Environmentally sound management of biotechnology

Biotechnology is the integration of the new techniques emerging from modern biotechnology with the well-established approaches of traditional biotechnology. Biotechnology, an emerging knowledge-intensive field, is a set of enabling techniques for bringing about specific man-made changes in deoxyribonucleic acid (DNA), or genetic material, in plants, animals and microbial systems, leading to useful products and technologies. By itself, biotechnology cannot resolve all the fundamental problems of environment and development, so expectations need to be tempered by realism. Nevertheless, it promises to make a significant contribution in enabling the development of, for example, better health care, enhanced food security through sustainable agricultural practices, improved supplies of potable water, more efficient industrial development processes for transforming raw materials, support for sustainable methods of afforestation and reforestation, and detoxification of hazardous wastes. Biotechnology also offers new opportunities for global partnerships, especially between the countries rich in biological resources (which include genetic resources) but lacking the expertise and investments needed to apply such resources through biotechnology and the countries that have developed the technological expertise to transform biological resources so that they serve the needs of sustainable development.[1] Biotechnology can assist in the conservation of those resources through, for example, *ex situ* techniques. The programme areas set out below seek to foster internationally agreed principles to be applied to ensure the environmentally sound management of biotechnology, to engender public trust and confidence, to promote the development of sustainable applications of biotechnology and to establish appropriate enabling mechanisms, especially within developing countries.

A Increasing the availability of food, feed and renewable raw materials

Basis for action To meet the growing consumption needs of the global population, the challenge is not only to increase food supply, but also to improve food distribution significantly while simultaneously developing more sustainable agricultural systems. Much of this increased productivity will need to take place in developing countries. It will require the successful and environmentally safe application of biotechnology in agriculture, in the environment and in human health care. Most of the investment in modern biotechnology has been in the industrialized world. Significant new investments and human resource development will be required in biotechnology, especially in the developing world.

A revolutionary new way of purifying water contaminated with sewage and chemicals developed by MEMTEC of Australia. The liquid is passed through a membrane which filters out impurities.

Objectives The following objectives are proposed, keeping in mind the need to promote the use of appropriate safety measures based on programme area D:

a To increase to the optimum possible extent the yield of major crops, livestock, and aquaculture species, by using the combined resources of modern biotechnology and conventional plant/animal/micro-organism improvement, including the more diverse use of genetic material resources, both hybrid and original.[2] Forest product yields should similarly be increased, to ensure the sustainable use of forests;[3]

b To reduce the need for volume increases of food, feed and raw materials by improving the nutritional value (composition) of the source crops, animals and micro-organisms, and to reduce post-harvest losses of plant and animal products;

c To increase the use of integrated pest, disease and crop management techniques to eliminate over-dependence on agrochemicals, thereby encouraging environmentally sustainable agricultural practices;

d To evaluate the agricultural potential of marginal lands in comparison with other potential uses and to develop, where appropriate, systems allowing for sustainable productivity increases;

e To expand the applications of biotechnology in forestry, both for increasing yields and more efficient utilization of forest products and for improving afforestation and reforestation techniques. Efforts should be concentrated on species and products that are grown in and are of value particularly for developing countries;

f To increase the efficiency of nitrogen fixation and mineral absorption by the symbiosis of higher plants with micro-organisms;

