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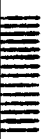
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GOVERNMENT POLICIES AND MACHINERIES FOR
THE COMMERCIALIZATION OF RESEARCH RESULTS ^{1/}

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^{1/} The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO

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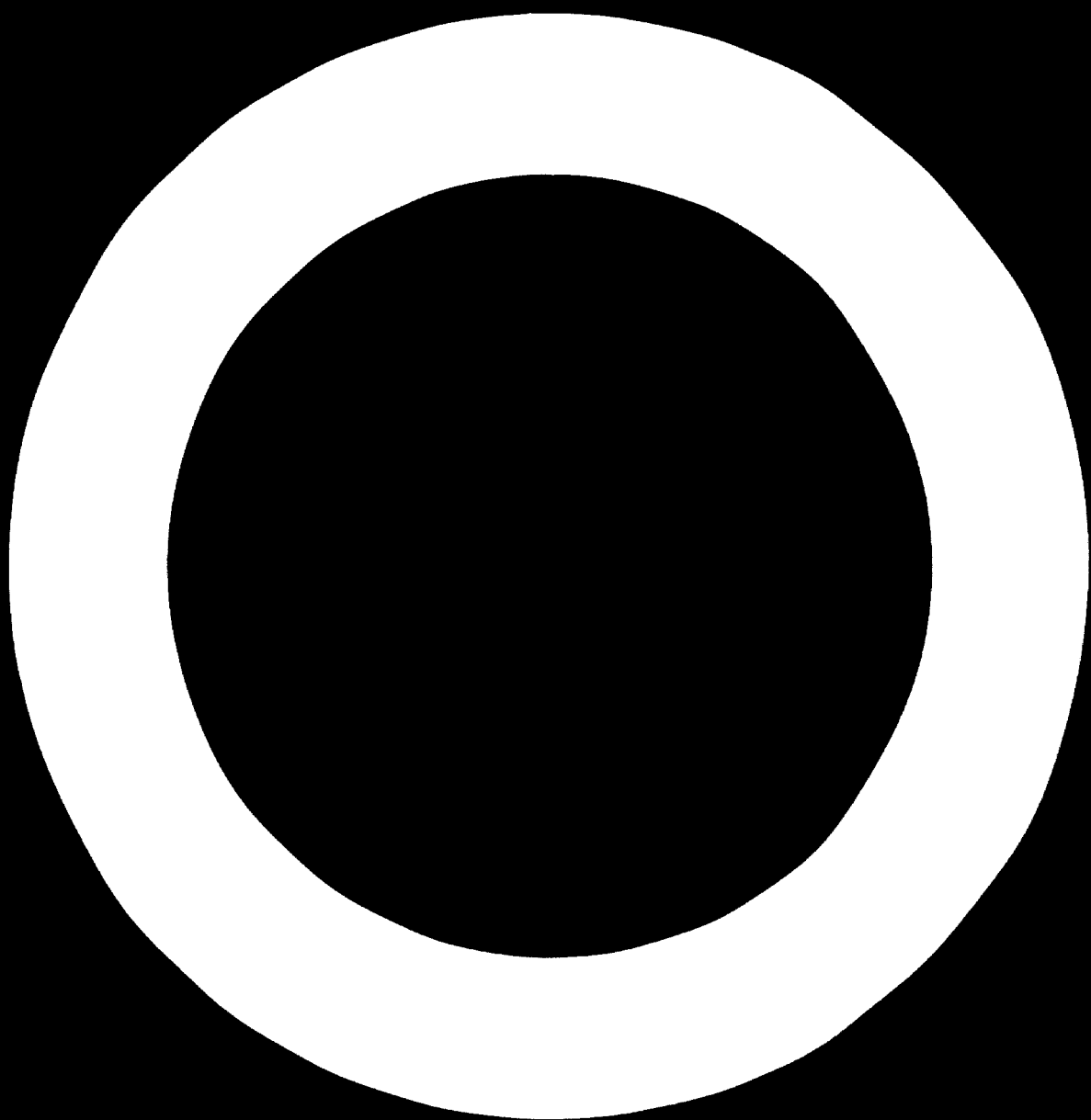
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SUMMARY

