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**WORKING GROUP ON
CONCEPTUAL AND POLICY FRAMEWORK
FOR APPROPRIATE
INDUSTRIAL TECHNOLOGY**

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**MANAGEMENT OF APPROPRIATE TECHNOLOGY/
Background Paper**

MANAGEMENT OF APPROPRIATE TECHNOLOGY

by

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MANAGEMENT OF APPROPRIATE TECHNOLOGY

1. The Need

The concept of Appropriate Technology developed in the context of industrialisation in developing economies has undergone considerable change. Dr. Shoemaker referred to it as Intermediate Technology where the stress was mainly on replacing scarce capital with cheap labour. The focus is now on having a technology which helps these countries to attain self-reliance and self-sustained growth and to use local resources, both human and material, to produce goods and services that are needed. The technology emphasis is, therefore, on the use of renewable resources and preserving the non-renewable, or the fossil resources. Adaptation of technologies in the developing countries has thus to save capital, and at the same time should be in a position to form capital for self-sustained growth. Similarly, productivity should be such that it is sufficient to help producers and workers to attain a better standard of living. The process of industrialisation should help in removing the disparities in the levels of incomes of the people as also in the levels of development of different regions, and within a region between the urban and rural communities. In countries where the population pressure is high, the main focus of Appropriate Technology is to create more employment opportunities so that migration to the urban centres is minimised. In fact, the role of Appropriate Technology is to create economic development with social justice.

In the developing countries, more than 50 per cent of the gross national product is contributed by the primary sector which also provides employment to half of the

active workforce. The role of the industrial sector particularly that of the rural industries is to extend support to agriculture both as a provider of inputs and as a processor of agricultural produce. Eighty per cent of the population live in the rural areas and agricultural activity is well dispersed. The industries that are required to support agriculture have also to be sufficiently dispersed, if they are to meet the needs of farming and of the farm communities.

The question that is often asked in the developing countries is the objective of industrialisation; how well can industry benefit both the consumer and the producer. Effective utilisation of resources - capital resources, physical resources and human resources - assumes great relevance. Again, both production and consumption needs are apparently at variance. Employment and entrepreneurship could be classified as the production need while the direct consumption indirect consumption by the other sectors could be the consumption need. The problem is then to match the two, i.e. to satisfy the consumer with goods of right quality and appropriate price and induce the producer to use less sophisticated technology. The producer is interested in maximising profit and trying to get the best (highest) price for his product. There are also conflicting areas between the interest of the entrepreneur and of the industrial workers.

The characteristic of the developing economy is the persisting low per capita income, the impact of which reflect in the market. The developed infrastructure is found only in the capital cities. There is hardly any infrastructure in the hinterlands. Entrepreneurial (local), managerial and technical skills are scarce in these countries. Though expatriate entrepreneurs are to be found in the capital cities and some of the larger towns,

local entrepreneurship is very shy, risk-taking capacity is low, and simple managerial skills for starting an industry are lacking in most of the regions.

These objectives of economic development with social justice - starting industries in less developed and rural areas with minimal infrastructure and small markets, saving of capital, at the same time, forming capital, creating employment and local entrepreneurship, increasing productivity, establishing viable units for small markets and in backward areas are all apparently contradictory. They appear as much contradictory as individual freedom and rapid economic development (as viewed in centrally planned economies).

The developing countries are not looking for 17th century or 18th century technology, but a "new innovative technology" to meet the challenge. Recently the United Nations Industrial Development Organisation (UNIDO) suggested a new approach:

"The search for greater technological flexibility, which is stimulated by typical factor proportions in developing countries, need not involve a return to primitive processes of production, to nineteenth century designs of equipment or to hand-operated blast furnaces. Rather, it requires a greater readiness to eschew unquestioned adoption of the most up-to-date and most prestigious capital-intensive and integrated production processes, which have been developed for use in countries where labour is particularly scarce and to seek out the efficient processes employed in those developed countries where the relative abundance of capital and labour is somewhat closer to the situation in many developing countries".

