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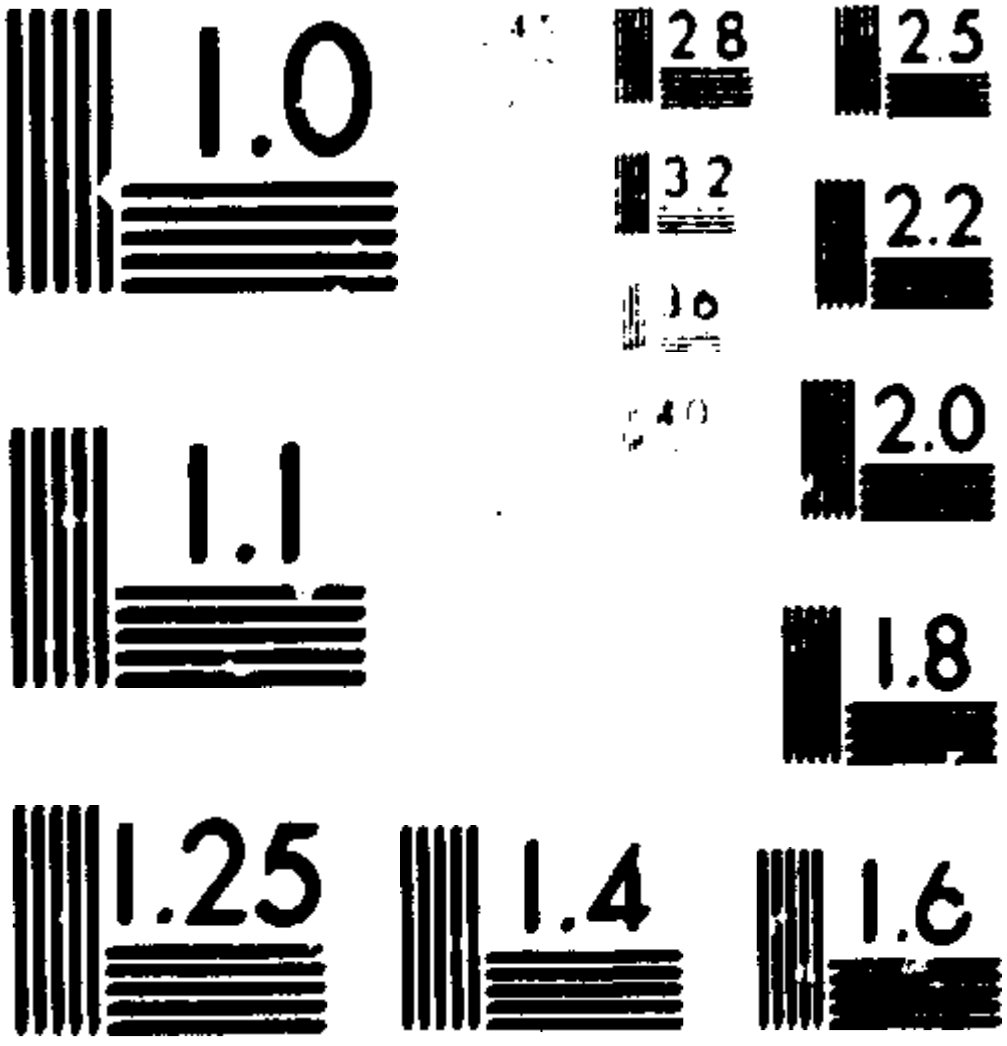

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GENETIC ENGINEERING AND ITS IMPLICATIONS FOR DEVELOPING COUNTRIES: SOME PRELIMINARY ISSUES FOR ACTION .

Prepared by the Technology Programme of UNIDO

GENETIC ENGINEERING AND ITS IMPLICATIONS FOR DEVELOPING COUNTRIES : SOME PRELIMINARY ISSUES FOR ACTION

I. Background

Biotechnology is widely acknowledged as a field of scientific and technological advance which will have a significant impact on the long - term development problems which will face humanity in the years ahead. [1] Its wide-ranging potential has been dramatically enhanced by advances in genetic engineering (i.e. research on the techniques of splicing synthetic genes into single-celled micro-organisms) by investing it with new dimensions of versatility, efficiency and economy. The time frame within which the potential of these advances can be realized in terms of practical applications will necessarily vary in terms of products, processes and sectors, but applications, once started, might well display an exponential trend. The advent of commercial applications is already heralded by the forming of new commercial enterprises, investments by multinationals and a keen debate on the patent rights. Science, which is universal, is being transformed into technologies, which are specific and the manner in which this transformation takes place will affect the range and cost of realization of the benefits. Developing countries, needless to say, have a stake in this process, perhaps unparalleled in the history of technological innovations.