Developing countries have been critically examining the present practice of importing technologies from the developed industrialised countries of the world because such import has not helped them, to the desired extent, in achieving their national goals of providing adequate food, shelter, clothing, health services and employment for the people. There is now serious effort on their part to institute R&D work in their own countries to develop appropriate technologies to suit local resources and needs. The developing countries will have to formulate suitable policies in the establishment of such institutions giving them specific areas of work. They have to chalk out policies for utilisation of R&D results. The developing countries should also create appropriate institutional structures for doing R&D work and for transfer of technology and converting it to industry. In certain situations, regional R&D and technology transfer institutions are needed. There is need for the governments of the developing countries to take a leading role in these activities. Some of the developing countries have already made substantial progress in this direction. Other developing countries could learn from the experience available already in this field. Such experience will be more relevant to the needs of the developing countries. In this connection, it would be worthwhile to study the experience of countries like India with a view to adapting such experience to local needs.



INTRODUCTION

In recent years, there has been a critical examination on the part of the developing countries regarding their efforts to increase living standards of their people by importing technologies from the developed industrialised countries of the world. There has been a feeling that in spite of large scale import of such technologies, the developing countries have not been able to make satisfactory progress in achieving the national objectives of providing adequate food, shelter, clothing, health services, employment and cultural life to their people. Doubts have been expressed whether the present methodology of importing wholesale what has been successful in the developed countries can solve the problems of the developing countries. It is almost axiomatic that technologies are first developed to suit the economic and social conditions of the countries of their (technologies) origin. Only when they have been successfully established, the question of transferring them to other countries arises. It is very seldom these technologies without further modification and adaptation will suit the conditions prevailing in the recipient countries with regard to the available raw materials and skills and the social needs of the people. Therefore, developing countries have been establishing more and more R&D institutions in their own countries to develop appropriate technologies to suit their own conditions with regard to resources and social conditions. Such technologies would help in

the achievement of national goals in a more satisfactory manner.

Some countries like India, Mexico, Brazil, Korea, Philippines, Egypt, etc. of the developing world have made significant progress in establishing R&D institutions. However, when technologies are developed as a result of the R&D work in national institutions of a country, the problem always remains of how to translate the technologies into industry. Even among the developing countries, some countries have achieved relatively greater progress with regard to establishment of R&D institutions than others. However, even those who are just now trying to establish R&D institutions in their countries are interested in the experience of other developing countries with regard to the establishment of such facilities and the policies and machineries instituted in those countries for translating the research results into industry. This paper discusses their problems and makes some recommendations based upon the experience already available in this field.

AGENCIES IN DEVELOPING COUNTRIES FOR DOING R&D WORK

One of the first things a developing country will have to decide for itself is the need for doing R&D work in the country and if it is to be done, in which areas. It is not possible for every country to do meaningful R&D work in all fields of technology. This is borne out by the fact that even the most developed countries, who have come to the present state of development after decades of R&D work still buy technologies from other countries. Moreover, most of the developing countries do not have the kind of resources,

at least to start with, like the countries in the developed world. Therefore, it is necessary for the developing countries to carefully select areas where they should concentrate the limited resources of man-power and money available to them. One of the most important pre-requisites for a successful R&D programme in a developing country is the selection of areas to match resources and needs.

The next most important thing is the training of personnel. For manning the R&D institutions in the country, there should be an advance programme for training personnel of the developing country. This training could be obtained in the developed countries of the world or in the more advanced developing countries themselves. Probably, it would be more appropriate if such training could be obtained in a set-up approximating to the set-up existing in the developing country. Such a situation does not exist in the developed countries of the world. It is, therefore, necessary for a developing country to tap the facilities available in other developing countries for training their personnel.