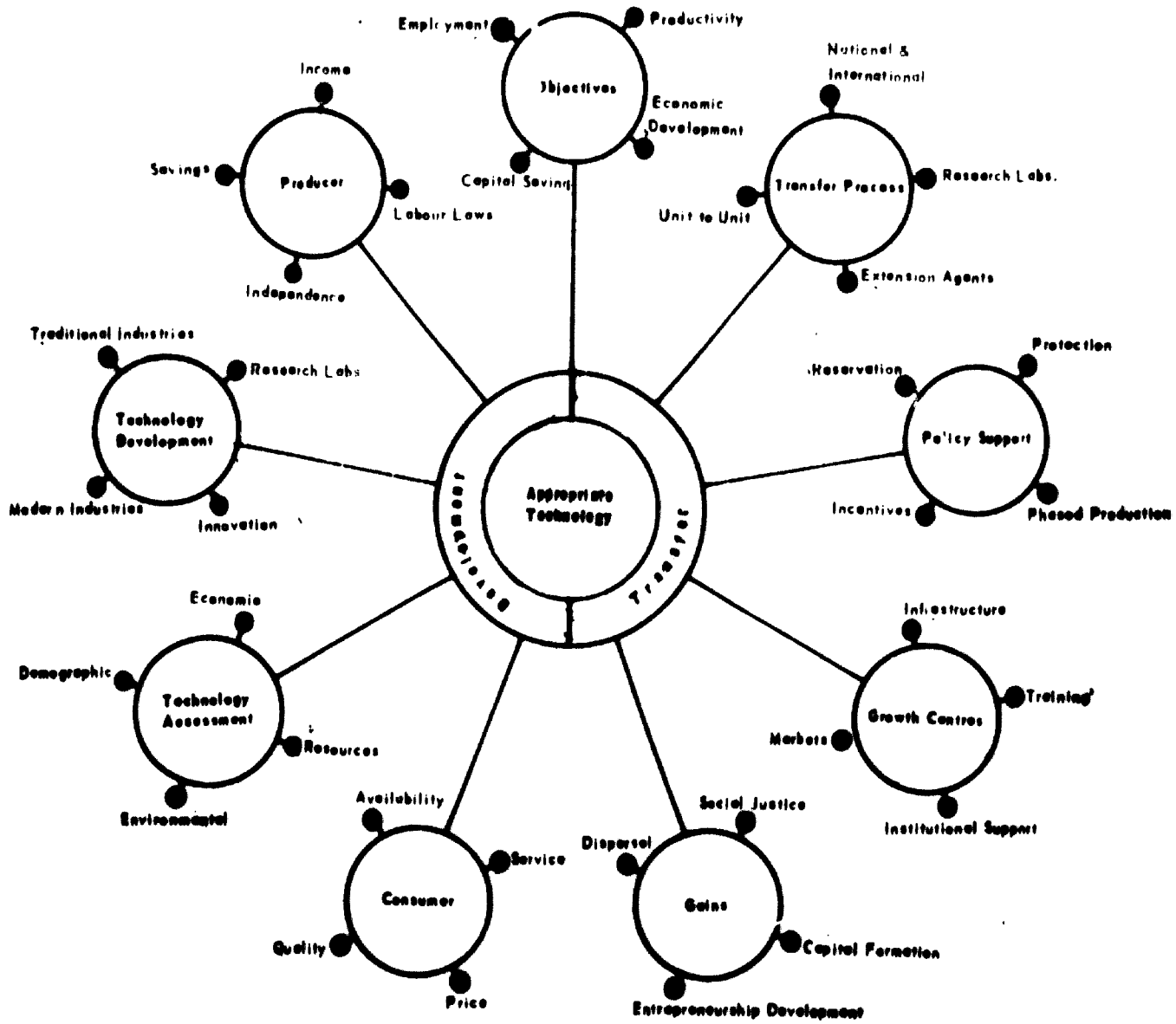
Though the concept of Appropriate Technology as an instrument of economic development with social justice has been accepted in developing countries, and propagated actively by international organisations like UNIDO, ILO, etc., very little has been done in these countries in the direction

of programme implementation. The metropolitan cities continue to grow at the expense of the rural areas, creating social and ecological problems. Disparities in incomes and levels of living are increasing.

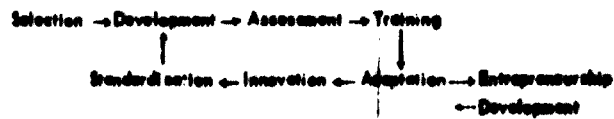
Acceptance of Appropriate Technology by individual firms and entrepreneurs has been insignificant in these regions. The promotional measures are either inadequate or tend to promote the "status quo". The non-availability of Appropriate Technology which is tested and proven is acting as a disincentive, and this is further accentuated by the aggressive propagation of sophisticated technologies by the developed countries. The internal and the external competition for the products of Appropriate Technologies is also a major difficulty in the promotion of these technologies.

The evaluation and assessment of technologies from the stand point of individual and social cost-benefit, followed by appropriate policy measures for developing, transferring these technologies, calls for management skills, administrative acumen, and bold promotional measures. A model appropriate technology transfer system is illustrated in figure-1, that shows the linkages of activities in development and transfer. Each of these activities could be sub-system with several variables which have to be taken care of.

APPROPRIATE TECHNOLOGY AND TRANSFER SYSTEM



APPROPRIATE TECHNOLOGY CYCLE



2. Application

Appropriate Technology cannot be applied to all types of industries. The industries producing plastics, metals, fertilizers, basic drugs etc., have to have capital intensive sophisticated technologies. For achieving economies of scale of production, capacities of production have to be of large. In the absence of large scale research and development facilities in the developing countries, these technologies have to be obtained from developed countries. In some of the developing countries, adaptation, modification and even new technologies have been developed. India's basic industry is today manufacturing most of the capital goods for the engineering and other industries which have been adapted to local conditions. The processing industries from the basic raw materials can use effectively the appropriate technology to produce different consumer and producer goods, e.g. the moulding of plastics by hand-operated or semi-automatic plants has been practised in most of the developing countries. They either process the basic raw materials of the sophisticated technology or import the basic raw materials. Likewise, fabrication from metals into final finished products can be attempted in the small scale sector with the use of simple technology which is inexpensive. The production of pesticides, fertiliser or production of basic drugs needs a sophisticated mass production technology while the formulations of pesticides or pharmaceuticals are not capital-intensive. Labour-intensive techniques or simple manufacturing technologies could be effectively used.

The primary agro-processing or forest based industries are by and large dispersed and located near the source of raw materials. These industries can use appropriate technologies. Similarly, it has relevance

to the production of a large number of consumer goods needed in the rural or semi-urban areas. It saves on the cost of transportation as they are located near the consumer points and the products are of relevance to the local consumers. In an economy where infrastructure is not well developed and the distribution channels are not well formed, the marketing and distribution costs are necessarily high. The local production to meet the local needs is economical and gains importance.

