of them are the consequence of their own style, rather than of the situation. Moreover, small organisations are often forced to recruit mediocre people due to resource constraints. This combined with the lack of HRD culture also creates conditions for adopting an autocratic style.

Obsession with cost

Entrepreneurs are often obsessed with the cost factor. It may be necessary to focus on cost, given the limited resources of an entrepreneur. However excessive focus on cost and profit prevents an entrepreneur from investing in important areas such as customer satisfaction, employee development, employee welfare, quality improvement and modernization. Though this saves money in the short term, it leads to greater loss in income and profit in the long term. This is more so in industries where the return on investment (ROI) is high enough to absorb the overheads such as STD charges, cost of quick response etc. Moreover, result-oriented and enthusiastic employees who spend a 'little extra' for getting the work done faster lose their motivation due to the constant questioning about the cost.

Negative balance sheet syndrome

For many different reasons, some entrepreneurs believe that it is better to have a negative balance sheet for their business. The purpose may be to save taxes, to project that one is not making money, to make employees believe that the company cannot pay higher salaries and so forth. However this practice has a negative impact on the employees, customers and bankers of the company. Recently one entrepreneur suffered due to his tendency to show loss. The bankers refused to finance him for a very good project and some of the employees left him feeling insecure to be with a company which 'was not financially sound on paper'.

Bad publicity by the ex-employees

Often owner bosses get emotionally charged when good performers leave the organisation. From the employer's point of view, resignation by an employee whom s/he has supported for a long time, is sheer disloyalty. Consequently, the owners destroy overnight, the relationship built over a long period when an employee gives the resignation letter. However, from the employees' point of view, they are only taking personal responsibility for their development and growth because they find that mentors who will take care of their ambitions are in short supply in today's world! When the relationship is broken and the owner decides not to settle the 'dues', the ex-employees start giving bad publicity about their past employer among the customers as well as prospective employees. Owners also forget the fact that sometimes an organisation is known by the employees who leave than by those who remain. As experienced by one of the owner-bosses, the bad publicity given by the sales staff who left the organisation played havoc with the sales targets and reduced the responses to the employment advertisement to practically nil over a period of three years. Another implication of the emotional reaction to employee turnover is that, the existing employees start leaving the organisation without giving any prior notice which makes it difficult for the owner of a small organisation to make alternate arrangements. An extreme case was of a factory where the employees used to 'vanish' overnight, leaving the keys of their residential quarters as well the resignation letter in the mail box.

Human Process Re-engineering for Growth

Many of the problems faced by small organisations have multiple causes. For example, poor interpersonal relationship and absence of team work in small organisations is often a result of various factors such as, the spider-web structure, informer culture, poor

tolerance for original mistakes, job insecurity, absence of systems for appraising performance and the tendency among owners to differentially reward while emphasizing team work. The common consequences are frequent turnover of employees, poor utilization of human resource, low levels of motivation and commitment among employees, problems of control and coordination and so forth. It is therefore important to consider all these factors in an integrated way for human process re-engineering in small organisations. Rather than the size of the organisation, the decision of the entrepreneur to grow is a more important factor to be considered. Therefore the focus should be on the basic approach to prepare small organisations and the owner bosses to shift to the new paradigms for managing the growth of their organisations.

From supervision to shared vision

The human resource problems such as poor motivation, lack of initiative, frequent personnel turnover, and interpersonal problems which are often faced by owner-bosses are rooted in the absence of proper aligning forces such as shared vision, mission and goals. The owner-bosses underestimate the power of motivation through commitment while using excessive control for obtaining the results. The belief among some of the entrepreneurs that 'mission, vision etc., are not necessary for small organisations', may be alright if the entrepreneur has no ambition of growing. However, any long term plans to grow should start from a statement of vision, sharing of dreams with the employees, clarification of goals, and values. If the owner-boss succeeds in sharing his/her vision with the employees, then the need for supervision can be minimized. Perhaps this may be the starting point for the owner-boss to move from the 'strategy of getting results through control' to the 'strategy of getting results through commitment' (Walton, 1988). Therefore helping the owner-managers to articulate their dreams, communicate and commit to their dreams, should become an important agenda for future work in the small organisations.

Dreaming and sharing the dream with the employees is the first step towards growth. While dreaming, it is also important to make employees the key actors of the dream. Otherwise, we can never dream of taking them along with us! If we know our destination, then success will depend on the intensity of our desire to reach our destination rather than on our destiny. Moreover, if the destination is shared with all the employees then direction becomes clear to all.

A vision is the master plan for growth and success. Small organisations with a vision tend to grow in a

planned way and react to the environmental demands more pro-actively. In the absence of a vision, organisations tend to drift according to the market currents and the energy of people in the organisation gets diverted in different directions.

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From managers to leaders

Owners and managers expect their nightmares to come true, whereas leaders expect their dreams to come true. As stated by Bennis (1990), leaders manage dreams. In other words, owners will have to shed their pessimism and transform themselves into optimistic leaders, if they want to achieve growth. They need to be original, do the right things (not just doing things right), focus on people, inspire trust, have a long-range perspective, challenge the status quo, personally accept blame for shortcomings in activities for which they are responsible and generously share the credit for successes and not ask their subordinates to accept sacrifices that they are not willing to make themselves.

From autocracy to democracy

All over the world there is an increasing trend toward democracy. To some extent, this reflects change in the political and personal values of people. However, the emergence of expertise and knowledge as key factors in business has created pressures within many organisations to abandon the hierarchical culture in favor of a more democratic culture. Experience has lost its old charm in comparison to expertise. Similarly, most parents belonging to the present generation are less authoritarian with their children, compared to the parents belonging to the last generation. Therefore, the new generation of employees who were treated with dignity by their parents expect similar treatment from their organisations and are less tolerant to authoritarian bosses and power culture. Power in future can be earned not by using it but only by not using it. The new generation employees, especially the knowledge workers, perceive more power in the employers, who are not keen to use it! The combination of leadership style of the owner and shared vision has got important implications on the fate of organisations. An autocratic leadership style of the owner, combined with lack of shared vision can lead to retardation in small organisa-

tions. If the autocratic style of the leader is combined with shared vision, the organisation may just survive. Some owner bosses make the mistake of adopting a participatory leadership style, without sharing any vision with their employees. Democracy, in the absence of any strong vision and guiding forces leads to chaos and confusion in the organisation. The ideal situation is to combine a participatory leadership style with a strong shared vision. Such a combination is likely to lead to excellence, provided the other factors such as commitment and competence of people, organisational strategy etc., are taken care of table 1.

Table 1: Implications of Leadership Style of the Owner and Shared Vision for the Organisation

	Shared Vision	No Shared Vision
Democratic Leadership	Excellence	Chaos
Autocratic Leadership	Survival	Sickness/Retardation

From fear to hope

One major block to growth in small organisations is the fear of growth. However, as Tichy and Devanna (1986) stated, managing the dramatic tension between fear and hope is an unavoidable part of the transformational drama. If the owner wants to transform his organisation into a large and excellent one, then it is necessary to overcome the fears. Delegation, empowerment, and trust are the key words! These words may sound just like those jargons which consultants sell now a days! However, if we understand the true spirit behind such jargons, they will soon transform themselves into powerful tools for growth and excellence! If the entrepreneur wants to break the cocoon and grow, s/he will have to recruit and retain the right people or develop the right competency among the people. Attempts to delegate and empower in the absence of required competency among the people will result in a fiasco. Often past failures are quoted as justifications for not attempting to succeed later. However, the fact remains, that all large organisations including the successful and large entrepreneurial organisations could not have grown without empowerment, delegation and trust.

From self to society

Making money is easy in today's world! Serving the society by sacrificing one's own material needs may also be easy. However, combining the two is the difficult challenge for any entrepreneur. True success means achieving the personal goals while also contributing to society by developing an institution worth that name! Therefore the owners will have to make a conscious

decision to shift from focussing only on gains to oneself to contributing to the society.

From spider-web structure to appropriate structures

Research and experience have established beyond doubt that the size and growth stage of an organisation are the most important factors which determine its structure. As an organisation grows in terms of employees, product line or turnover, different organisational structure will be required (See., Chandler, 1962), there are five stages of organisational growth:

Entrepreneurial Stage: In this stage decisions are made primarily by owner. The organisational structure is like a spider web with most people reporting to the central authority.

Functional Development Stage: In this stage, the organisation is forced to have specializations, and functions. Consequently, owners are forced to consult the specialists, or are forced to delegate authority to them. Problems such as poor coordination between the functions, poor communication etc., are common in this stage.

Decentralization Stage: The problems faced in the functional development stage, force the owners to decentralize by developing structures based on products, divisions etc. However, difficulties in sharing the resources between the units or divisions, increase in cost due to duplication of efforts, and loss of control of the owner arise at this stage.

Staff Proliferation Stage: In an effort to gain more control over the decentralized operations, organisations start adding staff at the corporate level. The common problem which arises out of this is the conflict between the line and the staff.

Re-centralization Stage: At this stage, the organisation attempts to re-centralize, mostly by steps such as computerization, new and sophisticated control systems, and micro-planning systems.

In summary, in order to excel, growing organisations should create organisational structures matching with their developmental stage.

In order to excel, growing organisations should create organisational structures matching with their developmental stage.

From culture of relationship and control to culture of performance and commitment

Some entrepreneurs believe that planned organisational climate and culture development are not necessary for small organisations. However, it is also true that no small organisation has grown to an admirable size without undertaking planned activities for developing the climate and culture. The cultural pattern of large and small organisations differ drastically. Small organisations are characterized by lack of trust, informer culture, lack of transparency, fear, low job satisfaction, low investment in HRD, and power culture. In small organisations employees end up spending most of their time trying to manage the relationships. Excellent large organisations are characterized by features such as higher levels of trust, transparency, more objective systems for performance appraisals, security, and higher investment in HRD. The concern for managing relationship is usually low in large organisations, as rewards are mostly based on performance and there are multiple authority figures. It is not easy to adopt the culture of large organisations in small organisations. However, any small organisation which plans to grow, should plan to make the shift.

Developing values such as openness, trust and authenticity will be necessary if a small organisation has to grow. For example, transparent communication with the employees will discourage informer culture in the organisation. Similarly appreciation for authenticity will help open communication and sharing of ideas and problems in the organisation. Moreover, the culture and values of small organisations will have to match the pace of change in the society. As stated by Senge (1990), when society reaches a particular stage of development, it will become difficult to retain and motivate employees by just satisfying their lower order needs such as food, clothing and shelter. The reason is that a society which has reached a certain level of development will provide innumerable options to the skilled individuals for earning their livelihood. Therefore organisations will have to create a cultural milieu that will satisfy the higher order needs of the employees such as status, esteem, autonomy and self actualization. All this will mean developing a culture of performance in the place of a culture of relationship and control.

From orthodoxy to heterodoxy

Business has evolved out of various stages such as land-intensive stage, labor-intensive stage, and capital and technology intensive stage. Business today is 'knowledge intensive' and the success of business depends to a large extent on organisational creativity

and learning. As stated by Hamel and Prahalad (1993), organisations with little capital or resources have surpassed the performance of established and rich organisations through their resourcefulness and open mindedness. Orthodox organisations conceive 'Strategy as a fit' between the organisation and the environment whereas learning organisations consider 'strategy as a stretch' towards creating a new environment. The philosophical solution therefore is to continuously develop competence and creativity in oneself as well as in the organisation.

At the personal level, entrepreneurs will have to become more open to new ideas and learning. They will have to learn to deal with the fast changes, rather than complain and worry. At the organisational level they will have to design systems and practices such as team work, periodic idea sharing meetings, use of external experts, and open communication so forth to ensure that the 'organisation' also learns.

Entrepreneurs will have to become more open to new ideas and learning.

From owner to coach

The owner bosses who wish to achieve growth of their organisations will have to consider themselves as 'gurus' or 'coaches', rather than as bosses. The difference between these two perspectives is clear – Gurus and coaches feel happy when they see their disciples rising above them whereas bosses feel threatened.

Overuse of ownership or position power in the absence of other sources of power such as charisma, expertise, relationship, love and care etc., may lead to rebelliousness among the employees. The overuse of ownership power has other implications the subordinates may stop contributing ideas to the owner. Moreover, as Schein (1985) puts it, the group acting on the assumption that the owner is a 'creative genius' who has idiosyncrasies, develops compensatory mechanisms to protect the organisation from the dysfunctional aspects of the leader's behaviour and the owners stop getting the true feedback from the staff.

From emotion to reason

In future, owner bosses may have to shift from emotional management to more rational management. For example, emotional reactions to the resignation of a

good performer, help only to make enemies out of ex-employees and create anxiety among the existing ones. Similarly, emotional reaction to the loss of a valued customer without trying to learn from the experience, may serve to attribute the reasons to external factors rather than to oneself. Though, such self serving bias acts as shock absorber in the short term, it only aggravates the problem in the long term. What is required is a rational response based on the conceptual understanding of the social realities and the dynamics of a competitive environment. Even if the organisation cannot afford to take care of the ambitions of its employees or the needs of its customers, the shift from emotion to reason, will remove half the problems associated with problems such as personnel turnover. For example, if the owner takes pride in developing the employees and allows them to go for better fortunes, the employees will also start taking pride in being the 'ex-employees' of the organisation. While many large organisations, especially multinational consulting organisations practice this, the authors have come across only one such example in the small scale sector wherein the owner used to even recommend and search for jobs for his employees! However, he used to make sure that a substitute is prepared before out-placing an employee.

From idiosyncracies to systems

A common complaint made by the employees of small organisations is the lack of 'proper systems' in the organisation. Most owner bosses are reluctant to develop systems such as leave rules, career plans, and performance appraisals, because they feel that, once a system is developed the employees may perceive them as their rights. Though it is difficult to stabilize systems during the formative years, it is also true that growth is not possible in the absence of systems. Attempt to grow in the absence of proper systems may kill the initiatives of the employees and may lead to chaos, recurring mistakes and delays. The owner may end up wrongly attributing such problems to the lack of efficiency among the employees. On the other hand, the decisions made by the owner in specific cases, even if based on some logic, are perceived as idiosyncratic by the employees. Unpredictability and inconsistency of the owners are often perceived by the employees as manipulation, and partiality. While it is clear that systems are necessary for growth, it is also true that systems in the absence of shared vision, appropriate culture, and a matching structure, will serve only as a dysfunctional set of rules.

Conclusion

Blocks to individual and organisational development and the areas for shift in orientations, identified

in this study have important implications for human process re-engineering in the small organisations. A closer analysis of the problems identified, indicates that there are three possible sources of these problems namely:

- Entrepreneur characteristics
- Employee characteristics
- Organisational Characteristics.

The characteristics of entrepreneurs such as their motives, attitudes, philosophy, skills, and knowledge influence the future of the small organisations owned by them. Similarly, the employee characteristics such as their knowledge, skills and attitudes have an important role in the success of small organisations. Finally, the characteristics of the organisation such as structure, strategy, culture, and systems also contribute to some of the problems identified. Therefore, small organisations will have to focus on all these three aspects. The success of the organisation will depend not on the strength of any single factor but on the strength of the 'entrepreneur-employee-organisation' alloy. Only a combination of these three *structural factors* can ensure the minimum *functional requirements for growth* namely, customer service, quality and innovation.

The success of the organisation will depend on the strength of the 'entrepreneur-employee-organisation' alloy.

Acknowledgement

The authors are grateful to Mr. P. Suryanarayana and Dr. T.V. Rao for their suggestions on this paper.

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Leadership Style & Performance of Public Enterprises: A Nigerian Study

Palmer B. Johnnie & Richman K. Ahiamadu

This paper is an analysis of the empirical data on the impact of leadership style of Chief Executives on the performance of public enterprises. The chief executives studied adopted peculiar leadership styles distinct from conventional ones. They adopted both task-oriented and task/people-oriented styles of leadership. These and other factors that centre on government intervention through political actions have contributed greatly to the poor performance of public enterprises in developing countries. But in public enterprises with people-oriented leadership styles, performance improved significantly.

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There is a consensus among researchers that most public enterprises are failures (Farooqi, 1981; Fubara, 1982; Moshi, 1988). The poor performance of these organisations have generated debates among various interest groups including governments. Over the years, a large number of persons, particularly management experts have tried to identify the reasons for the failure of public enterprises in developing countries.

It is amazing that even where they enjoy monopoly because of favourable government policies, most public enterprises still perform poorly. Empirical studies carried out by researchers seem to attribute the failure of these public enterprises to socio-political factors (Ejiofor & Osuji, 1987).

Even where they enjoy monopoly because of favourable government policies, most public enterprises still perform poorly.

Theoretical Foundation

Contemporary research approaches to leadership can be classified into three broad conceptual typologies. Historically, the first set of leadership theories that were popularised are the traits' theories (Peppers & Ryan, 1986; Stodgill, 1974; Handy, 1980; Segovia, 1998). The second set of theories on leadership that emerged as a result of the increasing "faithlessness" shown by a large segment of researchers on traits theories, is the behavioural theory (Jacobs, 1970; Blake & Mouton, 1964; Likert, 1967; McGregor, 1960; Ghiselli, 1971). The third approach which became popular is the situational-contingency perspective (Tennebaum & Schmidt, 1973; Fiedler, 1967; Salaman and Thompson, 1980).

The central postulate underpinning the traits' approach to leadership is the age old argument that leaders are born. This simply means that effective leaders are born with certain traits. Traits' scholars have always advanced their "centuries old" tradition of associating certain human traits with effective leadership. Scholars of traits' tradition (otherwise known as the "great-man" school) have consistently argued that effective leaders generally, are braver, more aggressive, more decisive, articulate, extravertic and are either very tall or short (Handy 1980). When emphasis on leadership shifted from traits approach, the behavioural approach became the dominant theory. This approach attempts to examine the relationship between leader behaviours and subordinate satisfaction and performance. The third, and perhaps most famous of leadership theories is the situational approach (Tennebaum & Schmidt, 1973) also known as contingency approach (Fiedler, 1967; Salaman & Thompson, 1980). Tennebaum and Schmidt (1973) believe that there are various factors that influence a manager's choice of leadership style.

Leadership studies generally have been numerous. But those on public enterprises in developing countries are scarce. Even the few studies on leadership conducted by scholars in respect of public enterprises have focused attention on specific and narrow aspects of the behaviour of various categories of employees at work. As Khan (1989) points out these studies have essentially examined aspects such as educational background, recruitment policy, problems of training, the nature of decision making by managers and have ignored other wider issues that may be important and relevant.

Performance Measures in Public Enterprises

There has been a general agreement by scholars that "performance" is an abstraction. Studies conducted in the past (Moshi, 1988; Fubara, 1982; Ahmed, 1982; Ogilvy Webb, 1980) measure performance, in terms of economic profitability. Others (Johnnie, 1988b; De Paula, 1967) argue that in an attempt to identify the level of performance of public enterprises, we should look beyond balance sheet records and use some additional indices, such as social profits and other non-quantitative factors. Campfield, (1971); and Martindell (1962) have earlier advanced a rather wholistic argument saying that a good way of measuring performance is by a complete review and evaluation of the organisation's total set of activities. By so doing, factors which impinge on organisational performance can be identified and evaluated. This is the view adopted in this study as well.

Griffin (1984) has identified indices such as production efficiency, corporate structure, health of earnings, research and development, economic function, executive effectiveness, service to stockholders, effectiveness of board of directors, fiscal policies and sales vigor, as factors that affect the performance of organisations. Some reservations could be expressed as to the possibility of evaluating these measures effectively, in view of their subjective nature. But that is a general limitation of social research vis a vis physical science research. Currently, attempts are being made to develop means of measuring organisational performance through the use of Human Resource Accounting (HRA), which is designed to fill the vacuum created by traditional accounting practice which does not see the human factor as an important component of the cost outlay of the organisation.

Leadership Style and Performance

In the past, effort to correlate the performance and leadership style of managers in public enterprises in developing countries were negligible. The focus of most contributors was limited to the evaluation of economic performance. However, there have been a few attempts (Johnnie, 1988; 1992) to advance the ontological argument that public enterprises were not established purely to make economic profits at the expense of political and social profits. They were *ab initio*, established to make economic profits but with strong emphasis on satisfying the political and social yearnings of the people.

To analyse the connection between leadership style and the performance of public enterprises, it is important to classify these organisations according to specific organisational configurations. Fubara (1982), World Bank (1987), Attah (1987) classified public enterprises into four broad taxonomical arrangements.

- Infrastructural enterprises, consisting of public corporations
- Strategic enterprises which include iron and steel, military complexes, shipping companies etc.
- Departmental undertakings at ministerial levels, the tourism committees, parks and gardens committees, etc. and
- State-Owned Companies limited by shares, such as Finance companies, manufacturing companies etc.

In spite of these apparent clear-cut classifications Aharoni (1981) Subramaniam (1976), Vahcic (1981), and

Rosete (1981) argue that governments of less developed countries are still unable to differentiate between enterprises earmarked for economic profits and those designated as concerns for social welfare services. These boundary lines have become essential because if the objective criteria for the enterprises are correctly delineated, appropriate styles of leadership can be adopted. This same argument can be developed in favour of Khandwalla (1986; 1988) who typologized strategic organisations into apex strategic organisations, spearhead strategic organisations, and human growth strategic organisations.

Khandwalla (1988) identified two types within the apex strategic organisation—the socially apex and the sectorally apex strategic organisations. Among others, the former includes the national planning commission, the cabinet office and similar agencies of the government. The sectorally apex strategic organisations are represented in the form of government ministries, the major industrial banks, the national chamber of commerce and industry, and the various development banks. The second category (Khandwalla, 1988) spearhead the socio-economic development in society and may be both public or private enterprises. They were established essentially to pioneer the development of new products, harness and develop essential and scarce raw materials. The third classification according to Khandwalla (1985) is the human growth strategic organisations. These are essentially voluntary which evolved overtime from the initiative of concerned individuals and groups. Their purpose is to ensure that there exists some form of social change and mobilisation. These organisations serve as institutions designed to conscientise society (Freire, 1970).

A critical appraisal of Khandwalla's analysis, clearly indicates that what determines effective performance is a function of the extent to which a particular public enterprise fulfils its espoused goals—profit-oriented or otherwise. Studies conducted by Ramamurti (1986), and Pavlin (1989) identified differences that exist between private and public enterprise leaders, in terms of personal characteristics and skills. These studies show that leaders in private enterprises are generally result-oriented whereas those in public enterprises are not. The lack of the entrepreneurial spirit of the executives in

What determines effective performance is a function of the extent to which a particular public enterprise fulfils its espoused goals—profit-oriented or otherwise.

public enterprises in developing countries, as well as the culture of the people are some of the factors affecting the leadership styles adopted. This view is strongly held by Ahiauzu (1986), Ozgediz (1983), Chowdhury (1986), Hofstede (1980) and Byrd (1987).

The managerial competence of most managers has also been affected negatively as a result of the government's inability to put in place appropriate operational guidelines.

Methodology

The research instruments used in this study were the questionnaire and personal interviews. Two types of questionnaires were designed. The first questionnaire labelled 'A' measured certain tested criteria of leadership qualities as depicted by Shahi (1989) in his study of Indian firms. The questions were structured and close-ended and were used to elicit answers as to whether or not alternative style (s) of leadership were used by managers. A combination of these factors provided the basis for the classification of leadership styles into job-centred, people-centred or job/people-centred perspectives. Questionnaires with inconsistent answers were discarded. The second questionnaire labelled 'B' was designed to evaluate the performance of public enterprises from a management point of view and determine the extent to which leadership style (s) impact on performance. In both questionnaires, based on respondents ability to judge, a rating scale of 1-7 was used. A leader is task oriented if the modal rating is 1, 2, 3 and people-centred if he is rated 5, 6, 7. The median rating of 4 suggests a leadership style that vascillates between both or could best be described as task/people-centred.

Table 1: Result of Random Sampling

A	Results		
	B	C	D
15	11	11	13
14	13	14	14
17	14	15	15
27	23	22	21
23	24	24	22
31	32	31	33

The study covered six public enterprises in Nigeria with activities covering Transport, Manufacturing and Trading sectors of the economy. Out of the total fourteen public sector companies, code '1' was given to selected viable enterprises, '2' to unviable enterprises and '3' to those that are presently partially viable, the

Table 2: Rating by Workers of Leadership Styles Adopted by CEOs in Public Enterprises

Leadership Qualities	Modal Ratings of CEOs by Workers					
	PE 1	PE 2	PE 3	PE 4	PE 5	PE 6
Consults Subordinates	6	7	6	7	1	4
Trusts Subordinates	6	6	6	5	5	6
Emphasis on objective	5	7	5	6	6	4
Is a good Manager	4	4	3	4	4	2
Delegates authority	5	6	6	3	3	5
Concern for people	6	6	4	3	3	5
Concern for task	3	5	7	1	6	6
Appreciates good work	3	5	5	5	5	4
Innovative and receptive new ideas	2	7	2	4	4	4
Takes risk for task	1	5	3	2	5	3
Team building	2	4	3	3	5	1
Stresses authority and position	3	5	5	6	6	3
Sum of Ratings	46	67	55	49	53	47

Source: Adapted from Shahi, 1980.

Table 3: Leadership Style Grouped by Ratings of Leaders on Leadership Qualities

PE Leadership Qualities	Task Oriented						People-Oriented						Task/People					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Consults subordinates	-	-	-	-	-	-	6	7	6	7	1	-	-	-	-	-	-	4
Trust Subordinates	-	-	-	-	-	-	6	6	6	5	5	6	-	0	-	-	-	-
Emphasis on objective	-	-	5	-	-	0	5	7	-	-	6	-	-	-	-	4	-	4
Is a good Manager	-	-	3	-	-	2	-	-	-	-	-	-	4	4	-	4	4	-
Delegates authority	-	-	-	-	-	-	5	6	6	3	3	5	-	-	-	-	-	-
Concern for people	-	-	-	-	-	-	6	5	4	3	3	5	-	-	-	-	-	-
Concern for task	3	5	7	1	5	6	-	-	-	-	-	-	-	-	-	-	-	-
Appreciates work	3	5	5	5	5	4	-	-	-	-	-	-	-	-	-	-	-	-
Innovative and new ideas	2	-	2	-	-	-	-	7	-	-	-	-	-	-	-	4	4	4
Takes risk for task	1	5	3	2	5	3	-	-	-	-	-	-	-	-	-	-	-	-
Team building	-	-	-	-	-	-	2	-	3	3	5	1	-	4	-	-	-	-
Stresses authority and position	3	5	5	6	6	3	-	-	-	-	-	-	-	-	-	-	-	-

Source: Research Data 1993.

numbers 11 to 17 represented the seven viable public enterprises. The unviable public enterprises were numbered 21, 22, 23, 24, while 31, 32, 33, represented partially viable public enterprises. These numbers when fed into the computer with the instruction "Randomise", gave four sets of results shown in table 1.

Result 'A' from table 1 was chosen enabling the investigation of three viable companies, two partially viable and one unviable company. Government Privatisation and Commercialisation reports on the unviable company reveal the fact that it was neither ready to close it or privatise or commercialise it. For

this reason we prefer classifying it as a partially viable company.

Characteristics of the companies

The criteria for inclusion of a company in the study are as follows:

- It must be carrying out a business in the name of a company registered in accordance with the Nigerian Companies Act 1968 or the Companies and Allied Matters Decree of 1991, as a Private Company.
- The Government should hold controlling equity share capital.
- The Government or the Head of Government should appoint the Board of Directors, the Managing Directors or General Managers.
- For companies with Government equity less than 50 per cent, the performance must be satisfactory to the Government and consistent with the motive for entering into business.

The last criteria was introduced to serve as a control and to enable companies with reduced 'publicness' to be included in the study.

Five departments in each company were studied. The questionnaire on leadership style adopted was administered to some senior and junior staff of five departments totalling twenty-five. This included the office of the Chief Executive or General Managers of these organisations. And the questionnaire to evaluate performance was given to the Chief Executives and four other heads. In other words, each department had one ques-

tionnaire to measure performance and five questionnaires to evaluate leadership style. On the whole, 180 questionnaires were distributed, but only 129 were used in this study because others could not found to satisfy our requirements.

Analysis & Findings

The research instruments used were designed to suit the use of the Spearman's Rank Correlation Coefficient which operates with the following assumptions:

- The sample of experimental units on which the two variables are measured is randomly selected.
- The probability distribution of the two variables is continuous.
- The number of ties is small, relative to the total number of observations.

To evaluate the Correlation Coefficient ρ , our analysis first presented the modal ratings of the leadership style as shown in table 2.

Table 2 shows that the workers rated their Chief Executives differently in respect of their inclination to adopt task, people or task/people centred leadership styles on a calibrated Likert Scale ranging between 1 and 7. The result also shows that every leader has a measure of each of the qualities. But the style preference of the leader depends on which qualities are predominant in his relationship with those he leads. Hence table 3 could be expressed as a percentage of the total rating of each of the public enterprises as shown in table 4. From the information given in table 4

Table 4: Leadership Qualities Expressed as Percentage Ratings of All the Public Enterprises

Leadership Qualities	Modal Ratings					
	PE 1	PE 2	PE 3	PE 4	PE 5	PE 6
Consults Subordinates	13.04	10.44	10.91	14.29	2.00	8.51
Trusts Subordinates	13.04	8.96	10.91	10.20	10.00	12.77
Emphasis on objective	10.87	10.44	9.09	12.24	12.00	8.51
Is a good Manager	8.70	5.97	5.45	8.16	8.00	4.25
Delegates authority	10.87	8.96	7.27	6.12	6.00	10.64
Concern for people	13.04	8.96	7.27	6.12	6.00	10.64
Concern for task	6.52	7.46	12.74	2.04	10.00	12.77
Appreciates good work	6.52	7.46	9.09	10.20	6.00	8.51
Innovative and receptive new ideas	4.35	10.44	3.64	8.16	8.00	8.51
Takes risk for task	2.17	7.46	5.45	4.08	10.00	6.38
Team building	4.35	4.35	5.45	6.12	10.00	2.13
Stresses authority and position	6.52	7.46	9.09	12.24	12.00	6.38

Source: Computed from table 2.

the extent of adoption by value of the leadership styles by each enterprise in our study could be obtained as sum of the unit percentages as presented in table 5.

Table 5: Leadership Styles Adopted by Leaders in Public Enterprises in Nigeria

Public Enterprises	Leadership Style		
	Task	People	Task/People
1	26.08	65.21	8.74
2	29.84	58.22	11.94
3	54.55	45.45	-
4	28.56	46.96	24.48
5	44.00	32.00	24.00
6	27.66	30.18	42.55

Source: Computed from table 4.

Table 6: Ratings of Motives for Establishing Public Enterprise by Managers Nigeria

Public Enterprise/Motives	1	2	3	4	5	6
Economic	7	5	5	5	7	5
Social	3	4	6	6	3	6
Political	1	6	2	2	5	4
Sum of Ratings	11	15	13	12	15	15

Source: Research Data 1993.

The interpretation of the data contained in tables 2-5, indicates that leaders in public enterprises in Nigeria adopt varying leadership styles. As could be deduced from table 5 leaders in public enterprises 1, 2, and 4,

Table 7: Ratings of Managers Motives Expressed as Percentages

Public Enterprise/Motives	1	2	3	4	5	6	Mean Equity < 50%	Mean Equity > 50%
Economic	63	33	39	42	47	33	63	39
Social	27	27	46	42	20	40	27	35
Political	10	40	15	16	33	27	10	26

Source: Computed from Table 6.

Table 8: Rating of Economic Performance of Public Enterprises in Nigeria

Economic Indices	Economic Performance Ratings by HODs					
	PE 1	PE 2	PE 3	PE 4	PE 5	PE 6
Health of Earnings	7	5	-	-	2	2
Production efficiency	5	5	5	5	3	-
Sales	7	5	6	4	2	6
Profitability	7	6	5	3	4	4
Effect of Fiscal Policies of Government	4	4	2	3	1	1

Source: Research Data, 1993.

adopted people-oriented style since the aggregate percentages on the qualities were higher—65.21 per cent, 58.22 per cent and 46.96 per cent respectively. In public enterprises 3 and 5 the leaders adopted task-oriented style having higher scores of 54.55 per cent and 44 per cent respectively. But in public enterprise 6, the style of leadership seems to vascillate between task and people. In order to establish the performance of these public enterprises, the responses to the questions in Questionnaire 'B' were analyzed. The heads of departments (HODs) were asked to rate the importance attached by them to the motives of the government for establishing their companies in terms of social, economic and political goals. The responses in terms of ratings are presented in table 6. The ratings for better appreciation were converted to percentages as shown in table 7.

Apart from public enterprise 1 which has just 40 per cent Government equity participation, the others with equity greater than 50 per cent face a fundamental problem of confused motives. The contradiction generated by the social and political emphasis of some of these public enterprises is that their business setting and situational variables such as competition for raw materials, competition with the private sector and competition for technical manpower were intense and difficult to be sustained by the current prices charged. This opinion was confirmed when the economics were analysed as shown in table 8. The table shows that all of the companies declared viable by the government have good economic performance. The others classified as partially viable show a very dismal performance. However, a generic performance picture is likely to emerge after the socio-political measures were rated. This is

Table 9: Socio-Political Ratings of Performance by Managers in Public Enterprises in Nigeria

Socio-Political Indices	Performance Ratings by Hods					
	PE 1	PE 2	PE 3	PE 4	PE 5	PE 6
Executive effectiveness	6	5	6	7	6	5
Effectiveness of Board of Directors	5	4	5	6	4	2
Service to stockholders	6	5	5	3	5	3
Corporate structure	5	5	4	4	4	4
Research and development	4	5	3	1	1	1
Employee Size	475	1947	270	150	150	125

Source: Research Data, 1993

Table 10: Percentage Calculation of Combined Performance Ratings of Economic and Socio-Political Variables of Public Enterprises in Nigeria

Performance Variables	Percentage Ratings					
	PE 1	PE 2	PE 3	PE 4	PE 5	PE 6
Health of earnings	10.00	7.14	-	-	2.86	2.86
Production efficiency	7.14	7.14	7.14	7.14	4.29	-
Sales	10.00	5.71	8.57	4.29	2.86	8.57
Profitability	10.00	8.57	7.14	2.86	5.71	5.71
Effect of Fiscal Policies of Government	5.71	5.71	2.86	2.86	1.73	1.43
Executive effectiveness	8.57	7.14	5.57	10	8.57	7.14
Effectiveness of Board of Directors	7.14	7.14	7.14	8.57	5.71	2.86
Service to Stockholders	8.57	5.71	7.14	4.29	7.14	4.29
Corporate Structure	7.14	7.14	5.71	5.71	5.71	5.71
Research and Development	5.71	7.14	4.29	1.43	1.43	1.43
Total	80.00	68.54	58.56	50.10	40.15	40.00

Source: Computed from tables 8 and 9.

shown in table 9. A close examination of these criteria shows that some public enterprises fared well economically and also have socio-political advantages. Since the overall performance is what is being used to judge the performance of public enterprises, tables 8 and 9 are expressed in percentages as shown in table 10.

Calculation of Spearman rank correlation coefficient, γ_s and population coefficient ρ_s

Tables 5 and 10 were brought together to obtain a contingency table with percentage ratings of the leadership styles and the corresponding performances of these public enterprises. This is presented in table 11. The concept of ranking allows the researcher to choose water values to assign as ranks, but in an arithmetic progression from the lowest to the highest. The above data therefore, were ranked from the least to the highest as shown in table 11.

The table shows that values are ranked from the lowest 5 for values ≥ 40 with the decimal of 0.1 to 0.9 to

Table 11: Comparative Ratings of Leadership Style and Performance of Public Enterprises

PE	Leadership Style	Performance
1	65.21 (People)	80.00
2	58.22 (People)	68.54
3	54.55 (Task)	58.54
4	46.96 (People)	50.01
5	44.50 (Task)	40.15
6	42.55 (Task/People)	40.00

Source: Computed from tables 5 and 10.

show the slight difference in the units. Therefore the performance ranking has 9.0 as the highest rank corresponding to the performance of 80 per cent for a worker-oriented leadership style of 65.21 per cent. The pattern follows down through the six public enterprises. To compute Spearman's Rank Correlation Coefficient the formula used was:

$$\gamma_s = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

where γ_s = Spearman's Rank Correlation Coefficient
 n = Number of pairs of measurement
 d_i = $u_i - v_i$ (difference in the ranks of the i^{th} measurement for sample 1 and sample 2)

Table 12: Rankings of Leadership Style and Performance of Public Enterprises

PE	Leadership Style		Performance	
	Performance	Rank	Percentages	Rank
1	65.21	7.5	80.00	9.0
2	68.22	6.8	68.54	7.8
3	54.55	6.4	58.56	6.8
4	46.96	5.6	50.01	6.0
5	44.00	5.4	40.15	5.0
6	42.55	5.2	40.00	5.0

Source: Research Data 1993

Table 13: Computation of Correlation Variables for rho sub s to Verify

Public Enterprise	Leadership Style rank U_i	Performance rank V_i	$d_i = u_i - v_i$	d_i^2
PE 1	7.5	9.0	-1.5	2.25
PE 2	6.8	7.8	-1.0	1.00
PE 3	6.4	5.8	0.6	0.36
PE 4	5.6	6.0	-0.4	0.10
PE 5	5.4	5.0	0.4	0.16
PE 6	5.2	5.0	0.2	0.04
Total	U = 6.15	V = 6.43		3.97

These variables were calculated and are presented in table 13:

Hence:

$$\begin{aligned} \gamma_s &= \frac{6 \sum d_i^2}{(nn^2-1)} \\ &= 1 - \frac{6 \times 3.97}{6(6^2-1)} = 1 - \frac{3.97}{35} \\ &= 1 - 0.11 = 0.89 \end{aligned}$$

This result shows that the leadership styles and performances are correlated up to +0.89. This is very close to perfect correlation which is +1 or -1. Also, it implies that there is a strong relationship between leadership style and performance. By the strength of this relationship the two variables linearly increase or decrease

together. In other words, improvement in the leadership style of public enterprises in Nigeria results in better performance. However, a high correlation does not imply causality as there may be other factors which contribute to high performance in addition to the style adopted in leadership. To enable us conclude that the linear relationship so established is also significantly causal, we proceeded to test the hypothesis that leadership style does not impact on performance, using the Spearman's Non-parametric test for rank correlation (McClave & Benson, 1988) against the hypothesis that leadership style linearly impacts on performance of public enterprises in Nigeria.

In this test we are interested in the extreme values to two sides of the distribution as shown in a two tail test of significance. (Recall that a Correlation of '0' implies no linear relationship). If we define ρ_s as the Population Spearman Rank Correlation Coefficient, then to determine if ρ_s is significantly different from γ_s or the extent of causality between the two variables we formulated our hypothesis thus:

$$H_0 : \rho_s = 0$$

$$H_a : \rho_s \neq 0$$

Test statistics γ_s (Note ρ_s is estimated by the corresponding sample statistic γ_s). Since $\gamma_s = 0.89$, assuming 5 per cent level of significance on one tail, from the Spearman Rank Correlation Table the Critical Ratio (CR) = 0.83.

For a two tail test $\gamma_s = 2(0.05) = 0.10$ and rejection region $\gamma_s < -0.83$ or > 0.83 for $\gamma_s = 0.10$. Since calculated ρ_s is greater than tabulated γ_s at $\alpha/2$ we reject the null hypothesis $H_0 : \rho_s = 0$. This implies accepting the alternative hypothesis, that there is a significant linearity between leadership style and performance in public enterprises in Nigeria.

Discussion

The qualities highlighted in our leadership style analysis as contained in table 4-6 show that the Chief Executives of the public enterprises in Nigeria mostly adopted the task-oriented style in leading people. The leader's personality, capability and skill as perceived by those he leads should give him a style of leadership that facilitates the achievement of his targets. Most of those interviewed, attributed the success or failure of the enterprises to the leadership style adopted by their Chief Executives. The analysis shows that a people-oriented leadership style provides for organisational success much more than the other styles. The task

oriented-leadership style has been identified to be the least effective in most Nigerian public enterprises. Infact, the rating of the performance of public enterprises 3 and 5 as shown in tables 10 and 11 clearly indicates that the leaders in these organisations have little concern for people which meant that the majority of the workforce is likely to have low concern for work as well. This attitude was confirmed during the interview sessions with workers in most of the public enterprises. They were observed to be sitting and idly away most of the times, as a result of inappropriate style of leadership at work and lack of effective supervision. It was discovered in the study that most of the task-oriented leaders in Nigerian public enterprises, instead of emphasising on higher productivity, had their own definition of work thereby transmitting the 'spirit' of "I am the boss" down the line. As a result many workers have become less committed, uninterested in creativity and innovation and morally less grounded as could be deduced from the percentage conversions of the ratings in tables 8 and 9.

What is needed in these organisations therefore, is leadership that is sensitive to the psychological needs and growth of workers through change, worker orientation, innovation and entrepreneurship in the face of multiple competition and diminishing market shares. In the study as contained in the comparative ratings of leadership styles and performance of public enterprises, (table 11) only public enterprise 1 truly imbibes this spirit. Public enterprise 2 was fast dwindling due to a sudden change in leadership style as a result of the appointment of a new Managing Director who had attempted to lower the values and moral tone of the people-oriented emphasis that had existed. From our interviews, the workers in these public enterprises needed a leadership style which shows cognitive sensitivity to the physiological and psychological expectations of the workers, in addition to concern for the overall goals, purpose and mission of management—a form of concessionary leadership style which may bring about the optimization of both the human and material resources, while at the same time satisfying the instrumental needs of the workers. This is likely to be the reason why the enterprises that are people-oriented are more successful than the others, including public enterprise 6 which shows an undulating performance level.

What is needed, is leadership that is sensitive to the psychological needs and growth of workers through change, worker orientation, innovation and entrepreneurship.

While public enterprises are performing poorly on economic grounds as judged by profit levels, and earnings, they seem to have good reports in terms of social-political assessment. In some cases, there is good leadership according to the responses got from the respondents but in real terms, these leaders are constrained to pursue goals that make the overall performance poor. The most likely reason for these failures is the fact that most of these organisations have motives espoused to neglect economic considerations. This contradiction is fundamental. Most of these public enterprises were incorporated as business concerns with clearly articulated commercial objectives but their activities seem to negate the statement of their aims and objectives. Their operations are completely outside the incorporation documents, therefore, relegating their primary motives to the background. This situation is clearly demonstrated in the case of public enterprises 2, 3, 5, and 6. Be that as it may, public enterprises in Nigeria could perform better if the espoused-theory does not contradict the theory-in-use (Argyris & Schon, 1978).

Any attempt to correlate these variables begins with the knowledge that for any organisational break-through to occur in terms of performance, the leadership style of the Chief Executive plays a vital role. This is not just a theoretical proposition. There have been instances in other countries where the effectiveness of the style of leadership of the leaders led to huge successes. The case of City Bank, Alpha Corporation, ICI, to mention but a few, are living testimonies. In these organisations, the Chief Executives have been the main force behind their good performances. As Singh & Bhandarker (1989, 281-292) point out, "without creation of their meaning, reorientation of beliefs and assumptions, no amount of manipulation or structure, strategy, systems and process will sustain organisational success. All of these dimensions are given life when they are consistent with the basic perceptions and values espoused by the Chief Executive, and when people also see the over arching meaning".

Against this background, the performance of the six public enterprises studied are viewed to be the direct reflection of the leadership style adopted by the Chief Executives (CEOs). Unfortunately, the CEOs who were involved in our study, (except that of public enterprise 1), have been found to espouse motives that created room for the failure of their organisations. They serve more as people representing interest groups, particularly, those who appointed them, (including political parties), who disregarded the primary motive of these companies as commercial entities and emphasised more on the importance of social and political goals. For example, the personal interviews show that there

had been conflict of interest between the General Manager and Chairman of public enterprise 3. The level of disagreement between the General Manager who opted for social goals as opposed to the Chairman who wanted to emphasise economic goals as the *raison detre*, became so intense that in 1991, the performance of the company gradually started sliding. In Public Enterprise 2, the Chairman of the company seems to be pursuing political goals whereas the Managing Director who is the CEO has a strong leaning and urge to pursue purely economic goals. This contradiction in goals seems to have brought far reaching negative consequences to the organisation. The economic viability of public enterprise 2 has also dwindled since a new Managing Director was appointed.

Public enterprise 1 recorded 80 per cent performance level due to the fact that the leadership style adopted by the CEO was people-oriented. Both in economic valuation and in socio-political terms, the appropriateness of the leadership style adopted by the leader seems to be the only single factor that could bring about the effective performance of organisations. The difference between the performance of public enterprise 1 which is growing very fast, and public enterprise 2 which was already retrenching workers due to dwindling performance reveals that the emphasis of leaders should depend upon their commitment to the values inherent in organisational motives.

