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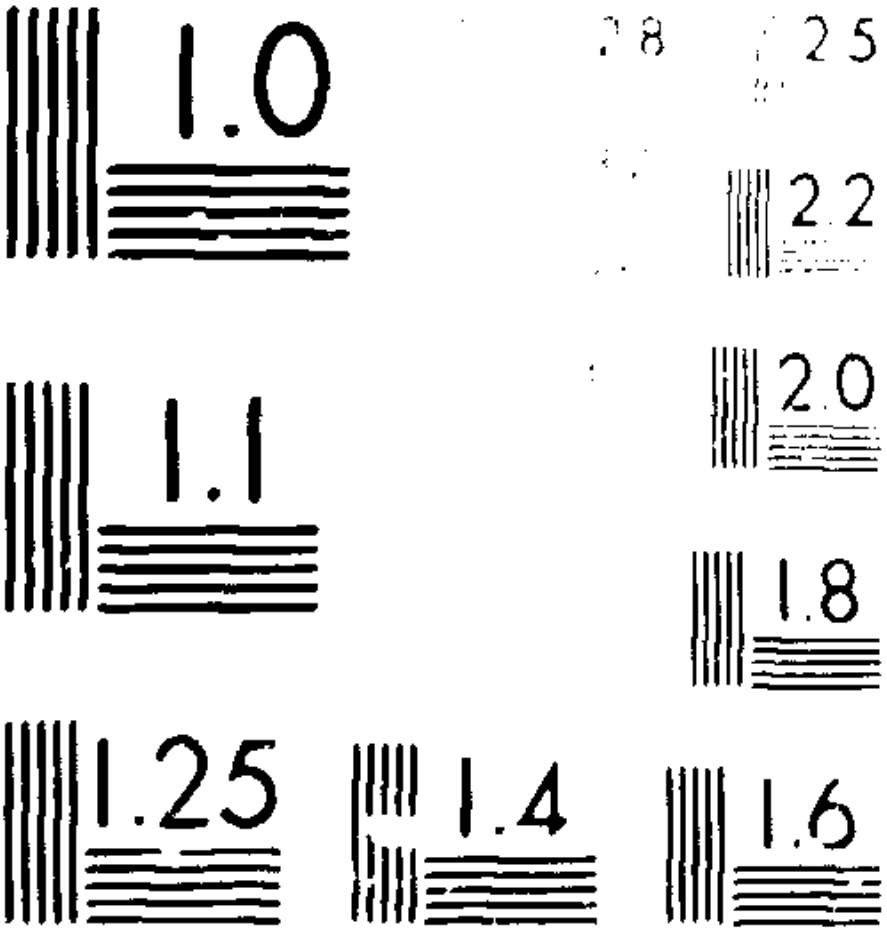
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GENETIC ENGINEERING AND BIOTECHNOLOGY AND DEVELOPING COUNTRIES *

Directions of action

Note by
UNIDO Secretariat

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INTRODUCTION

1. 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. 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-cell microorganisms) 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. To put it in the words of the conclusions of an expert report in the United Kingdom: "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 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." 1/

2. 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

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

fertilizers, pesticides and detergents; mineral processing; and recycling and waste treatment are likely to be affected. 2/ 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.

3. While the developed countries have already shown keen awareness of the potentialities of genetic engineering and biotechnology, 3/ the position in developing countries ranges from a substantial lack of awareness of the developments, through a general awareness unaccompanied by specific steps, to programmes and policies in a few countries. This calls for remedy for several reasons. Firstly, the developing countries have plenty of biomass resources and a variety of microorganisms. The economic potential of biomass is great and with the turnover rate of organic material being very high, microorganisms constitute an unrecognized source with a great potential as a source of as yet unexploited enzymes systems. 4/ Secondly, genetic engineering and biotechnology have a unique strategic significance in that their development can contribute significantly to the solution of many survival problems in developing countries. 5/ Thirdly, the basic technology in the field of genetic engineering and biotechnology is, unlike nuclear energy and most other technologies, quite simple and relatively inexpensive. Hence these technologies are particularly suitable to developing countries in utilizing their natural resources and in terms of capital investment and skill requirements.

4. In view of these facts, unlike in the case of microelectronics where socio-economic impacts in particular on employment have to be considered before deciding on entering the industry, the field of genetic engineering

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2/ See Impacts of Applied Genetics (Office of Technology Assessment, USA, 1981). For a summary of industry-related aspects see "The Impact of Genetic Engineering on Industry" (UNIDO/IS.269).