Appropriate Technologies are also described as "relevant" technologies for the developing countries. The relevance of the technology varies from one country to another depending on the resource endowment and manpower position of a particular country. The countries where labour is in short supply, the appropriate technology may have to be both capital saving as well as labour-saving. In countries where infrastructure facilities are not available, it may have to depend on the minimum infrastructure and develop plants which can meet the local markets and not design plants which entail large transportation costs for the finished products. Under these conditions, Appropriate Technology becomes an effective tool.

a) Stimulation of local entrepreneurship

Entrepreneurship in the developing countries is very shy and the risk taking ability is low. The entrepreneur would like to take up technology which is not complicated and which is comparatively cheap. He would not like to set up a large factory as he lacks the necessary management skills. The development of local or indigenous entrepreneurship based on local resources, using appropriate technology as it is often termed appropriate consistent with his skills and the local markets seems

to be the answer. This entrepreneur will have to be trained and helped in the use of technology, marketing of his products and to find finance from local institutions.

b) Dispersal of industrial activity

Attempts at industrialisation in the developing countries with the "imported modern technologies" have resulted in industrialisation of the metropolitan towns. The rural areas have not benefited by this process. Even the industries based on the primary sector are located in metropolitan towns with the result that the raw materials are transported to the metropolitan towns and finished goods transported back to the rural areas. Examples of this are not lacking in the developing countries. Bombay (India) has a concentration of textile mills and oil processing industries. The raw materials from the Western part of the country are transported to Bombay for processing in the mills and the products are despatched back again. Similarly, the concentration of insecticide manufacturers, pharmaceutical manufacturers in metropolitan towns like Bombay prepare formulations for supply to the rural areas. These technologies need infrastructure and social overheads which are available only in these towns. The resources are wasted in transportation, distribution, etc., resulting in high price to the ultimate consumer in the rural areas.

Appropriate Technologies on the other hand help in the dispersal of industrial activity and take it nearer the consumers and to the producers of raw materials. The establishment of giant plants in the metropolitan centres is creating ecological, sociological and other problems which could be minimised by having small units based on Appropriate Technologies using minimum infrastructure facilities in the rural areas.

The answer for industrialising the developing countries is not either Appropriate Technology or Modern Technology but a judicious combination of the two. What can be done effectively with Appropriate Technology, in a decentralised way need not be done with Modern Technology and vice versa. Appropriate Technology sector could be identified through a systematic process of cost (social and private) benefit analysis, keeping in view the development objectives and priorities. This is the first step in the system of development and transfer of Appropriate Technology to attain self-sustaining economic growth.

3. Status of industrial technology in developing countries

Technologies existing in the developing countries could be broadly classified into two distinct categories.

- a) Traditional technologies
- b) Modern technologies

The traditional sector has been in existence almost from the dawn of civilisation in these countries. It occupied a very important position before the Industrial Revolution in the West. It exported industrial goods to the Western countries. For example, Dacca Muslin, a fine textile produced in Dacca in Bangla Desh was exported to U.K. Likewise, several other industrial products of the traditional sector had a wide domestic market and an export market. This sector supplied all the rural requirements like agricultural implements, processing facilities, etc. It had the patronage of the kings and the Government in those days. It provided employment to a sizeable number of artisans. This sector declined after the Industrial Revolution in the West, and the colonisation of the West. The traditional sector was directly and indirectly suppressed to provide markets from the industrialised countries of the West.

In spite of this, in most of the developing countries, the sizeable number of non-farm occupations in the rural areas are in the traditional sector which are struggling to produce for the needs of the rural community. The technology in this sector is handed over from father to son and has undergone very little change in the last few hundred years. The capital investment in the technology is very low. Its productivity is also low. The products have undergone very little change over the years. This sector is mostly non-power operated and is dispersed all over.

Though certain concentrations of artisans can be found in some areas, the basic traditional trades like blacksmithy, carpentry, pottery, footwear are found in most of the settlements.

Studies have shown that there has been a decline in both employment, production and in the number of units in the traditional sector. This decline is attributed to the fact that the traditional sector is ~~is~~ no longer able to meet the growing production and consumption needs of the rural community. The progressive farmer's needs are not satisfied with the simple agricultural implements and processing facilities. He wants to use the modern tractor, electric pump sets, pesticides, fertilisers, etc.

The productivity of the traditional sector is so low that this sector is aptly described as "subsistence industry", i.e. where the producer consumes all he produces, with the result that there is hardly any surplus left for ploughing back into the economy. Many Governments, in their anxiety to preserve and promote the traditional sector either for the novelty or for retaining the employment potential of the sector, are giving subsidies and other assistance. This sector instead of contributing to the economy, is absorbing capital produced in the other sectors. In spite of subsidies, the Governments are finding it difficult to sustain this sector as such and are gradually thinking of upgrading or modernising this sector to increase its productivity and usefulness to the community.

The modern sector

Immediately after attaining freedom from the Colonial rule, the developing countries in their anxiety to industrialise their countries, imported modern technologies and modern package plants from the developed

countries. The units were set up in metropolitan cities or large towns as they needed high level of infrastructure. They had to be operated by foreign technicians who did not want to stay in the rural areas. Capital cost of this equipment was very high. The capacity of production was very high but the markets were so small resulting in low utilisation of the plants. Since these plants were automatic, the employment potential was also very low. The plants were quite complicated and any breakdowns in the plants could not be repaired with local facilities and the plants had to be shut down for getting imported components.

The overall performance of these plants, inspite of the fact that they are the most modern plants in the world, is comparatively very poor. The depreciation on these plants is high, the breakdowns are high and the plants work near or below the break even capacity, with the result that capital formation even with this modern technology is not there (many of them suffer losses and have to be protected). These plants are not based on local raw materials, local skills, and on local entrepreneurship. They produce luxury goods, or are assembling units importing the components. It has been the experience of many of the developing countries that neither the traditional sector nor the modern sector has been able to accelerate the economic development with the result that the disparity between developed and the developing countries instead of decreasing has been increasing.