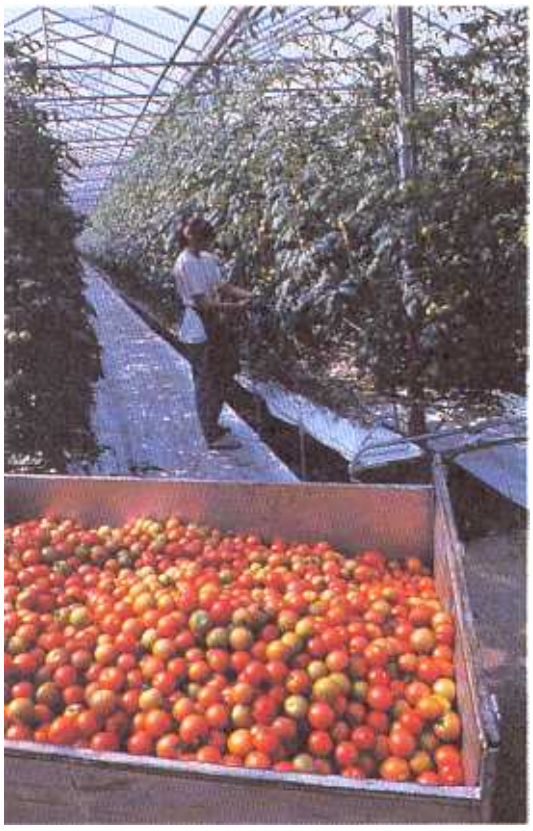
g To improve capabilities in basic and applied sciences and in the management of complex interdisciplinary research projects.

Management-related activities Governments at the appropriate level, with the assistance of international and regional organizations and with the support of non-governmental organizations, the private sector and academic and scientific institutions, should improve both plant and animal breeding and micro-organisms through the use of traditional and modern biotechnologies, to enhance sustainable agricultural output to achieve food security, particularly in developing countries, with due regard to the prior identification of desired characteristics before modification, taking into account the needs of farmers, the socio-economic, cultural and environmental impacts of modifications and the need to promote sustainable social and economic development, paying particular attention to how the use of biotechnology will impact on the maintenance of environmental integrity.

More specifically, these entities should:

a Improve productivity, nutritional quality and shelf-life of food and animal feed products, with efforts including work on pre- and post-harvest losses;

b Further develop resistance to diseases and pests;



These tomatoes are grown in a greenhouse heated using waste water from a power station. In the past the water would have been pumped out, heating up the river and damaging the plant and animal life.

c Develop plant cultivars tolerant and/or resistant to stress from factors such as pests and diseases and from abiotic causes;
d Promote the use of underutilized crops of possible future importance for human nutrition and industrial supply of raw materials;
e Increase the efficiency of symbiotic processes that assist sustainable agricultural production;
f Facilitate the conservation and safe exchange of plant, animal and microbial germ plasm by applying risk assessment and management procedures, including improved diagnostic techniques for detection of pests and diseases by better methods of rapid propagation;
g Develop improved diagnostic techniques and vaccines for the prevention and spread of diseases and for rapid assessment of toxins or infectious organisms in products for human use or livestock feed;
h Identify more productive strains of fast-growing trees, especially for fuel wood, and develop rapid propagation methods to aid their wider dissemination and use;
i Evaluate the use of various biotechnology techniques to improve the yields of fish, algal and other aquatic species;
j Promote sustainable agricultural output by strengthening and broadening the capacity and scope of existing research centres to achieve the necessary critical mass through encouragement and monitoring of research into the development of biological products and processes of productive and environmental value that are economically and socially feasible, while taking safety considerations into account;
k Promote the integration of appropriate and traditional biotechnologies for the purposes of cultivating genetically modified plants, rearing healthy animals and protecting forest genetic resources;
l Develop processes to increase the availability of materials derived from biotechnology for use in food, feed and renewable raw materials production.

Financing and cost evaluation $5 billion including about $50 million from the international community on grant or concessional terms.

B Improving human health

Basis for action The improvement of human health is one of the most important objectives of development. The deterioration of environmental quality, notably air, water and soil pollution owing to toxic chemicals, hazardous wastes, radiation and other sources, is a matter of growing concern. This degradation of the environment resulting from inadequate or inappropriate development has a direct negative effect on human health. Malnutrition, poverty, poor human settlements, lack of good-quality potable water and inadequate sanitation facilities add to the problems of communicable and non-communicable diseases. As a consequence, the health and well-being of people are exposed to increasing pressures.