The third most important pre-requisite is the decision with regard to the type of institutions that would be entrusted with the R&D work in the developing country. Here, the decision could be either a number of institutions spread throughout the country, each institution specialising in an area or a few allied areas or a central institution which is multi-disciplinary and

could cater to all the needs of the country. Such a decision would naturally depend upon the size of the developing country. In countries like India, Brazil, Mexico, Argentina, Philippines and Indonesia, it may not be possible for a single institution to serve the entire needs of the country. However, in smaller countries, a central institution with a few branches, if need be, could meet the situation. This is for each nation to decide for itself taking into consideration the various economic and social factors.

Having taken the decision for establishing the institutions, it is necessary for the government to clearly define the objectives of such institutions and the areas of activity. In other words, they should be given a clear mandate and goals to strive for. The institutions should be given the necessary resources, qualified staff as well as finances, for achieving their goals.

In developing countries, there could be four types of institutions for carrying out R&D work -

1. Universities and institutions of higher learning :-

Normally, universities in developing countries are manned with highly qualified professional staff whose competence could be utilised for doing R&D work useful to the country. As a matter of fact, if such a programme could be included in the university work, it would provide the professors and students in the universities not only a sense of participation in national

development but also would familiarise them with the problems of interest to the nation.

2. Specialized R&D institutions charged with the responsibility for doing R&D work in areas of interest of the country.

There are a number of such institutions in various developing countries. Among them can be mentioned the National Laboratories of the Council of Scientific & Industrial Research in India who have established 42 laboratories, some directly being managed by them and some in co-operation with industry, the Central Research Organisation, Rangoon, the Caribbean Industrial Research Institute, Trinidad, East African Industrial Research Organisation, Nairobi, National Science Development Board, Manila.

3. The established industry in the developing country could have strong R&D facilities not only to do research and development work necessary for their own day-to-day needs but also for developing new processes and projects in the interest of the nation.

4. Foundation and non-profit organisations

Besides the above four, there could be some independent inventors whose ideas could be utilised for the development of the nation.

GOVERNMENT POLICIES FOR SUPPORTING INDIGENOUS R&D

R&D is characterized by the following :-

- (i) It requires relatively large finances.
- (ii) It requires services of highly trained and qualified personnel.
- (iii) The results from R&D work are not immediately discernible and would require time before they are felt in the economy.
- (iv) There is every likelihood of a number of programmes taken up not coming to fruition as commercial units, at all.
- (v) Depending upon the type of problem to be tackled, there is a critical effort below which R&D work may not yield any worthwhile results. It is, therefore, necessary for funding agencies to provide these critical inputs for making R&D worthwhile.

Because of these reasons and lack of adequate resources in most developing countries, it is not very easy for them to mount reasonably strong R&D programmes. Private industry in developing countries, mostly used to imported technology, are not really in a position to support local R&D work. What they would at the most be interested in will be solutions to day-to-day problems with the help of qualified local technical people. Therefore, it becomes almost imperative for the governments of developing countries to step in a big way into the field of R&D

and this is happening all the time. For example, in India which is relatively more advanced than many developing countries with regard to R&D, Governments at the Centre and in the States contribute approximately 90% of the total amount spent on R&D in the country. The contribution of industry in this respect is rather limited, so far. Only now, this sector is trying to make some contribution towards this end. It may be worthwhile to note that Indian Parliament, as early as 1958, adopted a Science Policy Resolution to give positive encouragement to R&D work in the country. The resolution in part says :-

" The Government of India have accordingly decided that the aims of their scientific policy will be :-

- (i) to foster, promote, and sustain, by all appropriate means, the cultivation of science, and scientific research in all its aspects - pure, applied, and educational;
- (ii) to ensure an adequate supply, within the country, of research scientists of the highest quality, and to recognize their work as an important component of the strength of the nation;
- (iii) to encourage, and initiate, with all possible speed, programmes for the training of scientific and technical personnel, on a scale adequate to fulfil the country's needs in science and education, agriculture and industry, and defence;

- (iv) to ensure that the creative talent of men and women is encouraged and finds full scope in scientific activity;
- (v) to encourage individual initiative for the acquisition and dissemination of knowledge, and for the discovery of new knowledge, in an atmosphere of academic freedom; and
- (vi) in general, to secure for the people of the country all the benefit that can accrue from the acquisition and application of scientific knowledge."