The concept of "Appropriate Technology" has been evolved out of this dilemma between the modern sector and the traditional sector and attempts to combine the salient features of both. It is not a technology that is trying to make a compromise and suggest in the developing countries to use an outdated technology. It is in fact a new technology to meet the needs of the developing economies. It has sufficient

productivity to attain self-reliance and self-sustained growth. It is sufficiently low in capital cost and the technology could be developed and the equipment produced with local skills and resources. Its volume of production is consistent with the local market. It needs infrastructure which could be attainable in the rural areas.

4. Development of Appropriate Technology

Though the concept of Appropriate Technology has been accepted over the last two decades, not much work has been done either for developing or promoting it.

Innovative entrepreneurs both from the traditional or modern sectors have from time to time developed suitable technologies to meet their individual needs. These have been developed either by improving the existing traditional technologies by small additions of improved equipment or by getting a sophisticated technology and simplifying them for their own use. Various institutions, particularly the agricultural engineering institutions in some of the countries have developed improved agricultural equipment. The small industry proto-type design centres have also improved small hand operated machines, for use of the entrepreneurs. But systematic efforts in this direction have not taken place, nor have attempts been made to pool the resources available in the developing countries. Several approaches for the development of Appropriate Technology are being tried, and some of them are listed for discussion.

Improvement in traditional technology

Some of the improvements that can be thought of in the traditional technology are:

a) Better tools and equipment for increasing productivity. These are not readily available in the developing countries. Developed countries have some of the improved hand tools but these have to be modified and adapted. Rural artisan cannot depend on imported tools. These tools and equipment have to be developed locally though the basic idea or the principle could be a borrowed one. In this connection, examples from India could be:

- (i) Improved fly shuttle loom over the pit looms to improve the production and productivity of the weaver.
- (ii) Improved potter's wheel over the traditional wheel to produce earthen pots.
- (iii) Improved blacksmithy tools over the traditional tools.

- b) Provision of motive power for use by the traditional worker.

Provision of infrastructure, particularly electricity, to traditional industries helps in modernising them to increase productivity. In India, the Rural Electrification Corporation (a Government of India organisation) is giving special loans to the State Electricity Boards to make power available in the rural areas. Examples of electrification of traditional industries are:

- (i) Improved oil crushing units, power operated.
- (ii) Improved blacksmithy units using welding machines.
- (iii) Improved tannery
- (iv) Improved blacksmithy

c) Helping the artisan who is working in his own house with family members, to organise himself as a ~~small~~ industry by hiring or owning premises in industrial clusters, get power, take bank loans, hire purchase machinery, expand his market, etc. To do this, he will have to be provided with training both in the use of technology and management practices.

d) Suggesting new designs to the artisan so that he can manufacture the hand-made articles of a utility nature which will be of prestigious value.

e) The other approach in the area of technology development is simplifying the more sophisticated technology and reduce the size of the plant to meet local requirements. This innovative work is done by the entrepreneurs who import the first plant and subsequently design their own plants to meet their increasing requirement. This is also done by the machinery manufacturers. In India, the solvent extraction plants which have been developed with capacity ranging from 5 tons to 20 tons are based on the sophisticated technology of 100 ton plants.

Similarly, the cotton seed extraction units have been simplified; so also the rice bran oil extraction plants. India has also developed simple, inexpensive plants for manufacturing a large number of consumer items like food products, garments, hosiery, footwear, optical lenses, scientific instruments, etc.

f) Keeping in view the limitations as well as the positive aspects of appropriate technology, a mixed approach for appropriate technology promotion has been used in arriving at a technology-mix for industries. This mixed approach has the inherent advantage in that it optimises the use of scarce resources. In a country like India any item of food has to be used most effectively. If the oil were to be crushed only in the oil ghani or the oil expellers, it would leave oil in the oil cake to the extent of 6-10% depending on the equipment used. The oil cake from the oil ghani or the oil expellers is collected and further processed in a sophisticated solvent extraction plant for additional quantity of oil. The oil cake is then used for preparing edible protein. This mixed approach has the advantage of linking up the traditional industries from the villages to the modern industries in the towns where the end-product of one becomes the raw material for the other. Other examples could be equally interesting.

g) Rice milling is done in decentralised mills and rice bran is collected and processed to produce rice bran oil. This meaningful and planned linking of industries or developing cluster of industries with horizontal and vertical links seems to be the answer for many of the problems, of effective resource and manpower utilisation.

5. Acceptance of Appropriate Technology

Though Appropriate Technology has been accepted at the national level, embodied as an effective development strategy in the plans, acceptance by the individual enterprises is wanting. Several reasons could be attributed to it.

Psychological and sociological barriers for change in traditional industry.

Attempts to innovate or introduce changes in technology in the traditional sector industries often meet with resistance. Such resistance sets roots in a number of factors. Among them are the general low level of awareness; the limited horizon and the inability to view things in the larger time perspective. Another set of factors relates to the high level of insecurity and low level of aspiration.

Affiliative tendency to tradition bound organisations including one's family.

Strong affiliative tendencies are related to dependency behaviour which is strengthened by social approval and the threat of the withdrawal of such approval in the event of non-conforming behaviour.

The insecurity of the entrepreneur for change in the traditional technology is further accentuated by lack of technical and managerial skills for operating new technologies. Very often the technical skills are learnt by the artisan from his father and he works under the latter's guidance. A blacksmith who is given a welding machine, will have to know the techniques of welding, the types of welding rods to be used and the various other technicalities connected with the welding. Likewise, expansion or modernising traditional industry will have to employ a few workers ^{and} to borrow money from the financial institutions and this would call for managerial skills which are not available with the traditional worker.

