PUBLIC POLICY IMPLICATIONS OF BIOTECHNOLOGY FOR ASIAN AGRICULTURE*

AGRICULTURE was the first industry evolved by mankind and, perhaps, the first manifestation of its cultural instincts, and Asia one of its earliest homes. Biotechnology is the latest technology, what we call a frontier technology, that is capable of transforming in a revolutionary manner both agriculture and industry.

Human progress has often been described as the conquest of nature by man, the taming of the forces of nature and the harnessing of the resources of nature to the chariot wheels of human necessity and human purpose. We now know that progress lies not only in conquering and exploiting nature but in protecting it tenderly, in preserving its complex and delicate balance and in being in essential harmony with it. Shakespeare said of art as that which 'adds to nature', 'which does mend nature, change it rather; but the art itself is nature'. Today one can say this even more appropriately of science, especially of the new biology—genetic engineering and biotechnology. But, as Shakespeare put it, this science itself must be conceived as nature—'the great creating nature'—which kindly joins on and grows out of nature in creative munificence for the benefit of mankind. This is a concept that is also in accord with the fundamental philosophy of Asia, of the unity of man and nature, of matter and the spirit, and the interdependent progression of life on earth. The significance of the oncoming bio-revolution is that it can take mankind along this path of development, affecting the lives of millions of people and offering hope and opportunities, particularly for the developing countries so predominantly dependent on the fruits of agriculture.

Of the varied and far-reaching applications of biotechnology, what is most relevant and immediately required for the Asian region are in the basic field of agriculture, though its applications in industry, energy and human health are by no means less important. The exploding population growth and the relative scarcity of cultivable land have created critical problems for Asian agriculture notwithstanding the green revolution in India and the impressive advance of agricultural production in China and other countries of the region. The ancient earth of Asia is so much overburdened by the density of population and has been so ruthlessly exploited for so long that further rise in productivity has to come mainly from the addition of new biotechnologies to conventional methods for producing increased amounts of food, fuel, fibre and other bio-products. It seems necessary to turn to biotechnology in a systematic way and with a sense of urgency within a well-thought-out policy framework and with a practical programme of research, development and application.

Scientists have demonstrated the possibility through genetic manipulation of increasing the rate of photosynthesis in order to hasten the growth of plants and augment the yield of crops. Obviously this is an area of genetic engineering that requires special attention in the Asian region. It may be somewhat futuristic, but the case of the transgenic pig indicates the long-term prospect of developing animals that grow fast, eat less and give more lean meat. At any rate animal breeding through biotechnology is today a demonstrated technology. In India successful embryo transfer in cows through non-surgical means has been achieved and can be used to produce a better breed of cattle. Tissue culture technology in plants is already in widespread use in the world. For the Asian region and in the developing countries as a whole, it is particularly relevant for application in oil palm, coconut, banana, tubers, etc., all relevant to the needs of the common people. It can also be used for growing and rapidly multiplying elite plants and trees. One cubic centimetre of a single green cell in a bio-reactor can give rise to a million plants. This is a biotechnological breakthrough that can help us in replenishing lost forests, in greening waste lands and deserts, and in carrying out agro-forestry programmes.

Genetic engineering is evolving plants and crops that are tolerant to harsh weather conditions like drought and to salinity and alkalinity of the soil. It is also producing disease-resistant and pest-resistant varieties of plants, and, through nitrogen fixation, plants that can produce their own fertilizers. These developments in biotechnology are of far-reaching significance to Asian agriculture. It has been

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Based on an address by Dr K. R. Narayanan, Minister of State for Science and Technology, Government of India, delivered at a seminar, at the National Institute of Immunology, New Delhi, on 6 March 1989, organized by the Asia–Pacific Development Centre.

estimated that over 86 million hectares of land in South and South-East Asia are affected by salinity and alkalinity. Pests and diseases are destroying a sizeable proportion of our crops and we are woefully short of chemical fertilizers, which most developing countries have to import by spending precious foreign exchange. Besides, chemical pesticides and fertilizers may, in some conditions, pose hazards to human beings and cause damage to the environment. It has been estimated that the United States of America spends around 6.5 billion dollars annually on pesticides, weedicides and herbicides. And yet the value of crops destroyed by pests continues to be substantially large as pests develop resistance to the chemical concoctions. In the bargain the chemicals may pollute rivers and wells and other sources of water and pose serious health hazards to people. Chemical fertilizers also pose environmental problems in the developing world. Without running down the numerous vitally important and, in many respects, life-saving and life-improving chemicals, there is one sense in which the phrase 'the brutal chemical technology' can be applied. Of course any industrial activity may be 'brutal' unless it is hedged in by precautionary devices and measures against human and environmental hazards, and counterbalanced by art and culture.