Thus the Government took upon itself the responsibility of fostering R&D work. It is in pursuance of this resolution that 42 R&D institutions were established under Council of Scientific & Industrial Research and laboratories in various other organizations were also given encouragement. Among the other policies adopted by the Government of India for encouraging R&D work are the following :-

- I. When a technology is locally developed, its import is not generally permitted.
- II. When goods are manufactured with such technologies, the import of such goods is also not allowed.
- III. For those who sell technology to others, certain monetary incentives are provided.
- IV. For those who are developing technologies,

the following monetary incentives are provided :-

- (i) They can write off 133 $\frac{1}{2}$ % of their expenses on R&D, if such work is sponsored in a recognised institution. Otherwise, they can write off 100% of the Capital and revenue expenditure on R&D.
 - (ii) Contributions made to R&D institutions are deductible for income tax purposes.
 - (iii) If permission had been taken from the Government of India before starting R&D work, the developer of the knowhow can himself go into business utilising the results of R&D work. That is licensing is almost automatic.
 - (iv) Recognised R&D institutions are allowed to import R&D equipment and chemicals etc. without going through the usual procedural formalities.
 - (v) A 40% deduction for purposes of income tax is allowed on payments received for transfer of technology and for rendering services in connection with this by consultants, engineering firms etc.
- V. The Government has taken policy decisions for encouraging small scale industry (capital investment in plant and equipment is less than

Rs.1 million). For this sector, the Government have reserved a list of about 180 items, which should not be manufactured in the large scale sector. As most of the R& work done in national institutions is suitable for small scale industry, this policy provides incentives for utilisation of local R&D results.

VI. To encourage small scale industry, the Government of India have established industrial estates, technocrat estates and functional estates where small entrepreneurs could establish their factories. These industrial estates have facilities like central tool rooms, technical libraries, and testing and quality control units which can render service to all the units established in the industrial estates. In the functional estates, provision of utilities and removal of effluents and wastes are provided centrally.

VII. Small scale units get special treatment with regard to excise duties, sales tax, etc. in order to give them a competitive edge over large scale units in selling their goods.

The developing country wanting to support R&D must, therefore, take appropriate policy decisions which would give impetus to the establishment of R&D institution and utilisation of results from R&D. The experience available in this respect in other countries could be utilised in arriving at such policy decisions.

GOVERNMENT MACHINERIES FOR STARTING AND
UTILISATION OF R&D WORK

The policies of the Government can be converted into realities only through appropriate agencies specifically created for the purpose. Depending upon the policies, various structures will have to be created. In this connection, it may be worthwhile to consider experience of countries like India who have been able to achieve some progress in such matters.

The Government of India have created a number of organisations for carrying out R&D work in the country. These organisations are :-

1. The Council of Scientific & Industrial Research which has 42 R&D Institutions distributed all over the country. Some laboratories deal with specific subjects like chemistry, physics and metallurgy. Some laboratories deal with specific commodities like fuels, glass and ceramics, food and leather. Some institutions are devoted to the development of the region. These are called Regional Research Laboratories and they are multi-disciplinary. Several institutions have been established in collaboration with industry. They deal with textiles, jute, cement, plywood etc.

2. The Indian Council of Agricultural Research -

This organisation has 26 R&D institutions working on several problems in agriculture, fisheries, fibres, etc.

3. Indian Council of Medical Research -

This organisation has 8 laboratories distributed all over the country dealing with health, nutrition, medicine, etc.

4. Defence R&D -

This organisation has 34 laboratories doing work on problems of interest not only to defence, but also to other interests.

5. Bhabha Atomic Research Centre -

This organisation does work with regard to utilisation of atomic energy for peaceful purposes.

6. Railway Designs & Standards Organisation -

This organisation does work on problems of interest to Indian Railways.