The new technology would also meet diversification and/or expansion of the market. With the new tools and equipment and with increased productivity volume of production tends to be high. Capability to produce more complicated goods would be

ensured with the technology which in turn also entails finding new markets, or expanding the existing one. These skills and resources the traditional worker does not possess.

The traditional worker operates in his house with the help of his family members. With the new technology, he may have to move out of the house and work in a workshop or factory. These and the financial and other infrastructure facilities like motive power, are not available in the place where he is presently operating. Financial, infrastructure and marketing institutions are coming up in some of the developing countries, but he also lacks the knowledge and skills to get institutional assistance. The change from the traditional to the appropriate sector will have to be brought about through a process of education and extension. The change needs to be gradual.

On the other hand, entrepreneurs starting modern industries are equally reluctant to use appropriate technologies. They prefer a modern technology which has been working successfully in a developed country. Some of the reasons for the reluctance are:

Starting an industry with "appropriate technology" is time-consuming. It is not proven, tested, and choice in terms of alternative process of technologies is not available. The management would not like to take risk with such a technology.

Subsidies and incentives are given for fixed capital investment in machinery. No such incentives are available for employing labour. On the contrary, labour is made more expensive by Labour Laws, Factory Acts, and capital is made cheap by lower rates of interest.

Range of technologies, of different capacity and degrees of sophistication is not available to choose from.

The management feels strongly that it is easier to handle a machine than labour. This perception is partly due to labour laws, but mainly lack of human relations skills.

7. The Approach

The task of generating the new breed of "Appropriate Technology" has to be done by developing countries themselves. The developed countries who are concerned with the technologies suitable for them will not be interested in developing appropriate technologies. This is being done in some of the developing countries by the Government, industrial research laboratories, private R&D laboratories, by innovative entrepreneurs and even by some of the innovative consumers. It is not always necessary only to think of technologies from scratch. Most of the technologies in the developing countries are meaningful adaptations of the sophisticated technologies or systematic upgrading of the traditional technologies. Promotion and support for the innovators to innovate, standardise, test and market technologies is one of the methods being tried in many countries. India has set up the Invention Promotion Board for this purpose. The Council of Scientific and Industrial Research has set up a large number of laboratories for developing technologies relevant to the country.

Technologies developed and adapted in one developing country could be relevant to another developing country as the resource endowments and other factors of production are comparable. The pooling of technologies developed would minimise the gap in the process of transfer of technology between them.

Suggested Steps

1. Selection of technologies

To begin with it is suggested that industries that are dispersed and of a ubiquitous nature could be selected for technology development. These industries may be based on the local resources, primarily to meet the local needs of the community i.e. the technologies could be such which would cater to the small markets in the local areas and which would not involve a heavy burden on the existing transportation and other infrastructure facilities in the country. It is suggested that each country could select one hundred technologies for development.

2. Inventory of technologies

Before taking up the task of developing technologies, an inventory of technologies available for producing the same products should be made. This inventory would indicate the type of technology, the capital cost, labour requirement, infrastructure facilities, etc. Such an inventory would reveal the gaps, if any, existing in the range of technologies available for the choice of entrepreneur. Ultimately the technology selection has to be done by the entrepreneur taking into consideration all the relevant facts and data.

3. Development of Technologies

The inventory of technologies would reveal certain gaps either in the size of the plants available or in the cost range of the plants and also in the degree of sophistication. These gaps will have to be filled so that the entrepreneur gets a wide range of technologies to suit the market size. The development of technologies would also concern itself with the upgrading of rural technology to make it capital-saving as well as capital-forming.

The development of technology would consist either in standardising a process already developed or adaptation of the process or miniaturising the process to fill up the gap. This could be done by R & D institutions or taken up by manufacturers of equipment.

4. Evaluation of Technology

The viability of technologies available and developed will have to be assessed through an intensive study and the levels of production at which these technologies would be viable. The field data on the viability of technologies will be collected by observing the existing industries using the technologies. This data would be processed to indicate the viability range of different technologies at different costs of labour and size of market.

Since the ultimate selection of the technology is done by the entrepreneur on his economic considerations, the evaluation data on technology should clearly indicate the capacity at which the technology is viable, the labour

requirements, the capital cost of the unit, etc. The entrepreneur will substitute the local costs of capital i.e. the rates of interest and the local cost of labour and then do his own evaluation of technology to assess its viability.

8. Technology Transfer

Technology transfer is an integral part of appropriate technology development. One of the problems faced by the developing countries is that they have established research institutions at an enormous expenditure. The processes developed are not transferred to the field level. They remain only as the research achievements of the laboratories. Likewise the entrepreneurs who have innovated a technology do not bother to propagate them. In any country the metropolitan centres where a number of large and small industries have sprung up with or without foreign collaboration are storehouses of technology. Attempts are being made to transfer these technologies to the backward areas to correct the regional imbalances. Technology transfer could be visualised in two spheres; technology transfer within the same country - between entrepreneurs in different regions and technology transfer between different countries. Technology transfer at the national level can take any one of the following forms:

- a) From a metropolitan city to a backward region/hinterland. It is a diffusion of technology from a place of concentration into backward areas. Entrepreneurs in the metropolises have a need to expand, the facilities for which are being provided in the backward areas. Promotional as well as restrictive policies aid and assist in this form of technology transfers. Many of the states are now prohibiting the establishment of new enterprises or the expansion of the existing industries. At the same time, they are providing facilities in the backward regions, like developed land at low cost, infrastructure facilities, loans, etc.
- b) From a developed region to a backward region in the same country. Financial and fiscal measures are given to promote this type of technology transfer. Where licensing of industries is being done, this administrative tool is used to force industries to the backward regions.
- c) From an existing entrepreneur to a new entrepreneur through in-plant training, collaboration, etc. The new

entrepreneurs are given training in motivation, preparation of feasibility studies, management practices and then asked to work in an existing enterprise. The new entrepreneur learns the technology as well as the management practices; many times he enters into collaboration with the existing entrepreneur to start an industry.

d) Consultants, machinery suppliers and extension agencies help the new entrepreneur with the necessary technical knowhow and give turnkey projects for industries in the backward regions.

e) Through the efforts of research laboratories. The scientists in the research laboratories who have developed the processes are also helping new entrepreneurs with the technologies they have developed. The main emphasis in the technology transfer is in giving the new entrepreneur proven technology, i.e. a technology that has been tested and which the entrepreneur himself has seen working.