From the above analysis, it is clear that organisations in which the CEO's adopted worker-orientation as their major style of leadership in the management of workplace have performed better than organisations in which CEO's adopted task-orientation style. This argument does not in any way reject the view that there exists situational factors that could sometimes influence leaders to adopt task-oriented style of leadership at work. As Ahiauzu (1988) states: "where the motives of an organisation are given and the appropriate organisational strategies identified, under normal circumstances the choice of structure and processes for the organisation will be largely influenced by the nature of the behaviour patterns of the organisation's managers and workers."

Organisations in which the CEO's adopted worker-orientation in the management of workplace have performed better than organisations in which CEO's adopted task-orientation style.

Therefore, the identification of appropriate strategies, structure, emphasis on goal and the overall activities of the enterprise are the responsibility of the leader. The performance of public enterprises will generally improve if the appropriate leadership style is adopted in different organisations. Attempts were made to prove this statistically, using Spearman's Rank Correlation analysis as shown in tables 12 and 13.

The analysis confirms the hypothetical claim that $P \Rightarrow F$ (LS): that leadership style has a tremendous influence or impact on the performance of public enterprises. This influence has a tendency of improving with the continual use of the appropriate leadership style by managers. This argument if carried to its logical conclusion will assist public enterprises both in Nigeria and other developing and developed countries to improve upon their performances. The statistical analysis gave a high Correlation (0.89) between leadership style and performance, using Spearman's Rank Correlation Coefficient, which indicates that the impact is a significant one. When a leader adopts an inappropriate leadership style, the organisation is likely to experience poor performance in the area of formulating policies on finance, production, and other strategic issues. The only rational thing to be done by CEOs in public enterprises in Nigeria is to adopt the appropriate leadership styles that could lead to mission accomplishment. Since the problem has had a long recurring history, a lot of effort should be made towards the development of further research in this area of study.

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Small Scale Industries in Kerala: A Study

J. Justus & S. Kevin

In this paper an attempt has been made to study the impact of four variables, namely, capacity utilisation, profit retention, credit sales and delay in payment by debtors, on the profitability of small industrial units. Analysis of variance is used to make a size wise analysis of the performance of small industrial units in respect of these variables on profitability. Smaller units in the small scale industrial sector seem to be at a disadvantage. Three of the variables studied have a positive impact on profitability.

Small scale industries play an important role in the economic development of a country. The promotion of small scale industries has been widely recommended as one of the most appropriate means of industrialising the industrially backward regions or countries. To cite but one case in point, the High Performing Asian Economies (HPAEs) owe their progress to the profusion of small and medium size enterprises which absorb a large number of workers, reducing unemployment and attracting rural labour (World Bank, 1993). The small scale sector has certain inherent advantages like low capital intensity, high employment generation potential, shorter gestation period, more equitable distribution of income and wider dispersal of industries.

The small scale sector has certain inherent advantages like low capital intensity, high employment generation potential, shorter gestation period, more equitable distribution of income and wider dispersal of industries.

In India, the successive Five Year Plans have been assigning increasing importance to the development of industries in this sector. At the end of December 1993-94, there were 23.84 lakh small scale units in the country employing 139.38 lakh persons and producing goods worth Rs. 241648 crores (at current prices) (GOI, 1994-95).

There has been a phenomenal growth of small scale industries in Kerala in recent years. The total number of small scale units in the state at the end of 1988-89 was 55,427, estimated to provide employment to 3.66 lakh persons (Govt. of Kerala, State Planning Board 1989). The number of units increased to 1,10,384 by the end of 31st March, 1994 and provided employment to 6.30 lakh persons. The value of goods and services produced by these units during 1993-94 was estimated at Rs. 3607.94 crores (Govt. of Kerala, State Planning Board 1994).

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In spite of the rapid growth of small scale industrial units, there is widespread sickness among these units. The growing incidence of sickness and closure in the small scale sector is a matter of serious concern since this sector is a vital part of the industrial structure.

Methodology

The profitability of small scale industrial units depends on a number of factors. Capacity utilisation, profit retention, credit sales and delayed payment by debtors are four variables which are likely to have an impact on the profitability of small scale units. A study was undertaken to analyse the status of these four variables among the small scale units of Kerala and to examine the impact of these four variables on the profitability of small scale units.

All the small scale industrial units registered with the State Directorate of Industries and Commerce, Government of Kerala and falling under the purview of small Industries Development Organisation (SIDO) were considered for the study. These units are known as SIDO units. A multistage stratified random sampling technique was adopted to select the sample for the study.

Four districts were selected as the sample from among the 14 districts of Kerala. The small scale units from the selected districts were stratified into three sizes, viz., small, medium and large on the basis of their investment in plant and machinery. Finally, a proportional random sample was selected from each sample district and each strata using random number tables so as to get a total sample size of 60 per cent of the population. The final sample comprised 104 units; 58 units in the small size group, 27 in the medium size and 19 in the large size group.

The data for the study was collected from the sample units with the help of an interview schedule. Analysis of variance was used to study the size wise variation among the units. Probit analysis was used to study the impact of the variables on profitability.

Variables Selected for Study

Capacity utilisation

Utilisation of production capacity and efficiency of production are closely related. Optimum utilisation of production capacity will reduce the cost of production and increase the profitability. Underutilisation of production capacity has an adverse effect on the profitability of a concern.

The average percentage of capacity utilisation by the sample units during the year 1994-95 is presented in table 1. Across the three sizes, the average capacity utilisation is comparatively low among the small size units. To test the significance in the variation of average capacity utilisation across the three sizes, analysis of variance was used. The F-ratio and its significance level indicate that the difference in the average capacity utilisation is statistically significant.

Profit retention

Business firms plough back or reinvest a portion of their net income in the business. These are known as retained earnings. Profit retention is an indicator of growth and stability of the enterprise. It contributes to future profitability. The mean percentage of net profit retained by the sample units during 1994-95 is shown in table 1. Across the three sizes, it is seen that large and medium size units retain 50 per cent of their net profits in the business, while the percentage of retained earnings in the small units is only 25.71. The F-ratio and its significance level obtained from the Analysis of Variance show that the difference in the mean percentage of profit retention across the three sizes is statistically significant.

Credit sales

"When a firm sells its products or services and does not receive cash for it immediately, the firm is said to have granted consumer credit" (Solomon & Pringle 1977, 151). The major goals of granting credit are to achieve growth in sales, to increase profits and to tackle competition. These goals are aimed at generating a larger flow of operating revenue. However, "Credit sales cause certain inevitable costs. The major ones are cost of financing receivables, administrative expenses, collection costs and bad debt losses" (Hampton 1986, 251-52).

The average percentage of credit sales to total sales of the sample units during 1994-95 is shown in table 1. Across the three sizes, the mean percentage of credit sales is maximum in the small size and minimum in the large size. The analysis of variance shows that the difference across the three sizes is statistically significant.

Delay in payment by debtors

Credit sales give rise to receivables. The small scale units usually have a limited resource base and therefore, delay in payment by their debtors is likely to affect their operations. This will ultimately affect their profitability. The percentage of customers who take more time than the allowed credit period to pay their dues during 1994-95 is presented in table 1. Across the three sizes, this

percentage is the highest in the small size and the lowest in the large size. The analysis of variance shows that the difference is statistically significant.

Table 1: Size-wise Analysis of Variables

Variables	Small Units	Medium units	Large units	All units
Capacity Utilisation (per cent)				
Mean	67.66	72.66	71.74	69.700
Standard deviation	18.34	18.86	19.24	18.600
F ratio				0.803
Significance level				0.451
Net profit retained (per cent)				
Mean	25.71	49.81	50.00	36.400
Standard deviation	33.21	35.88	42.30	37.330
F ratio				5.895*
Significance level				0.004
Credit Sales to total Sales (per cent)				
Mean	70.84	68.15	50.00	66.330
Standard deviation	29.04	28.32	35.82	30.900
F ratio				3.475*
Significance level				0.035
Customers who delay payment (per cent)				
Mean	38.97	34.26	23.47	34.910
Standard deviation	22.78	22.69	22.98	23.300
F ratio				3.320*
Significance level				0.040

Source: Primary Data

Note: * Denotes significant at 5% significance level.

Impact on Profitability: PROBIT Analysis

Probit analysis (Aldrich & Nelson, 1990) is ideally suited to problems where the dependent variables are not continuous, but dichotomous (i.e., can take on only two values, say, zero and one). A random variable which can take on only two different values, designated as 1 and 0 for convenience, is known in statistics as a 'Bernoulli response variable' and has associated with it a parameter, say P , that represents the probability of observing a response $Y = 1$. Since the analysis seeks the probability value, it is known as a probability model. The assumption that a probability model is linear in the independent variables is unrealistic in most cases; hence a nonlinear model would be more appropriate. Probit is such a nonlinear probability model for estimation with a binary dependent variable. Probit is an abbreviation of the term "Probability unit".

The probit model

The dependent random variable, Y , is assumed to be binary, taking on but two values, say 0 and 1. The question of interest hinges on the value of the parameter P , the probability that Y equals 1 (or $P = P(Y = 1)$). Y is assumed to depend on K observable variables X_k , $k = 1 \dots K$. That is, the independent variables, we assume, account for the variation in P . We can indicate this relationship by writing $P = p(Y = 1/X_1 \dots X_k)$, or simply $P = P(Y/X)$, where X denotes the set of K independent variables. The remaining unknowns then are parameters b_k , $k = 1 \dots K$.

Probit parameters are typically estimated by a method called Maximum Likelihood Estimation (MLE) in contrast to ordinary regression models which are estimated by the method of Least Square Estimation (LSE). MLE results include the individual coefficient estimates b_k , and also t-ratios, t_k . The coefficient estimates of b_k can be used to measure the relationship between the independent variable X and the dependent variable Y . Estimated standard errors provide the measure of the likely variation in the estimated coefficients that one might anticipate to arise from sample to sample. The t-statistic is used for testing the null hypothesis that a coefficient, say b_k , is 0 (or equivalently that the variable X_k has no effect on Y).

In regression analysis, an F statistic can be used to test the joint hypothesis that all coefficients except the intercept are zero. A corresponding test is available in probit. The MLE produces a statistic C , that follows approximately a Chi-square distribution when the null hypothesis is true. The formal test is performed by comparing the computed statistic C to a critical value $X^2(K-1, \alpha)$ taken from a table of the chi-square distribution with $K-1$ degrees of freedom and significance level α .

Computer programme for probit analysis

Probit analysis is done on the Computer using SPSS/PC+ Advanced Statistics Version 4.0 (Norusis, 1990). In the programme, the independent variables are taken as stimuli and the dependent variable as the response. The problem is formulated in terms of the proportion responding at each level of the stimulus.

In the Probit model, instead of regressing the actual proportion responding on the values of the stimuli, the proportion responding is transformed. Each of the observed proportions is replaced with the value of the standard normal curve (Z score) below which the observed proportion of the area is found. To avoid negative numbers, the constant 5 is added. For example, if the

observed proportion is 0.95, the corresponding transformed probit value is 1.64. Addition of the constant value of 5 makes this 6.64.

Similarly, the log of the stimulus is used in the analysis instead of the actual value of the stimulus.

The regression model for the transformed response can be written as :

$$\text{Probit } (P_i) + 5 = A + B \log X_i$$

The probit programme estimates the regression coefficient B and the intercept value A. Using these values, the probit (P_i) corresponding to various values of stimulus (independent variable) can be calculated. These are Z scores of the Standard Normal Distribution. The probability value corresponding to the Z score can be obtained from the table showing area under normal curve. It is this probability value that the analysis seeks to find.

Interpretation of the probit model

In regression, b_k measures the effect of exogenous variable X on the average value of Y. In the linear probability model, b_k measures the effect on P ($Y = 1$) of a unit change in X_k , and this effect is the same for all values of X_k since the model is linear. In probit, the nonlinearity of the relationship between P ($Y = 1$) and each X_k means that the interpretation of the impact of a change in X_k on P ($Y = 1$) is less straight forward.

Assessing the impact of X_k on P ($Y = 1$) requires some effort. One way to do this is to select interesting values of the exogenous variables and compute the associated P ($Y = 1$), vary the X_k of interest by some small amount and recompute P ($Y = 1$), where $dP (Y = 1)$ indicates the difference in the two computed values of P ($Y = 1$) and dX_k is the corresponding difference in the

chosen X_k . The results can be tabulated to show the range of values of $dP (Y = 1)/dX_k$ corresponding to various values of X.

Probit Analysis of Small Scale Industries

In this study a probit analysis is carried out to determine the impact of important variables on the probability of a small scale unit being profitable or profit-making.

Variables used in the analysis

The dependent variable Y is a dichotomous variable, namely, the performance of small scale units, which are assumed to take on two values; profit making (1) or loss making (0). Four independent variables, which are continuous, are used in the analysis. These are:

X_1 = Proportion of credit sales

X_2 = Proportion of debtors who take more time to repay

X_3 = Retained earnings percentage

X_4 = Capacity utilisation percentage

Results

The probit analysis was carried out for each of the independent variables separately. The parameter estimates and goodness of fit chi-square values and significance levels obtained in the analysis for each of the independent variables are presented in table 2. In the case of all the variables, the significance level for the chi-square statistic is fairly high, indicating that the model fits the data fairly well. The regression coefficients are significant except for that of X_2 .

Table 2: Parameter Estimates of Probit Analysis

Independent variable	No. of cases analysed	Regression coefficient (B)	t-value of regr. coeff.	Intercept (A)	Goodness of Fit χ^2 value	D.F.	Significance level (P)
Proportion of Credit Sales (X_1)	98	0.55948	1.30*	4.45516	98.04	96	0.423
Proportion of debtors who take more time to repay (X_2)	99	(-)0.06775	(-)0.17	5.55782	98.99	97	0.425
Retained Earnings percentage (X_3)	60	1.19550	2.11**	3.68793	61.80	58	0.342
Capacity Utilisation percentage (X_4)	104	1.45126	1.51*	2.80811	103.51	102	0.440

* Significant at 20% significance level.

** Significant at 5% significance level.

The impact of each independent variable on the profitability of small scale units can be studied by tabulating the probability values for different levels of the independent variables. These are shown in tables 3 to 7. Table 3 shows the probability of a small scale unit being profitable at different levels of credit sales percentages. The probability increases with increase in credit sales but the rate of increase is declining with increase in credit sales. This shows that credit sales have a positive impact on profitability but there is no advantage in unduly increasing the credit sales proportion.

Credit sales have a positive impact on profitability but there is no advantage in unduly increasing the credit sales proportion.

Table 3: Probability and Rate of Change in Probability with Respect to Proportion of Credit Sales

Proportion of Credit Sales (per cent) (X_1)	Prob. of being profitable $P (Y = 1)$	Increase in Prob.	Rate of change (%) $dP (Y = 1)/dX_1$
10	0.504	-	-
20	0.5714	0.0674	0.674
30	0.6103	0.0389	0.389
40	0.6368	0.0265	0.265
40	0.6368	0.0265	0.265
50	0.6591	0.0223	0.223
60	0.6736	0.0145	0.145
70	0.6879	0.0143	0.143
80	0.6985	0.0106	0.106
90	0.7088	0.0103	0.103
100	0.7157	0.0069	0.069

Table 4 shows the probability of a small scale unit being profitable as the proportion of debtors who take more time to repay increases. The probability declines with increase in the proportion, but the rate of decline is negligible. Moreover, the regression coefficient is not statistically significant. Hence we may conclude that the proportion of debtors who take more time to repay has no impact on the profitability of a small scale unit.

Table 5 shows the probability of small scale unit being profitable as the retained earnings percentage increases. The probability increases as the retained

earnings increase, but the rate of increase is declining with increase in retained earnings percentages. This shows that retained earnings have a positive impact on profitability. Table 6 shows the probability of a small scale unit being profitable as the capacity utilisation percentage increases. The probability increases with increase in capacity utilisation, but the rate of increase is declining with increase in capacity utilisation. This is probably due to the fact that as the capacity utilisation exceeds the breakeven point or viability level, the economies of scale decline progressively. The analysis shows that capacity utilisation has a positive impact on profitability.

Table 4: Probability and Rate of Change in Probability with Respect to Proportion of Debtors who Take More Time to Repay

Proportion of debtors who take more time to repay (%) (X_2)	Prob. $P (Y = 1)$	Decrease in Prob.	Rate of change (%)
0	0.7123	-	-
10	0.6879	0.0244	0.244
20	0.6808	0.0071	0.071
30	0.6772	0.0036	0.036
40	0.6736	0.0036	0.036
50	0.6700	0.0036	0.036
60	0.6700	0	0
70	0.6664	0.0036	0.036
80	0.6664	0	0
90	0.6664	0	0
100	0.6628	0.0036	0.036

Table 5: Probability and Rate of Change in Probability with Respect to Retained Earnings Percentage

Retained earning (%) (x_3)	Prob. $P (Y = 1)$	Increase in P	Rate of change (%)
10	0.4522	-	-
20	0.5948	0.1426	1.426
30	0.6736	0.0768	0.788
40	0.7258	0.0522	0.522
50	0.7642	0.0384	0.384
60	0.7910	0.0268	0.268
70	0.8133	0.0223	0.223
80	0.8315	0.0182	0.182
90	0.8461	0.0146	0.146
100	0.8599	0.0138	0.138

Table 6: Probability and Rate of Change in Probability with Respect to Capacity Utilisation

Capacity Utilisation (per cent) (X_4)	Prob. P ($Y = 1$)	Increase in P	Rate of Change (%)
10	0.2296	-	-
20	0.3821	0.1525	1.525
30	0.4801	0.0980	0.980
40	0.5517	0.0716	0.716
50	0.6064	0.0547	0.547
60	0.6517	0.0453	0.453
70	0.6879	0.0362	0.362
80	0.7157	0.0278	0.278
90	0.7389	0.0232	0.232
100	0.7612	0.0223	0.223

The results of Probit Analysis show that, out of four variables studied, three have a positive impact on the profitability of small scale units. To understand which variable has the highest impact on profitability and which variable has the lowest impact, a comparative analysis of the rate of change in probability for each variable is required. The rate of change in probability is graphically presented in Fig. 1.

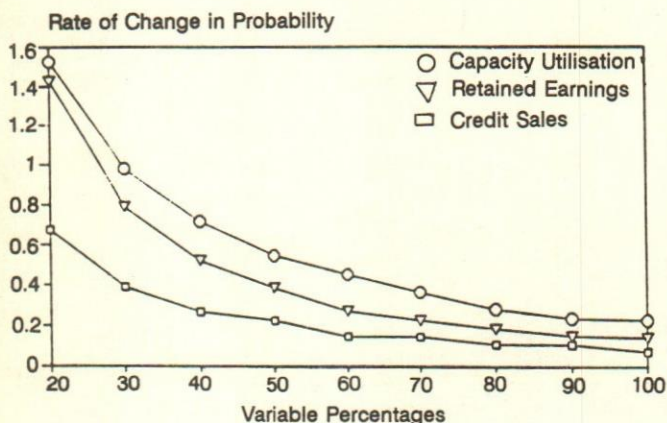


Fig. 1. Rate of Change in Probability on Account of Different Variables

The rate of change in probability is the highest in the case of capacity utilisation and the lowest in the case of credit sales proportion. The comparative analysis shows that capacity utilisation has the highest impact on profitability followed by retained earning and credit sales.

Summary

Four variables which are likely to have an impact on the profitability of small scale industrial units were studied.

- Capacity utilisation among small scale units averages around 70 per cent. There is not much variation among units of different sizes in this regard.
- Profit retention is on the lower side; the overall average being 36 per cent. But there is wide variation among units of different sizes.
- More than half the total sales are on credit basis. Smaller units have comparatively higher credit sales than the larger units.
- Around 35 per cent of customers of small scale units delay the payment of their dues beyond the credit period allowed. Smaller units have larger number of such customers.

Overall, smaller units among the small scale industrial units seem to fare poorly in respect of 3 of the variables studied.

Probit analysis indicates the percentage of customers who delay payments of dues has no impact on profitability. The other three variables have a positive impact on profitability. Capacity utilisation has the highest impact followed by profit retention and credit sales.

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Coping with Continuous Change – Spirals of Synergy & The Missing Loop

P.N. Rastogi

Today's business environment is increasingly complex, competitive, uncertain, and global. It is turbulent. To manage today, is to cope with the change. The latter is not an option, but an imperative. The salient issues in this context are: What to change? What to change to?, and How to change? The paper delineates the nature and rationale of the required insights and capabilities to resolve these issues and moves towards a nonobvious conclusion. It helps clarify and define the purpose, thrust, and direction of organizations toward managing for both today and tomorrow.

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Today's turbulent business environment, is in part, an outcome of the powerful shift in the world's economic system. A mass-production based industrial economy is being displaced by one based on knowledge and information. In such an economy, intangible attributes like speed, flexibility, and imagination; and intangible assets like 3 Cs. – concepts, competences, and connections – are more important for business success, than tangibles like mass, size, and physical assets. Competitive edge today, more than ever, resides in creativity and capabilities, knowledge and imagination. Mass-production, economy of scale, experience curves, and volume, are increasingly receding in importance.

Competitive edge today resides in creativity and capabilities, knowledge and imagination. Mass-production, economy of scale, experience curves, and volume are receding in importance.

Change makes experience outdated. And, change today is fast-paced, complex, and uncertain. It is pervasive and ubiquitous. How then may an enterprise cope with the challenge of continuous change? How may it survive, serve its stakeholders, and fulfil its core social purpose of wealth creation, under chaotic conditions? What is a company to do when markets shift suddenly, competitive advantages become transient, and threat of obsolescence is ever present?

The Approach & the Response

Responses to the foregoing, and similar questions, are neither simple, nor easy. The only feasible modus operandi is for the firms to develop their intellectual

skills and resources, and cultivate continually a set of generic capabilities.

Managements of firms today, increasingly need intellectual resources and skills pertaining to a number of domains. These domains relate to knowledge-intensive decisions and actions; sharp amplification of the firm's information handling capacity; fast response capacity to cope with emerging situations; coordination-intensive structures based on information technology; redesign of business processes and systems; development and use of creativity as a competitive resource of high value; the building of organization culture oriented around learning, innovation and achievement; and the development and management harmonious, mutually supportive, and reliable inter- organization relationships. These skills are knowledge-based, relational, behavioural, and 'soft'. They represent the essential complement of the firm's 'hard' skills pertaining to its superb core technological competencies, and/or service specialities. Both are vitally needed for the effective and efficient fashioning, and execution, of a firm's repertoire of responses, toward coping with continuous change. They however, also call for a changed, or new mindset of the management.

The new mindset requires the management to envision new horizons of opportunity, instead of remaining circumscribed in the company's existing markets. It requires the management to focus on creating new competitive space for the firm, instead of remaining locked on to defending the present business. The new perspective requires the firm to be viewed as a portfolio of generic capabilities including core competences; and not as a portfolio of products, or strategic business units. It enjoins the management to lead the customers, by visualizing and meeting their unmet and largely unperceived needs, and not merely following their expressed wishes. The mindset focusses on a matrix of needs and functionalities, instead of on the usual arrays of products and customers/markets. Finally, it emphasizes an orientation of continuous learning, the stretching of capabilities to the utmost, and persistence toward the realization of envisioned lofty future goals.

Strategic Inflection Points

The new mindset is however, needed most, and tested to its utmost when firms face "strategic inflection points". The latter refer to full scale changes in the way business is conducted. They can be caused by fast technological changes; they can also be caused by competition from a new way of doing things. But strategic inflection points go beyond technology and/or competition (Grove, 1996). They cannot be stopped or avoided. The only option open to firms is to focus on

getting ready for them. Classical competitive analysis (Porter, 1980) describes five forces that determine the competitive viability of a business. These forces are the power and prowess of a company's existing competitors, suppliers, customers, potential competitors, and the possibility that the company's product or service can be produced and/or delivered in a different, superior, or highly economical way. This possibility (threat of substitutes) is the most potent of all the above forces.

New techniques, new approaches, new technologies can upset an existing order or pattern of business, engender a new set of rules, and create an entirely new climate; or way in which to do business. This is what container shipping has done to traditional ports, what supermarkets have done to small stores, what microprocessors have done to mainframes, what digital media might do to entertainment, and what Internet might do to computing and corporate communications.

New techniques, new approaches, upset an existing order or pattern of business, and create an entirely new climate.

"When a change in how some element of one's business is conducted, becomes an order of magnitude larger than what that business is accustomed to, then all bets are off. Such a large change in any of the competitive forces is a '10 X' change" (Grove, 1996)

In the face of 10 X change, or 'super competitive forces', firms can lose control of their destiny, and business characteristics change inexorably. Such a phenomenon represents an inflection point. An inflection point occurs when the old strategic picture dissolves, and gives way to the new.

It is extremely difficult for firms to negotiate their course through strategic inflection points. "When you're caught in the turbulence of a strategic inflection point, the sad fact is that instinct and judgement are all you've got to guide you through" (Grove, 1996). Grove's thesis is that every corporation is assailed at intervals by unexpected crises that can lead to their dissolution. They are virtually impossible to sense, and prevent or forestall.

The best that companies can do is to set up systems and create a culture that anticipates such unex-

pected or sudden crises anytime. For this, according to Grove, companies should be paranoid. They should listen to the Cassandras, who prophesy doom or disaster. They should be primed to find innovative ways by which the disturbances can be quelled, the flames doused.

It is however, in this very context, that the mindset, insights, and generic capabilities based approach provide a cutting edge to a firm's capacity to cope with change and crises. The approach goes beyond Grove's prescription of being paranoid and looking over one's shoulder. One cannot cope effectively with change—large or small, expected or sudden—in the absence of fast, flexible, and focussed deployment of the needed generic capabilities. The latter are needed for managing both today and tomorrow, with or without strategic inflection points or discontinuities. They are needed for navigating in the virtually boundaryless market space of the world.

One cannot cope effectively with change in the absence of fast, flexible, and focussed deployment of the needed generic capabilities.

Managing for Today & Tomorrow

Coping with continuous change implies the need to manage for both today and tomorrow. Management needs to meet the demands of today, and the needs of tomorrow, simultaneously. It must cope with both incremental and discontinuous changes in the same, or different, time frames as necessary. This in turn, means that the management must pursue two tracks conjointly as follows:

- The firm must compete effectively in the short term through incremental innovations, and/or improvements, in the capabilities that are relevant to performance. It needs to become more efficient in terms of cost and quality, "doing things right", and mastering incremental change. But efficiency, or short term success, by itself, does not, and cannot, ensure long term success. Short term success, may in effect, tend to engender complacency and inertia, which may lead to failure in future.
- For sustainable success, the firm must also understand how, why, and when to initiate, or manage, discontinuous innovations and changes; in terms of its generic capabilities including, core competences/capabilities, alliances,

technology development, business system redesign, and knowledge management. Successful firms sustain their success through sustained development and deployment of their generic capabilities in an intelligent, flexible, and interactive manner.

Short term success, by itself, does not, ensure long term success. For sustainable success, the firm must also understand how, why and when to initiate, discontinuous innovations and changes.

The development and mobilization of generic capabilities, and the utilization of creative insights, define an enterprise's sense of direction and purpose clearly, consistently, and continuously. The articulation, emphasis, and integration of its generic capabilities by an enterprise, may differ from time to time, according to the nature and magnitude of perceived changes. An enterprise would craft its repertoire of responses to cope with extraordinary situations, in terms of:

- its early sensing, or anticipation of, the nature and magnitude of emerging, and probable change situations
- its creative utilization of insights, and imaginative deployment of generic capabilities
- its differential fashioning of responses to meet the different types, and classes of events, and change situations and
- its clear and consistent sense of purpose, and direction of efforts, as defined by its insights, mindset, and vision.

Weaknesses, inadequacies, or confusion along any of these dimensions, may depreciate the firm's capacity for coping effectively with change.

Managers must, in this context, learn to manage both short term effectiveness, and long term adaptability and success. They need to realize that flexibility, speed, innovation, consistency, reliability, and responsiveness, as the crucial; as product classes evolve, markets shift, new forms and modes of competition appear, and discontinuities emerge. Managerial insights and mindset, visionary leadership and generic capabilities, must stimulate both efficiency and breakthrough innovation. Both are necessary in the organisation's quest for continued survival and success, growth and development,

over short, as well as, long time horizons. For this, organisations need horizontal organisational structures, fluid team-based architectures, and frequent reconfigurations of the business system. Firms' must be able to create and manage such structures, architectures, and reconfigurations smoothly and recurrently, and as often as needed, in terms of the strength of their values, vision, and culture. Successful firms continually learn and observe what works well, and develop and incorporate best industry, or business practices, in their policies and operations.

During periods of evolutionary change, managers must engage in continuous incremental innovation and improvement, constantly sharpening the edge of their performance and proficiency. These may include things like expansion of markets, extension and enhancement of product lines, development of new products and processes, logistics efficiencies, improving technology, and providing superior customer service. At the same time, they must learn to anticipate and prepare the organisation for discontinuous change. During periods of revolutionary change, the focus of managerial efforts must however, accord proactive primacy to new technology, breakthrough innovations, and rapid and radical redesign of the business system as a whole, in terms of continuously cumulated and enhanced set of generic capabilities.

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Generic Capabilities—A Summary

The approach and the framework for coping with continuous change, and managing for both today and tomorrow envisaged here is primarily based on the constant cultivation of a set of generic capabilities. These capabilities need to be developed and deployed in conjunction with an open and inquiring mindset, and a shared inspiring vision. They undergird a firm's power and potency toward facing and shaping the challenges of change. A company therefore, needs to appraise itself regularly along the following dimensions (Rastogi, 1995(a), 1995(b), 1996, 1997):

- Has the company reengineered, and is it continuing to streamline its core business processes toward breakthrough improvements in

quality, cost, speed, productivity, and customer service?

- Has the company redesigned and aligned its internal processes and external linkages to become fast and flexible in its decisions and actions, work and performance?
- Is the company cultivating existing and new core competences/capabilities, and capitalizing on them by leveraging them across existing and new products and markets?
- Is the company maintaining a commanding position in the technologies relevant to its business with special reference to incremental and breakthrough innovations in its products and processes?
- Is the company proficiently exploiting the power of software toward enhancing its internal and external connectivity, problem-solving skills, knowledge management, and innovation?
- Is the company cultivating, sustaining, and expanding its collaborative advantage in terms of synergy and complementarities?
- Is the company developing and deploying the creative skills and talents of its human resources toward competing for both today and tomorrow?
- Can the company redesign its business system radically, as and when necessary, to ensure the continuing capture and in migration of value in the face of discontinuous changes in industry?
- Is the company becoming a learning organisation with the primacy of knowledge as the quintessential resource for its continuing survival and success?

Periodic self-appraisal by an organisation along all these dimensions, would enable it to assess its capacity for coping with change, and spot the deficiencies in its viability in a continuing manner.

Spirals of Synergy

The approach proposed here, in fact, goes further and deeper, in terms of its logical implications and concomitances. It requires an enterprise to build up growing spirals of synergy, that complement and reinforce each other, at successive levels. Each spiral is a self-reinforcing growth structure of a nexus of elements. The nature, structure, and characteristics of these successive spirals may be delineated briefly as follows:

The change-coping performance spiral

At the apex level is the spiral of Vision, Mindset (including Insights), and Generic Capabilities. It may be diagrammatically represented as in fig. 1.

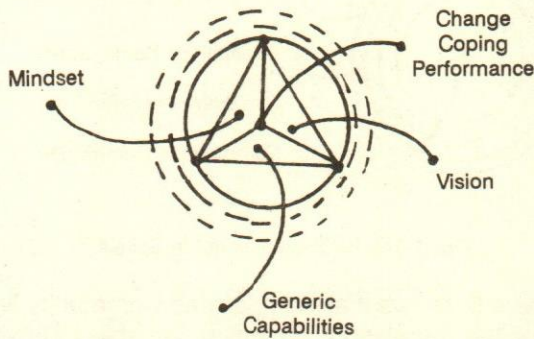


Fig. 1. The Spiral of Change-Coping Performance

The figure shows that Change-Coping-Performance of the company is an emergent from the synergistic nexus of its three macro level component elements. The nexus among them is such that if any component is taken out, missing, or weak, the whole structure collapses, and the spiral or growth cannot build, or take off. The three components strengthen one another in a synergistic manner. Together, they generate the growing power and quality of the firm's change coping performance, overtime. This performance can be measured in terms of financial success (i.e., profitability and growth in value of equity); as well as, in terms of industry leadership, size, continued growth, reputation for quality performance and innovation, ethical conduct, customer relationships, and being one of the best company to work in.

The capabilities configuration spiral

The generic capabilities outlined are complementary. They support and strengthen each other in multi-lateral ways. They form a dense web of inter-connections, or, a dynamic configuration of inter-active relationships. Together, they generate a synergistic spiral of the growth of generic capabilities, over time, as depicted in fig. 2.

The spiral here denotes the growing viability of the company, in terms of, its deepening and widening generic capabilities pertaining to business processes, technology, innovation, creativity, collaboration, and knowledge.



Fig. 2. The Spiral of Generic Capabilities Configuration

The spiral of capability development

The development of any specific generic capability in, and by, an enterprise, is also characterized by the growth of a synergistic pattern. The complementary component elements of this spiral are Knowledge, Commitment, and Cooperation, as shown in fig. 3.

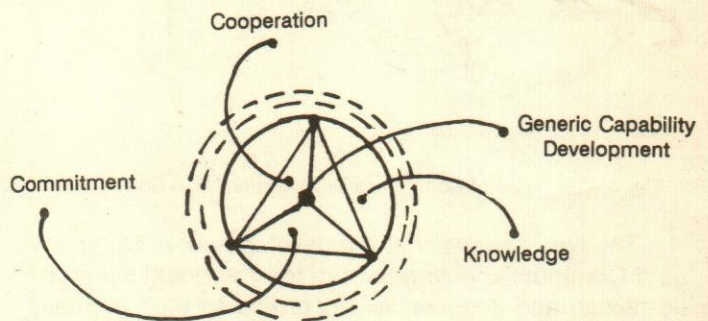


Fig. 3. The Spiral of Generic Capability Development

Knowledge, in terms of concepts, principles, methods, and techniques, etc., provides the content of a generic capability. Acquisition of, and proficiency in, the capability calls for strength of motivation, or, commitment of, the persons engaged in its cultivation. Cooperation of the people in the organisation is vital in an analogous manner, toward cultivation, delivery, deployment, and use of the capability by, and for, the organisation. Development of a capability in, and by, an organisation, then, depends on the conjoined and close nexus of the knowledge, commitment, and

Development of a capability in, and by an organisation, depends on the conjoined and close nexus of the knowledge, commitment and cooperation.

cooperation, as its constituent elements. The stronger the three elements, and their supportive inter-relationships, greater the development of the generic capability concerned.

The spiral of company's development as a community

A company's cohesion as a community, is vital for its continuing development and success, in the face of fast-paced change. Such a cohesion springs from a synergistic nexus of the company's shared Vision, the Commitment of its people to the company's visionary objectives, and their Cooperation toward translating the vision into reality. The synergistic nexus among these three elements may be depicted as in fig. 4.

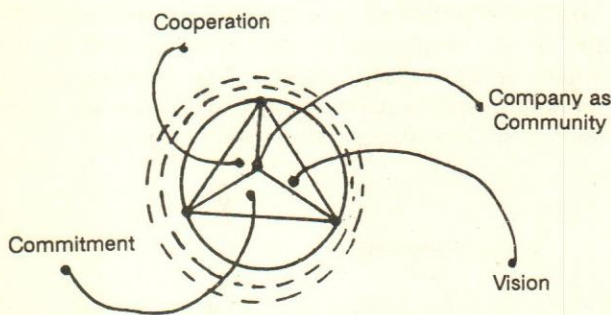


Fig. 4. The Spiral of Company's Development as A Community

The figure shows that the development of Company as a Community, emerges from the foregoing synergistic nexus, and progresses, according to their mutually reinforcing pattern of growth.

Spirals: Features & Relationships

The characteristic features of the four spirals, and the relationships among them, may be summarized as follows:

- Each spiral is based on an integrated and dynamic nexus of its constituent macro-level elements. The nexus is such that if any of the elements is missing, or inadequate, it remains unformed, and inoperative.
- Change-Coping Performance of the enterprise, development of its Generic Capabilities configuration, Capability Development at the company, and the Company' Development as a community, are synergistic emergents from their respective nexus of component elements.
- The spiralling character of the emergents is engendered by the synergistic, and mutually rein-

forcing interaction, among the constituent elements of the nexus concerned.

- The four spirals relate to one another in terms of their progressive inclusiveness, and consecutive foundational dependence. This pattern of relationships may be depicted as in fig. 5.

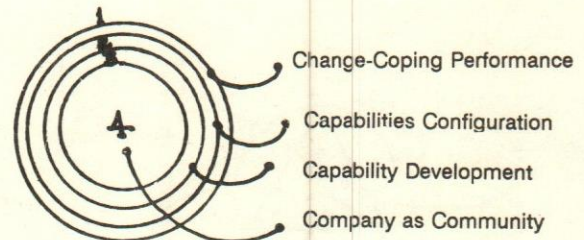


Fig. 5. The Relationships of the Spirals

Figure 5, shows that Company as Community is the base, or the foundation, on which Capability Development, Capabilities configuration, and Change-Coping Performance, are successively built. If this base, or foundation is weak, fragmented, or inadequate, the superstructure of Vision, Mindset, and Capabilities for coping with continuous change, cannot be effectively built, or even if built, cannot last. One therefore, needs to examine the fourth spiral further.

The Fourth Spiral: Structure

The fourth spiral composed of the Vision of an enterprise, the Commitment of its leaders and people to organisational vision and goals, and the Cooperation of its people toward the realization of the Vision; constitutes the basic driving force of the enterprise, and its ultimate foundation. How may, then, an enterprise move toward becoming a community animated by common purpose and shared destiny?

Of its three components, the vision of the company, can be effectively fashioned by its leaders. The vision extends the organisation into the future. It becomes, and provides the basis, for managerial leadership to plan, decide, and integrate the organisational personnel, into collective group effort. It is meant to inspire collective action, and provide the emotional connection between leaders and organisation members. The leaders can secure the vision's acceptance by people, through a skillful blend of communication, participation, and persuasion. Such an acceptance, may however, largely remain at an intellectual or rational level, without necessarily generating emotional involvement, identification, and affiliation. Commitment and cooperation, on the other hand, imply bonds of emotional attachment. They

can be supplied only by the heart, not by mind, and reason alone.

Obtaining committed and willing cooperation is neither simple, nor easy. Commitment is not mere intent; it is doing. It springs from our personal beliefs and values, and is part of our definition of who we are. Commitment defines us, gives us focus, and imparts us identity. If it remains weak, the nature and quality of cooperation, would also be weak.

Creation of cooperation, moreover, is complicated by several other factors. The latter include the ethnic diversity and demographics of the organisation membership; the history of the industrial relations in the company; the mental orientation of the knowledge workers; the informal groups in the company; and the impact and memory of previous downsizing(s), change efforts, and layoffs. More importantly, however, it is also affected by the values present in the larger society, which may also permeate in a company's culture. The decay of fundamental moral values such as honesty, integrity, dependability, truthfulness, sincere hardwork, doing one's best, service, and helpfulness, in the society at large, makes more difficult the task of fostering commitment and cooperation in a company. Companies are increasingly unable to hold themselves together, and ensure the cooperation of, and among, their employees, through the traditional methods of control like hierarchy, systems, procedures, and budgets.

What is, or can be, then, the basis for creating commitment and cooperation among people in an organisation? How may such a basis be identified, created, and strengthened? Here, we come across a missing loop of interacting factors, whose power and potency is exceeded only by their soft and intangible nature.

The Missing Loop

Human experience, and social psychological researches, highlight the role and importance of Trust in fostering cooperation among people. We cooperate willingly, and even spontaneously, with those whom we trust. In the absence of trust, organisation personnel spend their energy in protecting themselves. High levels of productivity, and reduction of transaction costs, are directly related to the level of trust present in an organisation and society. Trust suffers, when moral values are ignored. This is as true in the workplace, as in other areas of social life. Moral vacuum weakens our willingness to trust others. As moral decay enters an organisation, trust levels within it, deteriorate.

Trust is a high risk relationship, but forms the foundation of collaborative achievement and excellence.

Moral values like sincerity, justice, fairness, non-manipulation, rectitude, and integrity, are the necessary and important contributory conditions, for the sustenance and growth of trust.

What is the basis of trust? How is trust created? Again, experience and research tell us that trust is based on, engendered by, and fostered through, goodwill among people. The missing loop of intangible factors underlying committed cooperation, now emerges as in fig. 6.

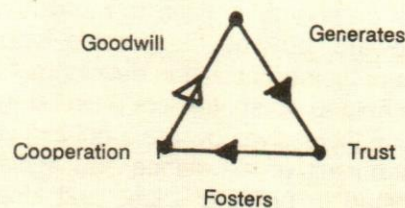


Fig. 6. The Missing Loop of Cooperation

Figure 6 however, highlights two further questions:

- What is the source of goodwill? How may goodwill among people be created to generate a climate of trust and cooperation in an organisation?
- What is the nature of linkage, or relationship, between goodwill and cooperation?

Answer to the second question is relatively easier. Assuming that the missing loop is a positive, i.e., a self-reinforcing feedback loop, cooperation is deemed to promote goodwill. This follows from the logic of the circular reactive structure of a positive feedback loop.

Answer to the first question is much more difficult. The source of goodwill emanates from the leaders.

The emotional state, however, also stems from the people's fundamental human need for belonging to an emotionally fulfilling larger whole; need for values and ideals that may guide their life; and need for a sense of purpose that imparts meaning to their life; and work. People also have a fundamental, or innate need, for connection with other human beings, and for sharing with them, the bonds of common beliefs and aspirations.

A non-parochial, or an universal sense of goodwill, can however, emerge only from a person's internal

spiritual longings and urges. The latter, have been, and remain, a perennial human concern stemming from man's inward gaze and search, his encounter with himself, and his quest for self-discovery. While, we cannot go into this perennial theme here¹, its essence and more specifically, the subtle hidden linkage between goodwill, and the sense of meaning and purpose in life, needs to be understood, and utilized by leaders, in the context of fostering trust and cooperation, and formulating visionary goals.

Leading Change

Leaders of an enterprise need to recreate, and actively strive toward, building the missing loop as the core and base of their organisation development efforts. In order to be able to do so, leaders must listen to their inner voice, give themselves over to a guiding vision, be passionate in pursuit of excellence and achievement, and be dedicated to uplifting values and ideas. They must possess integrity and character, rectitude and daring. They must inspire by personal example, and high performance accomplishments. They must be unyielding to despair.

True and successful leadership is not 'situational' or amoral. It is ultimately rooted in high moral purpose and the consistent display of respect for followers (O'Toole, 1995). Leaders who wish to bring about organisational change in today's volatile business world, must practise the moral art of value-based leadership. "Success does not hinge on which of the many available change methods, programmes, and processes is employed" explains O'Toole. Value-based leaders may face different challenges, and practice different leadership styles, but they all exhibit courage, integrity, authenticity, vision, and passion. They lead by example, rather than by power; and they inspire trust, hope, and action, in their followers. Successful corporate leaders "are dedicated to institutionalizing continuous change, renewal, innovation, and learning. And, the bottomline in what they do, is adherence to the moral principle of respect for people" (O'Toole, 1995). They seek to create strategic unity in a world characterized by discord and discontinuity.

Moral behaviour is based on obedience to universal natural laws, or principles, that are immutable (Covey, 1989). These include fairness, integrity, honesty, human dignity, service, quality, and excellence; and they are the foundation of 'principle-centred leadership'. Groups of people including families and organisations, can achieve their maximum potential

1. For a further elaboration of this theme, see Rastogi (1988).

through nothing less than moral transformation (O'Toole, 1995)².

Only through creating, and energizing the missing loop, can the leaders hope to develop an organisation as a community of shared meanings, values, and purposes. They further need to expand the orbit of goodwill, trust, and cooperation to encompass their external stakeholders i.e., customers, suppliers, and alliance partners.

The Spiral Road

The inference that emerges here, is that an ultimate building block of a company's capacity to cope with continuous change, is constituted by the missing loop. The missing loop is not the solution, or answer, to the problem of managing change; but is only a building block of foundation in the architecture, or superstructure, of the solution framework. If the missing loop remains missing, i.e., if trust and goodwill are lacking in an enterprise, its spiral of success cannot last, or grow. Such a conclusion may seem surprising, but is hardly revolutionary, or new.

Building up the spiral of change-coping performance, depends on the people throughout the company continually becoming highly skilled and competent at many things they are not good at today. Trust, goodwill, and cooperation, will help create, direct, energize, and integrate such wide, deep, and continuing changes in their behaviour throughout the organisation. Teams will catalyze and amplify performance aspirations, intensify focus and commitment, build generic capabilities, generate and spread knowledge and skills, organisation wide. They will engender rising trajectories of the people's competencies and performance. Corporate leaders must orchestrate this pursuit of long-term vision by the hundreds of people spread across the organisation. Such leaders would be great visionaries, good communicators, high motivators, insightful decision-makers, unassuming role models, passionate idealists, and wise and courageous individuals, in the face of difficulties, uncertainly, and change.