Objectives The main objective of this programme area is to contribute, through the environmentally sound application of biotechnology, to an overall health programme, to:[4]

a Reinforce or inaugurate (as a matter of urgency) programmes to help combat major communicable diseases;
b Promote good general health among people of all ages;
c Develop and improve programmes to assist in specific treatment of and protection from major non-communicable diseases;
d Develop and strengthen appropriate safety procedures based on programme area D, taking account of ethical considerations;
e Create enhanced capabilities for carrying out basic and applied research and for managing interdisciplinary research.

Management-related activities Governments at the appropriate level, with the assistance of international and regional organizations, academic and scientific institutions, and the pharmaceutical industry, should, taking into account appropriate safety and ethical considerations:

a Develop national and international programmes for identifying and targeting those populations of the world most in need of improvement in general health and protection from diseases;
b Develop criteria for evaluating the effectiveness and the benefits and risks of the proposed activities;
c Establish and enforce screening, systematic sampling and evaluation procedures for drugs and medical technologies, with a view to barring the use of those that are unsafe for the purposes of experimentation; ensure that drugs and technologies relating to reproductive health are safe and effective and take account of ethical considerations;
d Improve, systematically sample and evaluate drinking-water quality by introducing appropriate specific measures, including diagnosis of water-borne pathogens and pollutants;
e Develop and make widely available new and improved vaccines against major communicable diseases that are efficient and safe and offer protection with a minimum number of doses, including intensifying efforts directed at the vaccines needed to combat common diseases of children;
f Develop biodegradable delivery systems for vaccines that eliminate the need for present multiple-dose schedules, facilitate better coverage of the population and reduce the costs of immunization;
g Develop effective biological control agents against disease-transmitting vectors, such as mosquitoes and resistant variants, taking account of environmental protection considerations;
h Using the tools provided by modern biotechnology, develop, *inter alia*, improved diagnostics, new drugs and improved treatments and delivery systems;
i Develop the improvement and more effective

We now recognise that environmental protection cannot be achieved outside the wider context of sustainable development and that the war against poverty must be a major part of the task. The success of UNCED is imperative. We need an effective and implementable Agenda 21, the political will to make greater progress in ensuring adequate resources and technical cooperation and in reaching consensus on the responsibilities, obligations and burden-sharing of all countries – developed and developing. I am looking forward to helping the Commonwealth and its members play a positive role in an issue which is crucially important for us all.

Emeka Anyaoku
Commonwealth Secretary-General

utilization of medicinal plants and other related sources;
j Develop processes to increase the availability of materials derived from biotechnology, for use in improving human health.

Financing and cost evaluation $14 billion including about $130 million from the international community on grant or concessional terms.

C Enhancing protection of the environment

Basis for action Environmental protection is an integral component of sustainable development. The environment is threatened in all its biotic and abiotic components: animals, plants, microbes and ecosystems comprising biological diversity; water, soil and air, which form the physical components of habitats and ecosystems; and all the interactions between the components of biodiversity and their sustaining habitats and ecosystems. With the continued increase in the use of chemicals, energy and non-renewable resources by an expanding global population, associated environmental problems will also increase. Despite increasing efforts to prevent waste accumulation and to promote recycling, the amount of environmental damage caused by overconsumption, the quantities of waste generated and the degree of unsustainable land use appear likely to continue growing.

The need for a diverse genetic pool of plant, animal and microbial germ plasm for sustainable development is well established. Biotechnology is one of many tools that can play an important role in supporting the rehabilitation of degraded ecosystems and landscapes. This may be done through the development of new techniques for reforestation and afforestation, germ plasm conservation, and cultivation of new plant varieties. Biotechnology can also contribute to the study of the effects exerted on the remaining organisms and on other organisms by organisms introduced into ecosystems.