There are many departments of the Government of India and the State Governments who have R&D institutions. Many higher technological institutions, universities and independent research organisations also carry out R&D work.

A number of other organisations were created to support and co-ordinate R&D work and help small scale industry.

1. The Government of India have created the Department of Science & Technology to coordinate the whole activity under science & technology.

2. The Government have constituted a Committee called 'The National Committee on Science & Technology' for advising the Government on science policy and areas of research where resources should be directed.

3. The incentives under R&D etc. are administered by the tax collecting authorities.

4. The Government have constituted a Committee for screening applications for recognition as R&D institutions.

5. The Government have created the organization of the Development Commissioner for Small Scale Industry, Small Industries Service Institutes, and Small Industries Institute for Education and Training.

6. The Government have created State level R&D Committees having representatives of the Department of Science & Technology, the Council of Scientific & Industrial Research, the National Research Development Corporation of India, Development Commissioner for Small Scale Industries, various Departments of the State Government and industry to assist small scale industry in their R&D programmes.

7. The Government have created special financing agencies like the State Small Scale Industries Development Corporations and the National Small Industries Corporation for financing industry in the small scale sector.

8. The Government have created the Secretariat for

Industrial Approvals, Licensing Committee, Foreign Investment Board and Projects Approval Board for scrutinizing applications requiring foreign technology. These Committees have representatives from the Council of Scientific & Industrial Research, the Department of Science & Technology and the National Research Development Corporation of India so that they could bring to the notice of these agencies available indigenous technologies so that such technologies need not be imported.

Developing countries wanting to establish R&D institutions need to study the mechanisms established already in sister developing countries for such purposes. In most cases, adaptation of such mechanisms to suit local conditions may fulfill local needs.

For some small countries, it may not be possible to mount a significant R&D programme due to lack of resources: man-power and finances. Also, there may be some problems which are of common interest to many developing countries. In order to meet such situations, there is need to have regional R&D institutions doing work of interest to the countries of the region. In this way, the financial burden of R&D could be reduced. In such cases, there is also a need for regional technology transfer agencies to successfully transfer such technologies to individual entrepreneurs located in different countries of the region.

TRANSFER OF TECHNOLOGY FROM R&D INSTITUTIONS TO INDUSTRY

While it is possible to suitable policies and creation of appropriate machineries to do R&D work, there is still need for making policy decisions and creating suitable machinery for transfer of technology from R&D institutions to industry. It is seldom that work done on a bench scale in an R&D institution is suitable for utilisation at the industry level. Many inputs will have to be provided to make such technologies suitable for industry. There may be need for conducting investigations on a pilot plant scale or building a number of prototypes before such technologies can be transferred successfully to industry. There is also a need for bringing in design engineering firms and consultants at the stage of pilot plant level investigations or when the technology is being transferred from laboratory to industry to upscale the process and provide engineering services to make the process suitable for implementation at the industry level.

In the more developed countries of the world, transfer of technology from R&D institutions to industry is relatively easy. The organisations buying technology have resources to assess the technology offered and provide all the inputs necessary for successful transfer of technology like market studies, engineering services, upscaling of the process, erection, operation and selling the product. All they need in such countries is full disclosure of the process data or the engineering data. This is not so in the developing world. Depending upon the complexity

of the process or the technology, many inputs need to be provided to the entrepreneur to make the technology a successful commercial success. The entrepreneur in a developing country may need assistance in choosing a process, in conducting a market survey, unskilled, detailed engineering, purchase of equipment, inspection, installation, start up, maintenance, training of personnel and sale of the product. Of course, all the services might not be required in every case. But several of them will be necessary in a number of cases. Therefore, technology transfer from R & D institutions to industry is more difficult in a developing country than in a developed country. As most of these R & D facilities have to be established by the Government, it is also necessary for the Government to provide the inputs necessary for successful transfer of technology from R & D institutions to industry. The Government may have to provide policy and institutional support for effecting successful transfer of technology.

In this connection, the experience of India in this area may be of interest.