2. The importance of moral values as the defining characteristic of wealth creating entrepreneurs, is highlighted by Gilder (1989) as follows:
"The optimism and trust, the commitment and faith, the discipline and altruism, that their lives evince and their works require, all can flourish only in the midst of a moral order, with religious foundations. Secular culture has yet to produce a satisfactory rationale for a life of work, risk, and commitment, oriented toward the needs of others—a life of thrift and trust, leading to investments with uncertain returns".

Leaders would be great visionaries, good communicators, high motivators, insightful decision-makers, unassuming role models, passionate idealists, and wise and courageous individuals, in the face of difficulties, uncertainty, and change.

The spiral path of coping with continuous change is made up of the expanding spirals of synergy. Their horizons of growth and development, expansion and evolution, prowess and potential, are virtually limitless. Spirals of synergy both individually, and at progressively inclusive levels, represent twin modes of improving the organisation's ability to improve. They denote devices/mechanisms of acceleration; not of mere cumulation or governance. The spiral of a company's development as community denotes its progressive transformation into an improved community working continuously on the challenges to improve improvement. The organisation moves toward being and becoming a repository where people continually share information and the lessons learned, extract lessons from the global business en-

vironment, and convert them into ways of getting better at managing change. Values and vision, ideals and aspirations, drive the entire process inexorably forward – continuously and consistently.

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Diagnostic Study Using Taguchi's Methodology: A Case Study

P.B.S. Reddy

In the past two decades, the globally competitive market place has exerted enormous pressures on the manufacturing industries to improve the quality of their products. In response, many industries have started implementing various quality improvement programmes and the success of this movement is quite appreciable. This paper presents a study pertaining to a typewriter manufacturing industry. To improve the process capability of automats of this company, a detailed investigating study was carried out using diagnostic tools. Details of the study and cause-effect analysis have been presented along with a detailed exercise using conventional and Robust Design methodology.

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Quality has become a major strategic variable in business planning as competition on the basis of quality has gained momentum in the market economy. The field of quality engineering and management is going through dramatic changes in the last few decades. Under these circumstances a list of do's and don'ts and meeting tolerances are not sufficient for successful quality improvement. Many companies are carrying out serious deliberations as to how they can achieve quality edge. The concepts of TQM are fast catching up and hence the importance of diagnostic tools (Snee, 1986).

A list of do's and don'ts and meeting tolerances are not sufficient for successful quality improvement.

Problem on Hand

The study of friction cup

This study was carried out in a company manufacturing manual typewriters. In a manual typewriter, friction cup is an important member in the platen assembly. This cup consists of 336 teeth which are in contact with the teeth of the pawl. When the clutch is engaged by pressing the knob, the bush will go down causing the pawls to come close to each other to release the contact between the teeth of the friction cup and pawl. So, one can rotate the platen very easily. This helps to go to any part of the paper while typing simply by the rotation of the platen.

In the other case, i.e. when the clutch is disengaged, the teeth of the friction cup and the pawl are in contact with each other. Now, it is not possible to rotate the platen. However, this can be done in small increments only by operating the hand lever. These in-

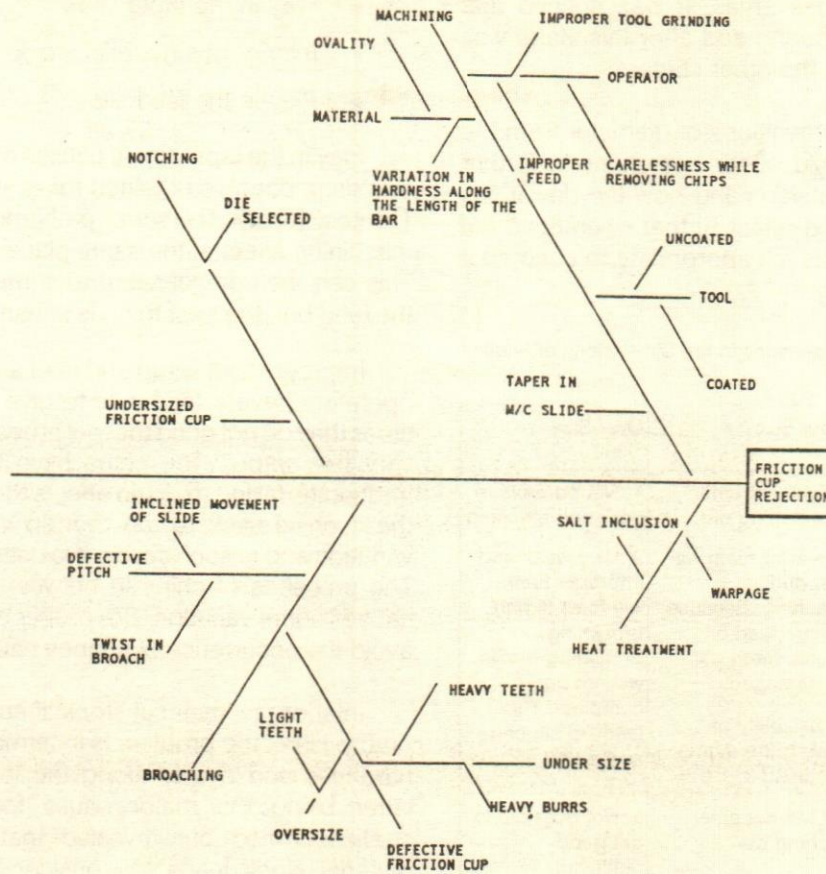


Fig. 1. Cause Effect Diagram for Friction Cup Rejection

crements must be equal to each other whenever we operate the lever. If this is not the case, then the problem is because of faulty friction cup.

To understand the root cause of the problem, a detailed diagnostic study was carried out. This problem was appropriately investigated using conventional experiments and using the concept of Taguchi's robust design methodology.

A detailed pareto analysis was carried out to identify the critical processes which affect the process capability of the system. It revealed that friction cup rejection is one of the chronic problems in the company.

In essence, friction cup is a ring like component which undergoes six different operations. The first one is machining in an Automat. In this, a bar of required dimensions is fed to obtain friction cups with height more than that required. During this operation, two steps of boring are done. The second operation is the height reduction in an ordinary lathe. Notching is done in the third operation followed by broaching. The broaching operation is done in two stages. In the first stage, half the total number of slots are made and in the second stage the remaining

slots (teeth) are made. This method is adopted with an aim to reduce the load on the broach. The teeth formed during broaching are somewhat weak. To impart the necessary strength to the teeth, heat treatment is done on the friction cup. The final operation is grinding in which the outer diameter is reduced. If any one of them is faulty, it will cause rejection of friction cup.

A defective friction cup can cause a variety of problems while the type writer is in use. More significantly, it can cause uneven spacings between lines if the pitch is improper or if the teeth of the cup are very light. The company under study has encountered a number of complaints associated with the friction cup. To identify the possible causes and their effects, a detailed Cause-Effect analysis was carried out.

Cause-Effect Analysis

Figure 1 depicts a comprehensive Cause-Effect diagram including the various problems associated with the friction cup. Study revealed that the major cause for the problem is defective teeth due to under or over size of the bore diameter. Therefore, machining and broach-

ing are the problem prone areas. It was noticed that rejection of friction cup during and after this stage was considerably higher than the other stages.

Any change in the dimensions of diameter from the designed tolerances would affect operations in further stages. The critical dimensions and how the deviations from the tolerances would affect further operations are presented in table 1. It was felt appropriate to conduct a detailed preliminary study.

Table 1: Consequences of Variations in the Dimensions of Friction Cup

Dimension	Tolerance Limits	Under Size	Over Size
Inner diameter (1) 34.68	+0.05 -0.00	1. It will not enter the notching die 2. Heavier teeth will form during broaching. Because of more load on broach, teeth will get damaged 3. Possibility of heavy burrs during broaching	1. Not possible to get good notching 2. Very weak and improper teeth will form during broaching. Broaching profile will not be complete. This leads to slippage at the end.
Inner diameter (2) 35.4	+0.05 -0.00	1. It will not enter notching die	1. Not possible to get good notching. 2. Possibility of buckling during press fit.
Outer diameter (3) 37.4	+0.00 -0.020	1. Leads to improper teeth during broaching. 2. Causes play between platen and friction cup resulting in loose fit.	1. It will not enter the broaching profile. 2. Difficulty in fitting the friction cup into the platen.

Preliminary Study

The problem was analyzed critically by working backwards i.e. starting from the stage where the problem is traced and back to the source-stages. The problem was first identified in the final assembly. Starting from the final assembly, a detailed study was carried out back to the stage of operation on Automats.

Inferior output from a machine is either due to chance causes or assignable causes. It may not be possible to eliminate the former completely and there is no need to worry about these as they cause only little variation. The real problem is with assignable causes. The preliminary study resulted in identifying the following assignable causes:

- Play in the taper slide
- Inferior raw material stock
- Play in the feed slide.

Play in the taper slides causes cyclic variation as only one component is obtained for every revolution of cam. The tool follows the same path and will have the same machining effect at the same place of every component. This can be compensated to some extent by changing the feed but, the best thing is squaring the slides.

Improper tool setup and feed are more frequent. The operators have a tendency to give high feed and some times they do not grind the tool properly. Both these things vary the output. The chips have to be removed very frequently; failing to do so affects the output. Sometimes, these chips stick to the tool tip causing considerable variation and in such cases, it is better to change the tool. The presence of chips in between slide and cam also causes some variation. So, proper care must be taken to avoid the occurrence of chance causes.

Inferior raw material stock affects the output considerably. Here, the problem is in terms of non uniformity of hardness and ovality along the length of the bar, the latter being the major cause for concern. Detailed studies carried out revealed that ovality in the raw material stock leads to considerable problems in the out-put, i.e. the friction cup.

From the preliminary study, it was observed that the quality of raw material (Ovality) and the tool used had considerable effect on the variation of the output produced. Hence, a detailed experimentation was carried out.

Experimental Design

The basic objective of this experimentation was to identify the ideal combination of tool and material which would make it possible to produce friction cups without ovality, by reducing the variation in the diameter. The next important step was identifying a suitable combination of tool and material to achieve as many components as possible near the target. The following four combinations were chosen to conduct experiments:

- Type A material and uncoated tool
- Type B material and uncoated tool
- Type A material and tool coated with Titanium nitride
- Type B material and tool coated with Titanium nitride.

For each combination, the output was checked. No adjustment was made from the initial setup existing during the process of collection of data. The data collection was stopped when the components were going out of tolerance limits. The order of production was maintained. Five consecutive components were considered as one sample sub group. All the samples were measured by using a dial gauge to identify the deviation from target value. Maximum and minimum values of deviation for each component were noted down. The difference between these two indicates the extent of ovality in the part. The data thus collected was subjected to analysis using designed experiments.

Experimental Analysis

The experimental results revealed that the number of acceptable components produced by the machine varied with the combination of material and tool type. The number of components accepted in each combination is shown in table 2. The combination of Type B material and coated tool produced the highest number of acceptable pieces. Combination of Type A material

Table 2: Number of Acceptable Pieces with Different Material-Tool Combination

Material-Tool Combination	Number of acceptable pieces
Type A Material and Uncoated Tool	23
Type B Material and Uncoated Tool	65
Type A Material and Tool Coated with Titanium Nitride	57
Type B material and Tool Coated with Titanium nitride	115

and uncoated tool produced the least. For these two combinations, Multi-vary charts were drawn as shown in Figs. 2 and 3. These charts give an idea of the extent of ovality associated with the product produced (friction cup). Some of the important observations made are as follows:

- Ovality associated was less with Type B material compared to Type A material, using the coated tool.

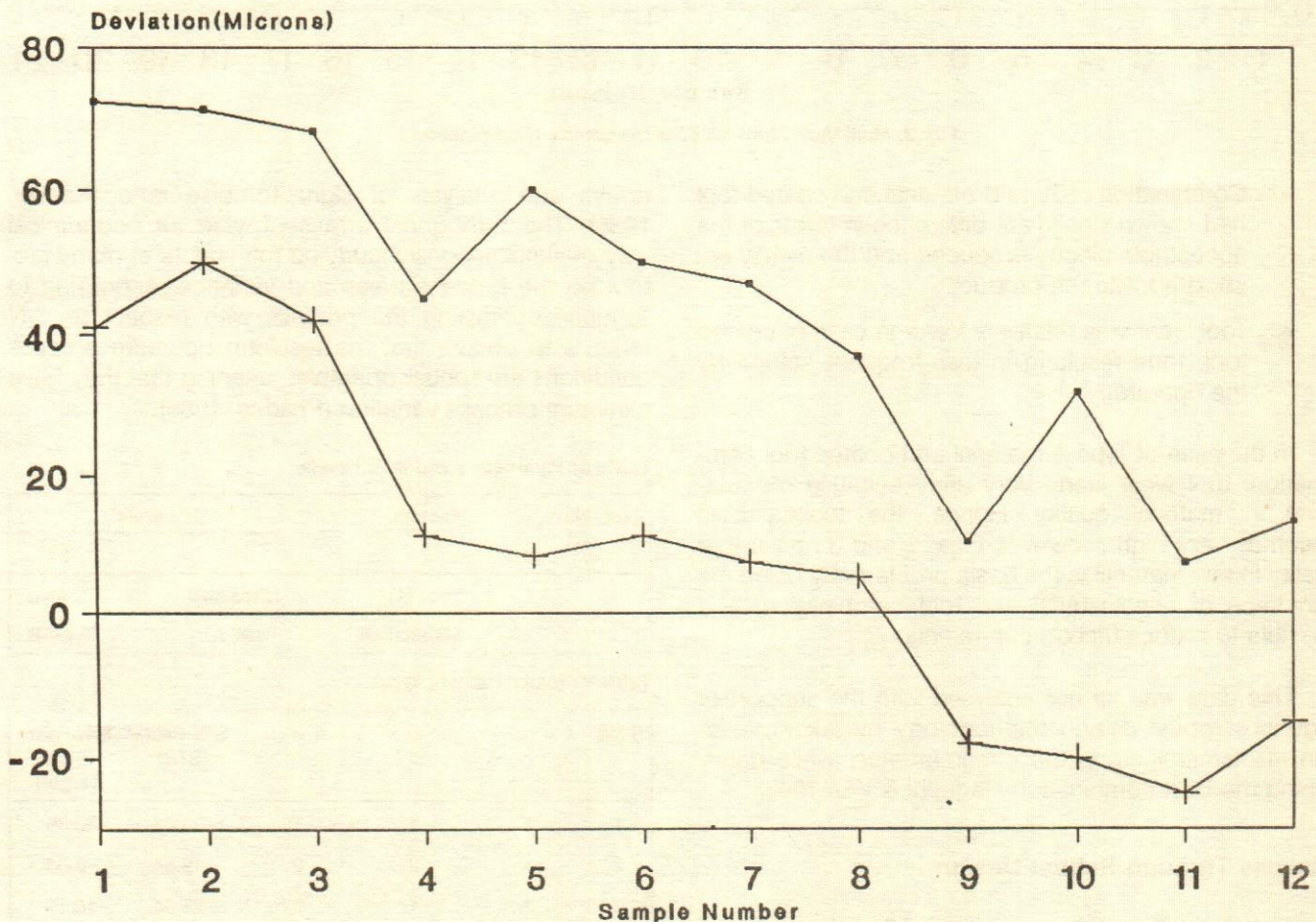


Fig. 2. Multi Vary Chart for Bore Diameter 1 (Combination 1)

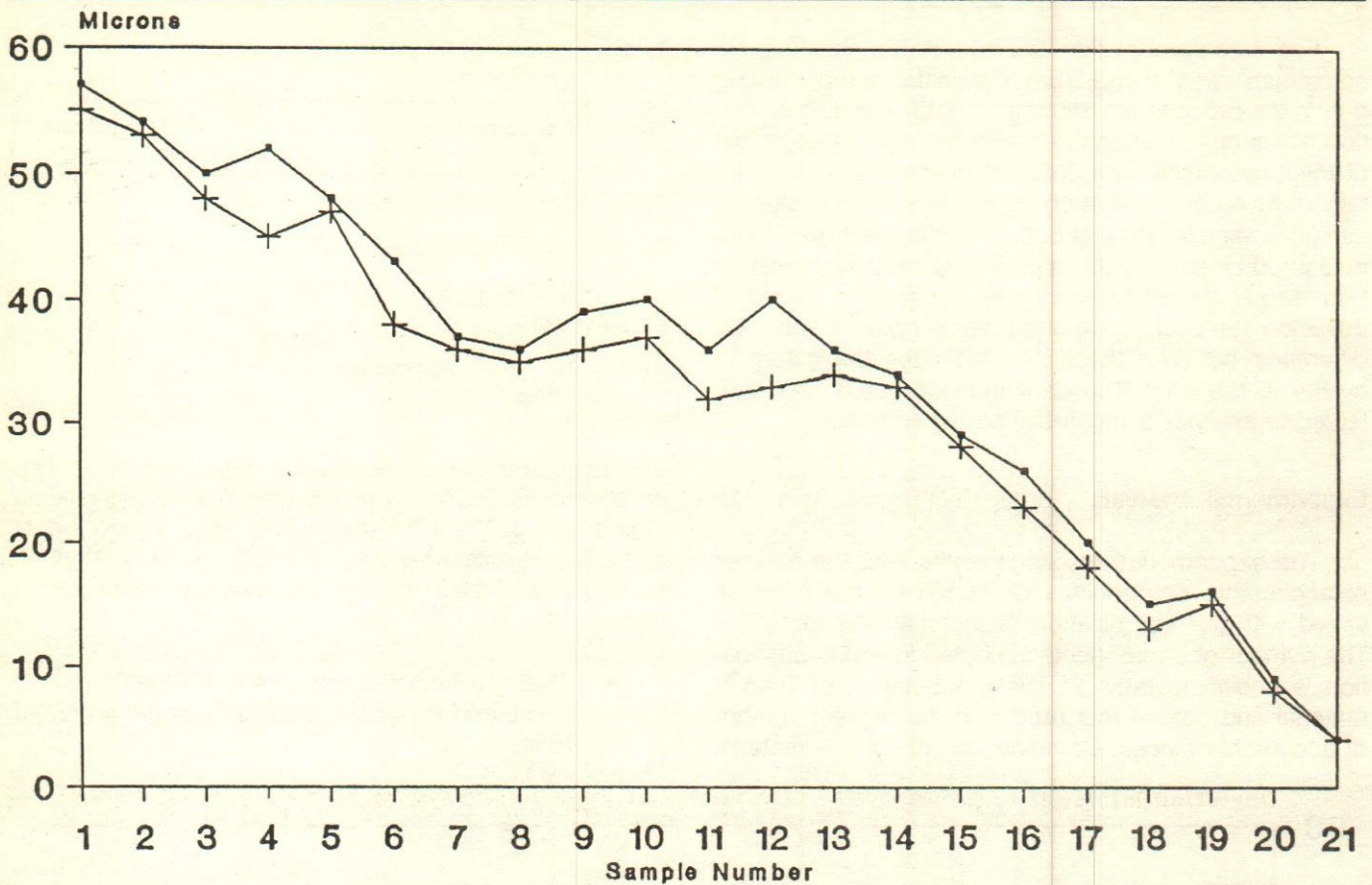


Fig. 3. Multi Vary Chart for Bore Diameter 1 (Combination 4)

- Combination of Type B material and coated tool had shown significant difference in terms of the acceptable pieces produced and the ovality associated with the product.
- Tool wear was relatively lower in case of coated tool, thus resulting in less frequent setups by the operator.

In the case of Type A material and coated tool combination, tool wear starts very early because of variations in material quality. Hence, the tooling cost becomes very high. However, Figs. 2 and 3 reveal that ovality in raw material is the basic problem. By using the right type of raw material and tool combination, it is possible to reduce friction cup rejections.

This data was further analysed with the support of Taguchi's robust design methodology by taking variation in diameter along the circumference, while determining the best combination (Taguchi & Wu, 1980).

Analysis Through Robust Design

The distinctive features of Taguchi's robust design methodology are experimental design using orthogonal

arrays and analysis of signal-to-noise ratio (Kacker, 1986). The orthogonal arrays provide an economical way of simultaneously studying the effects of many factors on the process mean and variance. According to Taguchi, optimising the process with respect to S/N ratio, is to ensure that the resulting optimum process conditions are robust or stable, meaning that they have minimum process variation (Phadke, 1986).

Table 3: Parameters and their Levels

Expt. No.	Factors	Levels	
		1	2
1	Tool (A)	Uncoated	Coated
2	Material (B)	Type A	Type B

Table 4: Experimental Layout

S.No.	A	B	A x B	S/N Ratio (STB)	S/N Ratio (Sign-Target)
1	1	1	1	-31.03	-20.98
2	1	2	2	-19.54	-6.03
3	2	1	2	-28.84	-16.11
4	2	2	1	-19.83	-13.18

Table 5: Anova—S/N Data (Minimizing Ovality)

Source	Pool	DF	SS	V	F	S	rho %
A	[Y]	1	0.91038	0.91938			
B	[N]	1	105.02239	105.02239	115.36105	104.11201	96.88
A×B	[N]	1	1.53423	1.53423	1.68526	0.62385	0.58
e1	[N]	0	0.00000				
e2	[N]	0	0.00000				
(e)		1	0.91038	0.91038		2.73114	2.54
Total (S/N)	[-]	3	107.46699	35.82233			

Table 6: Anova Level Sums Tables

Factor	Level	S/N Ratio
Main Effects		
A	1	-50.58118
	2	-48.67290
B	1	-59.87509
	2	-39.37900
Interaction of AB		
		B
		1 2
A	1	-31.03393 -19.54725
	2	-28.84115 -19.83112

Table 7: Anova—S/N Data (Target)

Source	Pool	DF	SS	V	F	S	rho %
A	[Y]	1	1.31405	1.31405			
B	[N]	1	79.87147	79.87147	60.78267	78.55742	66.96
A × B	[N]	1	36.13133	36.13133	27.49616	34.81728	29.68
e1	[N]	0	0.00000				
e2	[N]	0	0.00000				
(e)		1	0.31405	1.31405		3.94215	3.36
Total (S/N)	[-]	3	117.31685	39.10562			

For the present case, the basic objective considered for the application of Taguchi's methodology was to minimise the ovality of friction cup and to bring the process on to the target. The difference between the maximum and minimum values of diameter indicates the ovality in the part. The next important step was identifying the parameters which were affecting the process with respect to the quality characteristic. In this case, the two factors, tool and material, were considered and appropriate experimentation was performed. Each factor was set at two levels as shown in table 3. The experimental layout considered is shown in table 4. L4 array was selected to conduct the experiments. For each combination, deviation from target value was measured by using dial gauge. Maximum and minimum

values of deviation for each component were noted down. The difference between these two constitutes the ovality.

Experimental results for minimising ovality

L4 array was selected to conduct the experiments. In this case, the objective was to minimise ovality. So, Smaller-the-best case was adopted for computing S/N ratio (Phadke, 1989).

$$\frac{S}{N_{STB}} = -10 \log_{10} \left[\frac{1}{n} \sum_{i=1}^n (Y_i)^2 \right]$$

where y_i is ovality of each component. Ovality is the difference between maximum and minimum deviation of cup bore diameter. S/N values for each combination was computed as shown in table 4.

Table 5 gives the summary of ANOVA (Analysis of Variance) carried out. In this case, the material factor was found to be the most significant factor. Its contribution is around 97 per cent in total experimental variation. S/N ratio obtained for each factor level is shown in table 6.

Experimental results for achieving target value

In this case, the target value for the quality characteristic is zero. It was required to find an adjustment factor that can move the mean without changing the standard deviation. For this case, S/N ratio, Signed - Target, was considered the best to optimise the objective function as follows (Phadke, 1989 & Phadke and Taguchi, 1987):

$$\begin{aligned} \frac{S}{N_{\text{SIGNED-TARGET}}} &= -10 \log \sigma^2 = \\ &= -10 \log_{10} \left[\frac{1}{n-1} \sum_{i=1}^n (y_i - \mu)^2 \right] \\ \mu &= \frac{1}{n} \sum_{i=1}^n y_i \end{aligned}$$

where Y_i is ovality of each component. S/N ratio for each combination was computed and tabulated in table 4. Summary of ANOVA carried out for this case is shown in table 7. Material is found significant at 0.10 level. This study revealed that target value can be achieved by using Type B material.

Observations with robust design analysis

Robust design analysis has shown that ovality in the friction cup is mainly due to the raw material. Hence, the obvious choice left over was to change the raw material. Further, by changing the raw material, it is possible to reduce the number of adjustments and cost of tooling. The experimental results revealed that ovality associated with Type A material was very high compared to Type B. So, the combination of Type B material and

coated tool gives the optimum performance.

Conclusion

In the friction cup manufacturing process, the application of robust design methodology helped to identify the right combination of material and tool. The optimum settings obtained from this study had the potential to reduce the tool wear and machine down time thus leading to substantial improvement in quality and productivity. The results of the study had given considerable confidence to the company's TQM journey.

If managers insist that all experiments performed be designed by statistical methods in the research and on the shop floor, industrial productivity could be greatly increased.

Hence, traditional approach of engineering is just not enough in today's competitive environment, researchers have to use statistical designs of experiments for the development of processes/products in day to day life. If managers would insist that all experiments performed be designed by statistical methods in the research and on the shop floor, industrial productivity could be greatly increased.

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Understanding the Fundamentals of TQM

T. Thiagarajan & M. Zairi

This paper reviews the evolution and principles of Total Quality Management by closely examining various proposed models of implementation and all the major studies which sought to empirically measure and test the critical factors for effective TQM implementation. The paper concludes by covering the various dimensions of quality and the key principles and components for its effective introduction.

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To understand the development of TQM, it is necessary to look at the contributions of the so-called quality gurus and the modern quality revolution that shaped Japan as an effective global competitor. First, however, we must put TQM into perspective by defining it.

Defining Total Quality Management

A review of the literature reveals that there is no universally recognised definition of TQM. There is little agreement as to whether TQM should be described in terms of its ultimate goals or by the operational elements that need to be addressed to achieve these goals. Sometimes TQM is presented as a blend of both terms as :

"A comprehensive approach to improving competitiveness and flexibility through planning, organising and understanding each activity, and involving everyone at each level. TQM ensures that the management adopt a strategic overview of quality and focus on prevention rather than inspection" (Oakland, 1993).

"A positive attempt by the organisations concerned to improve structural, infrastructural, attitudinal, behavioural and methodological ways of delivering to the end customer, with emphasis on: consistency, improvement in quality, competitive enhancements, all with the aim of satisfying or delighting the end customer" (Zairi et al., 1994).

TQM means different things to different organisations. It is generally defined in a narrower sense to suit unique needs. Some definitions from an organisational point of view are as follows:

British Telecom (Kelly et al., 1991) elaborates TQM as:

- Total : everyone is involved
- Quality : meeting customers' (agreed) requirements, at lowest cost, first time, every time
- Management : it is owned and led by the management team, top down".

The US Department of Defense (Elshennawy & McCarthy 1992) states that

"Total Quality Management (TQM) is both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organisation. TQM is the application of quantitative methods and human resources to improve the material and service supplied to an organisation, all the processes within an organisation and the degree to which the needs of the customer are met, now and in the future. TQM integrates fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach focused on continuous improvement".

Milliken Industries, Ltd UK (Jeanes, 1990) defines it as "A total operational philosophy which covers every aspect of everything we do".

To the six best companies in Europe, TQM means "continuously improving processes and performance involving people to delight customers" (Binney, 1992).

What is TQM?

Fifteen characteristics of TQM can be distilled from the above definitions and viewed as a "What is TQM"? list:

- TQM is a management philosophy to guide a process of change.
- TQM ensures that quality be recognised as a corporate strategic priority, along with financial and other priorities.
- TQM starts at the top.
- TQM calls for planning.
- TQM requires organisation-wide involvement.
- TQM calls for everyone to be skilled and knowledgeable.
- TQM promotes teamwork.
- TQM is about achieving results by process based approach.
- TQM focuses on the customer.
- TQM recognises internal customer-supplier relationship.
- TQM considers suppliers as part of the organisations processes.
- TQM seeks disciplined approach in continuous improvement efforts.

- TQM aims to instill a "prevention not an inspection" ethic.
- TQM emphasises the importance of measurement.
- TQM reduces total cost of meeting customer requirements.

It is evident from the literature that, unlike the many quality related initiatives that mushroomed in the west in the 1960s and 70s, TQM is not a programme or method, neither is it a set of tools and techniques that can be "hooked-on" to "business as usual".

The Quality Gurus

Many organisations have been influenced by the writings of Deming (Hodgson, 1987; Watson, 1990), Juran (Krajewski & Ritzman, 1993), and Crosby (Powers, 1994) in their efforts to understand the requirements for an effective TQM. Many who have adopted their philosophies and systems in their organisations have found success in the market place, (Krajewski & Ritzman, 1993). Several authors and researchers have discussed the essential elements espoused in the writings of the gurus (see Watson, 1990; Logothetis, 1992; Akande, 1992; Saraph et al., 1989; Dahlgard et al., 1994; Anderson et al., 1994; Ghobadian & Speller 1994). This study attempts a synthesis of the key messages as evident in the writings of the gurus and in the literature on their approaches. Given the influence of the writings of Deming, Juran and Crosby on the bulk of TQM literature (Black, 1993 a, b) and on the practices of TQM, the discussion is largely confined to these gurus.

W. Edward Deming

Deming was greatly influenced by the work of Walter Shewart who originated the SPC techniques. It is not surprising that in much of his writings, Deming advocates a rigorous statistical approach as a means to better quality and productivity. The transformation of Japanese industries from shoddy producers into quality ones has been attributed to their strict adherence to Deming's statistical teachings.

Deming makes it clear that the statistical approach to quality is not just targeted at the employees, by calling on the senior executives to not only promote their use in both manufacturing and non-manufacturing sections but themselves use the knowledge in decision-making and daily work. In fact, Deming is credited with the original concept of quality as used today in management circles. He defines quality as "satisfying the customer, not merely to meet his expectations, but to exceed them".

Deming subsequently expressed his ideals and concept of quality in his 14-points for management (table 1) in his best-seller *Out of Crisis* (Deming, 1986). Using anecdotes and examples, he lays out the essentials for the total transformation of traditional scientific management into a new quality management which he warns cannot be achieved by adopting

Table 1: Deming's Fourteen Points

1. Create constancy of purpose towards improvement of products and service with the aim to become competitive and to stay in business, and provide jobs.
2. Adopt the new philosophy. "We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership of change".
3. Cease dependence on mass inspection to improve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.
4. End the practice of awarding business on the basis of price tag alone. Instead, minimise total cost. Move towards a single supplier for any one item, on a long term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.
6. Institute training on the job.
7. Institute leadership. The aim of supervision should be to help people and machines and gadgets do a better job. Supervision of management is in need of overhaul, as well as supervision of production workers.
8. Drive out fear, so that everyone may work effectively for the company.
9. Break down barriers between departments. People in research, design, sales, and production must work as a team, to foresee problems of production and use that may be encountered with the product or service.
10. Eliminate slogans, exhortations, targets for the workforce asking for zero defects and new levels of productivity. Such exhortations only create adversarial relationships, as bulk of the cause of low quality and low productivity belongs to the system and thus lies beyond the power of the workforce.
11.
 - a. Eliminate work standards (quotas) on the factory floor. Substitute leadership.
 - b. Eliminate management by objective. Eliminate management by numbers, numeric goals. Substitute leadership.
12.
 - a. Remove barriers that rob the hourly worker of his right to pride of workmanship. The responsibility of the supervisors must be changed from sheer numbers to quality.
 - b. Remove barriers that rob people in management and in engineering of their right to pride of workmanship. This means, inter alia, abolishment of annual or merit rating and of management by objective.
13. Institute a vigorous programme of education and self-improvement.
14. Put everyone in the company to work to accomplish the transformation. The transformation is everybody's job.

each point independently of the others. Deming offers his 14-points as a generic philosophy of management which is applicable anywhere, to the service industry, to manufacturing, to small organisations and to large ones.

Throughout, Deming emphasises that the management, not staff, bears the responsibility for making quality happen. The management must be committed to quality as the central goal and it must be of the highest concern to the organisation.

The other essence of his process-oriented approach is that the approach to quality must be preventive; that it should be built-in in the first place with every employee working as part of a single team to continuously improve quality. Skills training and education for everyone, including the management should be instituted. Decisions must be based on facts and systematic analysis and variations should be understood and controlled using statistical process control techniques to improve the processes in the manufacturing and support services. There is a need to blur the boundaries between the organisation and external stakeholders, namely suppliers and customers.

Terms often associated with Deming are statistical process control (SPC), variation and PDCA (plan, do, check, act) cycle. Now known as the Deming Cycle, the PDCA cycle is a structured approach to analysing and solving problems.

Joseph Juran

Joseph Juran stamped his reputation as a quality guru when he published his first edition of the *Quality Control Handbook* in 1951, a publication still much referred to. He categorised quality in terms of avoidable and unavoidable costs. The former resulted from defects and product failures like scrapped materials or man hours required for rework, repair, and processing customer complaints and which can be solved by using quality control techniques. The latter were associated with prevention and having quality "built in", which requires a change in attitudes and increased knowledge.

Juran's teachings emphasise the idea of managing for quality and getting it "right first time", rather than inspecting it into finished products. He believes that quality is the responsibility of all employees, rather than of a specialist development. He defines quality as "fitness for purpose or use".

He was one of the first to talk about the internal customer, the idea being that the next person on the

Juran's teachings emphasise the idea of managing for quality and getting it "right first time", rather than inspecting it into finished products.

process line should be looked upon as your customer and treated accordingly.

Juran is an advocate of customer-supplier partnerships, in which companies seek long-term relationships with a few suppliers. He also champions the idea of training groups of employees in problem-solving techniques, brainstorming, and teamwork. The Pareto analysis is also associated with Juran.

Like Deming, Juran strongly believes that quality problems are mostly due to the management, not the workers. He proposed three managerial processes for implementing a total quality programme: quality planning, quality control, and quality improvement which has become known as the Juran quality trilogy (table 2):

Table 2: The Juran Quality Trilogy

Quality planning	> Quality control	> Quality improvement
<ul style="list-style-type: none"> Identify the customer 	<ul style="list-style-type: none"> Choose control subjects 	<ul style="list-style-type: none"> Prove the need for improvement
<ul style="list-style-type: none"> Determine customer needs 	<ul style="list-style-type: none"> Choose units of measurement 	<ul style="list-style-type: none"> Identify specific projects for improvement
<ul style="list-style-type: none"> Develop product features 	<ul style="list-style-type: none"> Establish measurement 	<ul style="list-style-type: none"> Organise to guide the projects
<ul style="list-style-type: none"> Establish quality goals 	<ul style="list-style-type: none"> Establish standards of performance 	<ul style="list-style-type: none"> Organise for diagnosis—for discovery of causes
<ul style="list-style-type: none"> Develop process 	<ul style="list-style-type: none"> Measure actual performance 	<ul style="list-style-type: none"> Diagnose to find the causes
<ul style="list-style-type: none"> Prove process capability 	<ul style="list-style-type: none"> Interpret the difference (actual vs. standard) 	<ul style="list-style-type: none"> Prove that the remedies are effective under operating conditions
	<ul style="list-style-type: none"> Take action on the difference 	<ul style="list-style-type: none"> Provide for control to hold gains

With Deming, he has been credited with the Japanese quality revolution launched four decades ago. Juran (1993) attributes the global quality leadership of Japanese products to the leadership of the senior executives and their personal commitment to managing quality; company-wide training to manage for quality; training in the SQC usage, creation of an enabling environment

which promotes greater employee involvement in quality improvement activities; break-throughs in quality improvements, and aligning quality to corporate business strategy. He goes on to identify seven critical areas of commitment and involvement that a CEO needs to address to ensure effective TQM implementation (Juran 1993):

- Set up and serve on the company's quality council
- Establish corporate quality goals, and make them an integral part of the business plan
- Make provision for training throughout the entire company hierarchy in managing for quality
- Establish the means to measure quality results against quality goals
- Review results against goals on a regular basis
- Give recognition for superior quality performance
- Align the reward system to bring about the changes demanded by world class quality.

Philip B. Crosby

If Deming and Juran are credited with jump-starting the quality movement in Japan, Crosby can be credited with the quality awakening in the United States through his 1979 bestseller *Quality Is Free: The Art of Making Quality Certain*. Crosby owes his approach to quality management to his background in the quality arena. He came up through the ranks from inspector/tester to corporate vice president of ITT.

The essence of Crosby's approach to managing quality is based on management commitment to quality goals, prevention, and respect for employees and their efforts. Crosby advocates zero defects as the quality performance standard for everyone in the organisation. It calls for a change in culture and organisations.

Crosby lists four new essentials of quality management which he calls "the absolutes" (table 3). The key elements which can be synthesised from the absolutes are: understanding customer requirement; management commitment to satisfying the customer; communicating the requirements to the workforce; training the workforce to produce to customer requirements; prevention of errors by understanding the process involved in producing products and services; doing things right first as management performance standard; creating an enabling environment to achieve such standards, and measuring the costs of rejects, reworks and wastes.

Table 3: Crosby's Four Absolutes for Quality Management

Quality is defined as conformance to requirements
Quality is achieved by prevention not appraisal
The quality performance standard is zero defects
The quality is measured by price of non-conformance

Crosby talks about the three stages in the evolution of a TQ culture: First, the conviction that quality is an asset, followed by the commitment to implement quality as a way of life. Finally, the conversion to that way of life.

Crosby proposes a 14-point plan to facilitate the implementation of TQM (table 4). He places management leadership and demonstrated commitment and involvement central to the establishment of quality culture. He proposes the setting up of a quality structure comprising a high powered quality council to develop mission, goals, values and policies to manage the quality improvement process, and quality improvement teams to carry out the implementation policies to the quality council. He calls on the management to invest in educating and training employees in continuous improvement activity, and to recognise and celebrate successes in their quality efforts. He also stresses the need for having management for every key activity and tracking the cost of quality.

Although approaches of gurus in establishing a TQ ethic, they vary in terms of emphasis, and practices and techniques, they are largely complementary (Oakland, 1993). They share common ground on the need for management commitment and involvement, employee participation, customer orientation, process orientation, building in quality, continuous improvement, organisation and resources for quality, management, and supplier relationship for sustaining a TQ ethic.

The approaches of quality gurus as spelt out in the open literature either lack practical details or are inadequate for providing senior managers with total understanding of a TQ implementation framework. One needs to immerse oneself in the "theory" of a particular approach by reading deeply, attending seminars, being professionally involved in the implementation, or conduct scholarly research and writing to develop such understanding, (Anderson et al 1994). The approaches are also not always explicit in defining the key components. For example, while the criticality of leadership is a clear issue in the 14-points for effective quality management advocated by Deming (1986), the need to understand variation is less obvious. Senior managers hence rely on their own interpretation to extract and synthesise the key

elements required for effective TQM to guide them in the development of an implementation strategy. One could say that the quality gurus have led to total quality being tagged an ambiguous concept (see Dean and Bowen, 1994).

Table 4: Crosby's Fourteen Step Quality Improvement Programme

1. Management commitment: Help management recognise that it must be personally committed to participating in a quality improvement programme.
2. Quality improvement team: Bring together representatives of each department to form such a team.
3. Quality management: Determine the status of quality throughout the company.
4. Cost of quality evaluation: Establish the cost of quality of indicate where corrective action will be profitable for a company.
5. Quality awareness: Share with employees the management of what non-quality is costing through training and communication material.
6. Corrective action: Bring problems to light for all to see and resolve them on a regular basis.
7. Establish and ad hoc committee for the Zero Defect programme: After a year has gone by, a Zero Defects Day will reaffirm management's commitment, to the concept "Zero Defects" and the thought that everyone should do things right the first time.
8. Supervisor training: A formal orientation of the Zero Defects programme with all levels of management should be conducted prior to its implementation.
9. Zero Defects Day: Zero Defects as the performance standard of the company is established to provide emphasis and long lasting impression.
10. Goal setting: Regular meetings between supervisors and employees help people learn to think in terms of meeting goals and accomplishing specific task as a team.
11. Removal task and error causes: Individuals are asked to describe any problems that keep them from performing error-free work. The appropriate functional group will develop an answer to those problems.
12. Recognition: Award programmes are established to recognise those who meet their goals and perform outstanding acts. Awards should not be financial; recognition is what is important.
13. Quality councils: Quality professionals and team chairpersons should meet regularly to communicate and determine actions to upgrade and improve the quality improvement programme.
14. Do it again: Set up a new team of representatives and begin again to overcome the turnover and changing situations that can occur in the year and implement the typical quality improvement programme.

Quality Revolution in Japan

"The Japanese are headed for world quality leadership and will attain it in the next two decades be-

cause no one else is moving there at the same pace."

—*J.M. Juran at a European conference, Stockholm, 1966*

According to Juran (1993), the concept of quality assurance had its beginnings in Japan long before the lectures of Deming and Juran were heard in the country in the early 1950s. Apparently, the Japanese had achieved competitive and superior quality in certain areas such as the superior Japanese craft products of the 16th century, and some of their sophisticated military hardware used during World War II. But the Japanese had never tried to achieve quality status in the large-scale manufacture of consumer products, which at that time was dominated overwhelmingly by the Americans. US companies not only had a large domestic market, they also enjoyed global leadership in many world markets. In 1947, for example, US companies manufactured 80 per cent of the global cars built, half the manufactured goods, and 57 per cent of steel (Ripley & Ropley 1992).

The limited domestic market and the small and fragmented overseas markets prevented the Japanese from matching the scale of economies of American companies. They were forced to adopt and focus on strategies which achieved alternative savings: they focused on manufacturing quality in their products which realised in reduced scrapes and reworks, and hence, the reduction in costs per unit. To do so, among other things, they began focusing on effective work processes and maximising employee potential.

They heard about the teachings of Deming and Juran and wanted to learn them. The Japanese Union of Scientists and Engineers (JUSE) first invited Deming in 1950 to give a series of lectures on the use of control charts and statistical techniques for the control of quality. Deming went on to encourage the Japanese to use statistical techniques to focus on the problems of variability and their causes, and to strive for continuous improvement using the so-called Deming cycle. Deming also stressed the need to listen to customers and to keep track of developments in the market place.

Four years later, Juran was invited by the Japanese Federation of Economic Organisations and the JUSE to speak on how to manufacture products to design specifications, and how to inspect products for defects. His first two lectures were attended by a host of senior managers, including 140 CEOs from the largest manufacturing companies in Japan. This was in complete contrast to the American audience

for his lectures comprising engineers and quality control managers.

Juran's quality messages and techniques were translated into reading materials and used in worker group meetings; which later became quality circles. Based on his teachings, the Japanese introduced company-wide involvement in quality control, establishing programmes that yield continuous improvement and stressing on planning, organising and managing for quality.

The experience and knowledge gained from the two Americans enabled Japanese companies to launch their quality revolution around the following:

- The senior executives took personal charge of managing for quality.
- The executives trained their entire managerial hierarchis in how to manage for quality.
- Engineers were trained to use statistical quality control.
- Enabling environment was created which promoted employee participation in quality improvements. (QC) Quality Circle was the means.
- Quality improvement was maintained at a revolutionary pace.
- In recent years, quality has been linked to corporate business strategy (Juran 1993).

In maintaining their superior quality improvement pace over the West during the postwar decades, the Japanese evolved the means of measuring customer satisfaction, competitive quality, performance of major processes (such as cycle time for product development) and more. Corporate priorities were closely tied to these measures, with the CEOs taking personal charge of quality development.

With their vision set on determining the needs of customers, Japanese executives mobilised their entire workforce to develop better and lower cost products, continuously aiming for improvement at an unprecedented rate. The result was an increasing share of the world market in almost all industries.

The phenomenal rate of quality improvement in Japanese companies impressed visitors from the West. They learnt the basic differences between quality as practised by them and the Japanese. It was not until the late 1970s that several enlightened companies in the west began to manage quality for customer satisfaction,

rather than specification; ensured that top management took personal charge of quality; accorded quality the status of corporate priority and; ensured quality wide attention.

Models of TQM

Models offered by quality experts

In addition to the precepts, principles and models offered by quality gurus, there exists a growing body of literature by "disciples" of gurus and consultants describing the factors and characteristics for implementing TQM effectively.

As Burr (1993) observes there are as many models as there are quality experts and consultants. While there is no such thing as a "one fits all", model (Bendell, et. al. 1991; Burr, 1993), and one should treat the prescriptive types offered with caution, models, however, can be useful in guiding the decision making process during implementation (Boaden & Dale 1994), facilitating the conceptualisation of the range and scope of TQM (Sinclair, 1994) and contribute to the development of the organisation-specific approach.