9. International technology transfer

Transfer of technology from a developed country to the developing countries has been an on-going process for quite some time. This transfer under colonial rule was mainly utilised to exploit the local resources for producing semi-finished goods which fed industries in the developed country. Established, financed, and managed by foreigners, these industries did not develop any talent within the country. Local people were engaged only as unskilled workers. Further this type of technology transfer did not help dispersal; industries tended to be established only in places where the foreigners preferred to live and where infrastructure was well developed.

The developing countries, after liberation, import technology for starting basic industries like steel, aluminium, cement, copper, etc. Such technologies tend to be capital-intensive. Though essential for basic industries, they are not necessary for light industries. The need of the developing countries is not only technology, which is a means, but is to create employment by the use of capital and labour and to accelerate economic development.

In recent years, emphasis on the transfer of technology between developing countries has been growing, particularly in the area of light industry. Labour-intensive industry, based on technology developed or adapted by one developing country is more suited to the conditions of another.

Transfer of technology in the international field concerns itself with adaptation rather than mere transplant. This is attempted, though to a limited extent, even in transferring technology for basic industries from developed countries.

Gunnar Myrdal has this to say on transfer of technology:

"In the first place it had to be learned that scientific industrial technology, to be maximally useful in the under-developed countries, cannot simply be transferred but must be adapted to the conditions prevailing there. The

tropical and sub-tropical zones where these countries are mostly located have a different climate, and the importance of climate among all the problems besetting their economic development has been, in my view, grossly underestimated. The factors of production, capital and labour are locally available in quite different proportions. Educated, experienced and skilled managers, engineers and workers are relatively scarce. Domestic markets are small, depriving new industries of economies of scale, unless they can rapidly find large export markets. The external economies provided by a diverse surrounding industrial system are, of course, also absent and take time to develop."

Technology transfer, whether it is within a country or from one country to another, has the following elements:

- I. a) Type of technology
 b) Source of technology
- II. Mechanism of transfer or linkage mechanism between the sources with the potential adaptor.
- III. Potential adaptor - receiver of technology.
- IV. Environmental factors influencing the process of transfer/adaptation.

10. Technology Package

Technology for the manufacture of any item has three main components in it.

- 1) Technology hardware which mainly consists of plant, equipment and tools.
- 2) Technology software, i.e. knowhow for the manufacturing formulae, if any, and operating conditions for the plant.
- 3) Technology oddware, i.e. management aspect of the technology.

These three elements would be there in varying proportions even in the case of appropriate technology. The software part of technology is as important as the hardware part and in the process of technology transfer all the three will have to be transferred together. In most technology transfers where the entrepreneur buys the equipment, the manufacturers of equipment do not give him the knowhow nor is the entrepreneur equipped with the management skills for managing the enterprise. To facilitate and to build in technological capabilities in entrepreneurs, a phased programme of manufacturing has been advocated.

If (A), (B), (C) and (D) are the various stages in manufacturing as shown below, 'D' is ^{the} finished product and 'A' is the basic raw-material. Instead of manufacturing the finished product 'D' from 'A', in the phased programme the entrepreneur

manufactures 'D' from 'C' and gradually comes to 'B' and then 'A'. This facilitates in acquiring technological capability in stages by the entrepreneur. Similarly, while processing the raw materials, instead of processing the raw material to the final stage, he can do only one process or two processes and send the semi-finished raw materials for further processes.

This has been accepted as a suitable method of building up technological capabilities in entrepreneurs in the developing countries. This technique has been used in India for the manufacture of complicated items like television sets, bicycles, scooters, automobiles, tractors, etc. It has also been used in the case of pharmaceuticals, dyestuffs, insecticides, etc.



11 Technology Assessment

The emphasis of technology assessment for the developing countries, particularly for Appropriate Technology, is different from the emphasis given in developed countries. Appropriate Technology is not a static concept. The appropriateness itself goes on changing as the economy develops from one stage to another. In a developing country, technology assessment has to take into consideration mainly the employment generation and the effective resource utilisation. The technology policy and technology assessment units will help in planning research on Appropriate Technology keeping in view the requirements of the developing countries. It may be mentioned here that the technology assessment may have to be done on a regional basis, for the disparities in development and income are high. But, in any case, each developing country should have a technology assessment and a technology policy unit for Appropriate Technology and for the small scale sector so that the role of small scale sector, ^{and} the basic objective of effective resources utilisation with minimum of expenditure, is maintained. The other objective of technology assessment is to reduce the regional imbalances and also the disparities between the developed and the developing countries.

A systems approach for the assessment of technology for the developing countries is essential for developing a long range technology policy.