2. The wide-ranging impact that biotechnology propelled by genetic engineering will have on industrial development is not often realized. However, recent definitions of biotechnology have stressed its industrial orientation. To put it in the words of the conclusions of an expert report in the United Kingdom: [2] 'we envisage biotechnology - the application of biological organisms, systems or processes to manufacturing and service industries - as creating wholly novel industries, with low fossil energy demands, which will be of key importance to the world economy in the next century. Over the next two decades, biotechnology will affect a wide range of activities such as food and animal feed production, provision of chemical feedstocks, alternative energy sources, waste recycling, pollution control, and medical and veterinary care. We are convinced that it will shortly be possible to use microbial and other cells to make a wide range of organic chemicals which either cannot at

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1/ For example, Report of the United Nations Conference on Science and Technology for Development, A/CONF.81/16, p.116;

2/ Biotechnology: Report of a Joint Working Party, Her Majesty's Stationery Office, p. 7.

present be made economically on a large scale or, if they can be made, require extensive inputs of land, energy and capital plant for their production from feedstocks, such as oil, which will become more expensive'.

3. Thus changes can be anticipated - in a time frame which is subject to variable estimates but whose starting point has clearly been passed - in regard to industrial products, processes and sectors. Sectors such as food processing; chemical and pharmaceutical industries including fertilizers, pesticides and detergents; mineral processing; and recycling and waste treatment are likely to be affected. 1/ The energy situation will be affected through the introduction of both less-energy intensive processes and new forms of energy (e.g. from biomass and wastes). It may not be far off the mark to conjecture that the industrial applications might well provide the motive force for applications in other sectors.

4. The developed countries have already shown keen awareness of the potentialities of biotechnology and genetic engineering. While technological applications would appear to be more advanced in countries like USA, Japan, West European countries and the USSR, scientific work is carried out in a larger number of countries. 2/ A number of developed countries have set up committees or other mechanisms to systematically assess the implications of genetic engineering and the steps to be taken by them to avail of such potentialities. 3/ Concurrently, the patentability of new forms of life, following the decision of the United States Supreme Court of Justice is presenting a situation where scientific advances can be quickly mopped up into proprietary rights.

5. As against this, the position in developing countries varies from a substantial lack of awareness of these developments to a general awareness unaccompanied by specific steps. This calls for remedy, particularly for the reason that biotechnological applications may not necessarily be too sophisticated or capital-intensive for developing countries to adopt. On the other hand, these technologies may be particularly suitable to

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1/ It is estimated that the biotechnological industry already represents about 5% of the national income in Japan (New Scientist, 7 June 1980, p. 308);

2/ Of all biotechnological patents issued in 1977-79, 124 originated in Japan, 39 in U.S.A. 9 in USSR, 5 in Federal Republic of Germany and 7 in France (Nature, Vol.283, 10 January 1980, p. 123);

3/ United Kingdom, France, Federal Republic of Germany and Ireland, to mention only a few.

developing countries in utilizing their natural resources and in terms of capital investment and skills required. However, if the present trends were to continue a technology gap in this field as between developed and developing countries will be created which could well be substantially bridged if developing countries started taking action now itself. Moreover, if work on scientific and technological application is not initiated by developing countries, they may have to follow the conventional route of acquiring these technologies after their adoption and exploitation by the developed countries and perhaps after the technological advantage of a product's life cycle has been fully realized. Besides, in regard to the fulfilment of the basic needs, the areas in which the developing countries may have to develop technological applications of biotechnology may be different from those to which the developed countries might give prior attention. An increasing technological gap in this field will result in a pattern of products and processes generated to respond to developed country conditions and not a pattern directed by the needs of the developing countries themselves. Thus, having developed an awareness of technological dependence and its consequences, an area in which developing countries have a concrete opportunity to minimize the effects of such dependence could ideally be the area of biotechnology.

6. The question then is what the starting point for developing country actions is. By now it is clear that all scientific and technological progress of developing countries has to be built on the foundation of scientific and technological capabilities. Those capabilities are needed not only for technology development but technology application as well. This is therefore a logical area for priority action. The next section will present some preliminary ideas on the subject while the third and final section will refer briefly to other measures that may be necessary.