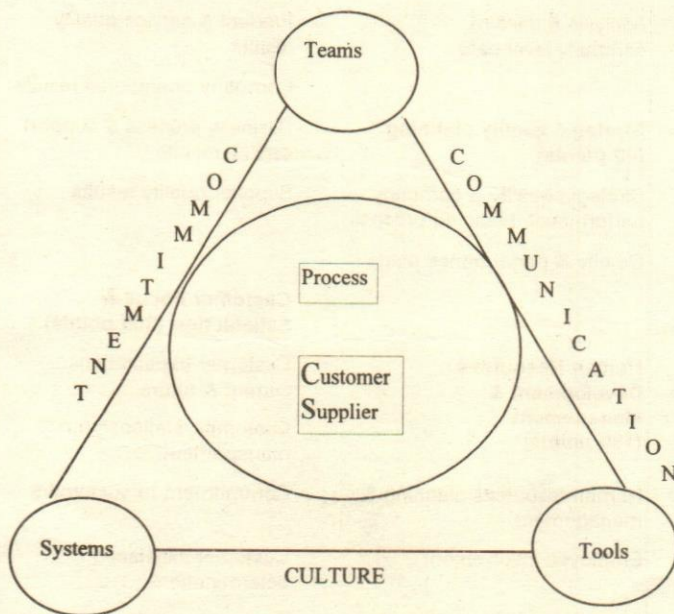


Fig. 1. A model of TQM (Oakland, 1993)

In the UK, the models proposed by Oakland (1993) and by Kanji & Asher (1993) are two of the better known ones. The core theme of the former model is the identification and management of the processes within the organisation. The processes are seen as chains of internal and external customer-sup-

plier relationships that must be managed effectively and efficiently. Surrounding the processes are the "soft" outcomes of TQM—culture, communication and commitment (i.e. the so-called foundation elements)—and the "hard" management necessities of TQM—the use of teams (ranging from high powered quality councils to work area quality circles), quality tools (for systematic data collection and analysis) and systems (based on recognised international standards). The Bradford model is shown in fig. 1.

Kanji & Asher (1993) used a 4-sided "pyramid" model to show the structure of TQM. It encompasses a set of four general governing principles, represented by the four sides. Each of the principles is translated into practice by using two core concepts. "Leadership" is at the base of the pyramid, aptly emphasising the critical role of leadership to make TQM happen. Table 5 shows the principles and concepts of the "pyramid" model (Kanji et. al., 1993).

Table 5: Principles and concepts of "pyramid" model

Principles		Concepts
Delight the customer	Customer satisfaction	Internal customers are real
Management-by-fact	All work is a process	Measurement
People-based management	Teamwork	People make quality
Continuous improvement	Continuous improvement cycle	Prevention

Source: Kanji & Asher, 1993.

Other quality authorities used different ways to explain their models, some of them novel. Kano (1993) used "The House of TQM" to show the structure of TQM. Using various parts of the house, namely, floor, base and pillars, he describes the factors and characteristics needed to achieve customer satisfaction and create a "prevention not inspection" management system, represented by the roof. Among the essentials for TQM, he talks about maximising employee involvement, training, management-by-fact, the need for building in quality, continuous improvement, tools and techniques, management by policy, and teams.

Cullen (1991) used a picture of a shield to put forward the hypothesis that there is a set of five conditions which are necessary and sufficient to establish TQM, namely, Leadership from the top, The cost of quality, Focus on customer satisfaction, Continuous improvement and Involvement of everyone.

Creech (1994) advocates building a TQM approach based on five interdependent system "pillars": products,

process, organisations, leadership and commitment. He explains his model in a systematic manner:

“Product is the focal point for organisation purpose and achievement. Quality in the product is impossible without quality in the process. Quality in the process is impossible without the right organisation. The right organisation is meaningless without the proper leadership. Strong, bottom-up commitment is the support pillar for all the rest”.

Kilmann (1985) talks about five tracks to quality transformation: the company culture, management skills, team building, strategy or structure and the reward system. He stresses that all five must be addressed to ensure that TQM is self-sustaining or the inertia of those left unchanged will cause the system to revert to its old comfortable process.

In common with the quality gurus, the writings by quality experts advocate emphasis on leadership, organisation-wide participation, teamwork, prevention, management-by-fact, processes, customer focus, management, system and tools. As in the case of the quality gurus, quality experts also suggest that features of TQM not explicit in the models are present by implications. For example, learning as a key concept in Deming’s (1986) teachings is implied in the foundation elements of the Bradford model (Oakland, 1993), and all principles of the “pyramid” model (Kanji & Asher 1993).

Models of quality awards

There has been a quality management framework as part of the Deming Prize in Japan for over four decades. However, it was not until 1987, when the Malcolm Baldrige National Quality Award (MBNQA) was established, that senior managers in the West started using the quality award criteria as guiding frameworks to plot the approach for effective TQM implementation. Since then, over one million copies of the MBNQA criteria are requested for and used by organisations worldwide as a roadmap, a planning tool and diagnostic framework in assisting TQM implementation efforts (Hart & Schlesinger, 1991).

The Malcolm Baldrige National Quality Award

The MBNQA or Baldrige Award as it is popularly known, was established to promote awareness of quality as an important element of competitiveness amongst American business organisations. It is offered to organisations in three categories, namely, manufacturing, service and small organisations (NIST, 1994). To win the award, organisations must demonstrate a high

degree of quality awareness and commitment, together with evidence of quality results. Among the many benefits to an organisation which applies for the award is the feedback on its quality efforts, which helps to assess the effectiveness of its implementation. It is claimed that many organisations apply to take advantages of this benefit.

Table 6: Baldrige Award: Categories and Examination items

Leadership (95 points)	Management of Process Quality (140 points)
Senior executive leadership	Design & introduction of quality products & services
Management for quality	Process management: product & service production & delivery processes
Public responsibility & corporate citizenship	Process management: business processes & support services
	Supplier quality
	Quality assessment
Information and Analysis (75 points)	
Scope & management of quality & performance data & information	
Competitive comparisons & benchmarking	Quality & Operational Results (180 points)
Analysis & uses of company-level data	Product & service quality results
	Company operational results
	Business process & support service results
	Supplier quality results
Strategic quality planning (60 points)	
Strategic quality & company performance planning process	
Quality & performance plans	
	Customer Focus & Satisfaction (300 points)
Human Resources Development & Management (150 points)	Customer expectations: current & future
Human resources planning & management	Customer relationship management
Employee involvement	Commitment to customers
Employee education & training	Customer satisfaction determination
Employee performance & recognition	Customer satisfaction results
Employee well-being & satisfaction	Customer satisfaction comparison

Source: (NIST, 1994)

The framework, which has undergone much revision since introduction, is generic in nature (Neves &

Nakhai 1994). The criteria, built upon several core concepts and values are specifically developed to be applicable to an organisation of any type or size. The ten core concepts and values (NIST, 1994) are: customer-driven quality, leadership, continuous improvement, full participation, fast response, design quality and prevention, long-range outlook, management-by-fact, partnership development and public responsibility.

The MBNQA framework has four key elements and is divided into seven categories. These features are shown in Fig. 2. The examination items of each category are shown in table 6.

Since the introduction of MBNQA, several nations started their own award schemes—a notable one is the European Quality Award (EQA) established by the European Foundation for Quality Management in 1991.

The European Quality Award (EQA)

The EQA was presented for the first time in 1992. It incorporates (EFQM, 1992):

European Quality Prizes: given to companies for their high standards of quality and their excellence and commitment to continuous improvement.

European Quality Award: awarded to the most successful exponent of TQM in western Europe.

Figure 3 illustrates the EQA framework. The nine elements of the framework, classified as either enablers or results, are seen as influencing one another. EFQM (1992) describes the various components as follows:

“The Results are concerned with what the organisation has achieved and is achieving, while the Enablers are concerned with how the results are being achieved.

Customer Satisfaction, People (employee) Satisfaction and Impact on Society are achieved through Leadership driving Policy and Strategy, People Management, Resources and Processes, leading ultimately to excellence in Business Results”.

Given that most of the available evidence on key components of TQM had been impressionistic, the quality award models, although criticised for some shortcomings (Garvin, 1992; Crosby & Reimann 1991), represented an important step towards offering a more holistic and widely accepted TQM framework. The two models discussed give greater attention to defining quality from the customer's perspective and on the measurement of results. The EQA and the revised Baldrige criteria also extend the framework for quality to include public responsibility and corporate citizenship,

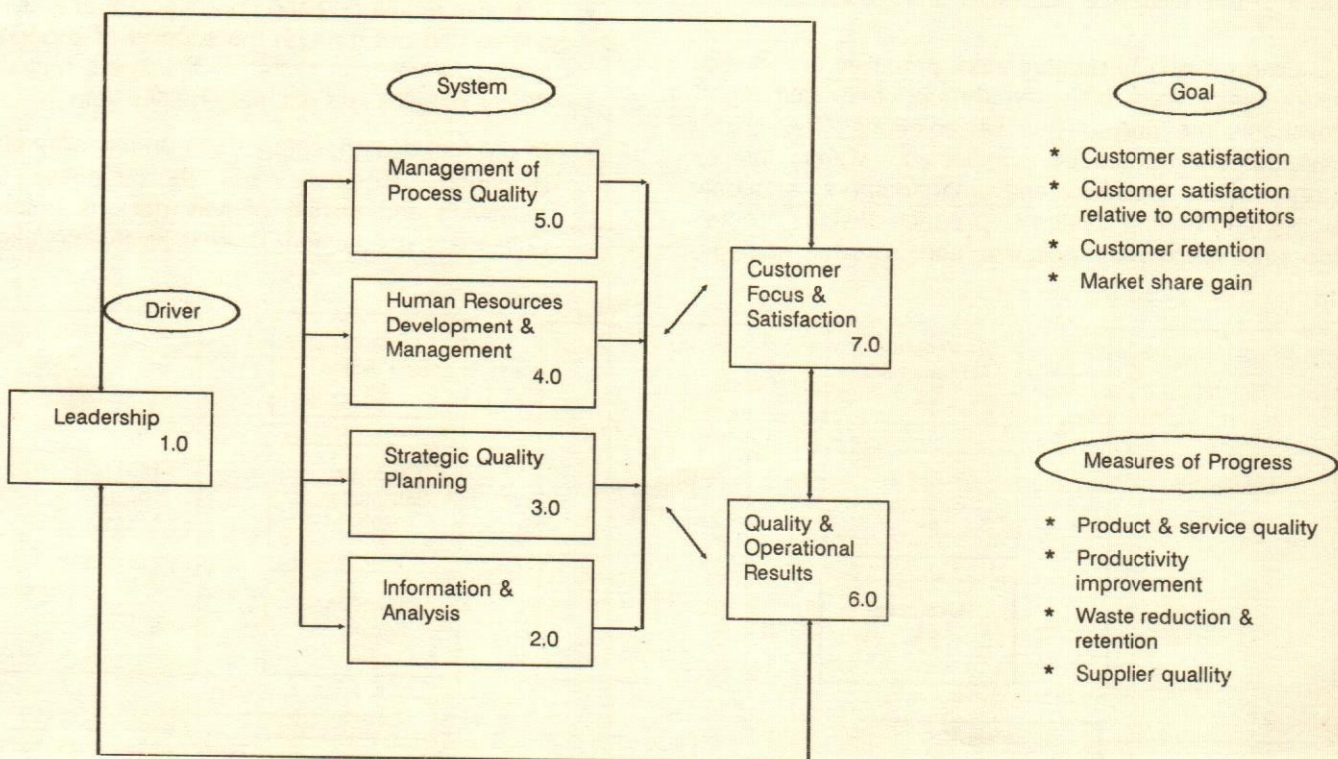


Fig. 2. Baldrige Quality Framework (NIST, 1994)

and measurement of employee satisfaction (EFQM, 1992; NIST, 1994).

Critical Factors of Quality Management

There are several empirical-based research projects that have contributed to the further understanding of TQM's basic principles by investigating the critical factors of quality management. In fact, almost all these studies have from the outset sought to utilise the critical success factor "paradigm" to understand effective TQM practices. In common with this research, the attempts were seen to empirically validate the knowledge of critical factors of effective TQM. Hence, an additional objective here is to develop an understanding of the methodologies and approaches used in these studies.

An article in *Harvard Business Review* by Garvin (1983) was the first published study in the field of quality management. It is based on a study of the quality management practices of nine US and seven Japanese window air conditioner manufacturers. The work, conducted in the early 1980s, was a systematic empirical study of the quality management practices in practice and their impact on quality performance. The findings of the study made a significant contribution to the knowledge of quality management then, as most of the available evidence had been impressionistic.

Data on quality management practices and quality performance were collected through both self report questionnaires and on-site observations. The quality management practices inspected were: quality programmes, policies and management attitudes; quality information systems; product design; production and employees policies; and supplier manage-

ment. Assembly line reject rate and after delivery service calls rate were analysed as surrogate measures of quality performance.

Garvin concluded that the high performers did especially well in several areas of quality management, as follows:

- Quality is the management's top manufacturing priority. This commitment is actively demonstrated. Quality issues form a regular agenda in management meetings.
- Quality department has more visibility with direct access to the top management. Several companies have vice presidents of quality.
- Quality is customer-driven i.e., satisfaction with the product quality is defined from the customers' viewpoint, not that of the production, marketing or design groups'.
- Employees' performance appraisal is aligned, not to the total output but to defect-free output for example, for supervisors, in terms of defect rates, scrap rates and the amount of rework attributable to their operations.
- Consistent improvement is maintained through comprehensive goal deployment process at all levels.
- Effective monitoring and improvement of quality are carried out through the support of superior quality information systems. Managers receive timely, detailed and accurate quality data.
- In product design, emphasis is on reliability engineering techniques and thoroughness in reviewing and testing of new designs before units reach production. There is involvement of

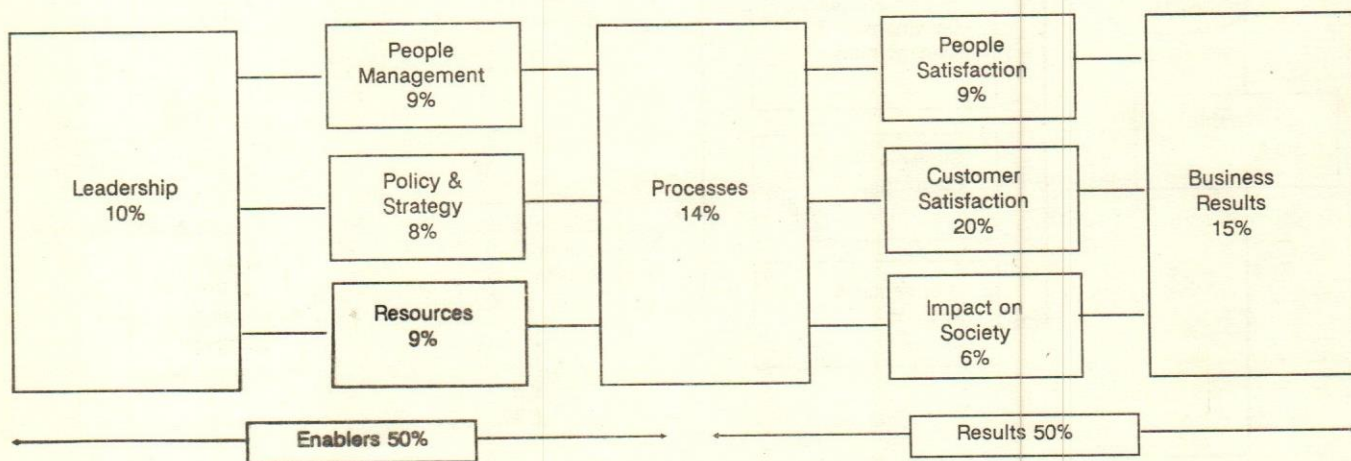


Fig. 3. The European Model for Total Quality Management (EFQM, 1992)

all affected departments at each stage of the review process.

- Training of new employees is intensive to reduce variations in the production process due to inexperience. Employees are trained in all aspects of the jobs required on the line. Training includes SPC techniques, problem identification and remedial techniques.
- Wide usage of quality techniques and tools such as SPC and control charts to control the production process.
- Effective communication especially before and during model changeovers to ensure smooth and defect-free production.
- Suppliers are selected based on their commitment to product and service quality, manufacturing capability and value for money. Careful monitoring of suppliers on their commitment to quality and quality audits of sites are common.

Garvin also concluded that the Japanese system of permanent employment, contributing to lower absenteeism and turnover, and their employees' union systems also help to improve quality in Japanese plants.

Saraph et. al. (1989) reported on their empirical work to develop an instrument for measuring the critical factors of quality management. The process involved an exhaustive review of writings of quality gurus, practitioners and academics, and focused on literature that address quality management from an organisation-wide, managerial point of view. One hundred and twenty organisational requirements (prescriptions) for effective quality management were generated from the literature. Through a judgemental process of grouping similar requirements, these were classified into eight separate categories. Saraph et. al. termed these as critical factors. Operational measures of the eight critical factors were developed using the 120 requirements. The eight critical factors identified are shown in table 7.

Table 7: Critical Factors and Associated Operational Measures

<p>Factor 1: The role of management leadership and quality policy</p> <p>Acceptance of quality responsibility by general managers and department heads</p> <p>Evaluation of top management on quality</p> <p>Participation by top management in quality improvement efforts</p> <p>Specificity of quality goals</p> <p>Importance attached to quality in relation to cost and schedule</p> <p>Comprehensive quality planning.</p>
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<p>Factor 2: Role of the quality department</p> <p>Visibility and autonomy of the quality department</p> <p>The quality department access to top management</p> <p>Use of quality staff for consultation</p> <p>Coordination between quality development and other departments</p> <p>Effectiveness of the quality department.</p> <p>Factor 3: Training</p> <p>Provision of statistical training, trade training, and quality-related training for all employees.</p> <p>Factor 4: Product/service design</p> <p>Thorough scrub-down process</p> <p>Involvement of all affected departments in design reviews</p> <p>Emphasis on producibility</p> <p>Clarity of specifications</p> <p>Emphasis on quality, not roll-out schedule</p> <p>Avoidance of frequent redesigns.</p> <p>Factor 5: Supplier quality management</p> <p>Fewer dependable suppliers</p> <p>Reliance on supplier process control</p> <p>Strong interdependence of supplier and customer</p> <p>Purchasing policy emphasising quality rather than price</p> <p>Supplier quality control</p> <p>Supplier assistance in product development.</p> <p>Factor 6: Process management</p> <p>Clarity of process ownership, boundaries, and steps</p> <p>Less reliance on inspection</p> <p>Use of statistical process control</p> <p>Selective automation</p> <p>Fool-proof process design</p> <p>Preventive maintenance</p> <p>Employee self-inspection</p> <p>Automated testing.</p> <p>Factor 7: Quality data and reporting</p> <p>Use of quality cost data</p> <p>Feedback of quality data to employees and managers for problem solving</p> <p>Timely quality measurement</p> <p>Evaluation of managers and employees based on quality performance</p> <p>Availability of quality data.</p> <p>Factor 8: Employee relations</p> <p>Implementation of employee involvement and quality circles</p> <p>Open employee participation in quality decisions</p> <p>Responsibility of employees for quality</p> <p>Employee recognition for superior quality performance</p> <p>Effectiveness of supervision in handling quality issues</p> <p>On-going quality awareness of all employees.</p>

The instrument, well grounded in the literature, was then validated by empirical research using a questionnaire survey. Respondents were asked to rate the level of current practice for the items in their organisation on a five point Likert scale (very low to very high). Data was collected from 162 managers of 20 firms in Minnesota, USA. Using reliability and detailed item analysis, the authors were able to validate this set of eight critical factors of quality management.

The study subsequently paved the way for several other empirical studies to be conducted using the instrument developed in the study (Engelkemeyer, 1991; Baker & Starbird 1992; Boltes, 1992; Black, 1993 a, b; Motwani et. al., 1994; Badri et. al., 1995). The first published study using Saraph et. al.'s (1989) instrument was by Baker and Starbird (1992). They used the instrument to evaluate the extent to which the factors critical to effective quality management are present among California food processors. The study also aimed to identify the organisational characteristics that are conducive to these factors. The study empirically confirmed the importance placed on the role of top management and their behaviour, and the quality policy in the pursuit of quality management, at least among California food processors. The results of the study also indicated that, compared to a centralised approach, company-wide sharing of responsibility for quality is generally more conducive to the pursuit of quality management.

Like Baker & Starbird, Boltes (1992) attempted to duplicated Saraph et. al.'s study in a specific industry – the Cooperative Extension System (CES). The study involved the identification of the critical factors for effective quality management in CES and the use of the instrument to identify organisational training needs. The study finding was largely consistent with the findings of earlier studies. Seven critical factors were identified:

- Administrative support for quality
- Strategic quality planning
- Continuous quality improvement
- Strategic human resources management
- Quality information and analysis
- Clientele satisfaction
- Quality in education and training.

Motwani et. al. (1994) also used Saraph et. al.'s instrument in their study of quality management practices in Indian organisations. The study, carried out in 1990, provided the opportunity to test the reliability and validity of the instrument in an international environ-

ment. The study involved interpretation of data to correlate the critical factors and the quality performance of the companies. Like Garvin's study, assembly line reject rates and after delivery reject rates were used as surrogate measures of quality performance. The study produced a few conclusions contradictory to widely accepted knowledge; notably that top management direct commitment and hands-on involvement are not essential for effective quality performance.

In the UK, Black (1993) replicated Saraph et. al.'s (1989) study using the 78 items from the original instrument, which were randomly distributed in the new instrument in an attempt to scientifically extract a set of empirical constructs from the data set. Using factor analysis, 13 factors were extracted, which were regrouped into three tiers of importance. In the second stage of his study, Black used 39 items extracted from the Baldrige criteria to build a survey instrument. Respondents were asked to assign a ratio score of importance to each of the items. Once again, using factor analysis, the items were grouped into ten critical factors, which rerouted into three tiers of importance. The ten factors are: people and customer management; supplier management; communication of improvement information; customer satisfaction orientation; external interface management; strategic quality management; teamwork structures for process improvement; operational quality planning; improvement measurement systems; and corporate quality culture.

While studies by Saraph et. al., and Black had sought to use the critical success factor "paradigm" to understand TQM practices, none was directed to empirically validate the factors as being absolutely essential to the success of TQM. The assumption in the studies was that the items ultimately incorporated in the instrument on the basis of synthesis from the literature (Saraph et. al., 1989) or national award criteria (Black, 1989) were critical.

A study by Ramirez and Loney (1993) at the University of San Francisco was the first reported attempt to empirically validate the criticality of the numerous factors, cited in the literature. The study was carried out to answer the question: what factors do we really need to have a successful quality process? Through a self-report questionnaire survey, managers of 37 quality award winning organisations, including Baldrige winners, and 26 quality consultants were asked to rate each of the 22 quality factors. They were asked to identify each as to its level of importance based on their experience in implementing the quality management process in their organisations. Using a 3-point scale, respondents were asked to indicate if the factor was either critical and absolutely essential to the successful

implementation of TQM, important, but not essential to a TQM process or neutral regarding the factor. Each of the criteria used was defined. Using the weighting scores of 3, 2 and 1 for critical, important and neutral respectively, each of the quality factors was given a total score. Ramirez and Loney were then able to rank the quality factors in the order of critically based on their total scores, and categories each factor as either critical, important or neutral based on the response profile. The findings are shown in Fig. 4.

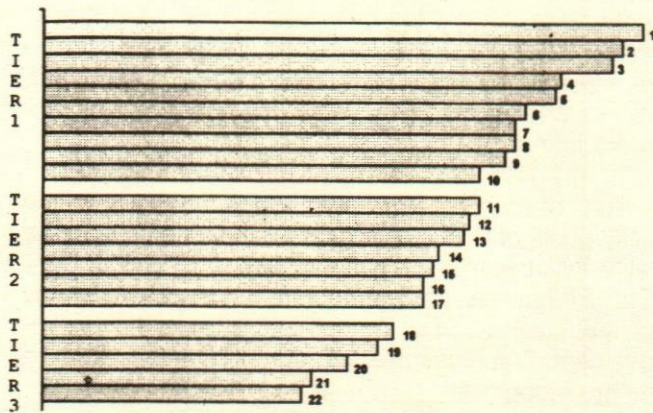


Fig. 4. Criticality of quality factors (Ramirez & Loney 1993)

Key:

Tier 1

1. Management commitment
2. Customer satisfaction
3. Clear vision statement
4. Cultural change
5. Education
6. Participative management
7. Strategic quality planning
8. Goal clarity
9. Error prevention
10. Top management steering committee

Tier 2

11. Problem solving
12. Measurement
13. Problem identification
14. Goal setting
15. Recognition scheme
16. QCCs/Improvement teams
17. Vendor partnership

Tier 3

18. Project improvement process
19. Publicized successes
20. SPC
21. Cost of quality
22. Zero defects attitude

The ten first tier factors ranked by the respondents as critical to the success of the TQM process are primarily related to management support and related activities. The results have not only clearly validated the criticality of top management commitment, but also management support activities such as creating a vision and designing the strategic quality plans, and the visibility of management commitment through participative management and the provision for education and training.

The seven "important" factors in the second tier can be categorised as tools and processes primarily related to usage at the shop floor level in the organisation. It is remarkable to find important tools and techniques such as SPC and cost of quality, and zero defects attitude as the bottom-most or neutral factors. As pointed by Ramirez et. al., these are tools and concepts taught by quality gurus.

The systematic empirical ranking and categorisation of quality factors in terms of their importance as identified by quality leaders and quality experts is a significant contribution of Ramirez & Loney's (1993) study to the knowledge of quality management. While the study reconfirmed the need for emphasis on management related factors to have a successful quality management process, it also placed many of the other factors in proper perspective. Companies, overwhelmed by the differing emphasis in the literature regarding quality management implementation, could use the 3-tier ranked list as a blueprint to prioritise resources allocations. For example, a third tier quality factor could be deferred until the organisation had implemented the critical and important ones.

In the last six years or so, studies have begun to gather and analyse data about the experiences of several TQM organisations on international basis to identify the common denominators of successful TQM initiatives (Johnston & Daniel, 1991; Binney, 1992; Harrington, 1993). Once again, strong evidence emerged on the need for leadership, greater employee involvement, continuously improving, managing-by-fact, effective communication, education and training, process and systems and TQM to be part of the organisation's strategy and planning process.

Summary

Three dimensions of quality

Based on the literature review and reflecting on Kano's three levels of quality model (Kano, 1993), the evolution of the basic principles and essentials of quality

management can similarly be traced along the three dimensions of quality:

Quality as conformance to requirement can be traced to the original teachings of quality gurus and the early management policies and practices used by organisations in Japan. Deming (1986) then emphasised the control of variation in production and Juran (1974) put emphasis on managing for quality rather than inspecting it into finished products.

In the last decade, the introduction of quality award frameworks, including writings by quality authorities such as Akao (1988) has made quality as conformance to requirements to *level of performance of quality from the customer perspective*. This involves determining the wants of the customers, systematically bringing these needs into focus in the organisation, and mobilising all individuals, aligning processes and continuously improving activities to satisfy them.

In recent years, enlightened organisations, led by the changes in the quality award frameworks (Neves & Nakhai, 1994), are defining *quality as delighting the customers* and achieving it by breakthrough performance, invention, innovation, and creativity (Vandermerwe, 1993).

Key principles and components of TQM

While there is a myriad of philosophies, models, practices and techniques of TQM, the key principles and components of TQM can be summarised into a coherent framework:

Goal: To succeed in the marketplace by satisfying customer needs better than the competition. Having quality "built in" rather than inspected is the means (Juran, 1988).

Definition of quality: The ability to satisfy customers, within the organisation and outside in the marketplace. Managing to satisfy the customer begins with listening to the customers and serving them effectively (Deming, 1986).

Theme: Continuous improvement embodies the fundamental principle of TQM (Kanji & Asher 1993). Both incremental and breakthrough improvement are encouraged by using improvement tools and techniques, and learning from within the organisation and through external benchmarking. Education and skills training reinforce this role for everyone in the organisation.

Role of top management: The top management is the main driver of TQM (Zairi, 1992). Senior executives

assume responsibility for determining and communicating quality policies, establishing a system of quality management, actively demonstrating commitment to quality as the number one corporate priority, and creating an enabling environment that can produce quality outcomes. Success of TQM resides primarily with the top management.

Role of middle management: Middle managers have a distinct place in TQM (Ishikawa, 1985). While senior executives may champion the quality caused, middle managers are the ones who actually lead quality efforts. Supervisors and divisional managers assume new roles as facilitators of continuous improvement, coaches of new methods, mentors and leaders of empowered employees.

Role of employees: Employee commitment to the quality goals of the organisation and participation in the quality initiatives is the cornerstone of TQM (Crosby, 1979). Employees are empowered and work in teams and are involved in a programme of continuous improvement. Employee needs are tracked and quality efforts are recognised.

Structural rationality: Managing through well defined horizontal customer-driven processes is an essential feature of TQM (Oakland, 1993). Business processes provide the framework for the deployment of people and other resources to satisfy the customer.

Role of external customers and suppliers: TQM blurs the boundaries between the organisation and the external customers and suppliers (Deming, 1986). Customers and suppliers are considered part of business processes. Customer needs drive key processes while suppliers assume an important role in the organisational goal of satisfying the customers.

Organisations seek partnerships with fewer suppliers and invest time and other resources in an effort to develop the necessary closeness.

Orientation: TQM focuses every aspect of the organisation's activity toward a customer-oriented, 'right-first-time' approach. The entire organisation understands the internal relationship and the interdependence of each individual and process as "customers and suppliers".

Emphasis: TQM calls for pro-active and systematic reviews and measurement of key processes that add value.

Belief: The results belong to the process, not the individual (Deming, 1986).

Philosophy towards change: Creation of a continuous improvement culture by improving management practices. Deming differs from the others by calling for a total transformation of existing management methods to achieve this.

TQM is now adopted by many organisations that take a strategic view of quality and recognise that continuously satisfying the customer is the route to success in the marketplace. They set their vision on satisfying the customer by having in place the prerequisites and the supporting practices and techniques. Experiences of as enumerated in literature are the cornerstones on which the edifice of success can be built by many an aspirant.

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The Cost Minimisation Problem Under Inflationary Situation

J.R. Purohit & B.B. Jani

This paper, considers the problem of the changing behaviour of the relevant cost associated with the cost minimisation problem for the probabilistic order-level system under inflationary situation. Numerical illustration is given in support of the theoretical results.

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Inventory management is crucial for any businessman. Not only does it help him run his business smoothly and efficiently in turn earning a sizable profit for him but also assists him in building up and carrying forward the goodwill of his customers that can prove to be an asset for the future.

Inventory management is crucial for any businessman. Not only does it help him run business efficiently earning a sizable profit for him but it also assists him in building up goodwill.

In the standard models, the usual assumption is that the relevant costs associated with inventory are fixed and do not change even with the passage of time. However, in everyday life this hardly holds, because the value of money changes day by day and it is unrealistic to consider such costs as fixed forever. The changing feature of costs is due to the changing price behaviour of the goods concerned. Inflation is one such economic force which causes price fluctuations and it is essential to visualise the effect of inflationary forces on the cost structure of the inventory system and thereby the solution pattern as well, as the decision making approach will also change accordingly.

Hence an attempt was made to study a pattern of changing behaviour of the relevant cost associated with the Cost Minimisation Problem for the probabilistic order-level system under Inflationary situation.

Methodology

The model is derived under the following assumptions:

- Order is realised as soon as it is placed. i.e. lead-time is zero
- The order level is S units. It is expressed in packages of 100 units each
- The scheduling period is prescribed and is t_p (time units) years
- Demand rate is D (units/year). Here we have the inventory system in which demand is assumed to occur with a uniform pattern
- Inflation rate is i (Rs./year)
- Nominal annual rate of interest is r (Rs./year) [$r > i$]
- Initially the purchase cost per item is C_0 (Rs./unit/year)
- Unit inventory holding cost is C_1 (Rs./unit/year)
- Unit shortage cost is C_2 (Rs./unit/year)
- $f(x)$ is the probability density of demand x during the scheduling period t_p
- The expected total inventory cost equation is a real and continuous function of the order level S .

Formulation of the model

A warehouse attached to an industrial unit operates to exercise control over produced goods. The items produced are stored in the warehouse and are constantly demanded by the consumers.

When the demand X and the order level S are constrained to discrete units $0, U, 2U, 3U...$ etc., let $P(x)$ be the probability distribution of the demand X during scheduling period t_p . Let $E(x)$ be its mean and the average rate of demand be given by D .

The problem is to determine the optimum value of the decision variable i.e. the order level S so that the total cost of the inventory system is minimum.

Derivation

Under the above assumptions the model is derived as follows :

Expected total inventory cost = $C(S)$

Hence, $C(S) = \{\text{Expected inventory holding cost}\} + \{\text{Expected shortage cost}\}$

$$= C_1 + C_2$$

We find that under inflationary situation:

$$C_1 = C_0(r + C_1)$$

$$\left[\sum_{x=0}^S (1 + (i/2)) (1 - (x/D)) (s - (x/2)) P(x) + \right.$$

$$\left. \sum_{x=S+U}^{\infty} (1 + (i/2)) (1 - (x/D)) (S^2/2x) P(x) \right]$$

$$\{\text{Expected Shortage Cost}\} = C_2 \sum_{x=S+U}^{\infty} (1 + (i/2)) (1 - (x/D)) ((x - s)/2x) P(x)$$

Hence the expected total cost equation of the system is :

$$C(S) = C_0(r + C_1) \left[\sum_{x=0}^S (1 + (i/2)) (1 - (x/D)) (s - (x/2)) P(x) + \sum_{x=S+U}^{\infty} (1 + (i/2)) (1 - (x/D)) (S^2/2x) P(x) \right] + C_2 \left[\sum_{x=S+U}^{\infty} (1 + (i/2)) (1 - (x/D)) ((x - s^1)/2x) P(x) \right] \quad (1)$$

Hence,

$$C(S) = (1 + (i/2)) [C_0(r + C_1) \left\{ \sum_{x=0}^S (S - (x/2)) P(x) + \sum_{x=S+U}^{\infty} (S^2/2x) P(x) \right\} + C_2 \sum_{x=S+U}^{\infty} ((x-s)^2/(2x)) P(x) \right] - (i/2D) [C_0(r + C_1) \left\{ \sum_{x=0}^S x(S - (x/2)) P(x) + \sum_{x=S+U}^{\infty} (S^2/2) P(x) \right\} + C_2 \sum_{x=S+U}^{\infty} ((x-S)^2/(2x)) P(x) \right] \quad (2)$$

The necessary conditions for S_0 to be the optimum order-level are:

$$C(S_0) \leq C(S_0 + U) \quad (3)$$

$$\text{and } C(S_0) \leq C(S_0 - U) \quad (4)$$

To find the conditions for our system, we first evaluate the difference... $C(S + U) - C(S)$ and after simplification we can get :

$$C(S + U) - C(S) = U [C_0(r + C_1) + C_2] M(S) - U C_2 [1 + (i/2) - ((iE(x))/2D)], \quad (5)$$

with

$$M(S) = (1 + (i/2)) \left[\sum_{x=0}^S P(x) + (S + (U/2)) \sum_{x=S+u}^{\infty} (P(x)/x) \right] - (i/2D) \left[\sum_{x=0}^S x \cdot P(x) + (s + (U/2)) \sum_{x=s+u}^{\infty} (P(x)) \right] \quad (6)$$

Applying this result in Eqs. (3) and (4) we obtain the necessary conditions for finding SO as follows :

$$M(S_0 - U) \leq \frac{C_2[(1 + (i/2)) - (iE(x)/2D)]}{(C_0(r + C_1 + C_2))} \leq M(S_0) \quad (7)$$

Solution of the model

To illustrate the use of the above model, let us consider a numerical example... Example : An item is ordered every week.

The demand for the item during the week is with probabilities

$$P(0) = 0.04, P(5) = 0.20, P(10) = 0.37, P(15) = 0.30 \text{ and } P(20) = 0.09.$$

$$\begin{aligned} i &= 0.09 & (\text{Rs./Week}) & & C_0 &= 10 & (\text{Rs./Unit/Week}) \\ r &= 0.1 & (\text{Rs./Week}) & & C_1 &= 5 & (\text{Rs./Unit/Week}) \\ D &= 5 & (\text{Units/Week}) & & C_2 &= 150 & (\text{Rs./Unit/Week}) \\ U &= 5 \end{aligned}$$

To find the values of M(S) of Eq. (6) it is best to proceed as in table 1, but...

$$\frac{C_2[(1 + (i/2)) - (iE(x)/2D)]}{(C_0(r + C_1 + C_2))} = 0.7059701 \quad (8)$$

Table 1: Values of Expected total inventory cost

X, S	P(x)	M(s)	C(s)
0	0.04	0.2853687	767.05
5	0.20	0.8725062	341.21
10	0.37	0.8713062	307.58
15	0.30	0.9362687	473.74
20	0.09	0.946	705.19

Hence by Eqs. (7), (8) and table 1,

$$S_0 = 5 \text{ or } S_0 = 10$$

$$\begin{aligned} \text{Since } M(S) &= 0.6725062 < 0.7059701 \\ &< M(10) = 0.8713062 \end{aligned}$$

We have calculated C(S) of Eq. (2) for all values of S. This is shown in the last column of table 1. From the table we see that the least cost of the system occurs when S = 10.

Hence we can say that the optimum order level is S = 10 which gives the minimum cost at Rs. 307.58.

Application of the Model

This model is applicable to all those situations in which the order level and demand size are discrete in nature. For this particular situation, we can use it for inventory problems pertaining to the situation where some fixed number of packages of goods are to be stored (e.g. package of biscuits bread packets, other food items, pharmaceutical products like pills prepared in tin foils etc.) we may apply it also in the case of storage and sales of newspaper, magazines, books etc. when shortage arises due to the probabilistic nature of the demand. □

Optimum Production Plan for A Silk Filature Unit

Basab Bhattacharya, P. Kumaresan & H.M. Muni Krishnappa

The prime objective of the study is to optimize the purchase, production and sales of a filature unit. The loss of Rs. 52.60 lakhs is inevitable as per the parameters included in the optimization model. The model recommends production of only the multivoltine silk and cessation of the production of bivoltine silk. The model also indicates that the existing reelers and rereelers are not sufficient to reach the optimum level of production and so recommends hiring 435 reeler and rereeler mandays during the peak periods of production.

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Silk reeling constitutes an important segment in the silk industry, and the successful working of the reeling units is essential for the development of the industry. The government owns large scale filature (reeling) units to protect the larger interests of the industry. However, owing to various reasons, the performance of these units has not been so encouraging over the years. The present study was therefore undertaken to develop an optimum production plan for a Government owned filature unit to improve its performance.

Methodology

A government filature unit located in Mysore district of Karnataka was selected for the study. The data pertaining to the purchase of raw materials, production of different deniers of silk, renditta obtained for different types of silk, receipt and disposal of inventory, reeling and re-reeling productivity, silk waste generated, absenteeism of workers, etc., were collected from the monthly progress reports and relevant registers of the unit.

Linear Programming (LP) Model Formulation

Very little work has so far been done in developing an optimal production plan for the filature units. Ramakrishnan (1989) suggested a model for vertical integration of future silk reeling plants in order to reduce the cost of production and lower the renditta by the way of utilization of bivoltine cocoons in fully automated reeling machine. Ram (1990) and Virani (1991) developed a linear programming model for optimizing the purchase, production and sales of the filature unit. In the present study, the LP model formulated to optimize purchases, production and sales of filature unit is as follows:

Objective function

$$\text{Max Net Profit } Z = \sum_{t=1}^{12} [(SPM_t * SSM_t + SPB_t * SSB_t + SPD_t * SSD_t + SPSW_t * SW_t + SPDP_t * DP_t) - (PPM_t * QPM_t + PPB_t * QPB_t + HR_t * RH_t + HR_t * RRH_t + OVC_t * (SM_t + SB_t + SD_t) + IC_t (QIM_t + QIB_t) + IF_t (SMI_t + SBI_t + SDI_t) + TFC * FC)]$$

where,

SPM_t = Estimated sale price of multivoltine silk in period t

SPB_t = Estimated sale price of bivoltine silk in period t

SPD_t = Estimated sale price of dupion silk in period t

PPM_t = Estimated purchase price of multivoltine cocoon in period t

PPB_t = Estimated purchase price of bivoltine cocoon in period t

$SPSW_t$ = Estimated sale price of silk waste in period t

$SPDW_t$ = Estimated sale price of dead pupae in period t

HR_t = Wages for hired labour per day in period t

OVC_t = Other variable costs per unit of silk produced in period t which include wages, power, fuel, stationary etc.

TFC = Total fixed cost which includes salary, depreciation, etc.

IC_t = Inventory carrying cost of cocoon in period t

IF_t = Inventory carrying cost of silk in period t

Decision variables are:

SSM_t = Quantity of multivoltine silk to be sold in period t

SSB_t = Quantity of bivoltine silk to be sold in period t

SSD_t = Quantity of dupion silk to be sold in period t

SW_t = Quantity of silk waste generated in period t

DP_t = Quantity of dead pupae generated in period t

QPM_t = Quantity of multivoltine cocoon to be purchased in period t

QPB_t = Quantity of bivoltine cocoon to be purchased in period t

RH_t = Quantity of reeler days to be hired in period t

RRH_t = Quantity of re-reeler days to be hired in period t

SM_t = Quantity of multivoltine silk to be produced in period t

SB_t = Quantity of bivoltine silk to be produced in period t

QIM_t = Quantity of multivoltine cocoon in inventory in period t

QIB_t = Quantity of bivoltine cocoon in inventory in period t

SMI_t = Quantity of multivoltine silk in inventory in period t

SBI_t = Quantity of bivoltine silk in inventory in period t

SDI_t = Quantity of dupion silk in inventory in period t

FC = Fixed cost.

Balancing constraints for cocoon

$$QPM_t + QIM_{(t-1)} = QIM_t + CCM_t$$

$$QPB_t + QIB_{(t-1)} = QIB_t + CCB_t$$

where

CCM_t and CCB_t are the quantity of multivoltine and bivoltine cocoons consumed in period t.

QIM_0 and QIB_0 are equal to zero.

Quality classification constraints

$$a_t * CCM_t = CCSM_t$$

$$b_t * CCB_t = CCSB_t$$

$$C_t (CCM_t + CCB_t) = CCD_t$$

where

a_t and b_t are the proportion of good quality cocoon in a lot of multivoltine and bivoltine cocoons respectively in period t

C_t is the proportion of double cocoons in period t

$CCSM_t$, $CCSB_t$ and CCD_t are the quantity of cocoon consumed for manufacturing multivoltine, bivoltine and dupion silks respectively in period t.

Yield constraints

$$RM_t * SM_t = CCSM_t$$

$$RB_t * SB_t = CCSB_t$$

$$RD_t * SD_t = CCD_t$$

where

RM_t , RB_t and RD_t are the renditta for producing multivoltine, bivoltine and dupion silks in period t

SM_t , SB_t and SD_t are the quantity of multivoltine, bivoltine and dupion silks produced in period t

Conversion constraints for by-products

$$d_t (SM_t + SB_t) = SW_t$$

$$e_t (CCSM_t + CCSB_t) = DP_t$$

where

d_t and e_t are the proportion of silk waste and dead pupae generated in period t

Capacity constraints

$$SM_t + SB_t \leq CF_t$$

$$SD_t \leq CC_t$$

where

CF_t and CC_t are the capacity for production of filature and charaka silks respectively in period t

Labour requirement constraint

$$\frac{SM_t}{P_t} + \frac{SB_t}{q_t} + \frac{SD_t}{r_t} = RB_t$$

where

P_t , q_t and r_t are the reeler productivity per day per basin for multivoltine, bivoltine and dupion silks in period t

s_t and r_t are the rereeler productivity per day per basin for multivoltine and bivoltine silks in period t

RR_t and RRR_t are the required reeler and rereeler days in period t

Labour balancing constraints

$$RE_t + RH_t = RR_t$$

$$RRE_t + RRH_t = RRR_t$$

where

RH_t and RRH_t are the labour to be hired for reeling and rereeling in period t

Labour availability constraints

$$RE_t \leq RMAX_t$$

$$RRE_t \leq RRMAX_t$$

$$RH_t \leq RMAX_t$$

$$RRH_t \leq RRMAX_t$$

where

RE_t and RRE_t are the existing reeler and rereeler days available in period t

$RMAX_t$ and $RRMAX_t$ are the maximum reeler and rereeler days available in period t

Silk balancing constraints

$$SM_t + SMI_{(t-1)} = SSM_t + SMI_t$$

$$SB_t + SBI_{(t-1)} = SSB_t + SBI_t$$

$$SD_t + SDI_{(t-1)} = SSD_t + SDI_t$$

where

SMI_0 , SBI_0 and SDI_0 equal to zero.