Realizing that a central organization would be necessary for transferring R & D results to industry, the Government of India formed, in December, 1953 a Company called the National Research Development Corporation of India for this purpose. Among the objectives of this Corporation are the following :-

1. To develop and exploit in the public interest for profit or otherwise :
 - (1) Inventions, whether patentable or otherwise, of Council of Scientific & Industrial Research,

including technical and engineering know-how of processes.

- (ii) Patents and inventions of different departments of Government of India and State Governments' commodity research committees, and other statutory research organizations, including technical and engineering know-how of processes.
 - (iii) Such other patents as may be voluntarily assigned, by general or special agreement, by universities, research institutions, or individuals, and
 - (iv) Such other processes and patents, the development of which may be entrusted to the Corporation by the Government of India.
2. To enter into reciprocal agreement with similar organizations in other countries to exploit Indian know-how in those countries and their inventions in India.
 3. To enter into agreement with private firm(s) to develop inventions by trial at their works and to reimburse them any loss that may be incurred during these trials.
 4. To instal and work pilot, prototype or smallscale units or full commercial plants to develop a particular invention or inventions and cause production from such invention or inventions, to sell or otherwise dispose of the products on payment or otherwise and generally on such terms and conditions as may seem fit.
 5. To afford facilities for advising and assisting

government departments, universities, research institutions and individuals in filing applications for patents and prosecuting the same before the Controller of Patents and to frame rules for the purpose and to vary them from time to time.

The Corporation during its 21 years of existence has developed expertise for translating R&D results into industry.

At present, the Corporation's work is divided into five main activities :-

1. Licensing

The Corporation assesses R&D work being done in more than a hundred R&D institutions and offers technology to industry. In doing so, it conducts either itself or through consultants, market surveys where necessary and also provides, where necessary, services of engineering consultants for upscaling and detailed engineering of the processes. A large number of processes which require relatively low capital investment could be transferred from R&D institution to industry without going through the stage of a pilot plant. At the end of March 1975, NRDG of India licensed to industry 789 processes of which around 300 are in production.

2. Pilot plants and demonstration plants

Some projects require pilot plants or demonstration units before the know-how could be transferred to industry. In such areas, NRDG have established its pilot plants and demonstration plants to prove the technology. Hitherto, 100% of this expenditure

was being borne by NEDC or the R&D institutions. However, at present such units are being established in collaboration with industry. NEDC pays upto 50% of the cost of such a project and industry pays, 50%. The project is implemented either by the industry or the R&D institution depending upon the facilities available and the work involved. When the project is successfully completed, NEDC expects the industry to pay back their (NEDC) contribution without interest. The know-how is then licensed to industry on royalty terms. However, when the project fails, NEDC writes off its contribution to the project.

There are some projects where such a participation is not adequate. The entrepreneur would like to have NEDC as a real partner by equity participation. In such cases, NEDC can participate in equity to the extent of 26%.

Until September, 1975, 52 projects worth Rs.63 million have been approved by NEDC.

3. Individual Inventors

NEDC helps individual inventors unsupported by any institution in patenting their inventions, building of prototypes and models and commercialising their inventions. NEDC also gives awards for meritorious inventions twice a year on Republic Day and Independence Day.

4. Horizontal Transfer of Technology

NEDC has now begun the activity of horizontal transfer of technology. When a licensee of NEDC successfully implements

a project, NRDC endeavours to take assistance from him while transferring the developed technology to a third party. In this process, the first licensee is compensated financially. There may be processes which might not have been developed with the help of NRDC and industry is willing to release such know-how through NRDC. In such cases also NRDC acts as the agent for transferring technology from one industry to another.

5. Export of Developed Technology

Having developed a large number of technologies which are appropriate to developing countries, NRDC is now able to offer them to other developing countries. Some developing countries are already making use of such technologies.

Organisation of the type of NRDC has been a popular type of structure being utilised in the developed countries for transferring technologies from R&D institutions to industry. About 18 such organisations already exist in the world and more are being formed. Sri Lanka recently established National Engineering, Research and Development Council for this purpose. Many other countries in the developing world are considering the need for establishing such institutions for effective transfer of technology to industry.