II. Possible establishment of an international research and development facility

7. While capabilities have to be built ultimately at the national level, the initial stimulus and support to national-level action have to emanate

at the international level in the case of sophisticated technologies such as that of genetic engineering. General micro-biological research in developing countries would itself appear to face problems of shortage of qualified R and D manpower as well as fragmentation in research efforts and lack of contacts with industry. 1/ It is safe to presume that work in the field of genetic engineering and biotechnological applications is extremely limited if not non-existent, in most developing countries. However, the setting up of biological research facilities are not expensive or time-consuming; what is critical is the training of a core of scientists and technologists. In this situation, an international research and development facility for biotechnology with special emphasis on genetic engineering might well be the most effective means of providing the motive force for strengthening national technological capabilities and setting up national institutions, by training of scientific and technological manpower who will later constitute the core of national-level efforts; by providing advisory services for establishing national institutions; by serving as a focal point for mobilization of effort; and not the least by providing access to developing countries of the expertise and experience of leading scientists and technologists from all over the world. It will also provide the necessary support to developing countries, which are not yet in a position to set up institutions on their own. 2/

8. Considering the nature of R and D in genetic engineering and biotechnolgoy and its importance to developing countries, isolated twinning arrangements between developed and developing country institutions cannot be a substitute for an international facility and cannot make the type of impact that is required in this field. On the other hand, the setting up of an international facility could well strengthen and accelerate twinning arrangements. Since each country will be interested in some applications rather than others, the balance of advantage would be in establishing a new facility rather than using an existing national institution to serve this purpose.

9. The functions of such a facility might be the following:

1) Train scientists and technologists from developing countries and thereby help them to establish their own core of trained professionals for upgrading and managing their research facilities;

1/ It is reported that only a mini-scule fraction of the approximately 100,000 micro-biologists of the world today belong to the developing countries. (The Lund Monitor on technological trends and challenges of the third world - the cases of micro-electronics and biotechnology, Research Policy Studies, Lund University, Discussion paper no. 137, p. 27)

2/ Parallels for such a facility could be found, for example, in the field of theoretical physics under the auspices of the IAEA.

2) Conduct basic and applied research, in particular on developing country problems and disseminate the results;

3) Provide advisory services to developing countries for setting up and strengthening the relevant R and D institutions, for drawing up and reviewing research programmes and priorities, and on problems arising in research;

4) Establish and operate a network of R and D institutions so as to promote joint research programmes, testing and sharing of results, pilot-plant activities, information exchange etc.;

5) Investigate and provide links between research and industrial application;

6) Enable internationally-known researchers to work as guest researchers and thus enlarge the access of developing countries to their knowledge of experience;

7) Sensitize and mobilize the interest of policy makers and scientists and technologists through arranging meetings and seminars; publication of papers; participation in other relevant meetings; and provision of replies to inquiries of a technical nature.

The performance of these functions by an international facility will provide the basis on which national and regional efforts can be planned realistically.

10. It is hoped that further ideas concerning the setting up of a research and development facility will be outlined in specific terms. It is important to concretize the objectives, functions and work programme of the proposed international facility in the form of a project document, so that it could receive due consideration by financing agencies.

III. Other measures

11. The setting up of an international facility, as suggested above, will provide a practical basis to promote the development of scientific and technological capabilities in developing countries. However, it will be but one aspect of the actions to be taken to promote the application of biotechnology and genetic engineering for industrial development. Consideration may have to be given to other important aspects such as transfer of technology and the social implications. For achieving better results, a measure of selectivity in regard to sectors may be needed and the following industrial and industry-related fields may need attention, bearing in mind their overall potential for contributing to development as a whole:

1) energy (biomass, fuel alcohol);
2) fermentation industries including food industries and drugs and pharmaceuticals;
3) fertilizers, pesticides and plant genetics; and
4) processing of minerals.

12. Having regard to the further work to be done, it might be useful to consider:

1) Establishing an advisory expert panel in the field of biotechnology and genetic engineering to advise and assist UNIDO in the formulation and implementation of programmes in this field;
2) The conduct of an International Symposium on the subject covering important facets of the problem and involving developing country policy-makers, scientists and technologists so as to promote action by developing countries;
3) Ways and means of mobilization of interest of developing country institutions and monitoring and dissemination of information on developments in this field.