Budget constraints

$$(PPM_t * QPM_t) + (PPB_t * QPB_t) + (HR_t * RH_t) + (HR_t * RRH_t) + OVC_t (SM_t + SB_t + SD_t) + FC_t = BUD_t$$

$$\sum_{t=1}^{12} BUD_t \leq BUDGET$$

where

BUD_t is the budget allotted to the period t

$BUDGET$ is the annual budget for the planning period.

Fixed cost constraint

$$FC = 1$$

Non negativity constraint

All variables ≥ 0

Decision variables included in the LP model are quantities of multivoltine and bivoltine cocoons to be purchased, consumed and kept in inventory as well as the quantities of multivoltine, bivoltine and dupion silks to be purchased, sold and held in inventory for each month of the year, 1994-95.

The parameters used in the LP model are as follows:

- The estimated purchase price of multivoltine and bivoltine cocoons and estimated sales price of multivoltine, bivoltine and dupion silks obtained through trend equation.
- The assumed composition of cocoon was 90 per cent good cocoon, 8 per cent double cocoon and remaining 2 per cent defective cocoons.
- The assumed renditta for multivoltine, bivoltine and dupion silks was 9.8, 10.10 and 12.5 respectively. The assumed reeling productivity for multivoltine, bivoltine and dupion silks were 0.95 kg/day/basin, 0.8 kg/day/basin and 1.2 kg/day/basin respectively.
- The labour absenteeism was to the tune of 15 per cent through out the year. The average number of working days was 25 per month and the filature unit worked one shift per day.
- The maximum number of reelers and rereelers that can be hired on any given day was 20 and 6 respectively.
- The number of working basins was 100 per day which was the licensed capacity of the unit.

The model constraints were selected based on the following considerations:

- Multivoltine and bivoltine silks are reeled out of good multivoltine and bivoltine cocoons respectively whereas dupion silk is produced from double cocoons.
- Multivoltine and bivoltine silks are reeled in cottage basins while dupion silk is reeled in charaka unit.
- Multivoltine and bivoltine silks require rereeling whereas no rereeling is required for dupion silk.
- The work load in the filature unit should be such that no reeler or rereeler in the permanent labour force remains idle. The unit can go for hiring additional reelers or rereelers at the rate of Rs. 35.00 per day whenever its requirement exceeds the permanent work force force available within the unit.

Performance of the Unit

Purchase of cocoons

The multivoltine cocoons required for the unit were mainly purchased from government regulated cocoon markets at Vijayapura, Ramanagaram, Tumkur, Siddlaghatta and Kollegal. Bivoltine cocoon was purchased from seed markets such as Bangalore, K.R. Pet, Sarjapura and Hassan. The purchase programme of cocoons was monitored by the head office located at Bangalore. The Purchasing Assistants examined the cocoon lot in terms of percentage of defective cocoons, size, shape, compactness and uniformity of the cocoons and assessed the raw silk yield. Based on the assessment, they purchased the cocoons in auction. The purchase frequency of the unit was 4-5 times a week.

Production of raw silk

The unit mainly concentrated on the production of multivoltine silk with meagre quantity of bivoltine silk. The production of bivoltine silk ranged from 0 to 10.00 per cent in the period from 1984-85 to 1989-90. However, the production of bivoltine silk gained momentum from 1992-93 and in the year 1993-94 it reached its zenith (25.4%). The unit was mainly engaged in the production of 20/22 and 26/28 denier sizes of both multivoltine and bivoltine silks followed by a meagre quantity of 13/15, 18/20 and 28/32 denier sizes of multivoltine silk over the years.

Sale of raw silk

The average inventory of silk level was very high with 9,643 kg during 1992-93 which was one of the major contributing factors for the heavy loss (Rs. 116.72 lakh) that the unit suffered during that period. The overall picture of the average inventory level of raw silk of the unit reflects that the production of the unit was not disposed of in an efficient manner. However, the minimum closing balance of raw silk during 1993-94 bears the evidence of some improvement made over the disposal trend.

The average inventory level of raw silk reflects that the production was not disposed of in an efficient manner.

Manpower utilization

The number of working days was maximum with 296 days during 1993-94. However, the percentage of

absenteeism in the same year was 15.55 which was higher by more than 5 per cent than the industrial standard.

Optimum Purchase, Production & Sales Plan

The optimal values for the purchase, consumption and inventory of multivoltine cocoon are presented in table 1. The optimal values for the production, sales and inventory of multivoltine and dupion silks are presented in tables 2 and 3 respectively. Under the optimal plan, the loss would be nearly Rs. 52.6 lakh as against the current loss of Rs. 75 lakh in 1993-94. It implies that even though the loss can not be averted completely, it can be considerably minimized by employing the optimizing model in decision making.

Table 1: Optimal quantity of multivoltine cocoons to be purchased, consumed and kept in inventory

Month	Optimal quantity of Multivoltine cocoons to be (Kg.)			Minimum reduction in price (Rs/Kg)
	Purchased	Consumed	Inventory	
April 94	12250	12250	-	0.00
May	12250	12250	-	0.00
June	18188	18188	-	0.00
July	19926	19926	-	0.00
August	24005	24005	-	0.00
September	24005	24005	-	0.00
October	24005	24005	-	0.00
November	19926	19926	-	0.00
December	64352	19926	44426	0.00
January 95	-	19926	24500	5.00
February	-	12250	12250	9.00
March	-	12250	-	6.00

Table 2: Quantity of multivoltine silk to be produced, held and sold

Month	Optimal quantity of multivoltine to be (Kg)			Reduction in price of sales (Rs/Kg)	Reduction in cost of inventory (Rs/Kg)
	Produced	Sold	inventory		
April 94	1125	-	1125	187.00	0.00
May	1125	-	2250	119.00	0.00
June	1670	-	3920	9.00	0.00
July	1830	5750	-	0.00	41.00
August	2205	2205	-	0.00	27.00
September	2205	2205	-	0.00	28.00
October	2205	2205	-	0.00	47.00
November	1803	1830	-	0.00	34.00
December	1830	0.00	1830	13.00	0.00
January 95	1830	3660	-	0.00	21.00
February	1125	1125	-	0.00	6.00
March	1125	1125	-	0.00	1034

Table 3: Quantity quantity of dupion silk to be produced, held and sold

Month	Optimal quantity of dupion silk to be (Kg)			Reduction in sales price (Rs/Kg)	Reduction in cost of inventory (Rs/Kg)
	Produced	Sold	inventory		
April 94	150	-	150	30.00	0.00
May	150	-	300	34.00	0.00
June	223	-	523	10.00	0.00
July	245	768	-	0.00	19.00
August	295	-	295	5.00	0.00
September	295	-	590	17.00	0.00
October	295	-	885	11.00	0.00
November	245	1130	-	0.00	22.00
December	245	2450	-	0.00	5.00
January 95	245	2450	-	0.00	8.00
February	150	150	-	0.00	11.00
March	150	150	-	0.00	354.00

As suggested by the model, purchase of multivoltine cocoon should be made in all the months excepting the last three months, i.e., January, February and March of the year 1994-95.

A bulk quantity of cocoon should be purchased during the month of December when the price of cocoon is expected to be low and that should be consumed in the ensuing three months. It is noteworthy that the model has suggested complete cessation of the purchase of bivoltine cocoon and the subsequent production of bivoltine silk. This is expected a priori, in view of the fact that the average estimated sale price of bivoltine silk was less than that of the multivoltine silk and the estimated purchase price of bivoltine cocoon was on the higher side than that of multivoltine cocoon was on the higher side than that of multivoltine cocoon for most of the months during the planning period. The low reeling productivity and high renditta of the bivoltine silk as assumed in the model based on the current performance and in view of the old machineries of the unit might be the other reasons for such discontinuance of bivoltine silk production.

A bulk quantity of cocoon should be purchased during the December when the price is expected to be low and should be consumed in the ensuing three months.

The dupion silk should be produced throughout the year and the same should be sold during the months of July, November, December, January, February and March.

The model recommends the hiring of an additional 435 number of reelers during the months of August, September and October (table 4). This comes to about 17 reelers per day. It is quite justified since the unit is supposed to produce the maximum quantity of multivoltine silk during that period as per suggestions given by the model.

Table 4: Hiring of additional reelers and rereelers

Month	Reelers to be hired	Rereelers to be hired	Reduction in cost in cost in hiring reeler	Reduction in cost in hiring rereeler
April 94	-	-	31.00	31.00
May	-	-	31.00	31.00
June	-	28	31.00	0.00
July	-	65	19.00	0.00
August	435	150	0.00	0.00
September	435	150	0.00	0.00
October	435	150	0.00	0.00
November	-	65	17.00	0.00
December	-	65	23.00	0.00
January 95	-	65	24.00	0.00
February	-	-	31.00	31.00
March	-	-	31.00	31.00

Table 5: Optimal budget allocation for the year 1994-95

Month	Budget allocated (Rs.)
April 94	1747848
May	1726778
June	2489902
July	2699305
August	3069400
September	2951535
October	2903045
November	2391845
December	6004405
January 95	681187
February	417375
March	417375

The model also considers the existing force of rereelers to be inadequate for achieving the planned production and therefore suggests hiring additional rereelers for the period from June 1994 to January 1995. The total quantity of silk waste generated in the process is 5,026 kg and the quantity of dead pupae is 39,403 kg. The total quantity of silk to be produced as suggested

by the model is 20,103 kg. The budget has been optimally allocated as shown in table 5. The maximum amount has been allocated in the month of December in view of the purchase of bulk quantity of the cocoon during that month.

Implications of Shadow Price

The model suggests the sale of multivoltine silk in the months of July, November, December, January, February and March. Selling of multivoltine silk in other months reduces the contribution margin by an amount equally to the shadow cost shown in the model. Thus, if the silk is required to be sold in the month of May, the contribution margin would be reduced by an amount of Rs. 119 per kg silk sold in that month. Similar interpretation can be given for dupion silk. The shadow costs for the sale of multivoltine and dupion silks are presented in tables 2 and 3 respectively.

As regards the inventory of multivoltine silk, the model recommends the production of first three months i.e., April to June to be held in the inventory and the accumulated silk including the production of July to be sold in the month of July leaving the inventory level at the end of that month at zero. However, if this inventory happens to be carried over to the next month, i.e., August, the contribution margin would be reduced by an amount of Rs. 28 per kg of silk held from July to August. Similar interpretation can be given for dupion silk inventory decisions.

Summary & Conclusion

This study was undertaken to optimize the purchase, production and sales of a filature unit. The loss of Rs. 52.60 lakhs is inevitable as per the parameters included in the optimization model. The model recommends production of only the multivoltine silk and cessation of the production of bivoltine silk. The model also indicated that the existing reelers and rereeler days during the peak periods of production.

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Crop Diversification & Its Implications – A Micro Analysis

N. Ajjan & K.N. Selvaraj

This study examines the impact of crop diversification (from potato to tea) on the small tea growers. In addition to the better economics of the change, there are other indirect benefits such as establishment of tea nurseries, industrial development and conservation of soil and ecology, concludes the study.

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Shifting from low value crops to high value ones is induced by changes in the domestic and international economic environment. Changes in the domestic and foreign demand have a significant bearing on the product mix (Rao, 1995). There are many social and economic factors that affect crop diversification, both at the micro and macro levels (Singh, *et. al*, 1986; Pope & Prescott, 1980). Among the many factors, relative product price (GOI, 1992; 1993), associated risk (Mythili, 1992) and economics of replaced crops (Gupta & Tiwari, 1985) play a significant role in crop diversification. Such crop diversification possesses either positive or negative effect on income and employment and may be capital intensive (Saini & Singh, 1986). Considering the influential factors, an attempt was made to analyse the impact of crop diversification among the small tea growers in Nilgiris district of Tamil Nadu.

Tea occupies the foremost position in Indian economy and was grown in an area of 4.25 lakh ha during 1992-93. Estimate shows that domestic tea consumption has been rising at the rate of six to eight per cent per annum compared to the population growth of two per cent and per capita income growth of four per cent (The Hindu, 1995). At this rate of consumption, by the turn of the present century, the entire production would be absorbed by domestic consumption, leaving hardly anything for export. As Singh (1991) observed the magnitude of growth rate of tea consumption has remained substantially higher than that of tea production during different periods. Therefore, a strong production base with increasing productivity and value addition is essential to cope with domestic consumption and maintain export share.

A strong production base with value addition is essential to cope with domestic consumption and maintain export share.

In South India, production from small tea growers (owning less than 10.12 ha) constitutes 29 per cent of the total production. However, productivity¹ is low among small tea growers compared to the large estates. This might be due to non-adoption of improved package of practices because of poor resource base. Swaminathan (1986) identified high investment and lack of income during the initial phase as the major reasons for diversification from potato to tea in Nilgiris district. In addition, erratic rainfall², high cost of cultivation of potato, market fluctuations and crop calamities influenced the conversion to the alternate cropping system.

With view of exploiting the potentialities of the small tea growers in the Nilgiris district, Tea Board, Coonoor formulated and implemented the Special Input and Interest Subsidy scheme (Crop Diversification Scheme). The present study was taken up to examine the emerging scenarios in the area, productivity and price of potato and tea, to assess the impact of the scheme on the area, productivity and production of tea, and to study the impact of the scheme on the income, employment and living conditions of the small tea growers and other indirect benefits of the scheme.

Methodology

The crop diversification scheme was introduced in 1987 on a pilot basis in Nilgiris to encourage the vegetable growers to take up tea cultivation as a regular and assured source of income. The scheme was converted into a regular plan scheme from 1991 with the target of covering 1250 ha during the Eighth Plan, out of projected 2500 ha.

For the present study, beneficiaries who received both the instalments of subsidy³ were listed out and 100 beneficiaries (constituting 22 per cent of the total beneficiaries) were selected at random and primary data were gathered through personal contact. Secondary data on area, production, productivity and export price of tea were collected from various issues of 'Tea Statistics' published by Tea Board and Regional Office of Tea Board, Coonoor. Domestic prices of tea over a

period of time were collected from Industrial Cooperative Tea Factories Federation Limited (INCOSERVE). With regard to potato, secondary data on area and productivity were gathered from various issues of 'Season and Crop Report for Tamil Nadu' and domestic prices were collected from Nilgiris Cooperative Marketing Society (NCMS).

Emerging Scenario

In Nilgiris district, there has been considerable change in the cropping pattern after the introduction of the development programmes. The main emphasis is to increase the area under perennial crops in order to reduce the problem of soil erosion and to increase the vegetative cover for eco-development. Of the total geographical area (2,54,381 ha), almost one fourth (28 per cent) is under cultivation. About 87 per cent of the cropped area is under perennial crops and the remaining 13 per cent of the area is utilized for seasonal crops. Among the food crops, potato and other vegetables account for eight per cent of the total cropped area. In the case of non-food crops, tea is grown in more than 60 per cent of the cropped area.

The main emphasis is to increase the area under perennial crops in order to reduce the problem of soil erosion and to increase the vegetative cover for eco-development.

In order to examine the performance of potato and tea over years (table 1) in terms of area, productivity and price, compound growth rates⁴ were computed for two periods and are set out in table 2. The results show that there has been a major shift in the cropping pattern during the study period. In area, potato registered negative growth, while tea showed positive growth. Potato recorded highest negative growth (-15.43 per cent) in area during the second period, while highest positive growth (5.19 per cent) in area was registered by tea during the first period. In productivity, both the crops registered positive growth rates during both the periods. Growth rates of yield of potato were higher than tea during the two periods. In the case of potato, the negative effect of decline in area has been compensated by increase in yield. Potato, which gained in yield benefitted from cultivation of high yielding varieties,

1. The average yield of a large estate is 8800 kg of green leaf per ha. (2200 kg of made tea per ha.), while it is 4000 kg of green leaf per ha. (1000 kg of made tea per ha) among the small tea growers.

2. Mean annual rainfall (1981-1992) is 1362.98 mm and the coefficient of variation worked out to 29.53 per cent.

3. The scheme provides input subsidy at the rate of Rs. 15000 per ha, out of which Rs. 12500 is payable as first instalment towards the cost of planting material, Rs. 1500 as second instalment towards the cost of fertilizers and pesticides and a third instalment of Rs. 1000 as compensation for crop loss.

4. Compound growth rates were computed for two periods, namely, 1981-82 to 1992-93 (period I) and 1987-88 to 1992-93 (period II). Period II refers to the initial period of diversification of the sample farmers. Compound growth rates were arrived by fitting exponential growth curves, $Y = ab^t$.

Table 1: Area, Yield and Price of Potato and Tea in Nilgiris District

Year	Potato			Tea		
	Area (ha)	Yield (kh/ha)	Price (Rs./kg)	Area (ha)	Yield (kh/ha) of made tea	Price (Rs./kg) of green leaf tea
1981-82	7736	10.00	1.66	39642	1758	1.76
1982-83	6900	11.25	2.02	38901	1782	2.59
1983-84	6939	12.00	1.74	39886	2221	4.29
1984-85	7042	14.99	1.70	40794	2163	4.89
1985-86	5594	13.46	2.30	40903	2134	2.46
1986-87	5609	14.15	2.95	51755	2126	3.20
1987-88	5882	14.72	2.45	53655	2812	3.20
1988-89	4555	15.74	3.09	54226	2737	3.11
1989-90	6442	16.84	3.74	57678	2917	6.79
1990-91	3331	18.01	3.85	60254	3225	6.86
1991-92	2659	19.26	3.94	61184	2785	4.36
1992-93	2867	20.60	4.04	61879	2923	5.47

Sources: Various Issues of "Tea Statistics", Tea Board of India, Calcutta.
Various Issues of "Season and Crop Report", Dept. of Statistics, Govt. of Tamil Nadu.

Table 2: Growth and Variability in Area, Yield and Price of Potato and Tea

Particulars	Potato						Tea					
	Period I			Period II			Period I			Period II		
	Area	Yield	Price	Area	Yield	Price	Area	Yield	Price	Area	Yield	Price
Compound Growth Rate (per cent)	-8.58** (3.30)	6.9*** (1.17)	9.55*** (2.50)	-15.43 ^{NS} (10.69)	6.46*** (0.007)	9.75 ^{NS} (5.94)	5.19*** (1.19)	5.29*** (1.79)	8.30 ^{NS} (6.70)	3.25*** (0.998)	0.99 ^{NS} (3.46)	11.16 ^{NS} (20.04)
Coefficient of Variation (per cent)	31.73	23.62	33.41	37.35	12.56	17.67	18.71	19.83	40.80	6.12	6.10	33.82

Figures in parentheses indicate standard error of the growth rate.

*** - $P \leq 0.01$ (two tailed test)

** - $P \leq 0.05$ (two tailed test)

NS - Not significant

intensive use of farm inputs like fertilizers and pesticides. Both the crops benefitted from price support. Tea showed higher positive growth than potato during the second period, while the situation was reverse in the first period.

Potato, which gained in yield benefitted from cultivation of high yielding varieties, intensive use of farm inputs like fertilizers and pesticides.

Variability in area, productivity and price of tea and potato was assessed by working out the coefficient of variation. The estimates of coefficient of variation indicated that variability in area and productivity of potato was higher compared to tea in both the periods. On the other hand, variability in price of tea

was more than that of potato as it depends on international market price.⁵

Impact of Crop Diversification Scheme

Area, productivity & production

The existing area under tea, of the sample beneficiaries and the area covered under the scheme were taken for estimating the contribution of the scheme

5. Coefficient of variation of average prices of world tea auction centres was 35.35 per cent (1980-1993) and with respect to export values per kg, it worked out to 42.75 per cent (1980-1993). The correlation coefficient, between domestic prices and average prices of World tea auction centres was 0.79 with t value of 4.50, which was statistically significant at one per cent level of probability under two-tailed test. The correlation coefficient between domestic prices and World tea prices worked out to 0.78 with t value of 2.81, which is statistically significant at five per cent level of probability under two-tailed test.

Table 3: Impact of the Scheme on Area, Productivity and Production of Green Tea Leaf

Year	Period I			Period II			Total Area covered under the scheme (ha)	Total Prodn. under the scheme in period I & II (lakh/kg)
	Sample Area (ha)	Productivity (Kg/ha)	Total production of Green Leaf By sample beneficiaries (lakh kgs)	Sample Area (ha)	Productivity (kg/ha)	Total Production by sample farms (lakh/kg)		
1988-89	7.80	35	0.0027	-	-	-	256	0.0896
1989-90	7.80	485	0.0378	49.76	40	0.0199	256	1.3440
1990-91	7.80	5000	0.3900	49.76	722	0.3593	256	14.6483
1991-92	7.80	8400	0.6786	49.76	5050	2.5129	256	35.2000
1992-93	7.80	11900	0.9282	49.76	9000	4.4784	256	53.5040
1993-94	-	-	-	49.76	11200	5.5731	256	28.6720
Total			2.0373			12.9436		133.4939

in increased production. The average productivity of tea in the sample farms was 5224 kg of green leaf per ha. during the establishment period.⁶ The total area covered by the scheme among the sample farms was 57.56 ha. inclusive of both the periods.⁷ Consequent to the shift, the production of 14.98 lakh kg (3.75 lakh kg of made tea) of green leaf tea was obtained by the sample beneficiaries. Under the scheme, 256 ha was brought under tea with an additional production of 133.49 lakh kg of green leaf (33.37 lakh kg of made tea) in the district. The share of sample farms in terms of area and production was 22 per cent and 11 per cent, respectively, of the total area and production under the scheme. The details are furnished in table 3.

Profitability

A comparative analysis was undertaken to assess the economics of potato and tea for the diversification periods. Investment analyses, such as, NPV⁸ and BCR⁹ were employed to examine the worthiness of the invest-

6. Establishment period is five years, which starts from the initial planting period to full bearing.

7. The sample beneficiaries diverted potato area to tea at two different periods. Period I refers to 1988-89 to 1992-93 and period II indicates 1989-90 to 1993-94.

8. NPV was estimated based on the formula, $NPV = \sum_{t=1}^n \frac{(B_n - C_n)}{(1+i)^n}$ and worked to Rs. 137478 and Rs. 116543 for potato and tea, respectively.

9. Benefit cost ratio (BCR) was estimated using the formula, $(BCR) = \frac{\sum_{t=1}^n B_n / (1+i)^n}{\sum_{t=1}^n C_n / (1+i)^n}$, where B_n refers to benefits in each year, C_n denotes costs in each year, n indicates number of years, i is interest (discount) rate and t is time period. The analysis was carried out at 20 per cent discount rate for the investment period of 20 years.

ment. The economics of potato and tea, of the sample farms for the two periods are furnished in tables 4 and 5. It could be observed that the mean return of tea ranged between 38 to 46 per cent of the return obtained from potato. This might have been because tea crop, being perennial in nature, has high initial establishment cost coupled with returns foregone for the first two years as it starts full bearing from the fifth year onwards. Though Net Present Value (NPV) is higher for potato, Benefit Cost Ratio (BCR) of tea (2.18) was more than potato (1.79), implying that tea has higher rate of return compared to potato (Swaminathan *et al.*, 1988).

Standard of living & asset creation

The details on improvement in standard of living and assets creation are given in table 6. More than 50 per cent of the beneficiaries opined that the quality of their food, clothing and education had improved by this shift in cultivation. A remarkable impact was observed in modernisation of house—72 per cent of the beneficiaries modernised their existing houses by expending, on an average, Rs. 5611 per household. About 30 per cent of the beneficiaries saved at the rate of Rs. 1750 per household.

Land value & employment

The diversification from potato to tea had resulted in significant appreciation in land value, besides generating employment on permanent basis. The market value of one ha. of tea was Rs. 1.59 lakh compared to Rs. 42165 per ha of potato. Tea generated employment throughout the year and it absorbed 1215 persons per ha upto establishment and 618 persons during the bearing period. On the other hand, potato provides seasonal employment and on an average 365 persons were utilized per ha for cultivation of potato.

Table 4: Comparison of Economics of Potato and Tea Under Crop Diversification Scheme (Period I)N = 12
(Rs./ha)

Year	Potato			Tea		
	Gross Return	Gross Cost	Net Return	Gross Return	Gross Cost	Net Return
1987-88	36064	23439	126425	-	-	-
1988-89	48637	25783	22854	175	39839	-39664
1989-90	62982	28877	34105	3211	18288	-15077
1990-91	69339	33209	36130	31100	6755	24345
1991-92	75884	38190	37694	49329	12714	36615
1992-93	-	-	-	65450	17240	48210
Mean	58581	29900	28682	29853	18967	10886

N - No. of Sample farms

Table 5: Comparison of Economics of Potato and Tea Under Crop Diversification Scheme (Period II)N = 86
(Rs./ha)

Potato				Tea			
Year	Gross Return	Gross Cost	Net Return	Year	Gross Cost	Gross Return	Net Return
1988-89	42951	26783	16168	1989-90	263	42388	-42125
1989-90	55576	29462	26114	1990-91	3285	21644	-18359
1990-91	61177	32997	28180	1991-92	27826	7535	20291
1991-92	66901	36889	30012	1992-93	55800	14138	41662
1992-93	74234	41316	32918	1993-94	76832	16915	59917
Mean	60168	33489	26679	Mean	32801	20524	12277

N - No. of Sample farms

Table 6: Impact of Crop Diversification on Living Standard & Asset Creation

Particulars	After diversification	
	No. of persons responded	Average Amount (Rs.)
Improvement in Quality of Life:		
Quality of food	65	
Quality of clothing	55	
Quality of education	65	
Recreation	40	
Participation in social activities	58	
Improvement in Assets:		
Modernisation of house	72	5611
Purchase of land	4	8750
Repayment of bank loan	8	3750
Savings in bank	30	1750

The diversification from potato to tea had resulted in significant appreciation in land value, besides generating employment on permanent basis.

Apart from the direct benefits, diversification of potato to tea provided several other indirect benefits. The steep increase in area under tea resulted in heavy demand for planting materials. Thus, many commercial tea nurseries were established in different parts of the district by the small tea growers and unemployed youth after undergoing the training programme on establishment of tea nurseries conducted by United Planter's Association of Southern India.

The increased production of green leaf tea created a demand for additional processing facilities. As a result, 20 new bought leaf tea factories and three industrial

cooperative tea factories were established. This further resulted in increase in demand for agro inputs and tea packing materials.

The annual crops like potato and vegetables require frequent tilling of soil, especially in steep slopes, where the scope for soil erosion is enormous. But tea cultivation requires tilling of soil only in the initial period and later acts as an effective barrier for soil erosion, thereby helping in restoring the ecological balance.

The annual crops like potato and vegetables require frequent tilling in steep slopes, where the scope for soil erosion is enormous. Tea cultivation requires tilling only in the initial period and later acts as an effective barrier for soil erosion.

Thus taking into account the various implications of diversification, the study suggests continuance of the scheme for sustainable development as it brings both forward and backward linkages.

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Crop Diversification & Yield Response to Fertilisers

A. Narayanamoorthy

The continuous declining trends of the area under foodgrain crops as well as yield response to fertilisers have created concern among the researchers regarding the future growth of foodgrains production. In this context, this paper tries to analyse the pattern of diversification of different crops and yield response to fertiliser at the national level from 1950-51 to 1990-91 by using macro-level data. Yield response to fertiliser has been declining especially in the recent years. The study cautions that production of foodgrains will go down in the future if an appropriate policy is not introduced to increase the yield response to fertiliser.

Introduction of water-HYV seed-fertiliser technology has increased the total production of foodgrains from 72 million tonnes (mt.) in 1965-66 to about 182 million tonnes in 1993-94, indicating an average increase of nearly 4 million tonnes per annum. Fertiliser was identified¹ as the main responsible factor, among others, for the huge production of foodgrains (Vaidyanathan, 1993). However, owing to the development of irrigation and subsequent changes in the system of farming (from subsistence to commercial), the area under foodgrain crops² has been declining (Nadkarni & Vedini, 1996). On the other hand, though the consumption of fertiliser has been increasing continuously, the increasing rate of production of foodgrains is not commensurate with the increasing rate of fertiliser consumption. That is, the yield response to fertiliser has been declining in recent years. One kg. of nutrient (NPK) produced nearly 40 kg of foodgrains during 1970-71 to 1974-75, but the same has declined to 14 kg during 1990-91 to 1993-94 (FAI, 1994). The declining trend of area under

Owing to the development of irrigation and subsequent changes in the system of farming (from subsistence to commercial), the area under foodgrain crops has been declining.

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1. For instance, the Economic and Social Commission for Asia and the Pacific has estimated that nearly 31 per cent gains in rice production in Indian agriculture for the period of 1965-80 was due to increase in fertiliser use (Maricar B. Jara, 1985). Likewise, Vaidyanathan (1993) has estimated that about 60 per cent of the incremental output of foodgrains between 1960-63 and 1987-90 is attributable to fertiliser in India (See also Desai, 1996).
2. Foodgrain crops include all cereal crops, gram and pulse crops. (The terms food crops and foodgrain crops are used interchangeably in this paper).

foodgrain crops and the poor response to fertiliser are causes of concern regarding the future production of foodgrains.

Though crop diversification is good for soil fertility and health, continuous diversification, from food crops to non-food crops will bring down the area under the former ultimately reducing the production of foodgrains. In this regard, several studies have already analysed the growth of area under different crops including the production and productivity of crops for both pre and post-green revolution periods (Alagh & Sharma 1980; Rath, 1980; Ranade, 1980; Venkataramanan & Prahalladachar, 1980). However, the available studies have failed to address how the growth rate of area and productivity of crops changed in the successive periods of green revolution and what would be the possible impact on the production of foodgrains in future. Likewise, several studies have confirmed the importance of fertiliser in increasing the productivity of crops, both at micro as well as macro-level (Joshi & Haque, 1980; Vaidyanathan, 1993, Narayana-moorthy, 1994 & 1995). Since fertiliser is the crucial input in increasing the yield of crops, its response has to be studied carefully to understand the future prospects of foodgrains production.

In the above context, a study was attempted to find out the pattern of diversification of different crops at the national level from 1950-51 to 1990-91. Since irrigation is the paramount input for crop diversification, analysis was made on irrigated crop pattern separately as well. Rate of growth for area and productivity of crops were computed and compared with different periods to judge the future prospects of foodgrains production. The response of fertiliser on foodgrains productivity and how it changed over the period was also analysed.

Data & Method

To understand crop diversification at the macro-level, data was collected from the reports published by the Ministry of Agriculture, Fertiliser Association of India etc. for the period of 1950-51 to 1990-91 on area under different crops, irrigated area, production and productivity of crops, HYVs area, consumption of fertilisers etc. Changes in the pattern of crop were measured by simple percentages for different points of time. However, to understand the pattern of growth of area under different crops and productivity, the growth rate was computed by fitting log linear function ($\log Y = a + bt$). For the purpose of analysis, the period was divided into five—period I (1951-52 to 1965-66), period II (1965-66 to 1990-91), period III (1960-61 to 1970-71), period IV (1970-71 to 1980-81) and period V (1980-81 to 1990-91). Since many studies have already analysed the changes

in the growth of different crops by dividing the periods into two as pre and post green revolution, an attempt was made to know how the rate of growth changed during the successive periods of green revolution. The fertiliser response on productivity of foodgrains was measured by using the following linear regression function:

$$(Y_t - Y_{t-1}) = a + b (F_t - F_{t-1})$$

where

$(Y_t - Y_{t-1})$ is yearwise change in productivity of crops

$(F_t - F_{t-1})$ is yearwise change in fertiliser consumption/ ha.

a – constant

b – regression coefficient

Crop Diversification at National Level

Factors like irrigation facility, soil condition, price policies of the government, general demand for agricultural commodities etc. determine the crop diversification. The macro-data show that both Gross Irrigated Area (GIA) as well as Gross Sown Area (GSA) have increased significantly in the last 40 years. For instance, GIA has increased from 28.4 million hectares in 1960-61 to about 61.8 ml. hectares in 1990-91, an increase of about 117 per cent. Likewise, GSA has increased from 152.7 ml. hectares to 185.4 ml. hectares (an increase of 21.4 per cent) during the same period. This means that the area under irrigation has increased at a much faster rate than the area under cultivation. When there is a change in GSA and GIA, it alters the crop pattern as the latter is mostly determined by the availability of irrigation. Table 1 furnishes the overall crop pattern of India for the period 1950-51 to 1990-91. It is clear from the table that significant changes have occurred in area under different crops in the last forty years. The percentage of area under foodgrain crops to total cultivated area has declined, while area allotted for non-foodgrain crops have increased. For instance, foodgrain crops area accounted for about three fourth of GSA in

Factors like irrigation facility, soil condition, price policies of the government, general demand for agricultural commodities etc. determine the crop diversification.

Table 1: Cropping Pattern According to Land Utilisation Statistics (Area in Thousand hectares)

Crops	1950-51		1960-61		1970-71		1980-81		1990-91	
	Area	Per cent	Area	Per cent	Area	Per cent	Area	Per cent	Area	Per cent
Paddy	31056	23.55	34056	22.29	37381	22.55	30237	23.31	42687	23.01
Wheat	10010	7.59	12931	8.46	18293	11.03	22225	12.87	24167	13.03
Coarse cereals	37674	28.56	44912	29.40	45949	27.72	41780	24.20	36318	19.58
Jowar	15554	11.79	18456	12.06	16871	10.18	16412	8.51	14357	7.74
Bajra	9774	7.39	11470	7.51	13391	8.08	11658	6.75	10476	5.65
Maize	3250	2.46	4401	2.88	5856	3.53	6032	3.49	5904	3.18
Ragi	2254	1.71	24378	1.62	2474	1.49	2504	1.45	2171	1.17
Small millets	4605	3.49	4997	3.27	4783	2.88	3876	2.30	2447	1.32
Barley	3198	2.42	3140	2.06	2556	1.54	1799	1.04	962	0.52
Gram	7803	5.92	9274	6.07	7820	4.72	6547	3.79	7521	4.05
Tur	2228	1.69	2429	1.59	2639	1.59	2877	1.67	3593	1.94
Other Pulses	10523	7.98	11962	7.83	12667	7.64	13284	7.70	13548	7.30
Total Cereals	78280	59.35	91889	60.15	101782	61.39	104210	60.37	103173	55.63
Total Pulses	20554	15.58	23665	15.49	21326	13.95	22708	13.15	24662	13.30
Total Foodgrains	101196	76.73	115564	75.64	124910	75.34	127608	73.92	127835	68.93
Sugarcane	1757	1.33	2417	1.58	2589	1.56	2897	1.68	3686	1.99
Groundnut	4406	3.34	6467	4.23	7552	4.56	6789	3.93	8309	4.48
Castorseed	593	0.45	466	0.31	468	0.28	542	0.31	810	0.44
Sesamum	1957	1.48	1575	1.03	1853	1.12	1747	1.01	2516	1.36
Rape and Mustard	1058	0.80	1145	0.75	1415	0.85	2268	1.31	2782	3.12
Linseed	1226	0.93	1267	0.83	1199	0.72	1163	0.67	1099	0.59
Total Oilseeds	10968	8.32	12777	8.36	14719	0.88	15698	9.09	24148	13.02
Coconut	615	0.47	716	0.47	1023	0.62	1064	0.62	1475	0.80
Cotton (lint)	5655	4.29	7619	4.98	7830	4.72	7752	4.49	7440	4.01
Jute and Mesta	571	0.43	1152	0.75	1080	0.65	1300	0.75	1016	0.55
Tobacco	379	0.29	401	0.26	431	0.26	460	0.27	411	0.22
Other crops	10752	8.15	12135	7.94	13209	7.97	15851	9.18	19466	10.48
Total Area Sown	131893	100.00	152772	100.00	165791	100.00	172630	100.00	185447	100.00

Source: Directorate of Economics and Statistics, Ministry of Agriculture, New Delhi.
FAI (1994), Fertiliser Statistics, 1993-94, Fertiliser Association of India, New Delhi, December.

1960-61, but it declined to 68 per cent in 1990-91. In the same period, on the other hand, area under non-food crops increased from 24 per cent to about 31 per cent. The reduction of area, however, is not the same across different food crops. The most vulnerable crops in terms of area are Jowar, Bajra, Maize, Ragi and Pulses. One may accept the fact that changes in the pattern of consumption of foodgrains by the people would have brought down the area under low value crops like coarse cereals (Gopalan, 1995). However, one cannot easily find reasons for the reduction of area under pulse crops. Despite being high value crops—not only in terms of money value but also in terms of protein content, the area under pulses has reduced from nearly 16 per cent in 1960-61 to 13 per cent in 1990-91 in the gross cropped area (GCA). In terms of area also, there

was no significant change in the pulses area (also see table 2 for average and co-efficient of variation of area under different crops for different periods). Though the area under important food crops like paddy and wheat has increased over the last forty years, the increasing rate of paddy area is much less than the increasing rate of gross sown area. At the same time, area under non-food crops like sugarcane, oilseeds etc. has increased impressively between 1960-61 and 1990-91. On the whole, between 1960-61 and 1990-91, GSA has increased by about 32.7 ml. hectares, of which only about 12.3 ml hectares have gone for the cultivation of food crops and the rest for the cultivation of non food crops (20.4 ml.ha.). This clearly indicates that most of the additional area brought under cultivation has been used for cultivation of non-food crops.

Table 2: Averages, SD and CV of Area under Different Crops

(Area in ml. ha)

Variables	1951-52 to 1965-66			1965-66 to 1990-91			1960-61 to 1970-71			1970-71 to 1980-81			1980-81 to 1990-91		
	Avg.	SD	CV	Avg.	SD	CV	Avg.	SD	CV	Avg.	SD	CV	Avg.	SD	CV
GSA	149.44	7.35	4.92	170.56	7.79	4.57	158.71	3.70	2.33	168.64	3.81	2.26	177.65	4.11	2.31
GIA	27.03	2.43	8.99	46.41	9.03	19.46	32.16	3.31	10.29	43.45	4.14	9.53	55.39	3.63	6.55
Cropping Intensity	113.92	1.29	1.13	121.87	4.52	3.71	115.66	1.20	1.04	120.27	1.73	1.44	126.36	2.30	1.82
Total Foodgrains	112.18	6.00	5.35	124.95	4.52	3.62	119.58	5.24	4.38	124.98	2.89	2.31	126.90	2.72	2.14
Paddy	33.01	1.98	6.00	39.13	2.04	5.21	35.84	1.16	3.24	38.78	1.20	3.09	40.84	1.26	3.09
Wheat	12.29	1.35	10.98	20.44	3.45	16.88	14.40	1.78	12.36	20.32	1.60	7.87	23.38	7.35	31.44
Jowar	17.18	1.71	9.95	16.42	1.13	6.88	17.61	2.01	11.41	16.22	5.87	36.19	15.72	7.34	46.69
Bajra	11.23	0.60	5.34	11.21	0.98	8.74	11.92	0.63	5.29	11.71	0.92	7.86	10.99	0.89	8.10
Maize	4.15	0.44	10.60	5.76	0.27	4.69	5.06	0.55	10.87	5.86	0.31	5.29	5.84	0.11	1.88
Total Cereals	89.05	4.41	4.95	101.45	3.99	3.93	95.72	3.61	3.77	101.58	3.67	3.61	103.59	2.35	2.27
Total Pulses	22.82	1.69	7.41	22.83	0.99	4.34	22.95	1.05	4.58	22.80	0.96	4.21	23.22	0.89	3.83
Sugarcane	2.10	0.36	17.14	2.88	0.37	12.85	2.46	0.23	9.35	2.75	0.23	8.36	3.18	0.27	8.49
Total oilseeds	13.32	1.48	11.11	17.80	2.34	13.15	15.07	0.69	4.58	16.98	0.52	3.06	19.87	2.05	10.32

Note: SD – standard deviation, CV – coefficient of variation

Source: GOI, MOI (Various issues) and FAI (1994).

Most of the additional area brought under cultivation has been used for cultivation of non-food crops.

However, one cannot clearly judge from the general cropping pattern whether it will affect the foodgrains production in future or not. As foodgrains production is mostly influenced by the cropping pattern in irrigated area, a detailed analysis on the irrigated crop pattern will give some clear picture in this regard. As productivity of a crop is much less in unirrigated area compared to irrigated one (Vaidyanathan et al., 1994; Dhawan, 1988), reduction of area in unirrigated region would not affect the total production of foodgrains adversely.³ However, a small reduction in the area under foodgrain crops in the irrigated region would lead to a huge reduction in the foodgrains production. Let us see how the cropping pattern of irrigated area has changed from 1960s to 1990s (table 3). As expected, area under food crops has declined a considerable extent between 1960s and 1990s in the irrigated area as well. In 1960s, food crops area accounted for about 79 per cent of the

irrigated crop pattern, whereas the same has reduced to 71 per cent in 1990s, a reduction of eight per cent. Though the total reduction of area is less, the proportion of area under paddy crop, an important food crop,⁴ has significantly declined from 45 per cent to 31 per cent in the same period. Likewise, pulses area has reduced from about seven per cent in 1960s to around four per cent in 1990s. Area under irrigated wheat has increased significantly; however, the percentage of increase is slightly less than the increasing rate of irrigated area. As in the general crop pattern, the irrigated crop pattern also confirms the fact that the area under non-foodgrain crops has increased impressively after the advent of green revolution. All these show that the area under non-foodgrain crops increases much faster when the irrigated area increases.

The area under non-foodgrain crops increases much faster when the irrigated area increases.

3. For a more elaborate discussion on productivity of crops between irrigated and unirrigated areas, see Vaidyanathan et al., 1994.

4. Right from 1950-51, the contribution of paddy in the total foodgrains production has been around 40 per cent. The latest information (1993-94) also shows that production of paddy accounted for nearly 43 per cent of the total production of foodgrains (182 ml. tonnes).

Table 3: Irrigated Crop Pattern: India

Crops	(Area in million hectares)							
	(1960-61 to 1962-63)		(1970-71 to 1972-73)		(1980-81 to 1982-83)		(1989-90 to 1990-91)	
	1960s	% to Total	1970s	% to Total	1980s	% to Total	1990s	% to Total
Rice	12.96	45.27	14.28	37.03	16.48	32.24	19.22	31.43
Wheat	4.38	15.30	10.36	26.87	16.09	31.47	19.01	31.08
Total Cereals and Millets	20.62	72.02	28.40	73.65	36.35	71.11	41.62	68.05
Total Pulses	2.01	7.02	1.92	4.98	1.99	3.89	2.35	3.84
Sugarcane	1.62	5.66	1.83	4.75	2.70	5.28	3.11	5.08
Cotton	1.03	3.60	1.59	4.12	2.21	4.32	2.64	4.31
Total Oil Seeds	0.46	1.61	1.31	2.93	2.47	4.83	4.92	8.04
Other crops	0.89	10.09	3.69	9.57	5.40	10.56	6.52	10.58
Total Irrigated Cropped Area	28.63	100.00	38.56	100.00	51.12	100.00	61.16	100.00

Source: GOI, Ministry of Agriculture, Indian Agricultural Statistics (Various issues).

Table 4: Growth Rate* (per cent/year) of Area under different Crops

Crop	1951-52 to 1965-66	1965-66 to 1990-91	1960-61 to 1970-71	1970-71 to 1980-81	1980-81 to 1990-91
Gross foodgrains	0.92 ^a	0.23 ^a	0.90 ^b	0.39 ^b	-0.12
Paddy	1.34 ^a	0.62 ^a	0.88 ^a	0.83 ^a	0.46 ^c
Wheat	2.19 ^a	2.09 ^a	2.97 ^a	2.21 ^a	0.51 ^c
Jowar	-0.23	-0.71 ^a	0.28	-0.46 ^c	-1.16 ^a
Bajra	0.46 ^b	-0.72 ^a	1.39 ^a	-1.39 ^b	-0.93
Maize	2.33 ^a	0.23 ^b	3.27 ^a	0.02	0.23 ^b
Total cereals	1.06 ^a	0.29 ^a	1.02 ^a	0.60 ^a	-0.23
Total Pulses	1.18 ^a	0.23 ^a	-1.16 ^a	0.42	0.20
Sugarcane	3.51 ^a	1.39 ^a	0.81	1.39 ^b	1.62 ^b
Nine oilseeds	2.49 ^a	1.55 ^a	0.79 ^b	0.46 ^c	2.80 ^a

Note: a, b, c - indicates significant at 1, 5 & 10 per cent level respectively.

* - computed by using $\log Y = a + bt$

Source: Data compiled from GOI (1994) and FAI (1994).