Objectives The aim of this programme is to prevent, halt and reverse environmental degradation through the appropriate use of biotechnology in conjunction with other technologies, while supporting safety procedures as an integral component of the programme. Specific objectives include the inauguration as soon as possible of specific programmes with specific targets:
a To adopt production processes making optimal use of natural resources, by recycling biomass, recovering energy and minimizing waste generation;[5]
b To promote the use of biotechnologies, with emphasis on bio-remediation of land and water, waste treatment, soil conservation, reforestation, afforestation and land rehabilitation;[6,7]
c To apply biotechnologies and their products to protect environmental integrity with a view to long-term ecological security.

Management-related activities Governments at the appropriate level and with the support of relevant international and regional organizations, the private sector, non-governmental organizations and academic and scientific institutions, should:
a Develop environmentally sound alternatives and improvements for environmentally damaging production processes;
b Develop applications to minimize the requirement for unsustainable synthetic chemical input and to maximize the use of environmentally appropriate products, including natural products (see programme area A);
c Develop processes to reduce waste generation, treat waste before disposal and make use of biodegradable materials;
d Develop processes to recover energy and provide renewable energy sources, animal feed and raw materials from recycling organic waste and biomass;
e Develop processes to remove pollutants from the environment, including accidental oil spills, where conventional techniques are not available or are expensive, inefficient or inadequate;
f Develop processes to increase the availability of planting materials, particularly indigenous varieties, for use in afforestation and reforestation and to improve sustainable yields from forests;
g Develop applications to increase the availability of stress-tolerant planting material for land rehabilitation and soil conservation;
h Promote the use of integrated pest management based on the judicious use of bio-control agents;
i Promote the appropriate use of bio-fertilizers within national fertilizer programmes;
j Promote the use of biotechnologies relevant to the conservation and scientific study of biological diversity and the sustainable use of biological resources;
k Develop easily applicable technologies for the treatment of sewage and organic waste;
l Develop new technologies for rapid screening of organisms for useful biological properties;
m Promote new biotechnologies for tapping mineral resources in an environmentally sustainable manner.

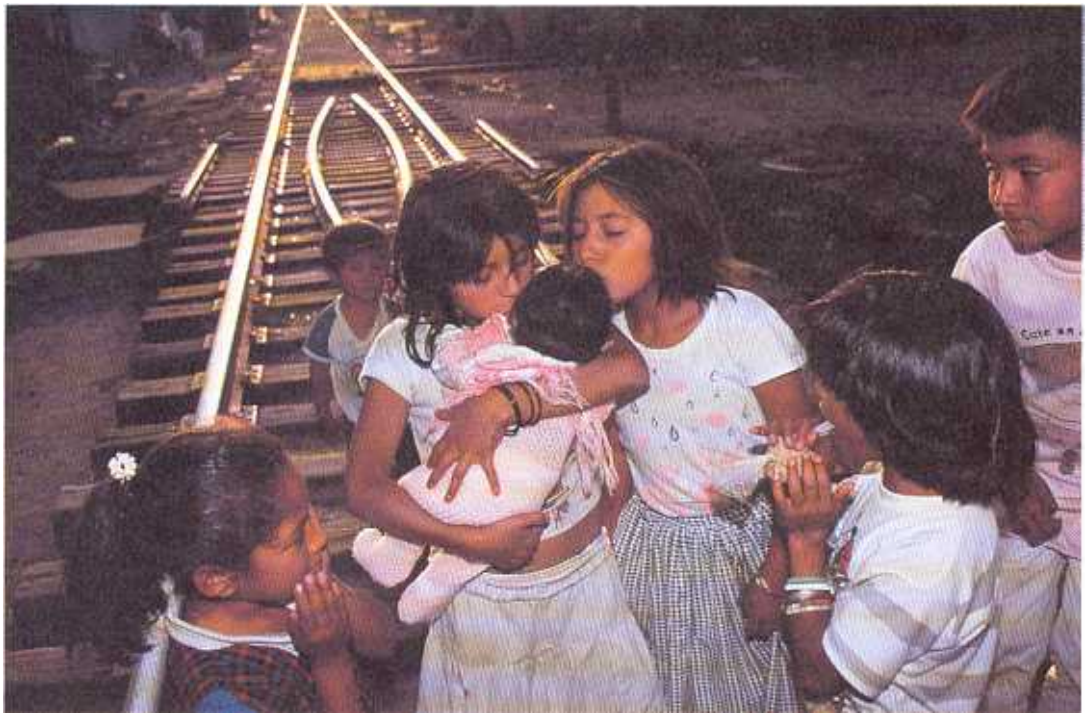
Financing and cost evaluation $1 billion including about $10 million from the international community on grant or concessional terms.