3/ See Elements of some national policies for biotechnology (UNIDO/IS.270/Rev.1).

4/ Report on Exchange of views with experts on the implications of advances in genetic engineering for developing countries (UNIDO/IS.259), p. 11.

5/ cf. Carl-Göran Hedén, The potential impact of microbiology on developing countries (UNIDO/IS.261), p. 66.

and biotechnology holds no special constraints for developing countries. If the technology can be developed in a suitable way they will be the most important beneficiaries. On the other hand, if the technology is developed in a manner unsuitable to their conditions and requirements they will not realize the full benefits of the technology. 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 areas of genetic engineering and biotechnology.

5. The foregoing makes it clear that developing countries should be in a position to initiate national actions without loss of time.

I. NATIONAL ACTIONS

6. National actions should be based on an integrated strategy, covering aspects of acquisition, development and application of the technologies as well as the supporting and complementary measures required.

7. Foremost in the list of action is the building up of technological capabilities, both for selection and acquisition of technology and for its development and application. To a much greater extent than in other technologies there is a greater need in biotechnology to take into account the local conditions. For example, the fact that the appropriate laboratories, pilot plants and factories can now, in principle, be ordered "from the shelf" does not help much if the buyer does not appreciate that biological feedstocks are complex and subject to seasonal variations and to decay processes that influence quality.6/ A good knowledge of the nature and availability of local biosources and the capability to utilize them can only come by strengthening endogenous technological capabilities.

6/ Carl-Göran Hedén, op. cit., p. 64.

8. The availability of molecular biologists in developing countries is now very limited and one of the first tasks in developing countries is to build up core technical groups in an effective manner with the requisite capability, commitment and appropriate facilities. The Meeting of Experts on the Implications of Advances in Genetic Engineering of Developing Countries, held in February 1981, recommended that the critical mass of a self-contained and viable group should include at least 9-14 researchers and industrial technologists: 7/

(a) One or two organic chemists for the synthesis of oligonucleotides;

(b) Three or four biochemists (including at least an enzymologist) for the isolation of DNA, cloning of the genes, selection of the desired gene, determination of the DNA sequence and maximizing the expression of the gene;

(c) One or two immunologists for carrying out radio-immune assay or preparing antibodies which include monoclonal antibodies;

(d) One or two protein biochemists for the purification of the protein product;

(e) One or two microbiologists to select or improve the desired strain of microorganism;

(f) One engineer as the fermenter designer and operator for the large-scale production of microorganisms; and

(g) One electronic expert for instrument servicing and control of the fermenter operation and performance.

9. The researchers and industrial technologists should have complementary skills to form a stimulating and broad-based group for all aspects of a genetic engineering project that can lead to the production of large amounts of the desired products. It is envisaged that in a large country several self-contained and viable groups may be formed, and in a smaller country one group may be formed. In certain cases it may be desirable for several smaller neighbouring countries to join forces and form a group.

10. In the initial stages the core groups have to be trained in facilities outside the developing countries, particularly in the International Centre for Genetic Engineering and Biotechnology to be established.

7/ UNIDO/IS.259, p. 14.

11. Alongside of establishing core groups, long-term programmes of education and training have to be initiated to produce a larger number of well-qualified personnel in the relevant disciplines. It will be noted that the core technical groups are interdisciplinary in nature. In this connection, the courses and curricula in the relevant disciplines will have to be carefully examined and reoriented.

12. Technological capabilities in terms of research and development alone will not be adequate. It has to be matched by a capability for commercialization and manufacture. In this connection, capabilities for process engineering and design have to be built up. Encouragement may have to be given to existing firms and also to innovative new entrants for exploiting the technology and taking it to the market. In particular, products of biotechnology suitable to local conditions and requirements have to be developed and marketed, if the full potentialities of biotechnology are to be realized.

13. In regard to acquisition of technology, though many firms have been established, the influx of new products, particularly those arising from genetic engineering is currently slow. 8/ However, the international technology market requires to be closely monitored. In this connection the capabilities for selection and application of these relatively new technologies have to be strengthened for both enterprises and government officials. Where technology transfer registries exist their capabilities for screening technology contracts in this area need to be strengthened.