Growth of Area Under Different Crops

Though the area under foodgrain crops has declined, one cannot say that it will make an adverse impact on the foodgrains production. If the reduction in the area under food crops is compensated by increased productivity of these crops, there would not be any serious impact on the total production of foodgrains. Let us analyse how the growth of area under different crops varies in the last forty years, 1950-51 to 1990-91. As mentioned, the growth rate has been computed by using a log linear function for different crops, GIA and GSA for different periods. The results are presented in table 4. As indicated by several studies, the growth rate of area under different crops including GSA is much better in the pre-green revolution period compared to the period of post-green revolution. However, the growth rate of GIA is much higher in the period of Post-Green Revolution (PGR). Indian planners have given much importance

for development of irrigation as it is very essential for food security of the country. As a result, irrigated area has increased manifold after independence (Mitra, 1996; Narayanamoorthy, 1995a). However, our main aim is not to compare the growth rate of pre and post green revolution period, but to trace how it moved in the sixties (1960-61 to 1970-71), seventies (1970-71 to 1980-81) and in the eighties (1980-81 to 1990-91). The reason for analysing the growth rate of different periods is to verify the argument that the area under food crops declines when irrigated area increases. Several micro-level studies have confirmed that the farmers of groundwater irrigated area have shifted their cropping pattern from food crops to non-food commercial crops.⁵ Since groundwater irrigated area presently accounts for about 50 per cent of the total irrigated area, a detailed analysis of the different

5. For more details in this regard, see Shah (1993) and Narayanamoorthy (1994).

periods would give some interesting results. As expected, the growth rate of gross food crops area has decelerated steeply in the seventies (0.39 per cent per annum) compared to the sixties (0.90 per cent p.a.) and reached negative growth in the eighties. However, in the same period, growth rate of GIA was very impressive. This clearly indicates that the farmers tend to allot more area for non-food crops or less area for food crops when the area under irrigation increases.

The growth rate of individual crop area also presents a dismal picture. The growth rates of Jowar and Bajra were very weak and negative right from the introduction of new agricultural technology. The growth rate of total pulses area was very poor in the post-green revolution period as well as in the seventies and in the eighties when compared to the pre-green revolution period. Although the growth rates of paddy and wheat were better than that of other foodgrains crops, during the eighties it was much less compared to the sixties and the seventies. For instance, the growth rate of paddy area was 0.88 per cent p.a. during the sixties, but was only 0.46 per cent in the eighties. Likewise, the growth rate of wheat crop was 2.97 per cent in the sixties, but went down to 0.51 per cent in the eighties. But, the area under non-food crops like sugarcane and oilseeds has consistently increased in the seventies as well as in the eighties. There are three reasons for the low growth of the area under food crops in recent years. First, since food crop involves a lot of risk (pest and rat ravages), farmers have reduced the area under food crops. Second, the net remuneration of food crops is very low compared to crops like sugarcane and oilseeds. Third, development of groundwater irrigation has made it mandatory for farmers to go in for high remunerative crops as the cost of groundwater is relatively higher compared to other sources of irrigation.

Since food crop involves a lot of risk, the net remuneration of food crops is very low compared to sugarcane and oilseeds. Farmers go in for high remunerative crops.

Growth of Crop Productivity

The productivity of a crop is mainly determined by the use of yield increasing inputs (fertiliser etc.), variety of seed and level of irrigation. Use of all these inputs/factors has increased impressively after the advent of new agricultural technology (table 5). Table 6 reveals how these reflect on the productivity growth of different crops in different periods.

It had been seen earlier that the growth rate of area under different crops has declined in the period of PGR. But, it is not true in the case of productivity of crops (table 6). The growth rate of productivity of almost all crops increased in successive decades of the green revolution and is very impressive during the eighties (1980-81 to 1990-91). However, the growth rate of pulses, bajra and maize was not consistent over the period. For instance, it was only 0.44 per cent per annum in the sixties and was negative (-0.79 per cent) in the seventies. It is worth mentioning here that the growth of area under pulses was also very low and not consistent. (See also table 7 for the average and CV of different crops productivity for different periods). This is the reason why the production of pulses and its per capita availability declined in the successive decades of green revolution (Vaidyanathan, 1994). The productivity of paddy and wheat was very impressive in the period of PGR (1965-66 to 1990-91) compared to the earlier period. However, although growth of paddy and wheat was comparatively good, it was not consistent over the period. The growth rate was very low in the sixties as well as in the seventies and gained momentum only in the eighties. Since the consumption of fertiliser was very high during the eighties, the growth of productivity of these crops was much better then. The trend indicates that the productivity of crops is much higher than the growth rate of area under different crops. It seems that the reduction of area under food crops will not make any serious impact on production of foodgrains as long as the current growth rate of productivity continues.

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Yield Response to Fertiliser Use

There cannot be two opinions about the importance of fertiliser in increasing production of foodgrains. In fact, without fertiliser, our foodgrains production would not have reached this satisfactory level. However, there is a growing concern about the declining impact of fertiliser on the productivity of foodgrains in recent years. The argument is that the incremental rate of productivity of foodgrains is decreasing when compared to the increasing rate of fertiliser consumption. Vaidyanathan (1993) stated that "the increment output attributable to fertiliser is lower than the official yardstick derived from field trials on farmer's field....". Hence, an attempt was made to find out the impact of fertiliser on

Table 5: Growth Rate* (per cent/year) of Factors which determine foodgrains Production

Variables	1951-52 to 1965-66	1965-66 to 1990-91	1960-61 to 1970-71	1970-71 to 1980-81	1980-81 to 1990-91
GSA					
Growth rate	0.93 ^a	0.46 ^a	0.46 ^b	0.51	0.48
Average (ml. ha.)	149.44	170.56	158.71	168.64	177.65
GIA					
Growth rate	2.09 ^a	2.68 ^a	3.18 ^a	2.99 ^a	2.05 ^a
Average (ml. ha.)	27.03	46.41	32.16	43.45	55.39
Fertiliser					
Growth rate	19.67 ^a	10.15 ^a	23.88 ^a	9.65 ^a	8.14 ^a
Average (ml. tn.)	0.30	5.24	1.07	3.59	8.63
HYVs					
Growth rate	-	10.66 ^a	-	10.41 ^a	3.51 ^a
Average (ml. ha.)	-	36.71	-	30.47	54.26

Note: a, b indicate significant at one per cent level and five per cent level respectively.

* Computed by $\log Y = a + bt$

Source: Computed from GOI (1994) and FAI (1994).

Table 6: Growth Rate* (per cent/year) of Productivity of Crops

Crop	1951-52 to 1965-66	1965-66 to 1990-91	1960-61 to 1970-71	1970-71 to 1980-81	1980-81 to 1990-91
Paddy	1.86 ^a	2.80 ^a	0.69	1.39 ^b	3.20 ^a
Wheat	1.16 ^b	3.44 ^a	0.46	2.09 ^a	3.04 ^a
Jowar	1.15 ^c	2.09 ^a	0.11	5.19 ^a	1.62 ^a
Bajra	1.16 ^b	1.55 ^a	4.47 ^a	-0.69	2.09
Maize	2.94 ^a	1.39 ^a	1.62 ^b	0.07	2.33 ^b
Total cereals	1.79 ^a	2.80 ^a	1.95 ^b	2.09 ^a	3.23 ^a
Total Pulses	-0.05	0.69 ^a	0.44	-0.79	1.62 ^a
Total Foodgrains	1.39 ^a	3.28 ^a	1.91 ^b	1.84 ^a	3.04 ^a
Sugarcane	3.20 ^a	1.09 ^a	2.09 ^a	0.93 ^b	1.62 ^a
Total foodgrains production	2.59 ^a	2.97 ^a	2.33 ^b	2.09 ^b	2.92 ^a

Note: a, b, c indicate significant at 1, 5 & 10 per cent level respectively.

* Computed by $\log Y = a + bt$

productivity of crops and how it has changed over the period of study. For calculating fertiliser response, simple linear regression was computed by taking into account the yearwise change in the per hectare use of fertiliser ($F_t - F_{t-1}$) and the yearwise change in the productivity ($Y_t - Y_{t-1}$) of crops for total foodgrains as well as paddy and wheat for different periods. Owing to the non-availability of time series data of fertiliser consumption on different crops, total per hectare consumption of fertiliser was taken for estimating fertiliser response. The estimates of the two studies conducted by the NCAER (1978 & 1991) have shown that paddy and wheat consumed about 60 per cent of fertiliser. Therefore, the consumption of fertiliser by crops like paddy and wheat was believed to be definitely more than the national average consumption of fertiliser. Since paddy and wheat are the important fertiliser consuming crops, the fertiliser impact was estimated

separately for these two crops besides the total foodgrains productivity. The results of fertiliser impact are given in table 8.

It is clear from the table that the fertiliser impact was very poor in the pre-green revolution period, especially for paddy crop. This is because of the reason that before the green revolution most of the areas were cultivated by the traditional varieties and hence the impact of fertiliser was very low. Moreover, since consumption of fertiliser during the pre-green revolution period was very low, it would be meaningless to analyse its impact seriously. The results of the yield response to fertiliser relating to the post green revolution period would be useful in judging the efficiency of fertiliser consumption. It is clear from table 8 that the yield response to fertiliser was very good in all the three cases between 1965-66 to 1990-91. However, it is not consistent in the successive decades of green revolution.



Table 7: Averages, SD and CV of Productivity of different crops. (in kg/ha)

Variables	1951-52 to 1965-66			1965-66 to 1990-91			1960-61 to 1970-71			1970-71 to 1980-81			1980-81 to 1990-91		
	Avg.	SD	CV	Avg.	SD	CV	Avg.	SD	CV	Avg.	SD	CV	Avg.	SD	CV
Paddy	898.47	105.10	11.70	1264.62	242.50	19.18	1010.83	83.59	8.27	1172.64	104.74	8.93	1491.91	165.76	11.11
Wheat	774.60	72.68	9.38	1555.73	394.21	25.34	970.18	182.09	18.77	1402.64	123.15	8.78	1951.09	200.90	10.30
Jowar	471.66	50.71	10.75	630.62	117.94	18.70	503.64	38.49	7.64	607.81	108.79	17.90	712.27	78.99	11.09
Bajra	318.13	36.39	11.44	462.58	111.07	24.01	375.91	87.05	23.16	454.82	93.46	20.55	514.18	111.59	21.70
Maize	862.13	116.44	13.51	1149.54	188.52	16.40	1019.64	94.68	9.29	1064.91	110.03	10.33	1297.82	179.40	13.82
Total Cereals	690.47	65.66	9.51	1088.42	238.84	21.94	791.00	75.94	9.60	998.36	88.38	8.85	1320.82	144.15	10.91
Total Pulses	478.93	36.42	7.60	501.15	51.65	10.31	484.45	51.28	10.59	481.00	42.68	8.87	531.09	36.04	6.79
Sugarcane (tonnes)	37.98	5.68	14.96	54.62	7.54	13.80	48.13	9.49	19.73	51.35	3.08	6.01	59.49	3.49	5.88
Nine Oil Seeds	494.13	49.85	10.09	578.42	98.48	17.03	497.72	47.24	9.49	541.90	42.84	7.91	658.00	87.98	13.37

Note: SD – standard deviation, CV – coefficient of variation

Source: GOI, MOI (Various issues) and FAI (1994).

Table 8: Regression coefficients: Fertiliser Impact on Productivity of Crops.

Crop	1951-52 to 1965-66	1965-66 to 1990-91	1960-61 to 1970-71	1970-71 to 1980-81	1980-81 to 1990-91
Total Foodgrains Productivity					
Coefficient	19.29	15.35 ^b	50.90 ^b	1.75	14.35 ^b
SE	43.31	6.47	23.11	15.91	7.31
R ²	0.02	0.19	0.35	0.001	0.29
Paddy Productivity					
Coefficient	1.65	23.80 ^b	60.39 ^c	8.29	18.78
SE	78.92	11.85	38.82	29.91	15.35
R ²	0.00	0.14	0.21	0.01	0.14
Wheat Productivity					
Coefficient	40.68	14.51 ^c	78.90 ^b	-0.84	13.05
SE	66.96	10.31	34.48	22.12	15.12
R ²	0.03	0.08	0.37	0.00	0.08

Note: SE standard error.

a, b, c indicate significant rate at 1, 5 & 10 per cent respectively.

Source: Computed from FAI (1994).

For instance, unit (here it can be considered as Kg.) change in fertiliser consumption increased about 50 unit of foodgrains in the initial period of green revolution (1960-61 to 1970-71). This was also true for both paddy and wheat. However, the response was very poor in the seventies. The yield response was better in the eighties when compared to the seventies. Although there was a recovery during the eighties, still it was much less than the response in the sixties. It clearly shows that the increasing rate of additional productivity declines when compared to the increasing rate of additional consumption of fertiliser in the recent period. The possible reason could be the imbalanced and inefficient use of fertiliser for crops. Recent studies (Narayanamoorthy, 1995; Tandon, 1995) have confirmed that the imbalanced use of fertiliser has been increasing alarmingly, especially after the decontrol

of phosphate and potash fertilisers, in the agriculturally advanced states like Punjab, Haryana, UP etc. Though crops' productivity of the eighties was better than the earlier decades, continuous use of fertiliser in the present form would spoil the quality of the soil and ultimately bring down the productivity of crops in future if an appropriate policy is not introduced to arrest the improper use of fertiliser (Sekhon, 1994).

The imbalanced use of fertiliser has been increasing alarmingly, especially after the decontrol of phosphate and potash fertilisers.

Acknowledgement

The author is thankful to his senior colleagues Dr. Ashok K. Mitra and Dr. R.S. Deshpande for their comments on earlier draft of this paper. However, the author alone is responsible for errors, if any.

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Diversification – An Approach for Maximization of Farm Income

G.N. Nagaraja, S.R. Subramanian & J.V. Venkataram

In the present study, an attempt has been made to identify types of farming systems and to assess the potentialities for increasing farm income through reallocation of resources in a farming system concept. The data collected from 180 respondents pertains to Bangalore rural district of Karnataka. Through resource reallocation the net farm income of marginal farm would increase in crop + dairy farming system. For small farms crop + fisheries system is most feasible followed by crop + dairy farming system. For medium farms net farm income would increase maximum in absolute terms in crop + sericulture system followed by crop + poultry farming system. Mulberry was suggested in all the seasons in tubewell irrigated land in different categories of farms.

In a developing country like India, where the agrarian sector plays a prominent role, the declining trend in the average size of farm holding poses a serious problem. There is a steady rise in population without any possibility of increase in land area. As the situation deteriorates, the farmers, particularly those belonging to small and marginal category are unable to make both ends meet with the income from cropping alone. The problem is further compounded by the repeated failure of monsoons.

In this context, it is imperative to evolve suitable strategies for augmenting the income from a farm. Integration of the various enterprises in a farm ensures recycling of residues, optimum resource utilisation, higher employment, minimisation of risk and uncertainties and increased farm income. Various enterprises that could be included in the farms are crop, dairy, poultry, fisheries and sericulture. A judicious mix of enterprise can be through effective recycling of residue or waste.

Integration of the various enterprises in a farm ensures recycling of residues, optimum resource utilisation, higher employment, of risk and uncertainties and increased farm income.

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A study was attempted to identify the types of farming systems and assess the potentialities for increasing the farm income through reallocation of resources in a farming system concept.

Methodology

Bangalore rural district was selected purposively since various farming systems were in practice in this district. This district is near Bangalore city and well

connected by roads for easy transport of farm produce like vegetables, fruits, milk, egg etc. To select the ultimate unit of sample, stratified multistage random sampling technique was adopted. A sample of 180 farmers was selected randomly among the identified farming systems within the selected villages by the probability proportion method. The data on the existing farming system and resource position, amount of resource use for different enterprises, output produced, expenses and income on the farms, and area under different crops, etc. were obtained through personal interview with the help of a pretested schedule. The information collected related to the agricultural year 1993-94.

The respondents were post stratified into marginal (≤ 1 hectare), small (> 1 and ≤ 2 hectares) and medium (> 2 hectares) farms based on the operational land holdings. The size of operational holdings was converted into standard dryland equivalent (0.50 hectare of wetland was considered equivalent to one hectare of dryland).

Functional analysis and linear programming are the two techniques that can be used to obtain optimum farm plans. But functional analysis assumes continuous availability of resources. Besides, programmes involving changes in resource levels can not be easily handled and determination of normative plans with resource inequalities appears to be impossible through functional analysis. Hence, linear programming technique (which overcomes the above lacunae of the functional analysis) was chosen as an analytical tool in this study.

The mathematical form of the other year (three seasons) linear programming model used in the study can be represented as follows:

$$\text{Maximise } Z = \sum_{j=1}^n C_j x_j \quad (1)$$

Subject to the following constraints,

$$1. \sum_{j=1}^n a_{ij} x_j > b_i \quad (i = 1 \dots k) \quad (2)$$

$$2. \sum_{j=1}^n a_{ij} x_j < b_i \quad (i = k + 1 \dots m) \quad (3)$$

$$3. \sum_{j=1}^n a_{ij} x_j = b_i \quad (i = m + 1 \dots r) \quad (4)$$

$$4. x_j \geq 0 \quad (5)$$

where,

$Z_j =$ Annual Net Farm Income

- $C_j =$ value of the j th activity
- $x_j =$ value of the j th activity
- $a_{ij} =$ co-efficient that reflects either an absorption of ($a > 0$) or a contribution to ($a < 0$) a constraint resource and
- $b_i =$ available quantity of i^{th} resource or the requirement to be met.

The objective function

The objective function for the basic model is to maximise the annual net farm income from various enterprises subject to the resource constraints specified in the model. The general economic objective of a farmer is maximisation of welfare. This concept is subjective and difficult to quantify. Hence the annual net farm income for the resources committed to the farming system of the average farms in Bangalore rural district, has been used as a proxy for maximising family welfare.

Net farm income per hectare of cropped land was calculated by deducting total variable costs such as seeds, human and bullock labour, cost of fertilizer and plant protection chemicals and depreciation on implements from gross return. For dairying activity, net farm income was obtained by deducting total variable costs such as value of fodder, concentrates, cost of medicines, labour, depreciation on building and equipment from gross return. In sericulture, the annual operating expenses of maintenance of mulberry garden was added to the annual production cost of cocoon rearing and deducted from gross return to get net farm income. In poultry, cost of feed, medicines, labour, depreciation on poultry house and equipment was considered. For fisheries, cost of manuring, feeding labour etc. was deducted from gross return to arrive at net farm income.

Results & Discussion

The average farm size of small farms was 0.78 hectares (0.58 ha dry, 0.17 ha tube well irrigated and 0.03 ha tank irrigated) of land and it was 1.96 ha (1.23 ha dry, 0.52 ha tubewell irrigated and 0.21 ha tank irrigated) of land for small farms. In case of medium farms, it was 4.12 ha (2.59 ha dry, 1.18 ha tubewell irrigated, 0.24 ha tank irrigated and 0.11 ha garden) of land.

The details of net farm income derived from the existing farming systems are furnished in table 1. The marginal farms realised a maximum net farm income of Rs. 28,922 from crop + poultry farming system (Rs 24,413). Among the existing farming systems in small farms, crop + sericulture gave a maximum net farm income of

Rs 64,590 followed by crop + dairy + sericulture (Rs 58, 464) and crop + dairy + poultry (Rs 55, 064). For medium farms also, crop + sericulture realised a higher net farm income (Rs 81, 488) followed by crop + poultry (Rs 68, 591) and crop + dairy + sericulture (Rs 59, 993). It could be inferred that crop + sericulture system helped in realising maximum income in all categories of farms.

Crop + sericulture system helped in realising maximum income in all categories of farms.

Table 1: Net farm income from existing farming systems

(In rupees)

Farming Systems	Marginal farms	Small farms	Medium farms
Crop + dairy	21,429	43,863	59,366
Crop + poultry	24,413	54,921	68,591
Crop + sericulture	28,922	66,590	81,488
Crop + fisheries	-	24,958	40,970
Crop + dairy + poultry	-	55,064	-
Crop + dairy + sericulture	-	58,464	59,993

Note: Net farm income excluded returns from perennial tree crops in garden land

Marginal farms

The optimum farm plan for various farming systems of marginal farms is presented in table 2. It could be seen from the table that during kharif in dryland, 0.38 ha of groundnut + redgram (8:2) HYV and 0.20 ha of ragi HYV was suggested in all the three models. In the tubewell irrigated land, during kharif, the plan included 0.17 ha of tomato hybrid and 0.17 ha of potato-kufri jyothi during rabi and 0.17 ha of brinjal HYV in summer season in models M₁ and M₂.

During kharif, rabi and summer seasons, model M₃ in tubewell irrigated land suggested 0.10 ha each under tomato hybrid, potato-kufri jyothi and brinjal HYV, respectively. 0.07 ha of mulberry M-5 was suggested for the entire year. In tank irrigated land, 0.03 ha of paddy HYV was suggested in all the models M₁, M₂ and M₃ during summer.

Resource reorganisation suggested 1.63 cross bred cows in crop + dairy farming system and 530 poultry fowls in crop + poultry farming system for an increase in net farm income by 187 per cent and 165 per cent, respectively, over the existing farming system.

Crop + sericulture system would generate a higher income than the existing system by 139 per cent. This might be due to the inclusion of mulberry in all the three seasons. In the optimum farm plan, number of cross bred dairy cows and poultry fowls remained the same.

Table 2: Optimal farm plans for marginal farms

(Area in hectares)

Farming systems	Crop + dairy Model M ₁	Crop + poultry Model M ₂	Crop + sericulture Model M ₃
<i>Kharif</i>			
Dryland			
Ragi HYV + avare	0.20	0.20	0.20
Groundnut + Redgram (8:2) HYV	0.38	0.38	0.38
<i>Tubewell irrigated</i>			
Tomato hybrid	0.17	0.17	0.10
Mulberry M-5	-	-	0.07
<i>Rabi</i>			
Tubewell irrigated			
Potato-kufri jyothi	0.17	0.17	0.10
Mulberry M-5	-	-	0.07
<i>Summer</i>			
Tubewell irrigated			
Brinjal HYV	0.17	0.17	0.10
Mulberry M-5	-	-	0.07
Paddy HYV	0.03	0.03	0.03
Dairy (No.)	1.63	-	-
Poultry fowl (No.)	-	530	-
Net farm income (Rs.)	61,672	64,656	69,165
	(187)	(165)	(139)

(Figures in parenthesis indicate the percentage increase over existing farming systems)

Small farms

The details of optimum farm plan for various farming systems of small farms are furnished in table 3. During kharif the optimum farm plan suggested 1.03 ha of groundnut + redgram (8:2) HYV and 0.20 ha of ragi HYV + avare in all the models except in models S₃ and S₆. In tubewell irrigated land, the recommendation was 0.52 ha of tomato hybrid in kharif and 0.52 ha of potato-kufri jyothi in rabi. In summer, the crops suggested were cabbage hybrid in 0.14 ha and tomato hybrid in 0.38 ha in all the models except S₃ and S₆. The resource reallocation in crop + fisheries farming system would increase the net farm income by 126 per cent followed by crop + dairy farming system (68 per cent). In the optimum plan 0.02 ha of tubewell irrigated land was brought under cultivation in summer.

Table 3: Optimal Farm Plans for Small Farms

(Area in hectares)

Farming systems/Farming enterprises	Crop + dairy Model S ₁	Crop + poultry Model S ₂	Crop + sericulture Model S ₃	Crop + fisheries Model S ₄	Crop + dairy + poultry Model S ₅	Crop + dairy + sericulture Model S ₆
<i>Kharif</i>						
<i>Dryland</i>						
Ragi HYV + avare	0.20	0.20	0.20	0.20	0.20	0.20
Groundnut + redgram (8:2) HYV	1.03	1.03	1.03	1.03	1.03	1.03
<i>Tubewell irrigated</i>						
Tomato hybrid	0.52	0.52	0.52	0.52	0.52	0.52
Mulberry M-5	-	-	0.20	-	-	0.12
<i>Rabi</i>						
<i>Tubewell irrigated</i>						
Potato-Kufri jyothi	0.52	0.52	0.32	0.52	0.52	0.40
Mulberry M-5	-	-	0.20	-	-	0.12
<i>Summer</i>						
<i>Tubewell irrigated</i>						
Cabbage hybrid	0.14	0.14	0.14	0.14	0.14	0.14
Tomato hybrid	0.38	0.38	0.18	0.38	0.38	0.26
Mulberry M-5	-	-	0.20	-	-	0.12
<i>Tank irrigated</i>						
Paddy HYV	0.21	0.21	0.21	0.21	0.21	0.21
Dairy (No.)	2.20	-	-	-	1.30	0.90
Poultry fowl (No.)	-	657.00	-	-	283.00	-
Fisheries (fingerlings)	-	-	-	225.00	-	-
Net farm income (Rs.)	73,893 (68)	84,951 (55)	94,620 (46)	56,315 (126)	85,094 (54)	88,494 (51)

Table 4: Optimal Farm Plans for Medium Farms

(Area in hectares)

Farming systems/Farming enterprises	Crop + dairy Model L ₁	Crop + poultry Model L ₂	Crop + sericulture Model L ₃	Crop + fisheries Model L ₄	Crop + dairy + sericulture Model L ₅
<i>Kharif</i>					
<i>Dryland</i>					
Ragi HYV + avare	1.00	1.00	1.00	1.00	1.00
Pure redgram HYV	1.59	1.59	1.59	1.59	1.59
<i>Tubewell irrigated</i>					
Tomato hybrid	0.36	0.36	0.36	0.36	0.36
Brinjal HYV	0.82	0.82	0.58	0.82	0.68
Mulberry M-5	-	-	0.24	-	0.14
<i>Rabi</i>					
<i>Tubewell irrigated</i>					
Cabbage hybrid	1.18	1.18	0.94	1.18	1.04
Mulberry M-5	-	-	0.24	-	0.14
<i>Summer</i>					
<i>Tubewell irrigated</i>					
Tomato hybrid	1.12	1.12	0.88	1.12	0.98
Mulberry M-5	-	-	0.24	-	0.14
<i>Tank irrigated</i>					
Paddy HYV	0.24	0.24	0.24	0.24	0.24
Dairy (No.)	3.20	-	-	-	2.30
Poultry fowl (No.)	-	113.00	-	-	-
Fisheries (fingerlings)	-	-	-	387.00	-
Net farm income (Rs.)	123,988 (109)	133,213 (94)	144,315 (77)	105,592 (158)	124,615 (108)

(Figures in parenthesis indicate the percentage increase over existing farming system)

Medium farms

By reallocation of resources in the optimum plan, with 3.2 cross bred cows, the net farm income would increase by 109 per cent. In model L₅, the optimum plan suggested 2.3 cross bred dairy cows and 0.14 ha mulberry M-5. This would increase the net farm income by 108 per cent over the existing plan. The normative plan proposed to bring under cultivation 0.17 ha in tubewell irrigated land which is left fallow. The details of the normative farm plans regarding various farming systems of medium farms are furnished in table 4.

Mulberry was suggested in all the seasons in tubewell irrigated land. In optimum farm plans, under the various farming systems, the number of cross bred dairy cows, poultry fowls and fingerlings maintained in the existing plan did not change. The increase in the farm income was due to the change in cropping pattern in the various farming systems. The increase in income also might be due to fuller utilization of land under tubewell irrigation.

Diversification of enterprises and especially inclusion of livestock and other activities in farm not only helps increase the farm income but also reduces the risk in farming.

Conclusion

Diversification of enterprises and especially inclusion of livestock and other activities in farm plans, not only helps increase the farm income but also reduces the risk in farming. The farming system approach helps organise the farm business to get sustained stable income from the farm as a whole. The extension agencies should plan strategies for diversification to reduce the risk in farming and to augment returns.

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Drip Irrigation for Sugarcane

P.K. Selvaraj, N. Asokaraja, P. Manickasundaram, I. Muthusamy & A. Mohamed Ali

Sugarcane, being a long duration crop, is highly water intensive, ranking next only to paddy, in its requirement of water. However, most of the water supplied is wasted in the traditional surface irrigation. The authors present the methodology of drip irrigation for sugarcane which had been successful in experiments and prove its feasibility under practical conditions.

Sugarcane is an important commercial crop in India with its demand being consistently on the rise due to the increasing trend in the consumption of sugar consequent to changing patterns of food intake. On a global basis sugarcane contributes 55 per cent of the total sugar production. In Tamil Nadu sugarcane is grown in 2.75 lakh hectares resulting in 220 lakh tonnes of sugarcane production. Sugarcane is a water intensive crop requiring large quantum of water on a continuous basis. The water requirement for sugarcane is estimated to be equal to 80 times the harvested stalk weight. For producing 1 part of sugarcane drymatter 250 parts of water is needed. Thus only one per cent of the total amount of water absorbed is actually retained in the part. Therefore adoption of efficient irrigation practices will go a long way in economising the water usage and also in bringing more area under irrigation.

Sugarcane Irrigation: Traditional Method

Sugarcane is irrigated more frequently in sandy loam soil and at longer intervals in deep soils. Currently irrigation by ridges and furrow method is widely practiced for sugarcane and this leads to enormous wastage. About 20 to 30 cm of water is applied in each irrigation. However, irrigation water does not bring additional yields but leads to a loss of water to the tune of 54 per cent. For sugarcane, alternate furrow irrigation and gradual widening of furrows are the recommended practices under the surface method. Similar to horticultural and plantation crops, drip irrigation has been recently found to be the most efficient irrigation practice for sugarcane crop also, offering a wide range of benefits.

Drip irrigation has become widely popular in recent years owing to its feasibility under water scarcity conditions. In this system, water is conveyed through GI or polyethylene pipes from an overhead tank or by a motor. Laterals of small polyethylene pipes are connected to these main pipes and laid down near the crop rows where the water is let out continuously as drips by drippers. It is essential to connect filters at the beginning

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of the water sources to remove dust, sand algae and other wastes and enable even distribution of water to all the plants. In the drip system, the root zone is always saturated and the crop does not suffer due to drought at any growth stage. Drip irrigation system also controls weeds due to the limited zone of wetting and thereby reduces the cost of labour for weeding.

Drip irrigation has become widely popular in recent years owing to its feasibility under water scarcity conditions. Drip irrigation system also controls weeds due to the limited zone of wetting and thereby reduces the cost of labour for weeding.

Water saving is the prime advantage in the drip system over other methods of irrigation. In this method irrigation is possible with 1/3 of the total water required under the surface method of irrigation. Drip irrigation is the only viable system for special situations like sandy soils, low rainfall areas, slopy lands and for areas where no other irrigation practice is feasible.

Heavy investment is the most important constraint faced as drip irrigation requires Rs. 30000 to Rs. 50000 per hectare. However it is still a profitable practice owing to its long-term benefits for sugarcane and plantation crops. Before installation of the drip system, proper planning is absolutely essential to get a detailed estimate on the drip system components like the length of the main and sub-main pipes, laterals, number of drippers/Microtubes, filters, pressure gauges, quantum of water required etc. in advance.

Drip irrigation studies were taken up in Agricultural Research Station Bhavanisagar in 1994-95. The method of study adopted is illustrated here as an example:

Experimental Method

Planting and fertilization

For drip irrigation experiment, Co 8021 variety of sugarcane was planted in paired row system at 100/60 cm spacing while the farmers went ahead with their usual practice of ridges and furrows at 80 cm row spacing. In the drip system Nitrogen fertilizer (urea) was also supplied through drip along with the irrigation water at 175, 225 and 275 kg/ha. In the farmers' surface method of irrigation, urea was applied as band placement. Nitrogen and potassium were applied in 3 equal splits

on 30th, 60th and 90th day after planting. Phosphorus and potassium were applied as band along the furrow as common at 62.5 and 112.5 kg/ha respectively.

Irrigation scheduling

In the drip system, irrigation water was applied at 3 different levels viz., 80, 60 and 40 per cent of surface irrigation at 5 cm depth. Irrigation was scheduled once in 2 days. For surface irrigation treatment, depth of irrigation was 5 cm applied through ridges and furrows. Three common irrigations were given before imposing treatments. Scheduling of irrigation was determined based on pan-evaporation data at 0.75 IW/CPE ratio.

Design of drip system

The design of drip system for sugarcane consisted of one lateral for every two rows of sugarcane. The laterals were laid in between pairs of rows, so that one lateral could cover two rows of sugarcane. Drippers with a discharge rate of 4 litres per second were connected to the laterals 70 cm apart. For irrigating sugarcane at 80 per cent and 40 per cent of surface irrigation (0.75 IW/CPE ratio) motor was run for 2 1/2 hours and 1 1/4 hours respectively.

Results

Water, fertilizer use and yield

The cane yield obtained under drip irrigation system along with application of 225 kg N/ha was 179 tonnes/ha (table 1). Under surface irrigation the yield was only 132 tonnes/ha at the same dose of 225 kg N/ha. Thus there was an yield increase of 32 per cent under the drip system over the surface method.

It is obvious that a higher rate of nitrogen and irrigation water would result higher yield under the drip system. It is interesting to note that even under a lower rate of water supply viz., 40 per cent of surface irrigation and at the lower dose of 175 kg N/ha, the yield obtained was 166 tonnes/ha which was quite comparable to that of 80 per cent of surface irrigation with 225 kg N/ha (179 t/ha). The yield reduction was only 7.3 per cent but this had achieved a total water saving of 44 per cent over the surface method besides saving 22 per cent of Nitrogen fertilizer.

The water requirement for sugarcane under surface (ridges and furrows) method was 1824 mm including effective rainfall, while it was 1531 mm only under drip irrigation even at a higher rate of application (80 per cent of surface irrigation) (table 2). This has resulted in

Table 1: Cane yield as influenced by irrigation systems and nitrogen

Treatments	Nitrogen (kg/ha)			Mean
	175	225	275	
Surface irrigation (ridges and furrows) 5 cm depth (0.75 IW/CPE)	119.6	136.2	124.6	125.5
Drip irrigation once in 2 days at 80% of surface irrigation (0.80 × 0.75 PE)	159.9	178.8	163.8	167.5
Drip irrigation once in 2 days at 60% of surface irrigation (0.60 × 0.75 PE)	164.0	172.5	166.7	167.7
Drip irrigation once in 2 days at 40% of surface irrigation (0.40 × 0.75 PE)	166.1	157.2	147.6	157.0
Mean	152.4	161.2	150.7	—

Table 2: Water use and yield of sugarcane in drip and surface irrigation systems (1994-95)

Treatments	Irrigation water (mm)	Effective rainfall (mm)	Total water used (mm)	Cane yield (t/ha)	Water use efficiency kg/ha/mm
Surface irrigation (ridges and furrows) 5 cm depth (0.75 IW/CPE)	1478	346	1824	125.5	68.8
Drip irrigation once in 2 days at 80% of surface irrigation (0.80 × 0.75 PE)	1185	346	1531	167.5	109.4
Drip irrigation once in 2 days at 60% of surface irrigation (0.60 × 0.75 PE)	934	346	1280	167.8	131.0
Drip irrigation once in 2 days at 40% of surface irrigation (0.40 × 0.75 PE)	682	346	1028	157	152.7

Table 3: Economics of drip and surface irrigation system

Treatments	Total water used (mm)	Nitrogen dose (kg/ha)	Net return (Rs/ha)	Cost-Benefit ratio
Surface irrigation (ridges and furrows)	1824	275	56,540	1:2.03
Drip irrigation once in 2 days at 80% of surface irrigation	1531	225	59,816	1:2.37
Drip irrigation once in 2 days at 60% of surface irrigation	1280	225	56,166	1:2.28
Drip irrigation once in 2 days at 40% of surface irrigation	1028	175	52,833	1:2.22

a net saving of 16 per cent irrigation water. From the yield point of view, drip irrigation at 40 per cent was quite superior in recording additional cane yield (32 tonnes) as compared to surface irrigation.

Water use efficiency

Drip irrigation in sugarcane has resulted in maximum water use efficiency (table 2). Irrigation through drip at 40 per cent of surface method has produced 153 kg of sugarcane for 1 hectare mm of water, whereas it was only 69 kg under surface irrigation. There has been higher cane yield with optimum irrigation water supply resulting in higher water use efficiency under the drip irrigation system.

There has been higher cane yield with optimum irrigation water supply resulting in higher water use efficiency under the drip irrigation system.

Economics

Drip irrigation to sugarcane at 80 per cent of surface irrigation along with 225 kg N/ha recorded a total net income of Rs. 60000/ha and at 40 per cent of surface irrigation with 175 kg N/ha it was Rs. 53000/ha. For every one rupee investment, there was a return of Rs. 2.22 to 2.37 under the drip systems (table 3). The total investment for drip system was Rs. 50000 per ha. For computing profit-loss accounts, Rs. 5000 as interest for Rs. 50000 investment and Rs.

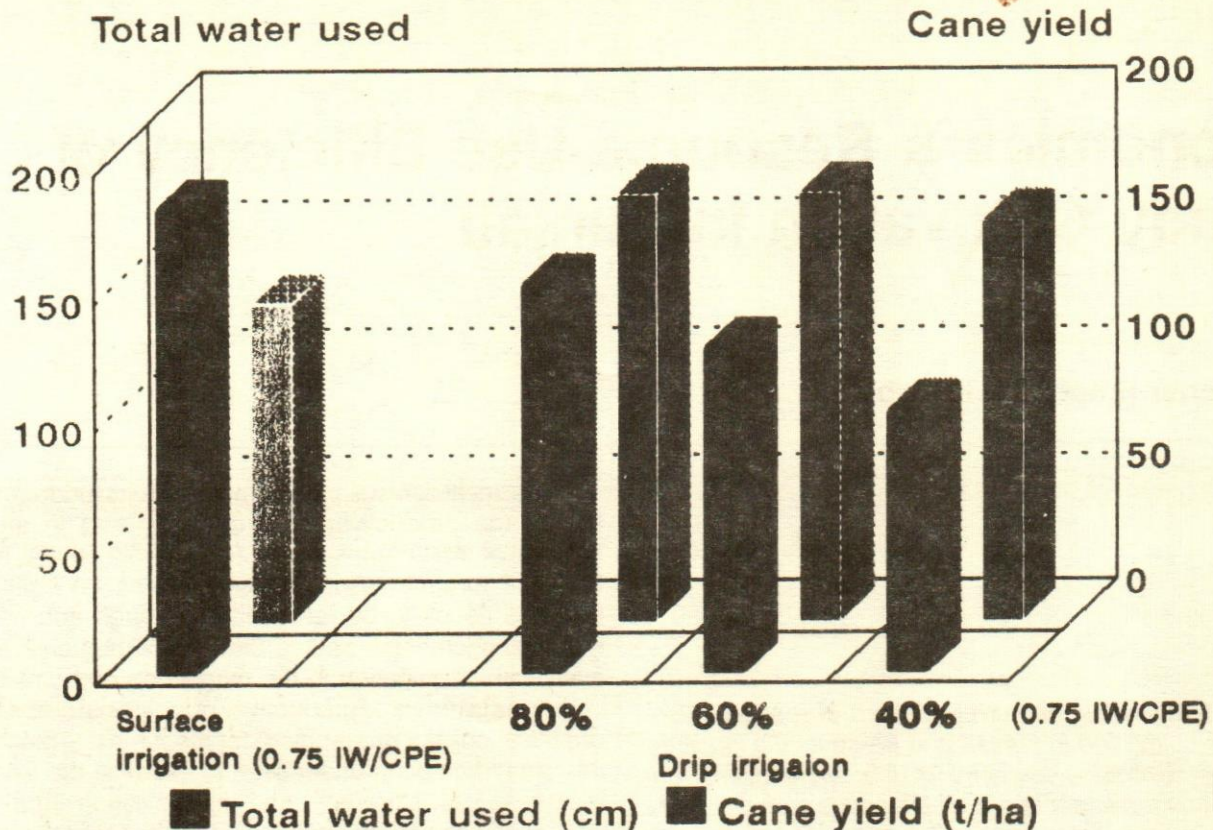


Fig. 1. Water use and yield of sugarcane in drip and surface irrigation systems

5000 as depreciation cost were taken into consideration in the cultivation expenses.

Adoption of Drip System for Sugarcane

The promising results obtained (Fig. 1) at Agricultural Research Station, (TNAU) Bhavanisagar, impressed the farmers who had been visiting the experimental site. Consequently, it has been adopted on a small scale and the farmers have laid out drip system for sugarcane in 7 acres near Sathyamangalam. The Sakthi Sugars has also adopted the drip system for sugarcane in 20 acres in their farms.

Other recommendations

Apart from the adoption of drip irrigation for water saving, the following technologies would provide additional benefits.

- Selection of drought tolerant varieties of sugarcane like Co.C.8001, Co.C.85061, Co.C.90063, Co.G.93076, Co.C.86071.
- For soil moisture conservation, application of

coirpith at 25 tonnes per hectare would reduce evaporation rate.

- Spreading of sugarcane trashes as mulch would also reduce loss of water from soil surface.
- Planting of single budded sprouts in polythene bags would reduce the water requirement to a greater extent.

Subsidy for drip system

Through a centrally sponsored scheme for Drip Demonstration Programme, Government of India has sanctioned a sum of Rs. 200 crores as subsidy. Government of Tamil Nadu, has also extended a subsidy of Rs. 15000 per hectare for laying out drip irrigation system. In Coimbatore District about 1.5 crore rupees was given as subsidy for the year 1995-96. This has benefitted 640 farmers in an area of 2350 hectares. The Executive Engineer of Agrl. Engineering Dept. may be contacted for more details about the cost and subsidy for the drip system.

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Economics & Resource-Use Efficiency of Paddy Cultivation in Punjab

Parminder Singh & D.K. Grover

The study analyses the current pattern of resource use in paddy cultivation in Punjab and presents the implications. It advocates enhancing the expenditure on nitrogenous fertilisers under all situations as it will augment the productivity.

The inefficient use of farm resources undoubtedly affects the productivity of crops, resulting in an unfavourable cost/returns structure. To avoid such a situation, the existing resource use patterns on individual holdings needs to be reorganized through appropriate farm management decisions. Since a comprehensive and analytical investigation in the magnitude and causes of variations in the value productivity of individual crops/farm organisations is a pre-requisite for resource use planning, this study has been undertaken to examine the existing resource use efficiency and its deviation from the economic use of farm resources. Paddy, being the major cereal crop in Punjab (occupying about 29 per cent and 41 per cent of the total cropped area in the state and an agriculturally advanced district, Ludhiana, respectively during 1993-94), was taken up for an indepth study.

Existing resource use patterns on individual holdings needs to be reorganized through appropriate farm management decisions.

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Methodology

The study was carried out in Ludhiana district of Punjab, where paddy is the major kharif crop. All the blocks of Ludhiana district were arranged in descending order or their weighted average value productivity per hectare of the major crops, i.e. paddy and wheat, pertaining to the year 1993-94. Two blocks—i.e. Delhon, the highest productive and Mangat, the least productive—were purposively selected to facilitate the comparative analysis of the two situations. The two stage stratified random sampling technique was used to select the study sample, treating village as first stage and the operational holdings as the second and the ultimate unit of sampling.

A comprehensive list of the villages pertaining to these two blocks was prepared and two villages from each block were chosen randomly making it four sample villages in all for the indepth study. All the holdings in the selected villages were enumerated and classified into two categories viz. owned tractor farms and custom hiring farms. Fifteen holdings from each category belonging to each village were selected by random sampling method, thereby making it a sample of thirty holdings from each village, sixty from each block and one hundred and twenty holdings from the district as a whole. Detailed primary information regarding output of paddy crop and various cost components such as seed, fertilizers, insecticides, weedcides, family labour, hired labour, hiring of inputs services such as tractor, thresher etc. on the farm during 1994-95, was collected with the help of a schedule especially designed for the purpose, using survey method.

To examine the factors affecting the value productivity of paddy crop under different situations/blocks, the Cobb-Douglas production function of the following form was fitted

$$Y = A \prod_{i=1}^{11} X_i^{b_i} e^u$$

where, Y represented the value productivity per hectare of the paddy crop, X_i s, the selected explanatory variables (per hectare); A, the technical efficiency parameter and b_i s the coefficients of production elasticity of the respective variables at the mean level of inputs used and output obtained. 'e' is an error term. The various explanatory factors included in the model are:

- X₁ : Value of seed (rupees)
- X₂ : Plant protection measures (rupees)
- X₃ : Micro nutrients (rupees)
- X₄ : Nitrogenous fertilizers (rupees)
- X₅ : Phosphatic fertilizers (rupees)
- X₆ : Family labour (rupees)
- X₇ : Hired labour (rupees)
- X₈ : Machine labour (rupees)
- X₉ : Irrigation with electric motor (rupees)
- X₁₀ : Irrigation with diesel engine (rupees)
- X₁₁ : Farm size (hectare)

The marginal value productivities of various inputs were estimated directly from the regression estimates at

arithmetic mean level of inputs, used as follows:

$$MVP(X_i) = : b_i \left[\frac{\bar{Y}}{\bar{X}_i} \right]$$

Where, b_i , is the output elasticities of variable X_i and \bar{X}_i and \bar{Y} are the arithmetic means of concerned variables.