The experience of NRDC in the field of technology transfer has highlighted several problems in the transfer of technology from R&D institutions to industry. For the successful transfer of technology from R&D institutions to industry, the

following points need attention :-

- (i) In a number of cases, laboratory research will have to pass through a pilot plant stage before the technologies can be transferred to industry. Investigations on a pilot plant scale are much more expensive than those on laboratory scale. Because of the higher quantum of investment required in pilot plant investigations, these decisions are not easily taken and technologies do not get upscaled and transferred. One should establish a methodology for upscaling laboratory technology, conduct pilot plant experiments and then transfer it to industry.
- (ii) There should be close association, even at the pilot plant stage or earlier, with engineering and consultancy organisations so that there may not arise unforeseen difficulties at the stage of transferring the knowhow to industry. Association of engineers with the project in the early stages will solve a large number of unnecessary problems which crop up later.
- (iii) The Government or the agency concerned should provide adequate finances not only for research work in the laboratory but also for carrying out development work in the pilot plant and demonstration plant stages.

- (iv) There is need for having trained men not only to engineer the projects but also to upscale them from laboratory stage. This is most important.
- (v) There is always an element of risk for utilizing a technology which has not been proved on a commercial scale. In developing countries which are just now coming into the industrial era, any failure on the first few projects, even if they are based upon indigenous technology, will act as a great deterrent for utilization of local technology. It is, therefore, necessary that adequate safeguards are provided for covering risks involved in such undertakings.
- (vi) It is most important that while selecting subjects for industrial R&D, great care is taken to see that these subjects are of interest to the economy of the country in the next 5, 10 and 15 years. There is great obsolescence in the technological field and what appears important today may not be so a few years later. There should be consultation between Government, R&D institutions, industry and transfer agencies in choosing problems of R&D.

- (vii) Wherever a number of R&D institutions have already been established in a developing country, it may be worthwhile to establish a NEDC type organisation to act as a promoter and a link between R&D institutions and industry for converting local technology to industry. The licensing organisation should have capability to assess the processes offered, make market surveys, if need be and write feasibility reports on technologies offered for transfer.
- (viii) There should be feed back from industry to R&D institutions and transferring agency for the successful development of indigenous technologies.
- (ix) The transferring agencies in developing countries should try to offer a package service to entire process. This package could consist of not only the technology and knowhow but also other services like detailed engineering, purchase of equipment, erection and commissioning and training of personnel which is required by the entrepreneur.

RECOMMENDATIONS

1. Developing countries should decide for themselves on policies with regard to R&D taking into consideration their resources and needs.

The experience available in developing countries could form the basis for arriving at policy decisions and creation of machineries in the developing country for R&D work.

2. Depending upon the resources available and the R&D problems identified, necessary institutional structures should be created.

3. Selection of proper areas of research is one of the most important prerequisites for successful R&D work and its translation to industry. At the national level, a structure has to be created for deciding areas of R&D work.

4. After creating the necessary institutional structures, they should be provided with adequate personnel and finances.

5. R&D personnel from developing countries should preferably be trained in other developing countries which have experience in the relevant fields.

6. Incentives may have to be provided for doing R&D work and for the utilization of its results.

7. Consideration has to be given for creating specific machinery for transfer of technology from R&D institutions to industry. This could be a unit within a multi-disciplinary organisation in a small country or an independent organisation dealing with number of organisations in a large country or a regional institution in the case of a region. However, it is

desirable that such an organisation is structurally independent of generators of technology in order to be able to make independent judgements and to function as effective linkage between R&D institutions and industry.

8. Machinery has to be created for giving inputs like market surveys, engineering services, etc. for effective transfer of technology to industry.

9. Consulting organisations could be encouraged to provide inputs for converting R&D into industry.

10. Availability of indigenous facilities for manufacturing equipment would greatly aid R&D work and the transfer of results. Encouragement has to be given to the establishment of such facilities.

11. In certain situations, there is need for regional R&D institutions and technology transfer centres.





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