D Enhancing safety and developing international mechanisms for cooperation

Basis for action There is a need for further development of internationally agreed principles on risk assessment and management of all aspects of biotechnology, which should build upon those developed at the national level. Only when adequate and transparent safety and border-control procedures are in place will the community at large be able to derive maximum benefit from, and be in a much better position to accept the potential benefits and risks of, biotechnology. Several fundamental principles could underlie many of these safety procedures, including: primary consideration of the organism, building on the principle of familiarity, applied in a flexible framework, taking into account national requirements and recognising that the logical progression is to start with a step-by-step and case-by-case approach, but also recognising that experience has shown that in many instances a more comprehensive approach should be used, based on the experiences of the first period, leading *inter alia* to streamlining and categorising; complementary consideration of risk assessment and risk management, and classification into contained use or release to the environment.
Objectives The aim of this programme area is to ensure safety in biotechnology development, application, exchange and transfer through international agreement on principles to be applied on risk assessment and management,* with particular reference to health and environmental considerations, including the widest possible public participation and taking account of ethical considerations.

Activities The proposed activities for this programme area call for close international cooperation. They should build upon planned or existing activities to accelerate the environmentally sound application of biotechnology, especially in developing countries.*

Management-related activities Governments at the appropriate levels and with the support of relevant



The Borde de Vias Colony in Mexico City. The inhabitants are largely made up of migrants from the country due to land erosion rendering soil unproductive. Such migrants arrive in the city at the rate of 1000 per day.

international and regional organizations, the private sector, non-governmental organizations and academic and scientific institutions, should:

a Make the existing safety procedures widely available by collecting the existing information and adaping it to the specific needs of different countries and regions;

b Further develop, as necessary, the existing safety procedures to promote scientific development and categorization in the areas of risk assessment and risk management (information requirements; databases; procedures for assessing risks and conditions of release; establishment of safety conditions; monitoring and inspections; taking account of ongoing national, regional and international initiatives, avoiding duplication wherever possible);

c Compile, update and develop compatible safety procedures into a framework of internationally agreed principles as a basis for guidelines to be applied on safety in biotechnology, including consideration of the need for and feasibility of an international agreement, and promote information exchange as a basis for further development, drawing on the work already undertaken by international or other expert bodies.

d Undertake training programmes at the national and regional levels on the application of the proposed technical guidelines;

e Assist in exchanging information about the procedures required for safe handling and risk management and about the conditions of release of the products of biotechnology, and cooperate in providing immediate assistance in cases of emergencies that may arise in conjunction with the use of biotechnology products.

Financing and cost evaluation $2 million from the international community on grant or concessional terms.

E Establishing enabling mechanisms for the development and the environmentally sound application of biotechnology

Basis for action The accelerated development and application of biotechnologies, particularly in developing countries, will require a major effort to build up institutional capacities at the national and regional levels. In developing countries, enabling factors such as training capacity, know-how, research and development facilities and funds, industrial building capacity, capital (including venture capital), protection of intellectual property rights, and expertise in areas such as marketing, research, technology assessment, socio-economic assessment and safety assessment are frequently inadequate. Efforts will therefore need to be made to build up capacities in these and other areas and to match such efforts with appropriate levels of financial support. There is therefore a need to strengthen the endogenous capacities of developing countries by means of new international initiatives to support research in order to speed up the development and application of both new and conventional biotechnologies to serve the needs of sustainable development at the local, national and regional levels. National mechanisms to allow for informed comment by the public with regard to biotechnology research and application should be part of the process.