Some of the areas of interaction with technology in the developing countries are:

- 1 Economic
 - a Capital cost and availability
 - b Foreign exchange required
 - c Growth in the economy - capital saving for reinvestment
- 2 Demographic
 - a Direct employment
 - b Indirect employment
 - c Cost of labour
 - d Migration to cities
 - e Balanced development of different regions
- 3 Resources
 - a Resource utilisation
 - b Effectiveness
 - c Renewable or non-renewable resources
- 4 Effect on other sectors
 - a Impact of industrial technology on agriculture and vice-versa
 - b Construction
 - c Transportation
- 5 Skills
 - a Entrepreneurial and managerial skills
 - b Skilled workers
- 6 Gestation period
 - a Time required for starting the industry
- 7 Institutions
 - a Type of institutions for promoting technologies - fiscal, financial and industrial

- b Subsidised rate of interest
 - c Capital subsidies - tax holidays
 - d Technical institutions, etc.
 - e Infrastructure availability
- 8 Consumers
- a Quality and price
 - b Scope for export
 - c Comparison with international prices
- 9 Social considerations for adaptation and transfer of technology.

Technology assessment for the developing countries takes into consideration these and many more factors to arrive at Appropriate Technology and industrial policy for the future. In addition to the normal function of projecting the technology requirements for the future the technology assessment units could constantly review the technologies that are becoming obsolete and suggest alternate technologies for development.

12. Policy Formulation/Appropriate Technology

The existing policies, both financial and fiscal, tend to promote either the traditional industries which are non-productive or the modern sophisticated industries. The incentives given are linked with the capital investment in the industry. For traditional industries the incentive is withdrawn once the industry is even slightly modernised. This arrangement tends to support the status quo in industrial relations and is not conducive to the development and promotion of appropriate technologies.

The policies will have to be formulated taking into consideration the objectives of industrialisation. If employment is one of the objectives, then incentives should be given and linked with employment. If modernising the artisan sector is one of the objectives, then there will be disincentive for non-modernising and incentive for modernisation. At present, the reverse operates in many of the developing countries. Excise duties, sales tax and other forms of fiscal levies are laid on industries which use power but these are exempted where industries do not use power. Likewise, capital subsidies are given on heavy investments, no employment subsidy is forthcoming.

The Labour Laws in most of the developing countries are adaptations from the developed countries. These Laws tend to make employment of labour more difficult than having an automatic plant. They should be consistent with the level of development of industry. It is suggested that Labour Laws should be compatible with the investment per worker in industry and not based on the number of people as at present.

The infrastructure is available only in the bigger cities and the metropolitan areas in the developing countries. If the objective of industrialisation is to bring

about dispersal of industries and introduction of appropriate technologies in industries and if the industries are reserved for agricultural sector and the rural sector, then it is essential that certain growth centres should be located and infrastructure developed. The location of the growth centres should be such that each growth centre serves a certain hinterland and a number of settlements. It is possible to think of a hierarchy with industrial mix in these growth centres which link up hierarchial towns. Examples of this are:

- 1) Lowest level of growth centre, repair of agricultural implements - primary processing of oil seeds.
Next level.
- 2) Production of agricultural implements - solvent extraction of oil cake.
Next level.
- 3) Production of agricultural machinery - Protein foods, further processing of oils, etc.

Development of growth centre and development of infrastructure as a pre-requisite for the introduction of Appropriate Technologies in the rural areas.

The infrastructure that is to be developed by the growth centre could be both social overheads and physical infrastructure would cover industrial land, factory buildings, power, raw material depots, transportation, training facilities, financial institutions, etc. The social overheads would include hospitals, schools, hotels, entertainment, etc. The development of growth centre would reduce the migration of educated and skilled workers to the metropolitan cities in search of employment.

13. Reservation of sectors of industry

The appropriate technology, though economically and financially a viable proposition for the developing countries, needs, in the initial stages, a certain degree of protection from the organised large industries located in the metropolitan cities or from the goods that come into the country. Some kind of protection, either reservation of sectors for the development through appropriate technology or differential taxation for the two sectors, could be considered.

14. Institution building

Though research institutions and extension agencies have been established to promote small and medium industries, no specialised institution has come into the field for the development and promotion of appropriate technology. Information on technology, though essential, is one of the elements lacking in the developing countries. It is suggested that either a separate institute or a Technology Development and Transfer Cell be established as a part of the industrial promotion agency in each country. The task of the technology development cell would be three-fold.

a) To identify technology available in the country and prepare an inventory of technologies for the industries selected on priority for development. The inventory could indicate both the equipment, know-how and the sources of supply. The cell could also undertake a continuous evaluation of the technologies for making the information available to the prospective entrepreneurs.

b) The cell could coordinate the technology development efforts of various other organisations and research laboratories and help them through its effort the type of technology that is needed for different industrial sectors.

The cell could supply technology information to entrepreneurs and extension agents working in the field of a responsive assistance or basis through the publication of bulletins.

It may be mentioned here that technology information of the type required has to be collected through field agents. The latter should constantly feed the cell by live and unpublished information about the technologies developed by innovators and entrepreneurs.

c) The cell could also establish contacts either with technology development cells or agencies in other countries and try to form a technology grid among themselves.

The cell could also initiate transfer between the supplier or the donor of technology and its receiver. Here the role of the cell would be more like that of a catalyst where it brings the donor and the receiver together. The technology transfer could be between two firms with or without the help of extension agencies. The cell could also promote the other types of technology transfers, viz. from the research laboratories, from published literature etc. The Indian experience in this area has been that technology transfers have been possible from one region to another where the entrepreneur, after getting initial training in the area of project identification, project viability, project management, works in a factory and gets the technology. This kind of technology transfer has also been tried successfully in the case of entrepreneurs from other countries coming to India for training.