14. Supportive action may be needed for the exploitation of genetic engineering and biotechnology, inter alia, through the adoption of appropriate patent laws and health regulations. Consideration could be given to the introduction of certain new elements in the national patent laws in developing countries which might facilitate faster access to

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8/ See Commercialization of Genetic Engineering Technologies: Some Considerations (UNIDO/IS.272).

proprietary biotechnologies. These might include shorter duration of patent life, full disclosure provisions, extending into commercial utilization information required for domestic exploitation of the patent by the patent holders, foreign investment regulations, etc.[9/]

15. As regards complementary measures, a bio-resource policy has to be developed so that an integrated use of biomass resources balancing in particular food, fuel and fertilizer could be evolved. Biomass generation in a systematic way would also need attention. The establishment of national biological resource-development teams would help in providing the detailed data needed for bio-resource policies and also in developing decentralized applications. They would also provide a critically important training function at the same time helping to screen the microbial and plant kingdoms for new materials that could be exploited in the interest of the national economy.[10/]

16. An important bottleneck in the initiation of integrated policies and programmes is that biotechnology and its applications cut across several departments. Hence, special co-ordinating mechanisms and policy directions from the highest levels may be needed.

II. INTERNATIONAL ACTION

17. The single most effective method for strengthening the technological capabilities in this field would be the establishment of the International Centre for Genetic Engineering and Biotechnology. A decision that such a centre should be established was taken in a high-level meeting held in Belgrade in December 1982 in which 28 countries participated with 7 more as observers.[11/] A ministerial-level plenipotentiary meeting will be held in July 1983 to resolve the outstanding issues and to subscribe to the final act of establishing the Centre. The Centre will provide the means for training core technical groups and for establishing in due course national centres of genetic engineering and biotechnology. It will be able to network national and regional institutions and other specialized networks and institutions in a substantive manner. Moreover, it should be noted that there is a "non-competing group" of

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9/ Report on Exchange of views with experts on the Implications of Advances in Genetic Engineering for Developing Countries (UNIDO/IS.259), page 24.

10/ Carl-Göran Hedén, op. cit., p. 65.

11/ The Establishment of an International Centre for Genetic Engineering and Biotechnology: Report of a Group of Experts (UNIDO/IS.254). Report of the High-level Meeting on the Establishment of the International Centre for Genetic Engineering and Biotechnology, ID/WG.382/7.

technologies, namely, those relevant and specific to the conditions of developing countries, which may not be developed due to the absence of market pull, but which are needed to improve the living standards of the developing countries. The development and applications of such technologies will be possible only through national and international efforts which the Centre can generate. The Centre will also be able to promote the training and operation of bio-resource development teams at the national level.

18. Though the Centre covers important elements of support to national action, such as training and advisory services, international action complementary to the activities of the Centre could also be considered. This could be in several ways some of which would also lend themselves to regional activities and co-operation among developing countries:

- an international mechanism for promotion of biomass generation and its industrial conversion;
- development of model multidisciplinary curricula and training programmes that would facilitate the generation of technological capabilities in developing countries; 12/
- arrangement of fellowships, training programmes, etc., complementary to the actions of the Centre;
- assisting developing countries in the commercialization of the relevant technology, in particular by strengthening the relevant national institutions for this purpose;
- strengthening the capability for selection and acquisition of genetic engineering and biotechnologies at the national level; 13/
- information dissemination 14/ complementary to the information activities of the Centre, particularly to strengthen bio-informatics and the systematic collection and storage of bio-resources at the national level.

12/ Carl-Göran Hedén (op. cit., p. 65) refers to one of the bottlenecks in educational systems "which; at the elementary level, rarely use microbiology as a gateway to the biology of nutrition, hygiene, ecology and the cycles of nature, and at the university level, do not provide for the transdisciplinarity which clearly is the lifeblood of biomolecular engineering. Actually education may well prove to be the most critical determinant for future development ..."

13/ It is intended to strengthen UNIDO's Technological Advisory Services in this regard.

14/ One activity already intitiated by UNIDO is the issue of a quarterly Genetic Engineering and Biotechnology Monitor. Also see the recommendation of the expert group meeting: "UNIDO should explore the possibility of collecting and disseminating information on bio-technologies in, or hereafter coming into, the public domain for potential use and application in developing countries" (UNIDO/IS.259), page 23.

19. In particular international action could provide developing countries with the initial expert assistance in the policy field to review the possibilities and constraints at the national level and to provide a basis on which policy actions and programmes could be initiated. Their initiation can no longer be delayed since the decades of the 1980s and 1990s would be critical in determining whether developing countries would benefit from their bio-resources in an optimal and self-reliant way. But "the greatest need may well be to establish the principles that will govern the legal and political decisions required by the possible application and control of this new technology". 15/

15/ Saran A. Narang, Genetic Engineering: The Technology and its Implications, UNIDO/IS.260.