Cost/returns structure

The cost and return structure of paddy cultivation under different situations has been worked out and presented in table 1. The total operational costs per hectare of paddy cultivation came to Rs. 8,983 and Rs. 10,387 in the highest and least productive blocks respectively (table 1). The expenditure, (in absolute term), on human labour and fertilizers was lower i.e. Rs.2679 & Rs. 1707 in the highest productive block as compared to Rs. 3901 & Rs. 1996 the least productive block. Interest on working capital and expenditure on irrigation was also found lower in the highest productive block whereas, in case of machine labour, it was higher (Rs. 2279) in the highest productive block as compared to the least productive block (Rs. 2054). The higher use of most of the conventional inputs in the least productive block was the sole reason for higher cost of cultivation.

Gross returns per hectare from paddy crop came to Rs. 20452 & Rs. 17205 in the highest and least productive blocks respectively. Respective returns over variable costs per hectare were Rs. 11469 and Rs. 6818. The gross returns as well as the returns over variable costs per hectare in the highest productive block were higher than that of the least productive block. It was partly because of the lower operational cost and corresponding higher yield per hectare in the highest productive block.

The comparative economics of paddy crop on owned tractor farms as well as custom hiring farms in the highest productive block showed that the total operational costs in the former was higher than that of the latter custom hiring farms. The expenditure on human labour, machine labour, irrigation and micro nutrients was higher on owned tractor farms as compared to custom hiring ones (table 1).

The gross return was marginally higher (Rs. 20600) on owned tractor farms. But returns over variable costs was less (Rs. 10673) as compared to custom hiring farms (Rs. 12268). It was mainly because of higher operational costs in the former category.

In the case of the least productive block, the operational cost was more on the owned tractor farms compared to the custom hiring farms as the expenditure on

Table 1 : Economics of Paddy Cultivation in Ludhiana District of Punjab, 1994-95

(Rupees)

Particulars	Situation I-Highly Productive Belt			Situation II-Least Productive Belt		
	Owned Tractor Farms (a)	Custom Hiring Farms (b)	Overall OT+CH (a+b)	Owned Tractor Farms (a)	Custom Hiring Farms (b)	Overall OT+CH (a+b)
Operational Costs	9927 (100.00)	8035 (100.00)	8983 (100.00)	10637 (100.00)	10132 (100.00)	10387 (100.00)
Human Labour						
Family Labour	458 (4.61)	973 (12.11)	716 (7.97)	848 (7.97)	1205 (11.89)	1027 (9.89)
Permanent Labour	1231 (12.41)	629 (7.83)	931 (10.36)	1006 (9.46)	601 (5.93)	804 (7.74)
Casual Labour	1179 (11.88)	884 (11.00)	1032 (11.49)	1930 (18.14)	2209 (21.80)	2070 (19.93)
Total	2869 (28.90)	2486 (30.94)	2679 (29.82)	3784 (35.57)	4015 (39.63)	3901 (37.56)
Machine Labour						
Owned	1947 (19.61)	-	974 (10.84)	1424 (13.39)	-	712 (6.85)
Hired	731 (7.36)	1879 (23.39)	1305 (14.53)	756 (7.11)	1928 (19.03)	1342 (12.92)
Total	2678 (26.96)	1879 (23.39)	2279 (25.37)	2180 (20.49)	1928 (19.03)	2054 (19.78)
Seed	158 (1.59)	117 (1.46)	138 (1.54)	220 (2.07)	130 (1.28)	175 (1.68)
Fertilisers						
Nitrogenous Fertilizers	1086 (10.94)	1185 (14.75)	1136 (12.65)	1170 (11.00)	1206 (11.90)	1188 (11.44)
Phosphatic Fertilizers	537 (5.41)	605 (7.53)	571 (6.36)	827 (7.77)	788 (7.78)	808 (7.78)
Potassic Fertilizers	-	-	-	-	-	-
Total	1623 (16.34)	1790 (22.28)	1707 (19.00)	1997 (18.77)	1994 (19.68)	1996 (19.22)
Manuring	445 (4.48)	223 (2.78)	334 (3.72)	-	-	-
Plant Protection Measures	498 (5.03)	528 (6.57)	512 (5.70)	512 (4.81)	436 (4.30)	474 (4.56)
Micro Nutrients	218 (2.20)	104 (1.29)	161 (1.79)	40 (3.76)	441 (4.35)	421 (4.05)
Irrigation						
Electric Motor	388 (3.91)	347 (4.32)	368 (4.10)	339 (3.19)	367 (3.62)	353 (3.40)
Diesel Engine	466 (4.69)	88 (1.10)	277 (3.08)	579 (5.44)	225 (2.22)	402 (3.87)
Total	854 (8.60)	435 (5.41)	645 (7.18)	918 (8.63)	592 (5.84)	755 (7.27)
Interest on Working Capital	584 (5.88)	473 (5.89)	528 (5.88)	626 (5.89)	596 (5.88)	611 (5.88)
Yield Value of Main Product	-	-	-	-	-	-
Value of By-Product	20600	20303	20452	17009	17401	17205
Gross Income						
Returns over Variable Cost	10673	12268	11469	6372	7269	6818

Figures in parentheses indicate the per cent to total operational costs.

Table 2: Marginal Value Productivities of Different Inputs for Paddy Cultivation in Ludhiana District, 1994-95

Inputs	Situation I—Highly Productive Belt			Situation II—Least Productive Belt			Combined Situation (I+II)
	Owned Farms (a)	Custom Hiring Farms (b)	Overall OT+CH (a+b)	Owned Farms (a)	Custom Hiring Farms (b)	Overall OT+CH (a+b)	
Seed	-5.3065	15.8259	-2.2823	-5.1877	0.2945	-2.0548	-4.9771
Plant Protection Measures	-12.7943	-2.6402	0.5792	0.3687	3.1330	-0.4936	-0.3017
Micro-Nutrients	-0.0047	-0.7028	-0.0762	-1.7137	0.2644	0.1880	-0.1294
Nitrogenous Fertilizers	3.8184	20.4932	6.6739	12.5256	3.5408	7.7379	5.3522
Phosphatic Fertilizers	-0.0077	0.1812	0.1254	0.9358	-1.9366	-	0.0573
Family Labour	2.7886	0.4632	0.5913	0.7943	0.3913	0.3133	-0.7601
Hired Labour	1.9370	-	0.4928	0.5121	-	-0.1323	-0.9759
Machine Labour	-0.6985	-	0.3949	-	-	-	0.6424
Irrigation (EM)	4.9376	-	-3.4491	-	-	0.2145	1.6378
Irrigation (DE)	0.1017	-0.3230	0.2953	0.1733	0.0696	-0.0642	0.0554
Farm Size (ha)	-64.9195	236.5741	-25.8807	128.8490	369.3503	181.9760	107.4869

machine labour, seed and irrigation was more in the former. Gross return as well as return over variable costs per hectare (Rs. 17009 & Rs. 6372) were lower on owned tractor farms as compared to custom hiring farms (Rs. 17407 & Rs. 7269). It indicated that hiring of tractor rather than owning it was more economic in this particular situation.

Resource Use Efficiency of Different Inputs

The marginal value productivities of different explanatory variables were computed at arithmetic mean level for different situations (table 2).

Highest productive block: owned tractor farms

The marginal value productivity coefficient for nitrogenous fertilizers was found to be statistically significant (3.82) showing the scope of additional use of this input. The coefficient of plant protection measures was found to be negative and significant showing the over utilization of this resource in this particular situation. The coefficients of remaining inputs like family labour, irrigation, seed, micro nutrients, phosphatic fertilizers and machine labour were found to be non-significant.

Highest productive block: custom hiring farms

The coefficients for seed, nitrogenous fertilizers, phosphatic fertilizers and family labour were 15.83, 20.49, 0.18 and 0.46 respectively, all statistically significant. The data on seed and nitrogenous fertilizers showed that these inputs can further be increased for

increasing the returns from paddy cultivation. On the other hand coefficients of phosphatic fertilizers and family labour were 0.18 and 0.46 showing that these particular inputs were being used beyond the optimal point. The coefficients of all other explanatory variables like plant protection measures, micro nutrients and irrigation (DE) were found to be non-significant.

A comparative picture showed a greater scope for increasing the expenditure on nitrogenous fertilisers in both the farming situations, though productivity associated with an increase of one rupee on nitrogenous fertilizers was much higher in custom hiring farms as compared to owned tractor farms.

Highest productive block: overall

The coefficient for nitrogenous fertilizers was found to be statistically significant indicating that more investment in nitrogenous fertilizers was needed in this particular situation.

The coefficient of all other variables like seed, plant protection measures, micro nutrients, phosphatic fertilizers, family labour, hired labour, machine labour, irrigation (EM) and irrigation (DE) turned out to be non-significant.

Least productive block: owned tractor farms

The coefficients for nitrogenous fertilizers, phosphatic fertilizers, family labour, irrigation(DE), farm size and micro nutrients were found to be statistically significant.

On the other hand the coefficients of phosphatic fertilizers and family labour were 0.94 and 0.79 showing thereby over use of these resources. Besides, the value of coefficient (0.17) for irrigation (DE) also showed that this particular variable was used beyond the optimal point.

The positive and significant coefficient of the farm size suggested an increase of the farm size for better use of the resources. The coefficient of farm size (128.84) indicated that with an increase of the operational holding by one hectare, the overall value productivity per hectare of paddy would increase by about Rs. 129.

The negative and significant coefficient for micro nutrients showed over use (may be substandard quality) of this resource. Coefficients of variables like plant protection measures, seed and hired labour were found to be non-significant.

Least productive block: custom hiring farms

The coefficients for nitrogenous fertilizers, farm size and micro nutrients were found to be statistically significant.

The positive and significant coefficient of farm size shows increased farm size to make more effective use of the various inputs. The value of coefficient for micro nutrients (0.26) showed that this particular input was being used beyond the optimal point.

Besides, the coefficients for inputs like seed, plant protection measures, phosphatic fertilizers, family labour and irrigation (DE) were found to be non-significant.

The comparative picture of the two situations, i.e. owned tractor farms and custom hiring farms, showed that there was a greater scope of increasing the expenditure on nitrogenous fertilizers in both the situations though the marginal value productivity was much higher on owned tractor farms. Similarly, the positive coefficient of farm size showed the scope to further increase the operational size of holdings in both the situations.

Least productive block: overall

The coefficients for nitrogenous fertilizers (7.74), and farm size (181.98) turned out to be statistically significant.

The value of coefficient for micro nutrients (0.19) implied that this resource was being used beyond the optimal point. The coefficients for the remaining explanatory variables like seed, plant protection measures, family labour, hired labour, irrigation (DE) were found to be non-significant.

The comparative analysis of the two situations i.e. the highest and least productive blocks showed that there was greater scope to increase the expenditure on nitrogenous fertilizers in both the situations, though the marginal value productivity of this variable was slightly higher in the least productive block as compared to the highest.

Ludhiana district overall: combined

The coefficient for nitrogenous fertilizers (5.35), was found to be statistically significant. The coefficients for variables like family labour and hired labour were found to be negative and significant indicating overuse of these resources. The coefficient for the remaining explanatory variables like seed, plant protection measures, micro nutrients, phosphatic fertilizers, irrigation (EM) and irrigation (DE) turned out to be non-significant.

Concluding Remarks

The study brought out that the total operational costs per hectare of paddy cultivation was lower in the highest productive block as compared to the least productive block, whereas, the gross returns as well as returns over variable costs per hectare turned out to be higher in the case of the former. The farm category comparison revealed that the operational costs per hectare of paddy on owned tractor farms was higher compared to the custom hiring farms in both the study blocks of Ludhiana district. The gross income per hectare from paddy was observed to be higher on owned tractor farms as compared to custom hiring farms, in the highest productive block. But in the case of the least productive block, it was found to be lower (though marginally) on owned tractor farms as compared to custom hiring farms. The returns over variable costs per hectare was observed to be lower in owned tractor farms as compared to custom hiring farms in both the highest as well as the least productive blocks.

The analysis further brought out the scope of increasing the expenditure on nitrogenous fertilizers for paddy crop in all the situations. Though the comparative analysis of the two situations i.e. the highest and least productive blocks showed that there was a scope of increasing the expenditure on nitrogenous fertilizers in both the situations, the marginal value productivity of this particular variable was slightly higher in the least productive block as compared to the highest. For the district as a whole, the coefficients for nitrogenous fertilizers and human labour were found to be statistically significant, indicating the over use of human labour at present, and scope to enhance expenditure on nitrogenous fertilizers in paddy cultivation profitably. □

Power Tillers in India – Prospects & Future Role

P.S. Tiwari & A.C. Varshney

Increased cropping intensity and modernization of agriculture have increased the power requirement of Indian farms. Power tillers are the most viable power source in this context. The paper presents the features of the power tiller which makes it suitable for varied farm activities and recommends a few steps to popularise its adoption by the farming community.

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Animate (human and animal) power has been the main source of farm power on Indian farms and will continue to contribute a major proportion in the coming decade, because of the agro-climatic and socio-economic conditions of the farmers in the country. Since draught animals are progenies of local milch animals, they may continue to provide the farm power for field operations. However, their number is decreasing (Anon, 1987). Though the total bovine population in the country has increased from 227 to 273 million during 1961-1987, the number of draught animals has reduced from 80.4 million in 1961 to 73 million in 1987. A study conducted by the International Crop Research Institute for Semi Arid Tropics in 12 villages of Andhra Pradesh during 1976 to 1982 has revealed that ownership of bullocks has come down from one pair per household to one animal per household. On the other hand, the costs of real wages and fodder have been steadily increasing in the period (Reddy, 1990). Excluding the Eastern region where animal energy use has increased marginally from 213 to 221 animal-pair-hours/hectare (aph/ha) during 1972-1991, there had been a drastic reduction in animal energy use in Northern (157 to 58 aph/ha), Southern (142 to 112 aph/ha) and Western (133 to 93 aph/ha) regions. However, increased cropping intensity and modernization of agriculture have increased the power requirement on Indian farms. Due to the increased cost of feeding to draught animals many small and marginal farmers have limited their reliance on draught animals and avail the services of mechanical power sources either of their own or on hire basis.

Growth of Supplementary Farm Power

Tractors and power tillers supplement draught animal power. The number of tractors has increased from about 4000 during the year 1961-62 to about 2.05 million during 1994-95. However, tractors have their own limitations for use in small fields and their costs are also beyond the reach of small and marginal farmers.

The rate of growth of tractor population has been higher in the state of Punjab, Haryana, Uttar Pradesh, Rajasthan, Gujarat and Madhya Pradesh, accounting for about 76 per cent of the total tractor population. In other states where paddy is the major cereal crop and land holdings are of smaller size, power tillers play an important role in supplementing the draught animal power.

Tractors have their own limitations for use in small fields and their costs are also beyond the reach of small and marginal farmers.

The cumulative increase in the number of tractors and power tillers in India in the last 20 years is shown graphically in fig. 1. The figure clearly shows the period of sluggish down time of power tiller industry which continued till late eighties. This was the period when the farmers were completely unaware of this new power source and the government mainly concentrated its efforts on tractor popularization with the import of around 74,000 tractors till 1976-77. Import of power tillers ended in the year 1973-74 with a total import of 2629 power tillers only. Annual percentage increases in the number of power tillers have been highest in the year 1971-72 due to import of about 1600 power tillers during this year. Excluding the year 1971-72, the average annual percentage increase during the first five years of seventies has been about 20 per cent. In this period many manufacturers came into the power tiller business. However, with the closing down of some factories in the late seventies, the power tiller industry witnessed its down fall in the eighties and in this period the average annual percentage increase in the number of power tillers was only around 10 per cent.

Considering the utility of power tillers primarily for wetland cultivation, the Government of India issued licences to six firms during the year 1963 for indigenous manufacturing of power tillers. Total licensed capacity of these firms was 40,000 power tillers per annum. It was considered that Indian farmers may adopt power tillers possibly at a high rate of 80,000 units per annum. The reason was that they could be purchased at a cheaper cost than a tractor and could serve multifarious jobs at the farm. Nevertheless, the estimated potential demand did not materialise. In 1973 the Government of India set up a committee to study the reasons for the low demand of power tillers. In 1975 the committee highlighted the points that required immediate action, hoping that with the reduction of the price of power tillers and mass scale demonstration programmes, the Indian farmers may adopt 20,000 power tillers annually (Pangotra, 1976).

Among the various reasons for the inadequate growth of the power tiller industry in the sixties and seventies, the main reason was the absence of wide publicity and other extension activities to make the farmers aware of this new machine (Reddy, 1975). Non availability of credit in adequate measure to small and medium farmers, lower cost of bullocks, cheap agricultural labour and above all the non availability of service and repair facilities even in major Indian cities till early eighties were some other problems for non popularity of power tillers. However, this situation is changing rapidly. The cost of bullocks and their feed and maintenance cost and cost of agricultural labour are increasing. Farmers' awareness about the usefulness of power tillers in the cultivation of paddy and upland crops, orchards and forestry is increasing day by day.

The acceptability of power tillers among the farmers has been increasing since the year 1988-89. The main reasons for this increase are the introduction of subsidies, launch of All India Coordinated Research Project on Power Tillers by Indian Council of Agricultural Research and development of a variety of power tiller matching equipments for wetland and upland cultivation, orchards and forestry. In the first five years of the nineties, the average annual percentage increase in the number of power tillers has been about 12 per cent. While during the same period the average annual percentage increase in the number of tractors has gone down to 9.5 per cent from about 11 per cent in the eighties (Fig. 1). Presently the demand for power tillers is more than their production and new manufacturers are coming up in the power tiller business. Currently about 10,000 power tillers are being marketed annually in the country.

Land Use & Cropping Pattern in India

The total geographical area of India is 328.73 million hectares of which 155.6 million hectares is cultivable land. Net sown area increased from 118.75 million hectares during 1950-51 to 139.50 million hectares during 1989-90. Area under forest increased from 40.50 to 67.8 million hectares in the same period. The gross cropped area increased from 131.9 to 181.10 million hectares registering a compound growth of 0.56 per annum. Net irrigated area increased from 20.85 to 45.14 million hectares while the gross irrigated area increased from 22.56 to 59.64 million hectares from 1950-51 to 1989-90. The average size of farm holdings has been reducing gradually due to the ever increasing population. The average size of holding in 1991 was 1.6 ha which was further divided into 2 to 6 parcels resulting in very small plot sizes. The number and operational area of marginal, small and semi-medium farmers have shown an increasing trend while that of medium and large farmers showed a decreasing trend as evident from table 1. Mar-

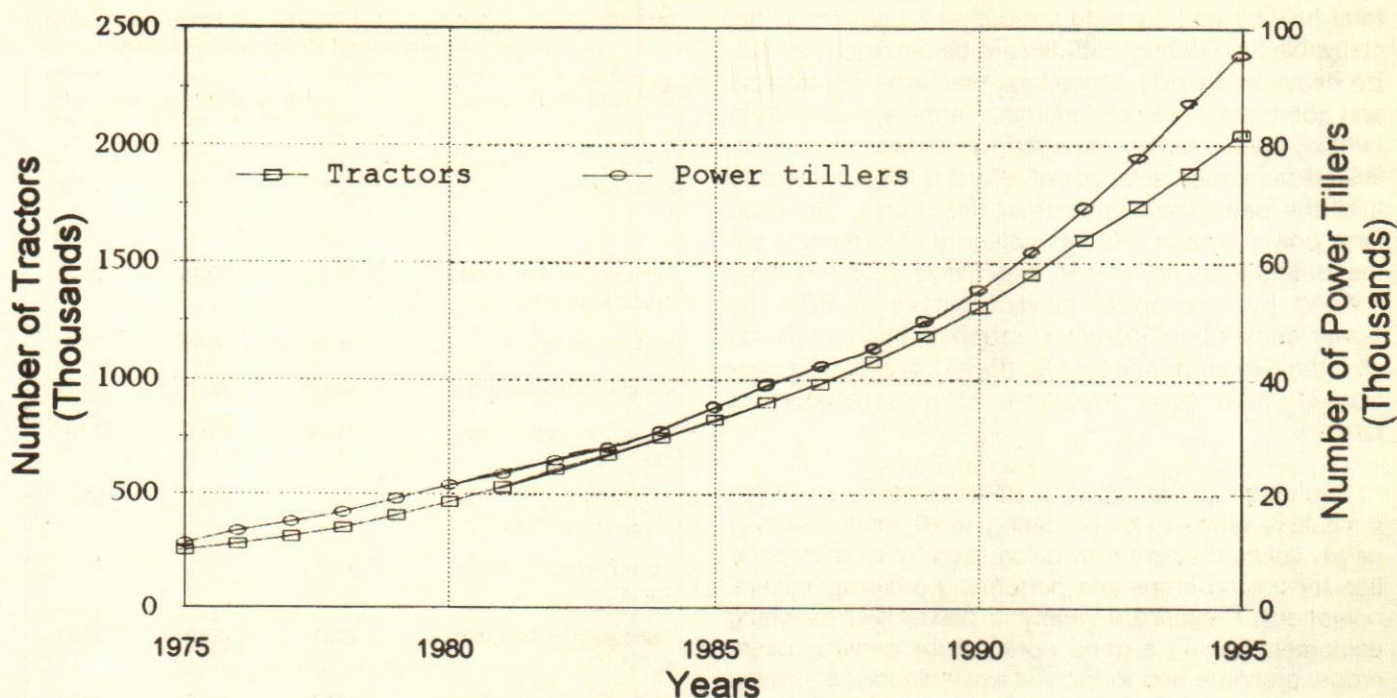


Fig. 1. Cumulative increase in number of tractors and power tillers

ginal, small and semi-medium farmers constituted 89.8 per cent of the total holdings and cultivated 51.3 per cent of the total cultivable land in the year 1985-86.

Broad cropping pattern shows that though foodgrains have a preponderance in gross cropped area compared to non-foodgrains their relative share came down from 76.7 per cent during 1950-51 to 70.9 per cent during 1989-90. Among the foodgrains, rice is the major crop that covered about 23.4 per cent of the total sown area followed by wheat which covered about 13 per cent during 1989-90. Oil seeds, cotton and sugarcane are the major non foodgrain crops that covered about 12.6, 4.3 and 1.9 per cent respectively of

the total sown area during the year 1989-90.

Scope of Power Tillers

Power tillers have been specially designed for wetland cultivation in lowland paddy fields. They are very popular in paddy growing countries like Japan, China, Republic of Korea, Philippines, Islamic Republic of Iran, Sri Lanka, Thailand etc. In India also they have been well accepted by the farmers in the paddy growing states of Eastern and Southern India. In other paddy growing states, their number is low mainly because of the non availability of spare parts and service facilities. Medium and large farmers who held 10.2 per cent of the

Table 1: Distribution of Land Holdings (1980-81/1985-86)

Category of holding and size	No. of operational holding (Millions)		Area operated (Million hectares)		Average size (Hectares)	
	1980-81	1985-86	1980-81	1985-86	1980-81	1985-86
Marginal (Less than 1 ha)	50.12 (56.4)	56.74 (58.1)	19.73 (12.1)	21.606 (13.1)	0.39	0.38
Small (1 to 2 ha)	16.07 (18.1)	17.88 (18.3)	23.17 (14.1)	25.533 (15.6)	1.44	1.43
Semi-medium (2.0 to 4.0 ha)	12.45 (14.01)	13.25 (13.5)	34.64 (21.2)	36.58 (22.3)	2.78	2.76
Medium (4.0 to 10.0 ha)	8.68 (9.1)	7.92 (8.1)	48.54 (29.6)	47.01 (28.7)	6.02	5.94
Large (Above 10 ha)	2.16 (2.40)	1.93 (2.0)	37.70 (23.0)	33.18 (20.30)	17.41	17.20

Figures in parentheses indicate percentages

total holding and cultivated about 48.7 per cent of the cultivable land during 1985-86, are better placed to utilize heavy and costly agricultural machines like tractors and combines. Small and marginal farmers, especially in rainfed areas, where productivity is low, have very limited resources and cannot afford to buy tractors to fulfill the power requirements of their farms. The main farm power source with this category of farmers is still the draught animal power that needs to be supplemented by mechanical power sources to fulfill the power demands of increased cropping intensity. Being an intermediate power source, power tiller may be considered as a good alternative for this category of farmers.

Although power tillers were introduced in Indian agriculture primarily for preparing seedbeds in low land paddy fields, they are now being used for land preparation for upland crops and performing other agricultural operations. Presently a variety of power tiller matching equipment having a good potential for growing major crops, orchards and forestry is available for performing agricultural operations ranging from seedbed preparation to harvesting and threshing.

Seedbed preparation and sowing

Inferior quality of seedbed, traditional method of broadcasting and mixing the seeds into soil and a considerable delay in transplanting operation due to low power availability are among the various reasons for low paddy yields from considerable areas of paddy cultivation in the states of Madhya Pradesh, Bihar, Assam, Orissa, Maharashtra etc. Power tillers are the most suitable power source for preparing the seedbed for paddy crop in wetland and upland paddy fields. The capability of rotovator to prepare a fine seedbed in only one operation and to shred and mix weeds and crop residues into soil make them suitable for seedbed preparation for other crops also. Table 2 presents the results of a study conducted to compare the power tiller and bullock farming systems for raising paddy crops under the soil conditions of Faizabad (UP) region (Dept. of Agricultural Engineering, 1988). It is evident from these results that power tiller farming system is economical and generates more income compared to the bullock farming system. This is because of higher crop yields due to better quality of seedbed and lesser competition of weeds with the crop. Another study was conducted to compare power tiller and tractor farming systems for raising paddy crops at Narendra Dev University of Agriculture and Technology, Kumarganj, during the years 1986-87 and 1987-88. The power tiller farming system gave a benefit cost ratio of 2.30 against 2.08 with the tractor farming system mainly because of higher crop yields due to better quality of puddling,

Table 2: Performance Results of Bullock and Power Tiller Farming Systems for Transplanted Paddy Crop Production

Performance Parameter	Value for different treatments		
	T ₁	T ₂	T ₃
Field capacity	ha/h	0.046	0.078
			0.109
Time required for field preparation h/ha	70.33	19.86	28.41
Puddling index, %	36.50	56.43	66.91
Weeding efficiency, %	46.82	78.31	85.74
Water percolation rate, mm/day	11.99	9.25	7.68
Cost of seedbed preparation, Rs/ha	684	366	536
Cost of weeding (twice), Rs/ha	1085	847	723
Grain yield at 14% m.c., kg/ha	2851	2932	3150
Cost of cultivation, Rs/ha	4828	4210	4262
Income, Rs/ha	5039	5192	5562
Benefit cost ratio	1.04	11.23	1.30

Source: Dept. of Agricultural Engineering, 1988. Based on average data of three crop seasons 1985-86, 1986-87 and 1987-88) at NDUAT, Faizabad, U.P.

T₁ = Ploughing once by mouldboard plough attachment to country plough + ploughing twice by country plough after flooding + planking twice by bullocks.

T₂ = Rotapuddling once + planking twice by Mitsubishi power tiller (6.0 kW).

T₃ = Rotapuddling twice + planking twice by Mitsubishi power tiller.

lesser water loss through percolation and lesser weed growth. Studies conducted at other places have also indicated less water percolation rate, higher crop yield and net benefits in paddy fields prepared by power tiller rotovator than from the seedbed prepared by tractor or bullock systems.

The ability of the power tiller rotovator to prepare a fine seedbed makes it suitable for crops other than paddy also. Studies have shown that the quality of seedbed prepared by operating the power tiller rotovator once is equivalent to three times ploughing by indigenous plough or blade harrow operated by bul-

Power tillers are the most suitable power source for preparing the seedbed for paddy crop.

locks. Apart from better quality of the seedbed, the time required and the cost for seedbed preparation for upland crops are also lower than the bullock farming system. Table 3 shows the results of a study conducted to compare the power tiller with the bullock farming system for raising wheat crop under the soil conditions of Bhopal region (Varshney et. al. 1990). These results clearly indicate that the power tiller system is economical and gives higher crop yields in the cultivation of upland crops also.

Table 3: Performance Results of Bullock and Power Tiller Farming Systems for Wheat Crop Production

Performance parameters	Value for different treatments			
	T ₁	T ₂	T ₃	T ₄
Soil moisture,% (db)	20.73	21.15	21.20	20.93
Final depth of seedbed, cm	11.90	12.45	9.80	12.25
Effective field capacity during final operation, ha/h	0.08	0.1	0.09	0.11
Mean weight diameter of soil clods, mm	14.90	13.50	15.50	13.20
Cost of seedbed preparation, Rs/ha	373.00	520.00	285.00	517.00
Grain yield, kg/ha	3229	3520	3548	3665

Based on average data of two crop seasons 1986-87 and 1987-88) at CIAE, Bhopal.

T₁ = Blade harrowing twice by bullocks + sowing by CIAE bullock drawn 3-row seed-cum-fertilizer drill.

T₂ = Blade harrowing thrice by bullocks + sowing by CIAE bullock drawn 3-row seed-cum-fertilizer drill.

T₃ = Rotatilling once by Mitsubishi power tiller + sowing by CIAE power tiller operated 5-row seed-cum-fertilizer drill.

T₄ = Rotatilling twice by Mitsubishi power tiller + sowing by CIAE power tiller operated 5-row seed-cum-fertilizer drill.

Sowing crops in rows not only saves costly seeds but also eases subsequent field operations like interculture, plant protection and harvesting. Row seeding permits the use of mechanical weeders for weed control and facilitates regulated application of fertilizer near root zones which in turn increases the yield by 5-10 per cent. Different designs of power tiller operated seed-cum-fertilizer drills suitable for specific crops and regions are available for sowing paddy, wheat, coarse cereals, pulses and oil seeds. Planters-cum-fertilizer applicators are available for planting groundnut, maize, potato and sugarcane. For sowing pregerminated paddy seeds under puddled soil conditions, pregerminated paddy seeder has been developed at Orissa University of Agriculture and Technology, Bhubaneswar. A till-plant system where tillage and sowing operations could be done simultaneously is also available. The system is very useful for rainfed agriculture where Rabi crops re-

Power tiller system is economical and gives higher crop yields in the cultivation of upland crops also.

quire to be sown in a very limited time span under residual moisture conditions.

Interculture and plant protection

A serious problem that results in low crop yields in irrigated and rainfed agriculture during Kharif season is weed control. If not controlled, weeds may reduce the yield to the extent of 20-60 per cent. Pre-emergence weedicide followed by mechanical weed control have been found economical and environment friendly methods of weed control. The number of days available for interculture operation in Kharif crops is very limited and farmers often lose a greater proportion of their crop yields due to heavy weed growth. The traditional tools for mechanical weeding have very low capacity and therefore, require about 300 to 700 man-hours to cover one hectare. Power tiller with its compact size, light weight and less wheel width is one of the best suited machines for performing interculture operation in widely spaced row crops like soybean, sorghum, groundnut, pigeonpea etc. Table 4 presents the comparative performance results of power tiller operated cultivator, bullock drawn blade hoe and manually operated wheel hoe for interculture operation in sorghum crop (Varshney & Narang, 1992). These results clearly indicate the better economics of power tiller operated cultivator over wheel hoe and blade hoe. Although the weeding efficiency of power tiller operated cultivator is lower than that of a wheel hoe or blade hoe, weed intensities after 25 days of interculture were comparable in all the cases probably due to the higher depth of operation during interculture with a power tiller cultivator which uproots deep rooted weeds also. Where row spacings permit, power tiller rotovator as such may be used for interculture in crops like sugarcane and cotton. Earthing operation in potato, sugarcane and other similar type of crops could be performed by using a furrower or ridger with power tiller.

Power tiller with its compact size, light weight and less wheel width is one of the best suited machines for performing interculture operation in widely spaced row crops like soybean, sorghum, groundnut, pigeonpea.

Table 4: Performance Results of Power Tiller, Animal and Manually Operated Interculture Equipment (1987-88)

Performance parameter	Power tiller cultivator	Animal drawn blade hoe	Manual wheel hoe
Power source	Mitsubishi Power Tiller CT85/VWH120	Pair of bullocks	Human power
Number of soil working tools	3	1	1
Type of soil working tool	Sweep	Blade	Sweep
Size of soil working tool, cm	15	20	20
Depth of operation, cm	8.60	5.20	2.00
Width of operation, cm	24.00	26.40	34.00
Speed of operation, km/h	1.17	1.12	-
Effective field capacity, ha/h	0.107	0.044	0.015
Crop damage, %	1.08	0.75	0.00
Fuel consumption, l/h	0.750	-	-
Weeding efficiency	48.30	53.60	70.60
Weed density after 25 days of weeding, g/m ² (d.b.)	114.60	112.50	102.70
Number of labourers required	1	1	1
Human energy required for weeding	man-h/ha	9.35	22.73
Cost of operation, Rs/ha	192.43	253.86	152.67

Moisture content of soil % (db)	= 22.5
Initial weed intensity, g/m ² (db)	= 24.5
Crop	= Sorghum, variety CSH5
Row to row spacing, cm	= 45
Age of crop, days	= 19
Average height of crop, cm	= 14.60

Harvesting & threshing

Power tiller operated vertical conveyor reaper is an ideal machine for harvesting upright crops like paddy, wheat and barley. Its field capacity is about 0.25 ha/h. It saves about 51 per cent expenditure and 78 per cent labour compared to manual harvesting by sickle. Power tiller operated fixed platform type reaper is suitable for harvesting bunch crops like soybean, greengram etc. Its field capacity is about 0.16 ha/h. It saves about 10 man-days of labour per hectare. Power tiller operated TNAU paddy thresher and OUAT hold-on type paddy thresher are good machines for threshing paddy crop while a power tiller engine can be used to operate any paddy or wheat thresher of appropriate horsepower.

Power tillers for orchards and forestry

Power tillers are an economical and effective means for preparing the nursery seedbed for raising seedlings of orchard and forestry plants. Pits dug by a power tiller operated post hole digger are circular in shape and can be dug at a cheaper rate compared to manual digging and digging by a tractor operated digger. Due to their compact size and less turning radius, power tillers are the best suited machines for performing operations like interculture, spraying and dusting in orchards and forestry. Since the centre of gravity in the power tiller is close to the ground, it can be used on undulating terrains more easily than tractors. Power tiller operated tree felling machines can be very economically used for felling trees up to 20 cm diameter grown under agroforestry and social forestry. When operated in reverse direction, the power tiller can be used for basin preparation for orchard plants.

Transport and other activities

Power tillers with one ton capacity trailers are good alternatives for bullock carts in the villages for carrying agricultural inputs to the fields and produce to the homes and markets. Power tiller engine can be used to energize irrigation pump, thresher, chaff cutter and similar stationary machines requiring 8 to 12 horsepower.

Power Tillers in Indian Agriculture

Being the most versatile and an alternative power source for the replacement of bullock power especially in paddy-based farming, power tillers are very popular in the states of Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Maharashtra, West Bengal and Assam. Apart from their use in the paddy seedbed preparation, they are being used for potato cultivation in West Bengal and for sugarcane and orchard cultivation in the state of Maharashtra. Farmers in other states also are impressed with the power tiller technology. Nevertheless, the technology is not getting extended at the desired pace primarily because of financial constraints and non availability of prompt after sales services.

Japanese design rotary type power tillers are the most popular in the country with Mitsubishi and Kubota (MAMCO) ruling the roost. The former is being manufactured by M/s VST Tillers and Tractors Limited, Bangalore and the latter by The Kerala Agro Machinery Corporation, Ernakulam. Mitsubishi power tillers are being marketed through private dealership established throughout the country by M/s VST Tillers and Tractors

Limited and KAMCO power tillers through the Agro Industrial Development Corporations of various state Governments. Current production level of each of the above firms is around 5,000 power tillers per annum. KAMCO power tillers are in great demand in the states of West Bengal, Assam and Kerala with the present production level falling short of demands. The company has setup another manufacturing unit at Palkkad for the production of about 3,000 additional power tillers. A china make power tiller with the trade name "Shrachi" is another in the fray being marketed by M/s Bengal Tools Limited, Calcutta.

Future Prospects

Considering the cropping pattern and the size of land holdings in India, power tillers will play a promising role in mechanizing small and marginal farms in the country. On medium and large size farms also they are an appropriate farm power source for performing operations like interculture, spraying and dusting. Since paddy is the major cereal crop of India and most of the paddy fields are of small size where the operation of tractors is either difficult or uneconomical, power tillers are the best power source for the replacement of bullock power. Use of tractor power has been mainly for the cultivation of upland crops other than paddy, and in the regions where the size of land holdings is big. Some marginal and small farmers are also using tractors on hire basis but at the cost of sacrificing timeliness. Due to the high hiring charges for mould board ploughs and disc ploughs, majority of farmers are hiring tractor drawn cultivators both during Rabi and Kharif seasons. Broadcasting of seeds before cultivating is the most popular method of sowing adopted by these farmers in rainfed areas of Uttar Pradesh, Madhya Pradesh, Bihar and Orissa that are the major paddy growing states with lowest crop yields. This practice results in poor germination, high weed growth and crop lodging ultimately leading to poor crop yields. By adopting proper cultural practices and supplementing/substituting the bullock power with power tillers, the productivity level can be enhanced.

As evident from table 2, with the use of power tillers the yield level of paddy crops can be enhanced by about 10 per cent over bullock farming system. Excluding the states of Punjab and Haryana where the yield of paddy crop is maximum and farms are highly mechanised with the use of tractors. There is a plenty of scope for increasing the paddy yields in the other states. Considering only 50 per cent mechanization of paddy growing areas by power tillers, the total production can be increased by about 2.0 million tonnes if

only 5 per cent increase in paddy yields over traditional system is considered. Savings due to reduced cost of cultivation and reduced water percolation will be an additional income for the farmers. For mechanization of 50 per cent of paddy growing areas by power tillers and considering the command area of an 8-12 hp power tiller as six hectares, the country will require about 3.5 million power tillers with 3.5 million rural youth getting employment as power tiller operators. Considering that one workshop with five mechanics will take care of the repair and maintenance of 100 power tillers, the number of people employed as power tiller mechanics will be around 2.1 lakhs. With the increase in service and repair facilities, more farmers may opt for having power tillers like the farmers in the states of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh and many other states in Eastern India. In these states, even farmers with very small land holding or without any land holding own 2-3 power tillers. Hiring rates in these states vary between Rs. 70-80 per hour and during peak seasons power tillers are operated for even up to 20 hours a day. An entrepreneur can earn Rs. 27,000 to 34,000 per annum with 850-1000 hours of operation in a year and can repay the loan/capital borrowed within 2.5 years (Tiwari & Varshney, 1995). Power tillers will provide the individual farmers an opportunity to perform the agricultural operations on time which will increase the agricultural productivity of the nation. Increased productivity and income through employment opportunities will spur the economic development of the country.

Wide publicity highlighting the usefulness of power tillers should be made.

Measures for Popularization

In spite of their potential in the country, power tillers are not getting popular at the desired pace due to various reasons. Some steps which must be considered for the popularization of power tillers in the country are as follows:

- Live demonstrations must be jointly conducted by state agricultural universities, research organizations, dealers, manufacturers and Government agencies to make the farmers aware of this versatile power source. Wide publicity highlighting the usefulness of power tillers should be made through media.
- Manufacturers should identify good dealers for providing prompt after sales services so that

farmers may not face problems during peak seasons. Experience has shown that the sale of power tillers has increased significantly in the areas where the reputation of the dealer is good.

- Considering the poor economic condition of the small and medium farmers, the Government should provide a subsidy of at least 50 per cent as in case of sprinkler system of irrigation. Manufacturers may consider reducing the cost of power tillers and spare parts.
- The procedure of getting bank loan should be such that even illiterate and poor farmer may not face difficulty in availing it.

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Total Factor Productivity Growth in Indian Manufacturing (1973-94)

NPC Research Division

In our earlier study on labour productivity and labour intensity we have estimated the productivity ratios for 46 Indian manufacturing industries for the period 1973-92 [Productivity Vol. 36 (1), 1995]. In the previous issue of productivity [Vol. 37 (4), 1997] we estimated capital productivity for the 46 Indian manufacturing industries and for the total manufacturing sector. The methodology adopted for capital stock estimation had also been detailed therein.

In the present paper, we estimate Total Factor Productivity Index (TFPI – Solow) for the same industry groups. TFPI (Solow) is reported along with Labour Productivity and Capital Productivity Indices for the period 1973-94 at 1981-82 prices. TFP Solow Index is based on the Cobb-Douglas production function. Under the assumptions of constant returns to scale, autonomous Hicks-neutral technological progress and payment to factors according to marginal product, the following equation is obtained:

$$(A'/A) = (Y'/Y) - [(1-\beta) (L'/L) + \beta (K'/K)] \quad \dots(1)$$

where Y denotes gross value added (net value added plus depreciation) at 1981-82 prices computed using industry group specific price indices. Gross value added is the increment to the value of goods and services that is contributed by manufacturing and is obtained by deducting the value of total inputs from the gross value of output. Depreciation of consumption of fixed capital due to wear and tear and obsolescence during the accounting year and is taken as provided by the factory owner or is estimated on the basis of cost of installation and working life of the fixed assets.

Number of labourers is represented by L while K stands for capital stock computed at 1981-82 prices by deflating current values with Machinery and Machine Tools price index. Capital has been estimated as gross fixed capital stock. It represents the depreciated value of fixed assets owned by the factory as on the closing day of the accounting year. Fixed assets are those which have a normal productive life of more than one year. β denotes the income share of capital.

The superscript (') stands for the time derivative. From equation (1) the discrete form is obtained as

$$(\delta A/A) = (\delta Y/Y) - [(1-\beta) (\delta L/L) + \beta (\delta K/K)] \quad \dots(2)$$

Once computation of $\delta A/A$ is done (for different years) with the help of equation (2), the Solow index is obtained using the following identity (taking A(0) as unity).

$$A(t+1) = A(t) [1 + (\delta A/A)] \quad \dots(3)$$

The following table gives industry group-wise indices of Capital Productivity, Labour Productivity and Total Factor Productivity.