Training for technology transfer and adaptation


Introduction of appropriate technology has to be done in stages so that it causes the least disturbance in employment of labour. The entrepreneur also learns the technology in stages and adapts himself to the new situation. The systems approach for the technology adaptation in the traditional industry is desirable as the entrepreneur is not interested in just having a new technology since he has to build, produce and market. He knows the new designs, he has the necessary infrastructure and finance for increased production.

15. The Indian experience in the field of small industry promotion has been considerable. The small industries from a very moderate beginning are now contributing substantially to industrial production (36 percent). The total number of small industries is nearly 400 thousand industries.

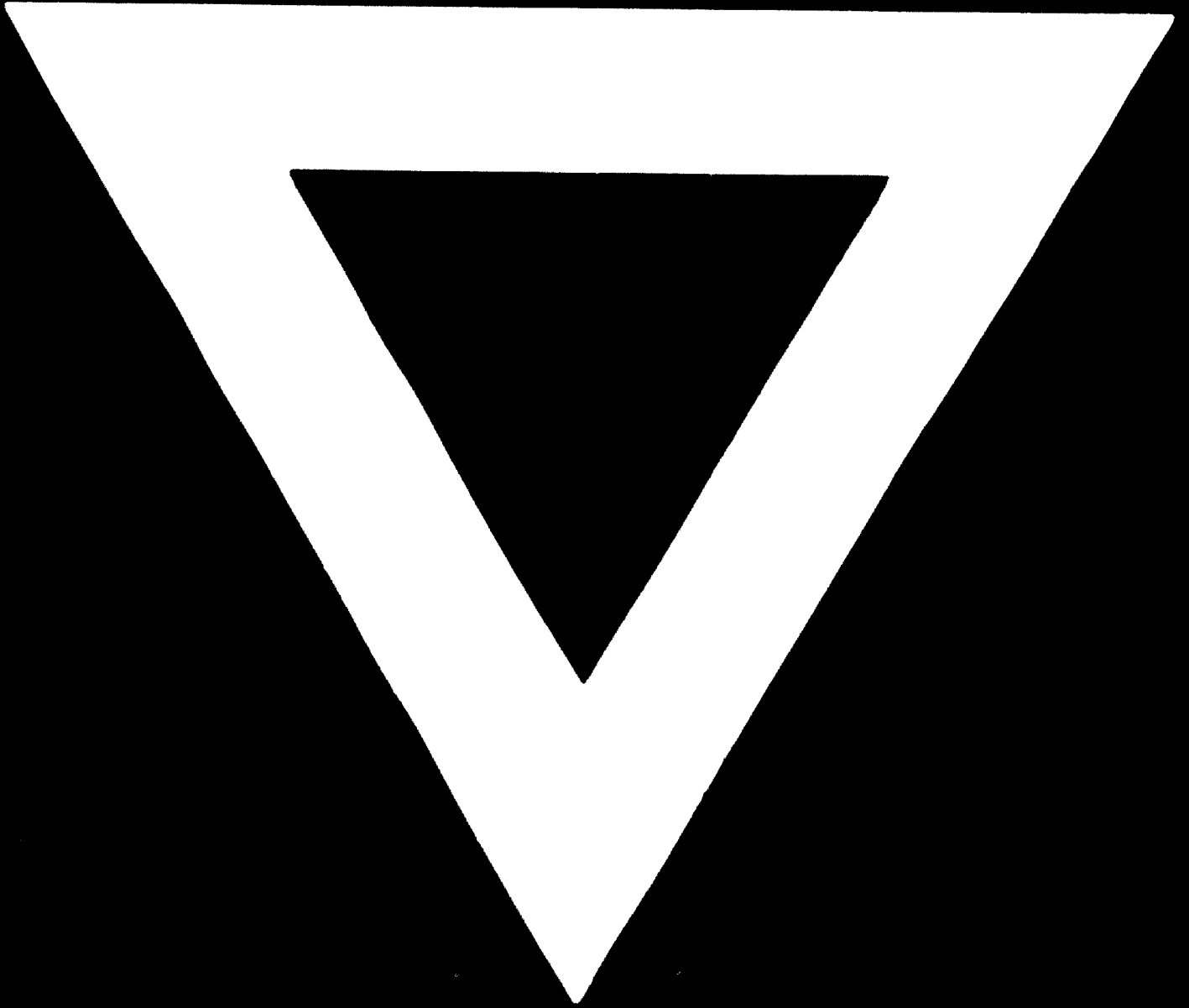
In addition, we have the traditional industries which also account for considerable production and employment. The traditional sector is being gradually modernised by the introduction of modern tools, financial assistance, infrastructure facilities, and new markets. The sector today is even exporting to other countries and earns foreign exchange for the economy. The modern sector which also uses appropriate technology in varying degrees is

manufacturing sophisticated goods like radio, television, bicycle, scientific instruments etc., using labour intensive technologies which are located in small towns. India has developed a number of institutions for supporting both the traditional sector and the modern sector of small industries. The assistance ranges from financial assistance to marketing assistance and training of entrepreneurs, both in management and technology.

International cooperation for developing, pooling and transferring appropriate technology from one country to another is very meaningful and this can be done only if the developing countries identify local institutions that can undertake the task of identifying and developing technologies. Such institutions and extension agents from different countries could be brought together in workshops, seminars and in training programmes. Likewise, entrepreneurs from different countries could be brought together to exchange technologies, to learn the management and software technology of work. It can even be envisaged that a donor entrepreneur would visit the receiving entrepreneur and help him set up the industry. This collaborative arrangement between small entrepreneurs using appropriate technology would be a very meaningful exercise to the developing countries. It can help them to acquire relevant technology at a fraction of cost which they would pay for getting the technology from the developed countries.



B - 10



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