Some activities at the national, regional and global levels already address the issues outlined in programme areas A, B, C and D, as well as the provision of advice to individual countries on the development of national guidelines and systems for the implementation of those guidelines. These activities are generally uncoordinated, however, involving many different organizations, priorities, constituencies, time-scales, funding sources and resource constraints. There is a need for a much more cohesive and coordinated approach to harness available resources in the most effective manner. As with most new technologies, research in biotechnology and the application of its findings could have significant positive and negative socio-economic as well as cultural impacts. These impacts should be carefully identified in the earliest phases of the development of biotechnology in order to enable appropriate management of the consequences of transferring biotechnology.

Objectives

a To promote the development and application of biotechnologies, with special emphasis on developing countries, by:

i Enhancing existing efforts at the national, regional and global levels;

ii Providing the necessary support for biotechnology, particularly research and product development, at the national, regional and international levels;

iii Raising public awareness regarding the relative beneficial aspects of and risks related to biotechnology, to contribute to sustainable development;

iv Helping to create a favourable climate for

investments, industrial capacity-building and distribution/marketing;

v Encouraging the exchange of scientists among all countries and discouraging the "brain drain";

vi Recognising and fostering the traditional methods and the knowledge of indigenous people and their communities and ensuring the opportunity for their participation in the economic and commercial benefits arising from developments in biotechnology.[9]

b To identify ways and means of enhancing current efforts, building wherever possible on existing enabling mechanisms, particularly regional, to determine the precise nature of the needs for additional initiatives, particularly in respect of developing countries, and to develop appropriate response strategies, including proposals for any new international mechanisms;

c To establish or adapt appropriate mechanisms for safety appraisal and risk assessment at the local, regional and international levels, as appropriate.

Management-related activities Governments at the appropriate level, with the support of international and regional organizations, the private sector, non-governmental organizations and academic and scientific institutions should:

a Develop policies and mobilize additional resources to facilitate greater access to the new biotechnologies, particularly by and among developing countries;

b Implement programmes to create greater awareness of the potential and relative benefits and risks of the environmentally sound application of biotechnology among the public and key decision makers;

c Undertake an urgent review of existing enabling mechanisms, programmes and activities at the national, regional and global levels to identify strengths, weaknesses and gaps, and to assess the priority needs of developing countries;

d Define and implement strategies to overcome constraints identified in the areas of food, feed and renewable raw materials; human health; and environmental protection, building upon existing strengths;

e Undertake an urgent follow-up and critical review to identify ways and means of strengthening endogenous capacities within and among developing countries for the environmentally sound application of biotechnology, including, as a first step, ways to improve existing mechanisms, particularly at the regional level, and, as a subsequent step, the consideration of possible new international mechanisms, such as regional biotechnology centres;

f Develop strategic plans for overcoming targeted constraints by means of appropriate research, product development and marketing;

g Establish additional quality-assurance standards for biotechnology applications and products, where necessary.

Financing and cost evaluation $5 million from the international community on grant or concessional terms.

* See research paper No. 55, entitled "Environmentally sound management of biotechnology: safety in biotechnology – assessment and management of risk" (February 1992), prepared by the United Nations Conference on Environment and Development secretariat to take account of comments made at the third session of the Preparatory Committee for the United Nations Conference on Environment and Development on part II of document A/CONF.151/PC/67, which incorporated the findings of the ad hoc workshop of Senior-level Experts on Assessing and Managing Biotechnology Risks, held in London in June 1991.

1 See chapter 15.
2 See chapter 14.
3 See chapter 11.
4 See chapter 6.
5 See chapter 21.
6 See chapter 10.
7 See chapter 18.