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Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing

Years	Food Products (20-21)			Refining of Sugar (206)			Hydrogenated Oils Vanaspati (210)			Beverages, Tobacco & Tobacco Products (22)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	95	87	103	54	70	100	73	53	101	170	107	105
1975-76	96	75	105	59	70	103	69	43	103	122	54	107
1976-77	99	69	107	53	61	104	102	56	105	124	68	109
1977-78	116	66	110	59	49	107	140	67	106	81	46	108
1978-79	139	62	112	83	49	110	128	58	108	97	53	110
1979-80	115	46	112	67	38	110	150	58	109	86	42	110
1980-81	71	29	111	36	24	108	170	53	111	76	34	111
1981-82	93	35	113	60	36	111	142	38	111	73	33	111
1982-83	125	40	115	119	53	114	141	38	113	73	33	111
1983-84	189	42	118	203	54	116	121	25	115	137	47	118
1984-85	189	37	119	202	40	117	112	25	115	153	37	119
1985-86	204	36	120	206	36	117	196	32	118	136	25	120
1986-87	208	33	121	238	38	118	180	26	119	146	27	122
1987-88	206	31	121	238	39	119	178	23	121	131	23	123
1988-89	251	34	123	335	53	121	146	18	121	151	21	125
1989-90	282	35	126	343	46	123	133	17	122	122	21	125
1990-91	254	28	127	262	33	124	149	13	123	139	19	126
1991-92	256	26	127	278	34	124	143	12	125	147	20	127
1992-93	237	23	128	294	33	125	107	9	125	141	17	129
1993-94	297	26	130	358	33	127	118	9	126	170	18	130

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Cotton Textiles (23)			Wool Silk & Manmade fibre textiles (24)			Jute Hemp & Mesta Textiles (25)			Textiles Products (26)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	90	68	101	109	61	103	109	84	101	82	68	101
1975-76	81	52	102	111	60	104	128	91	103	88	52	104
1976-77	83	44	103	106	52	105	123	77	103	81	45	106
1977-78	87	39	104	125	50	109	116	66	103	85	39	108
1978-79	104	41	106	155	52	110	109	51	103	95	32	111
1979-80	108	38	107	131	43	111	126	59	104	69	21	111
1980-81	107	31	108	141	36	113	151	58	106	77	21	111
1981-82	99	24	108	159	36	116	143	45	106	92	24	113
1982-83	89	19	108	157	29	118	122	37	105	103	23	114
1983-84	114	21	110	189	28	120	108	26	104	101	20	116
1984-85	111	17	111	193	28	121	85	21	100	126	23	118
1985-86	125	16	112	231	30	123	103	18	102	99	17	118
1986-87	139	17	113	248	29	124	169	31	107	125	18	120
1987-88	133	14	113	223	26	125	149	22	106	125	15	123
1988-89	141	13	114	255	25	126	149	17	107	147	17	124
1989-90	165	16	115	345	29	129	129	15	105	158	19	127
1990-91	181	15	116	408	30	132	132	13	106	172	19	128
1991-92	157	12	116	367	23	133	145	14	107	204	20	131
1992-93	156	10	117	396	22	134	152	15	107	203	20	132
1993-94	168	10	118	490	25	137	162	13	107	244	25	138

Note: LPI: Labour Productivity Index

KPI: Capital Productivity Index

TFPI: Total Factor Productivity Index

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Wood & Wood Products Furniture & Fixture (27)			Paper & Paper Products Printing etc. (28)			Pulp, Paper & Paper Board (280)			Leather, Leather & Fur Products (29)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	93	58	103	108	73	103	129	84	105	126	68	105
1975-76	91	47	104	108	57	104	115	61	106	115	40	105
1976-77	105	42	106	105	47	106	100	44	108	122	37	111
1977-78	108	37	108	107	43	107	93	40	109	123	28	114
1978-79	108	33	109	105	38	108	96	36	110	108	22	115
1979-80	100	30	109	103	32	109	90	31	112	109	18	117
1980-81	88	21	110	103	25	111	88	23	114	96	14	116
1981-82	89	20	111	109	24	112	88	21	115	102	14	118
1982-83	85	17	111	92	18	113	55	12	114	115	14	119
1983-84	110	14	116	104	16	115	76	12	117	142	15	121
1984-85	109	16	114	125	16	117	104	13	121	146	16	122
1985-86	90	12	114	107	15	116	84	12	119	123	12	123
1986-87	100	12	115	126	14	118	105	13	121	121	12	123
1987-88	112	12	117	124	13	119	90	11	121	151	14	125
1988-89	131	12	119	136	12	120	112	11	124	124	11	126
1989-90	124	10	119	158	14	120	147	15	124	137	13	128
1990-91	185	14	121	171	14	122	157	15	126	163	11	131
1991-92	185	13	121	159	12	122	132	12	126	184	13	132
1992-93	96	7	119	145	11	123	113	10	126	204	12	134
1993-94	108	6	122	176	11	124	117	10	127	292	17	137

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Rubber, Plastic, Petroleum & Coal Products (30)			Chemical & Chemical Products (31)			Basic & Industrial Chemicals & Gases (310)			Fertilizers & Pesticides (311)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	114	82	103	95	66	103	84	81	100	93	61	103
1975-76	99	60	106	88	46	105	68	53	103	83	39	106
1976-77	140	45	111	95	48	106	75	46	105	97	43	107
1977-78	141	43	113	100	44	108	102	52	107	105	37	109
1978-79	126	29	115	117	45	110	99	49	108	140	45	112
1979-80	101	27	115	102	34	112	86	36	109	130	36	114
1980-81	97	30	113	91	28	113	87	22	114	103	29	114
1981-82	93	23	115	100	27	114	96	25	114	136	32	116
1982-83	111	28	118	108	29	115	96	23	115	160	40	116
1983-84	91	16	119	132	30	117	88	18	117	176	37	117
1984-85	128	21	121	129	28	117	90	17	119	237	48	117
1985-86	215	30	125	126	26	119	93	16	120	183	37	118
1986-87	201	27	126	132	23	120	118	17	122	198	32	119
1987-88	207	25	127	146	25	121	122	17	122	222	37	120
1988-89	214	23	130	159	26	122	160	20	123	256	43	122
1989-90	217	24	130	190	26	125	125	15	124	272	44	124
1990-91	244	24	132	215	24	126	139	15	126	337	48	124
1991-92	213	20	133	207	23	127	151	15	127	362	43	126
1992-93	279	25	135	245	26	129	129	13	128	365	49	126
1993-94	318	25	138	265	26	130	155	14	129	340	40	127

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Paints & Varnishes (312)			Drugs & Medicines (313)			Non- metallic Mineral Products (32)			Structural Clay Products (320)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	97	69	102	108	81	102	93	74	101	89	53	103
1975-76	93	57	102	130	81	105	95	61	103	93	49	104
1976-77	97	50	104	132	71	106	103	56	105	94	43	105
1977-78	93	43	106	126	64	107	120	60	106	103	44	106
1978-79	134	46	111	132	55	109	111	46	107	109	39	108
1979-80	117	41	111	143	52	111	100	38	108	99	36	108
1980-81	91	27	112	153	47	112	98	33	110	87	29	109
1981-82	87	22	113	142	40	114	100	29	111	86	26	110
1982-83	92	21	114	170	44	115	119	30	114	71	22	110
1983-84	112	24	116	213	50	117	122	25	116	56	14	110
1984-85	109	21	116	191	40	118	140	25	118	67	14	112
1985-86	95	18	116	207	38	119	152	21	120	69	13	113
1986-87	134	20	118	215	37	120	146	16	122	68	11	114
1987-88	120	19	119	237	38	122	163	16	124	88	12	116
1988-89	100	14	120	258	37	123	179	15	125	91	11	117
1989-90	149	20	122	279	38	125	204	16	127	84	10	117
1990-91	154	18	124	303	34	126	243	18	128	92	10	119
1991-92	190	24	126	344	37	128	278	19	130	93	9	120
1992-93	146	16	127	352	37	130	223	14	130	94	8	120
1993-94	140	13	130	416	40	132	87	5	127	125	9	123

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Glass & Glass Products (321)			Cement Lime & Plaster (324)			Basic metal & Alloys Industries (33)			Iron & Steel in Primary/ Self Finished Forms (330)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	82	60	101	99	75	101	127	105	101	144	114	100
1975-76	72	45	102	120	77	104	108	52	105	116	50	105
1976-77	83	40	104	127	71	105	122	48	106	127	46	106
1977-78	107	47	105	163	82	107	110	39	107	114	38	107
1978-79	99	40	106	135	57	108	120	41	109	125	39	109
1979-80	82	35	105	117	44	109	105	31	109	106	27	110
1980-81	80	31	106	111	34	111	112	30	111	119	29	111
1981-82	94	30	108	104	27	112	122	29	112	132	29	113
1982-83	99	24	110	205	48	118	118	26	113	132	25	114
1983-84	104	24	110	221	36	122	126	25	114	138	24	115
1984-85	128	25	111	244	39	123	108	20	115	118	20	116
1985-86	174	30	114	268	31	127	122	20	116	132	20	116
1986-87	149	23	114	254	24	129	107	17	115	108	17	116
1987-88	154	21	115	282	23	131	124	18	117	119	18	117
1988-89	175	20	118	320	23	133	168	22	119	174	23	119
1989-90	260	22	123	357	24	134	165	19	119	155	18	119
1990-91	226	20	122	488	30	136	198	18	123	205	18	125
1991-92	311	23	127	605	35	138	158	12	123	165	11	125
1992-93	262	17	127	383	23	138	195	15	126	192	14	127
1993-94	289	13	131	331	18	138	408	27	128	229	15	128

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Foundry for Casting & Forging (331)			Ferro Alloys (332)			Copper Manufacturing (333)			Aluminium Manufacturing (335)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	100	135	97	114	103	100	129	46	107	105	58	104
1975-76	88	64	100	91	82	101	69	28	107	99	44	106
1976-77	88	50	102	95	92	102	182	73	110	137	49	108
1977-78	87	45	102	76	47	105	57	27	108	102	36	109
1978-79	103	51	104	98	48	107	96	43	111	111	39	110
1979-80	101	44	105	72	32	108	110	57	111	78	33	108
1980-81	109	44	106	115	45	111	68	32	111	45	15	109
1981-82	97	36	106	89	25	113	63	28	111	44	14	109
1982-83	84	30	107	65	16	114	128	46	113	70	21	111
1983-84	95	28	109	67	16	119	134	44	114	61	19	111
1984-85	76	21	108	54	11	119	69	20	114	77	23	112
1985-86	96	22	110	89	19	120	65	19	114	69	18	112
1986-87	94	20	110	93	20	123	20	5	108	57	14	111
1987-88	104	20	111	101	23	124	76	24	141	116	16	126
1988-89	112	19	112	98	20	124	51	14	139	187	27	131
1989-90	146	12	113	92	19	124	118	29	148	252	30	132
1990-91	178	12	113	72	13	125	157	32	149	166	24	130
1991-92	156	10	114	65	8	131	145	30	150	201	25	133
1992-93	177	8	117	74	12	130	28	6	146	224	24	136
1993-94	183	10	116	24	3	126	20	3	144	242	21	136

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Zinc Manufacturing (336)			Metal Products & Parts (34)			Machine Tools & Parts (35)			Agriculture Machinery (350)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	558	408	117	98	71	102	111	73	103	114	64	103
1975-76	268	111	116	95	55	103	107	54	105	121	67	104
1976-77	290	68	121	102	48	105	128	56	107	150	67	109
1977-78	501	64	135	99	45	106	126	49	109	118	53	109
1978-79	232	39	135	103	41	107	128	46	109	127	52	111
1979-80	259	45	136	111	39	109	118	39	111	113	44	112
1980-81	248	42	136	107	31	110	123	37	111	139	47	114
1981-82	196	29	136	109	29	111	127	34	113	145	41	114
1982-83	160	28	137	107	26	112	137	33	114	139	34	116
1983-84	288	54	141	129	24	114	154	31	116	138	32	117
1984-85	109	20	139	119	22	114	178	33	118	156	35	118
1985-86	67	16	137	124	20	115	181	27	119	182	37	119
1986-87	159	33	143	132	19	116	179	25	119	191	33	119
1987-88	153	30	144	155	21	118	183	25	120	224	39	120
1988-89	149	24	145	162	19	120	179	22	121	193	33	121
1989-90	210	29	146	131	15	120	209	23	123	241	35	122
1990-91	216	24	147	128	12	122	219	22	124	309	43	125
1991-92	238	19	158	143	13	123	259	31	133	297	35	125
1992-93	420	30	160	134	11	124	269	27	135	254	32	126
1993-94	119	8	158	169	11	126	272	25	136	253	28	126

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Prime Movers Boilers (352)			Industrial Machinery for Food & Textiles (353)			Industrial Machinery other than Food & Textiles (354)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100
1974-75	105	82	103	104	79	102	87	64	102
1975-76	117	51	105	101	56	104	116	59	107
1976-77	200	52	108	120	56	106	125	58	109
1977-78	143	51	108	126	51	108	81	31	109
1978-79	111	33	109	137	47	110	95	44	108
1979-80	96	26	110	116	37	110	109	44	110
1980-81	92	23	111	174	31	112	106	41	109
1981-82	99	23	113	106	24	112	103	40	111
1982-83	100	20	114	107	21	113	107	44	111
1983-84	101	16	117	114	21	115	160	51	113
1984-85	144	22	117	119	17	116	164	46	114
1985-86	151	22	120	122	11	119	157	36	114
1986-87	101	13	119	147	15	116	171	38	115
1987-88	105	13	120	151	15	117	156	38	116
1988-89	119	12	122	155	14	118	151	29	118
1989-90	122	12	122	210	17	119	157	30	118
1990-91	117	9	122	225	17	120	148	25	119
1991-92	107	9	122	242	17	121	156	23	120
1992-93	99	7	122	240	14	123	161	25	121
1993-94	79	6	122	224	13	124	179	28	122

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Refrigeration & AC (355)			Machine Tools & Parts (357)			Electrical Machinery (36)			Electrical Industrial Machinery (360)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	96	72	102	140	96	104	90	55	103	88	48	103
1975-76	75	43	102	133	89	106	98	52	104	101	51	104
1976-77	102	48	106	158	84	107	105	50	105	107	49	105
1977-78	161	72	108	145	68	109	112	47	107	113	45	106
1978-79	141	60	109	145	66	110	114	43	108	109	41	107
1979-80	123	34	111	158	61	111	107	39	109	99	36	108
1980-81	140	46	110	150	53	112	122	39	110	119	40	109
1981-82	168	51	112	208	69	114	128	37	111	122	36	110
1982-83	206	56	113	220	64	115	153	40	114	151	39	112
1983-84	184	42	114	303	72	118	164	37	115	151	39	112
1984-85	159	32	115	357	67	120	197	41	117	218	48	116
1985-86	223	41	117	257	51	120	164	31	117	148	31	115
1986-87	222	29	118	250	45	120	185	30	118	158	29	116
1987-88	229	27	120	247	38	120	213	31	121	185	34	118
1988-89	251	19	121	206	27	120	225	28	123	182	27	119
1989-90	322	29	131	196	26	121	257	29	124	217	33	120
1990-91	258	26	133	201	22	122	264	28	126	247	36	122
1991-92	265	24	134	184	21	122	*	*	*	219	32	122
1992-93	376	25	134	200	21	124	*	*	*	227	31	123
1993-94	372	18	139	191	17	123	*	*	*	206	25	123

* Included in Industry Group 35

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Transport Equipment (37)			Locomotive Parts (371)			Railway Wagons (372)			Motor Vehicles (374)		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	99	76	102	92	78	100	105	81	101	98	70	102
1975-76	104	59	103	55	75	98	129	83	101	95	52	105
1976-77	132	53	106	66	76	98	159	92	101	119	55	107
1977-78	131	48	107	92	104	100	146	81	101	119	50	108
1978-79	143	25	113	225	13	121	126	70	102	121	44	109
1979-80	112	22	113	146	13	119	113	53	103	94	32	110
1980-81	111	21	113	136	12	119	107	45	103	95	29	111
1981-82	121	21	114	75	7	117	110	41	104	116	31	114
1982-83	136	22	116	119	11	120	113	33	105	127	30	116
1983-84	146	21	116	103	10	119	101	24	105	139	27	117
1984-85	147	19	118	118	12	121	94	21	105	139	24	118
1985-86	144	16	118	38	3	119	118	23	107	140	21	120
1986-87	164	17	119	141	11	134	116	23	107	158	21	121
1987-88	163	15	120	79	6	131	167	20	111	151	18	122
1988-89	172	15	121	86	6	132	114	12	109	165	19	123
1989-90	197	15	122	101	6	133	185	16	112	169	23	121
1990-91	230	17	123	70	4	131	186	16	113	189	25	123
1991-92	210	15	124	61	4	130	144	13	111	180	23	123
1992-93	220	14	125	95	5	132	152	9	113	176	21	124
1993-94	238	14	126	59	4	128	143	9	112	416	23	125

Table 1: Labour Productivity, Capital Productivity and TFP (Solow) Indices in Indian Manufacturing (Contd.)

Years	Motorcycle Scooter (375)			Bicycle Parts (376)			Other Manufacturing Industry (38)			ALL INDUSTRIES		
	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI	LPI	KPI	TFPI
1973-74	100	100	100	100	100	100	100	100	100	100	100	100
1974-75	114	89	102	99	81	101	93	98	99	104	84	102
1975-76	100	42	104	103	56	103	109	66	102	103	68	104
1976-77	153	61	113	110	56	104	144	71	105	110	61	105
1977-78	132	45	115	117	53	106	128	56	106	113	53	107
1978-79	136	45	117	98	39	105	135	48	107	130	51	110
1979-80	123	38	118	119	50	108	136	45	109	117	41	110
1980-81	135	37	119	124	41	108	155	42	110	107	34	111
1981-82	161	42	121	152	48	111	157	37	111	122	35	112
1982-83	146	32	121	151	42	112	193	44	113	130	34	114
1983-84	195	39	128	160	40	114	237	45	115	155	34	116
1984-85	204	28	131	147	34	115	304	47	118	155	30	117
1985-86	211	24	134	115	24	115	445	66	120	170	29	118
1986-87	206	20	136	146	22	117	326	43	120	179	28	118
1987-88	200	18	139	169	30	119	339	40	122	183	27	120
1988-89	211	18	141	179	24	121	305	35	123	204	27	121
1989-90	201	17	142	161	23	120	391	38	126	217	27	122
1990-91	297	26	145	251	30	126	365	34	126	237	26	124
1991-92	327	23	146	201	23	125	469	41	129	231	23	124
1992-93	310	21	146	228	24	126	503	38	131	254	24	126
1993-94	362	23	148	255	26	128	789	58	135	289	25	127

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Book Reviews

Management in New Age: Western Windows, Eastern Doors: by Subhash Sharma, New Delhi, New age International (P) Ltd., 1996, p. 233, Rs. 160.

Almost a decade ago, I had the privilege of attending a discourse by Swami Chinmayananda on the relevance of the Gita in present day management issues. The lecture had been thoughtfully organised by a Delhi based Chamber of Commerce (FICCI?). In his inimitable style, the Swamiji forcefully brought out that the Indian manager required a lot of supplementing to his management perspectives by drawing from the rich Indian ethos. Exhortation of the Lord to Arjuna to concentrate on his actions without getting unduly tormented by the memories of the past or worries about the future outcome, is very relevant to the manager of today as well. The qualities of selfless devotion, relentless pursuit and a concern for others mark out a successful manager. It is not the physical might or the superiority of knowledge or the lavish riches but a heartfelt concern for others and an approach of righteousness that establish one as a leader par excellence. Thus had spoken Swamiji to a spell bound audience of managers drawn from industry.

"Western Windows, Eastern Doors; Open them for the knowledge in the store" sums up very aptly the message contained in the book, "Management in New Age, Western Windows Eastern Doors" by Subhash Sharma. By using the metaphors of Western Windows and Eastern Doors he has advocated the adoption and assimilation of concepts that emerge from a fusion of Western and Eastern philosophies. Dr. Sharma has brought out successfully the relevance of many an Eastern thought represented by 'Indianism' and Zen Buddhism to the present day management practices.

The book presents a rational and critical examination of the origins and growth of the current management theories. Knowledge building in the spheres of social sciences is related to the type of approach followed in the collection of knowledge. The author has classified the approaches as: ordered objective, Or-

dered subjective, not ordered objective and not ordered subjective. It is the 'ordered Objective' approach which has contributed most of the theories built.

The author brings out that the nature of social processes have been shaped by modes of thinking. The author lists five principal modes: Power acquisition, Calculative and acquisitive, knowledge acquisitive, liberation from oppression and concern for others. The 'Calculative and acquisitive' mode of thinking is the accumulative instinct and has the driving force of money. Modern management theories which are largely based on 'Cost-benefit approach' are largely influenced by this mode of thinking.

The significance of 'Cognitive dominance' has been brought out next. The dominator tends to manipulate the dominated through language, ideas, theories, metaphors etc. There is no voluntary involvement of the people. The development of various current management theories is next traced. The management theories can be classified as per the approach followed towards management problems. These approaches are in terms of Cultural factors (Culturalist) or non-cultural factors (structuralist). The objective factors can be universal or relativistic. While proposing a taxonomy of management theories, the author identifies four Types of theories as Structural Universalist (e.g. Taylor's scientific management), Culturalist Universalist (e.g. Weber's Protestant ethics, McClelland's theory of achievement motivation), Structural Relativist (contingency theory) and Cultural Relativist (e.g. Japanese management, Confucian ethos or Gandhian thought systems), Although most of the theories are positivistic, these carry or acquire a normative content. Besides, the modern thought system is primarily based on cost-benefit approach and therefore lays a high emphasis on "efficiency, competition and hedonism." Pursuit of wealth and pleasure become the major concern, the symptoms of maldeveloped societies.

Chapters 1 to 4 present a very rational, thought provoking critique of modern day management theories, their basics, origins, growth, their acceptance and spread.

Simultaneously, the author is also able to establish the flaws, inadequacies and incompleteness inherent in these. Besides, most of these concepts are valid for homogeneous type of societies. For heterogeneous societies with multiplicity of "diverse ideological structural, cultural, language, regional characteristics" referred to by the author as 'M-Form Societies', there is a need to develop a more acceptable concept which is relevant to present day needs.

The remainder of the book deals with the development of alternate concepts essentially drawn from the eastern philosophies. The author has collected and presented a large number of ideas and concepts from the eastern philosophies in general and Indian thought in particular which inspire and promise the opening up of new horizons of management thought.

Mahatma Gandhi had offered a talisman: "Whenever you are in doubt, recall the face of the poorest and the weakest man and ask yourself if the step you contemplate is going to be of any use to him." The author has called it Gandhian T-test. This alternative approach has groundings in the belief of the 'Survival of the weakest' as against 'Survival of the mightiest'. The concept projects an attitude of compassion and concern for all living beings. It has roots in the maxim of 'harm minimisation' as against 'utility maximisation.'

The concept of HSD, (Human and Social Development), implies emancipation from the three modes of domination: natural (material), social (politico-economic) and cognitive (cultural, ideological, spiritual). The domination occurs as the mind set is rooted in 'rajas' and 'tamas' gunas. In order to avoid maldevelopment, the development must be viewed in its holistic sense of the ethical (dharma), material (artha) sensual (Kama) and spiritual (moksha) aspects.

The Guna theory also provides a basis for TQM, (Total Quality of Mind). The author has explained that the emergence of a particular type of society is dependent on the dominance of guna: Harmony (Satva), Intense activity (Rajas) and Inertia (Tamas). Quality of Mind determines the quality of human beings. TQM model, as proposed by the author, can be considered to comprise nine components—Mind, Motivation, Mission, Machines, Methods, Money, Materials, Manpower and Marketing. The optimal utilization of machines, methods, money and material to provide quality for marketing, is dependant on the quality of manpower.

The author has proposed NEEDS, (Necessities, Entitlements, Empowerment, Desires and Self-realisation) as an alternate model of 'Basket of Needs' against Maslow's 'Hierarchy of Needs'. Hierarchy of Deeds is

another concept touched by the author. Deeds are clarified as tamasik, rajasi and satvik with tamasik deeds forming the basis.

OSHA (O-Oneness with nature, S-Spiritual guna, H-human guna A-Animal guna) is another alternate model suggested by the author for behavioural analysis. Depending upon the dominance of the Guna, spiritual, human or animal, the behaviour is likely to get developed.

MBA (Manas, Budhi and Ahamkar) is another alternate concept proposed by the author as a decision making model. Here manas refers to the mind, budhi to intellect and ahamkar is self-sense.

The concept of HQD, (Human Quality Development), is another thought advanced by the author, who identifies four types of personalities: S-Types where Satva guna dominates; R-S types, where Rajas backed up by Satva dominates: R-T Types, where Rajas backed up by Tamas dominates and T-Types where the low drive dominates on account of Tamas guna.

The author has resorted to the coining of a number of acronyms and substituting new words for alphabets of well known abbreviations. AUM as All Unmanifest and Manifest; MBA as Manas, Budhi and Ahamkar, VEDA as Vision, Enlightenment, Devotion and Action etc. have been coined. One is not able to discern any logic in this approach. The audience for this book is expected to be serious students of social sciences/management studies and are not likely to need these props for better understanding of the new proposed alternative concepts. On the other hand, these may present wrong interpretations of many well known Indian concepts to students from the West and the Eastern doors may remain locked.

The author has mainly drawn from Indian philosophy although there are a few passing references to other eastern thoughts. (Ref. Ch. 25). Islam, Confucianism, Japanese old traditions (which have left a mark on the Japanese styles of management contrasted with Western approaches) provide a rich source of alternative models. These should have been explored to justify the title of 'Eastern Doors' otherwise, the title 'Indian Doors' could be more appropriate.

But perhaps the major flaw in the book is that the author has not gone into the depths the title has demanded.

Drawn from the vast canvas of Indian thought (chiefly, Hinduism, Buddhism and Jainism) the author has presented concepts, philosophy, values, eternal truths, ethos which could be foundations for alternate

management 'mantras'. It is perhaps desired by the author to inspire and motivate a scholar to work in that direction. To this limited extent the author has been successful. The book should particularly appeal to a Western mind wanting to know more about Indianism. To an Indian student, the book should be an eye opener as he may find the 'Indian' concepts more appealing and responsive to the present day problems as compared to the management theories presently taught.

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Organisational Development for Excellence by Kesho Prasad, Macmillan India Ltd., Delhi, 1996, X + 307, Rs. 175.

In the past two decades, the organisational revitalization process has undergone fundamental changes. Traditional interventions in this regard have focused on the content of an activity only. But the organisational development (OD) and human resource development (HRD) approach have shifted the focus from mere 'content' to 'organisational processes', 'work teams', 'collaborative management' and 'on-going change processes'. In addition to human relations, structural and technical aspects of organisational configurations are becoming subjects of analysis. These concepts increasingly highlight the development rather than the control aspect. Globalization and liberalization, which have resulted in greater competitive pressures in all business spheres, have put added importance on these concepts. With the weakening of employee collectives the individual's behaviour and performance are catching greater attention of the academia and management consultants. HRD and OD are considered major philosophies to help confront the issues involved in the new realities. These recommend greater attention to be given to self-renewal capabilities of individuals through organisational restructuring.

Prasad's book seeks to examine the various issues involved in organisational restructuring through OD with the help of illustrations including those from the vast experience of the author, who is a General Manager (OD and HRD) at Bharat Heavy Electricals Ltd. The author's extensive references to OD experiences of various Indian organisations in support of his formulations is the singular strength of this book which has generated many useful ideas for the reader. The eight chapters comprising it deal with issues, among others, such as OD in the liberalization context, strategies for organisational growth, computerization and OD, and OD in public sector enterprises.

While analysing strategies for organisational growth in Chapter Five, Prasad has underscored that mere alliances, collaboration agreements and mergers as sleeping partners with renowned global players are not enough. Rather, he has emphasized the need for a critical awareness on the part of Indian Organisations to resort to organisational scanning before indulging in such tie-ups. And OD efforts have been advocated to meet organisational competitiveness. Chapter Five, in fact, is the best part of the book. The discussions on Transactions Analysis (TA) (pp. 104-12) and Management by Objectives (MBO) (pp. 126-28) are also very interesting to the reader. The cases mentioned in support of the author's formulations add to the value of the book.

While the book is replete with useful material for academics and managers, certain limitations—many of which being serious ones—are also noticeable. From technical point of view, the book is wanting in its editing. The introductory chapter consisting of 53 pages could have been summarized into about 20 pages or so. There is lot of repetition of points. Prasad has indulged more in quoting the work of others than making his own points in this chapter, which has hampered lucidity and clarity. There is also a need for proper paragraphing and repositioning of the material included. Especially in this chapter sub-themes have not been imaginatively identified. The author has uncritically indulged in borrowal of others' without properly contextualizing them and without articulating his own position. Ideas contained in a paper by T.V. Rao which was presented by him at a seminar has been generously used in nearly 20 pages (pp. 23 to 44) to explain the dimensions of OD. This has undermined the scholarship of the author and the value of the book. Chapter six is titled Sharing of Experiences, where the author narrates some OD cases and experiences. A better way of presenting these could have been dividing these cases into sub-themes to which they relate, and taking them to the respective chapter where that theme has been handled.

The chapter OD in Public sector enterprises (PSEs) should have got better treatment. The discussion in this chapter ends abruptly. Systemic issues involved in OD in PSEs should have been discussed adequately. We too have success stories of OD/HRD in some areas of this sector. The success variables need to be critically identified. Another point needs to be made: As has been openly admitted is American Literature, HRD and OD work best in non-unionised situations, where integration of the employee into the aims and values of the organisation is sought. Power remains thus firmly in the employer's hands. In the context of the public sector, the power table often gets turned in favour of the unions, who resist or show indifference to HRD efforts,

even as they are not aimed to weaken them. Prasad has not discussed this issue at all, and also how OD dimensions are to be looked at in the context of the legal framework of IR in India. The index at the end is also very sketchy and needs to be prepared in greater detail and more imaginatively too. The style of referencing is peculiar, and is not fully helpful to the reader.

Despite these drawbacks, this book is a welcome addition to the literature on OD in the Indian context. It will be a useful reference for management students, academics, trainers and consultants.

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Multinational Scramble for New Markets by Brojendra Nath Banerjee, New Age International (P) Limited Publishers, New Delhi, p. 296.

This work of Mr. Banerjee is timely and revealing. It analyses the impact of the agreement reached at Uruguay round of GATT, through which the World Trade Organisation (WTO) has been formed. In his treatment of the issues the author questions the benefits that are expected to flow to the developing countries after the strengthening of new multilateral trading system. Analysing whether the protective measures that the industrialised nations adopt would be reversed in the face of the new agreement at the Uruguay round, he emphatically says that it will not be possible for the WTO to intervene in the disputes involving powerful economies.

On the basis of chronology of events the author shows that the multilateral system is an extension of bilateralism or unilateralism. The powerful economies firstly negotiated the agreements either bilaterally or in a group and later incorporated these in the draft agreement. Because of this the author doubts the intentions of the developed economies and suspects the outcome of the agreement reached at Uruguay round stating that the agreement at the Uruguay round marks the beginning of 'bitter' trade disputes as it is a treaty of unequals.

The book provides an insight into the controversial nature of Uruguay round. It starts with the establishment of GATT in 1948. The GATT was established to find ways to make global trade more free. In all its earlier rounds, the issues were to reduce tariff and non-tariff barriers because it was believed that trade is mutually beneficial and so if trade grows it will benefit both the developing and the developed world.

Mr. Banerjee rightly points out that the GATT agreement is an agreement between the weak and the strong. In the markets the rule of jungle operates and only the strong survive. The Indian industry should restructure itself and produce quality goods. This requires efficiency of labour. The author stresses that the advantage of cheap labour is lost if the products can not come upto the expectations of the consumers.

India has to become competitive because the withdrawal of protection under GATT article XVIII would render Indian economy quite open. India is planning to argue its case against the withdrawal of protection.

He cites Mexico's somersault as a result of unbridged openness against powerful competitors. He points out that Mexico opened all sectors of the economy especially the consumer goods sector and at the same time the government over-spent which led to crisis. Despite all the favours for liberalisation, Indian government did not open the flood gates to consumer goods imports and therefore has kept the trade deficit under check. The author suggests that if India wants to avoid the Mexican situation it should increase its reserves, not by borrowings but through trade account or foreign equity. He also hopes that foreign portfolio investments in India would stay at the present level so that India will be able to face the situation. By strengthening industrial production and encouraging food grain output, the balance of payment problem can be structurally solved.

He points to the growing strength of Indian economy and says that Indian debt situation is more manageable now as compared to the past (1980s). The rate of debt increase has declined. Moreover the share of short term debt has also been declining leading to more stable repayment schedule.

He suggests that inflation should be checked, FDI encouraged and the foreign institutions seeking hot money discouraged.

The author identifies five controversial areas of concern for India: reduction of subsidies, import of three per cent of domestic demand for agricultural products, government policy about public distribution system, seed patenting and product patenting instead of process patenting.

Next the author discusses the critical issue of intellectual property right, the new drug policy and the surrender by India at the Uruguay round. He hints at the dominance of North-North trade over North-South trade and the growing protectionism practised by developed countries. He recommends protection of the

farmers. He also makes an analogy between East India company's trade and colonisation thereafter and GATT by quoting Vandana Shah's article in the Telegraph. The Indo-U.S. commercial alliance is also analysed.

He goes on to discuss the Marrakesh declaration and expresses a new international trade order in favour of developed economies. He asserts that India gains a little out of the agreement.

The author contends that the road from GATT to WTO was more of discords than accords. He discusses the Indian assertion of freeing trade from social issues and also deliberates on India's objections on social clauses. He criticizes the non-inclusion of emigration issues in the WTO discussions. He also discusses the new emerging issues before WTO. The author points out that India has succeeded in creating awareness among developing countries on the need to present a united front to resist pressures from the developed world.

Next, the author talks about globalisation process and asserts that there are two areas to look into: globalisation from above and globalisation from below. He discusses both the aspects.

Then the author discusses the re-entry problem of China to GATT and the US 301 declaration also. He also discusses the Indian problem of enforcing intellectual property rights if it makes its own legislation (unilateral) for the sui generis system. He doubts India's capability to muster the required support to get the sui generis system implemented through WTO. The author also asserts that the farmers will gain the most if it is possible for them to harness the full potential of exports of agricultural commodities.

In the last chapter the author analyses the post-GATT scenario with special focus on Indian scene. He refers to the legal petitions pending before the supreme court filed after the ratification of WTO by Government of India and indicates the failure of the government to enact a patent act consistent with Indian realities and its commitment to world community as a whole. He also discusses the widening of trade deficit, deepening of fiscal crisis and the mounting debt obligations. The author further shows that the developed countries may erect barriers to India's exports (agro or others) selectively on the basis of either containing certain chemicals or pesticides or on the basis of social clauses. In the end he points out that multilateralism has been defied by U.S.A. when it reached a bilateral agreement with Japan for the opening of its market for U.S. Automobiles. This was done just after the agreement at the Uruguay round was reached.

As the title of the book suggests, the discussions of Uruguay round reflect nothing but a scramble for markets by the developed nations. The book has clearly brought out the issues of general concern for the developing countries and India in particular. The impact of GATT agreement on various sectors of the economy has clearly brought out and the book will be a prized reading for students of International Business.

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Marginal Costing by Prof. J. Made Gowda, published by IMP Publishers, Davangere, p. xii + 324, Rs. 150.

Businesses need support information for efficient decision making. Larger businesses need them more, and large businesses in the modern competitive or market driven world need them the most. Various theories on management accounting have been developed but they are still in the process of evolution to provide meaningful information based on financial and cost accounting data to enable managers make effective decisions.

Marginal costing is the simplest among the several available techniques of classification of cost. However it has a wide appeal in the world of business. Judicious application of marginal costing based information can provide wonderful guidance in taking many decisions regarding optimal resource allocation and profit planning. Even smaller businesses can employ marginal costing based data without much cost and difficulty. Therefore, dissemination of knowledge of marginal costing is always a welcome step.

A separate title on marginal costing may perhaps serve the purpose of dissemination of knowledge better. But, the author of this book has expressed his views that there are "number of conceptual flows... in the literature on marginal costing". That was a sufficient motivation to read up the entire book between two covers with a curiosity of finding out what are those 'flows' and how are they suggested to be removed. But the exercise drew a blank.

One may also disagree with the author when he writes 'there is a need for a system which is capable of classifying voluminous data into relevant and irrelevant from the view point of a decision.... Marginal costing has been taking this responsibility.... The terms variable cost and relevant cost are not synonym for each other. Similarly equating variable cost with product cost and with direct cost is not

convincing to any one who possesses a little knowledge about management accounting.

The book is divided into four chapters. The first and last chapters occupy more than eighty per cent of the total pages. The first chapter is devoted to the fundamental concepts of marginal costing. Next the author goes into cost volume profit analysis, then he compares the profit effect of absorption costing and variable costing through valuation of finished goods stock under different situations. The last chapter is devoted to discussions on the application of marginal costing.

The author introduces the concept of marginal costing and goes into the calculation of break even point and graphic presentation in different ways considering single and multi-product situations. Many methods of segregating semi-variable costs into fixed and variable are described. However, inclusion of 'account classification method' which is the most popular technique among many businesses and exclusion of those methods which are just repetitions in different words would have been better for the readers.

The author then describes the effect of changes in fixed cost, variable cost, sales price and sales quantity on profitability, while explaining the relationship between sales, variable cost and contribution. The effect of change in sales quantity could have been logically extended into the discussion of operating leverage as it provides a neutral measure of variability of profit and it can also provide important guidelines in making long term decisions of strategic content.

The effect of inventory valuation method on reported profit is well explained in the book. The author has argued in favour of using variable costing as the method of inventory valuation for reporting purposes. The arguments favouring such treatment are convincing. But, that may result in undervaluing the finished goods stock on hand. The readers of annual report have the right to know the true and fair value of assets, which is the central concern of the Companies Act, 1956.

In the end, the book covers a wide variety of applications using marginal costing based data. Many of the applications discussed actually use relevant costs rather than just marginal cost. The list of application of marginal costing is less than comprehensive because at least two fields of applications could be added in it, which are the allocation of production over plants in case of a multi-plant business, and the role of the point of indifference in evaluating mutually exclusive alternatives.

Pricing is an important policy decision where cost data can become a crucial input. The author has discussed full-cost-plus pricing in normal market situation; and variable-cost-plus pricing in recessionary market situation. However, an abnormal situation, where goods are produced but for some reason the market is not willing to buy them at a price equal to or higher than variable cost should also have been covered. Future relevant cost becomes the reference point in determining the price of such goods.

In general, this book fills pages by stretching the explanation of existing literature and stuffing it with more illustrations. While doing so, or rather justifying to do so, the author has made many sweeping statements without any *prima facie* logic and without any supportive arguments or references. For example; "A look at the literature on marginal costing reveals that different terminologies such as differential costing, direct costing, incremental costing, marginal costing, relevant costing, variable costing are used synonymously and interchangeably to denote the same marginal costing." On the other side, the distinction in terminology is lost in a way because the author has removed such a distinction in the last chapter while discussing the applications of marginal costing.

Any book on cost and management accounting published in 90s is definitely incomplete if it has not drawn references from activity based costing which is rather more relevant to marginal costing theory. Marginal costing assumes that the cost could be the function of either product or time. The ABC system emphasizes that cost determinants are mostly different from product and time. At least larger and complex firms can combine marginal costing and ABC for decision making.

The author has mentioned at some places about industry practices and research findings on various matters. The names of firms and industry, and references of research would have added credibility to the statements. The question of credibility also arises when some imaginary stands of some 'sections' or 'group of people' is mentioned and argued out against them by the author. The excessive use of uncommon abbreviations and coining of new unusual terms come as obstacles to involved reading. However, the numerous illustrations mostly adapted from examinations may be liked by students who want solved examination problems on marginal costing. The book would have become more focused if the target group(s) had been clearly identified by the author. Practitioners may not have the patience to go through the pain of long reading sessions, especially when however brief literature is handy to serve the

purpose. Students who want more practice from solved examples would benefit from the book to some extent.

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International Financial Management by P.G. Apte, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1995, p. 657, Rs. 150.

Management of international finance has emerged as one of the most challenging areas in the field of management. With globalisation spreading its tentacles and gaining the world, the ever-expanding dimensions of information revolution are further reducing the size of the world continuously. Since the collapse of the Bretton Woods arrangements, most of the countries have gone in for floating exchange rate system which has made international financial transactions further complicated.

The book under review consists of 21 chapters. The book starts with summarising the conceptual framework of contemporary financial engineering. With the evergrowing increase in the flow of international finance and its complicated nature, the risk of the firms has multiplied many folds. The international financial market has become a highly volatile one. The greatest risk before the firm is the changing value of the respective currencies, which results in a number of accounting problems also. Mainly, the firm has to face transaction exposure, transaction exposure, translation exposure and operating exposure because of currency fluctuations, caused by the different rates of inflation prevailing in the various countries, their changing share in world market, political stability etc.

Apart from individual firms, even countries have to maintain their accounting records of international transactions which is generally known as the balance of payments accounting. Major international transaction such as imports, exports invisible etc. are covered under current account while long-term flow of capital is covered under capital account. The IMF and the rest of the transactions are carried a separate head. Sometimes the balance of payments account does not present the correct picture if the under invoicing and over invoicing of the flight of capital and other illegal transactions are very high.

The present day financial system which was created at Bretton woods conference in 1994 replaced the earlier system based on gold by US dollar. Although this

arrangement came to an end in 1973 when most of the countries switched over to floating exchange rate, the supremacy of US dollar continued to reign even in the post Bretton woods era, because of the fact that in IMF, World Bank and other financial institutions the largest chunk of finance is in the form of US dollars.

With the rapidly growing financial transactions, new financial market have also evolved. One of the biggest financial market is Euro-market with New York and Tokyo being the other important financial centres. The strongest currencies of the world are US dollar, Japanese yen and German mark. Because of the fluctuation in the value of these currencies and their interest rates, international financial markets are highly sensitive.

Exchange rate determination and forecasting has also been explained with the help of various quantitative models. The firms generally cover their exchange risk through hedging and speculation. Various techniques of hedging have also been elaborated. One of the most crucial questions in international financial management is the expected fluctuations of exchange rate in the near future, which is generally known as the management of operating exposure.

Like exchange rate, interest rate in the international market is also highly sensitive. Any fluctuation in the interest rate is going to have long run implications on the cash flow of the firm. The fluctuation in the interest rate and exchange rate are mainly responsible for financial swaps.

Traditionally the major means of flow of international finance were loans, grants etc. However, of late, the share of international equity investment has also increased substantially. Large number of indian companies have gone for Euro and GDR issues. The last part of the book deals with project appraisal, accounting implications and taxation system.

The author is to be complemented on the book as it is the first serious study carried out by any Indian scholar on International Financial Management. Although, a number of such studies are available from foreign scholars, those have little relevance for understanding the implications of international financial system on India as such. With more MNC's coming to india and Indian companies trying to become global, the utility of this book is further enhanced.

The numericals given in the book are highly useful to Indian students of International finance. The language used in the book is quite simple; however, the terminology and abbreviations used in the book have not been elaborated separately. A large number of students are

not familiar with these terms. The references have been given at the end of the pages but a bibliography at the end would have been welcome. In spite of such minor lacunae, the book is a pioneer work and will bridge the existing gap in the Indian literature a long way.

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Management of Technology and Innovation: Competing through Technological Excellence by P.N. Rastogi, (1995), New Delhi, Sage Publications, p. 301, Rs. 325 (cloth), Rs. 195 (paper).

The Indian economy has been liberalized and globalized to a large extent in the last five years. And the new rule of the game for the Indian business organisations is competition. One area where most Indian companies lag behind their multinational competitors is technological capability. Continuous improvement to technology and innovation of more efficient technology are *sine qua non* for long-term survival and market leadership of a company. However, a cursory look at management and innovation of technology in the Indian organisations leaves one saddened. It is high time that the Indian companies pull their socks up and do something drastically different than what they have been doing in the past.

The book under review is a timely and thought-provoking volume. It covers a variety of issues from the nature of technology, its strategic management, recent developments in technology to development of technology, its organisational requirements and national technological policy. The author had taught at the premium technological institute, the Indian Institute of Technology, Kanpur and currently teaches at the Indian Institute of Management, Lucknow. He has been closely associated with the theoretical developments and applications in the field.

The book has been divided into five parts and 17 chapters. Part one focusses on the nature, definition and importance of technology for an enterprise. It also hinges business strategy with technology management. Towards the end, this part discusses the need for a corporate R&D centre and what it can and cannot do for an organisation.

Part two exclusively elaborates upon manufacturing technology. The author has done a detailed analysis of productivity, various approaches on productivity enhancement and the nexus between productivity and quality.

He also elucidates the process of technology absorption. "What are the reasons for external acquisition of technology? What are the channels of technology acquisition? And how can a technology be absorbed smoothly?" These issues are highlighted. The sixth chapter is important and focusses upon World Class Manufacturing (WCM), a style based on digital electronics technology. It consists of total quality management (TQM), just-in-time (JIT) and computer integrated manufacturing (CIM). In addition, the author points out possible future developments in this area. The next chapter relates to phases in WCM implementation and requirements for flexibility in manufacturing. The eighth chapter is concerned with the investment analysis of technology. The author here discusses frameworks for strategic financial analysis and strategic cost management.

Part three deals with the various ways of technology development. The author highlights the management of the product development cycle and reduction in its time through concurrent engineering. He focusses on the significant theme of the management of technological innovation. He also pinpoints the helping and hindering organisational factors in the innovation of technology. The next two chapters are related to the refinement and fusion of existing technologies to create a new hybrid technology.

The fourth part has three chapters all dealing with the organisational design aspects of technology management. The author deals with the emerging organisational structure for WCM. Further, he delineates how information technology will alter coordination and decision making in an organisation. He points out how new business organisations will differ from the traditional organisation on the dimensions of command and control, structure, growth, planning, operation, training and development, etc. The next chapter relates to the creation of organisational culture to foster creativity and innovation. The last chapter of this part deals with the learning organisation. The author cites examples of the Japanese companies as learning organisations.

The last part, consisting of two chapters, highlights the macro issues of technology management. Chapter 16 is related to the development of national technological policy with special reference to the technological policies of the United States and Japan. A framework is provided for national technology capability building. In the last chapter, the macro and micro aspects of management of technology are discussed in the Japanese context.

The book is comprehensive in nature and covers almost all the important aspects of the subject. The

presentation of all materials is lucid and engrossing. The recent developments in the field are intensively discussed. The salient points of each chapter are presented at the end of the chapter under the heading "Points to ponder" to help the reader to recapitulate.

A stark aspect of the present book is lack of case studies and illustrations. The application side has not been given sufficient attention. Indian examples, cases and illustrations could have indeed made the book more interesting. Nonetheless, the present volume is an important contribution to the field. It is a reference book. But it can also be used as a text in the cour-

ses on management of technology, organisational design, and creativity and innovation. This book is highly recommended to the student of management and technology.

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Management & Change

Volume 1 • Number 1 • April, 1997

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The *Management & Change* is published twice a year in April and September. Annual subscription rates are as follows: *For India* - Institutional: Rs. 300; Personal: Rs. 200

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For further enquiries, please write to the Editor, *Management & Change*, Institute for Integrated Learning in Management, Lodhi Institutional Area, Lodhi Road, New Delhi-110 003. Telephones: 4631033, 4647820, 4647821 Fax: 91-11-4647796

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