The new methods and techniques of biotechnology offer, to some extent, alternatives to the ill effects of chemical pesticides, weedicides and herbicides, and chemical fertilizers. Drought-resistant, disease-resistant, and pest-resistant varieties of plants and crops are today within the reach of genetic engineering, and also plants that produce their own fertilizers. There is also the eminently practicable prospect of generating new resources from the enormous agricultural wastes, which would incidentally but significantly, open up avenues of decentralized rural industrialization in developing countries. One great advantage is that, though biotechnology is not danger-free, in its application to agriculture it is not hazardous to the environment, and it would, at the same time, reduce costs of production and enhance the productivity of plants and crops and of the strictly limited commodity that is land.

Genetic engineering and biotechnology today are almost the monopolistic preserve of the advanced industrialized countries of the world. Research and development as well as production and marketing are in their hands, particularly in the hands of the big multinational companies. Recently they have asserted intellectual property rights and extended patent protection to biotechnology-based innovations, such as life-saving drugs, vaccines, and even higher forms of life, including seed and plant varieties, and animals. Developing countries have to deal with this monopolizing trend, individually and collectively, through correct policy formulation. The invasion of private capitalistic commercialization into biotechnological research and development is something that is pregnant with danger, especially if it is extended to the patenting of higher life-forms. The claim of intellectual property rights over genetically engineered higher life-forms could well forebode the remote beginnings of a new biotechnology-based slave-owning system. Obviously the distortions, the misdirection and the misuse of this powerful new technology have to be vigilantly guarded against as much as the attempt of the industrialized nations to develop it in disregard of the interests of the developing countries.

There is no way of doing this except through indigenous and endogamous research and development, through what is called South–South cooperation, through cooperation with international organizations and also with the developed countries themselves on terms of equality and mutual benefit.

Everything ought to begin with work in our own individual countries by our own research institutions and governments. If we only sit and wait for the fruits of R & D of the advanced nations on the ground of letting somebody else invent the wheel so that we do not have to re-invent it, then we would miss the bus of the new biotechnological revolution as we missed the technological revolutions in the past. Fortunately several countries in the third world, viz. India, Brazil, China, Mexico, Cuba, Malaysia, Thailand, Indonesia, Philippines, Pakistan, etc., have developed the infrastructure as well as the scientific-technological competence to interact meaningfully within the framework of collective self-reliance. Governments have to take conscious decisions to promote biotechnological research and development as a thrust area. Fortunately this is an area that does not require very large investments for making an impact.

India has embarked upon an active programme for the promotion of genetic engineering and biotechnology studies and research and their applications in priority areas of agriculture, industry, energy, health and environment. There is today a full-fledged Department of Biotechnology within the Ministry of Science and Technology. There are

prestigious institutions like the National Institute of Immunology, New Delhi, and the Centre for Genetic Engineering at the Indian Institute of Science, Bangalore. There are also the Genetic Engineering Units established at the Madurai Kamaraj University and the Jawaharlal Nehru University, New Delhi. In the agricultural sector, the Indian Council of Agricultural Research has carried out pioneering work, which was at the root of India's Green Revolution and which is today opening up new vistas for our agricultural development. The Department of Biotechnology is operating pilot projects in oil palm as part of the Technology Mission on Oilseeds. Tissue culture techniques are being employed to raise the quality and yield in respect of cardamom, bamboo, sugarcane, mulberry, banana, tea, eucalyptus, sandalwood and potatoes. Apart from its application to food crops and cash crops, tissue culture techniques are proposed to be used for increased production of biomass and for forest regeneration. Biofertilizers, biological control of pests, cattle herd improvement through embryo transfer technology, animal birth control vaccine, and aquaculture are some of the major programmes relating to the broad field of agriculture. Human resource development occupies a central position in India's biotechnology programme as we believe that educated and trained manpower is the basic prerequisite for the success of our programmes in this frontier technology area. It involves education and training in India and abroad, and exchanges and interaction among scientists at national and international level. At the end of this national effort, and South–South cooperation as well as wider international cooperation, there is a bright future for the application of biotechnology for the benefit of mankind. I am not drawing the picture of a biotechnological paradise, but when I contemplate the ultimate fruits of this new branch of science and technology, I recall the lines of the poet who sang of an imaginary land:

Where there is neither death nor age
And the poor have all the money
The wells are full of wine
New bread grows on trees
And roasted pigs run about,
Crying, 'Eat me, if you please.'

There is, however, no Garden of Eden without a snake in it. Biotechnology has also its adverse effects. We do not yet know the long-term consequences of playing with the genes of living organisms, cloning them, splitting them, indeed tampering with the still inscrutable balance of nature and the ultimate mysteries of life. All one can say is that one has got to be extremely cautious and think deeply over the chain of possible consequences to mankind and to the universal order while we delve into the secrets of life, tampering with the geometry and chemistry of nature for satisfying the hunger, the thirst and the insatiable greed of man. We also ought to ask if the final solution to the endlessly increasing wants of man is only more and yet more production and the incessant multiplication of goods, or if some checks and restraints ought not to be put on this ceaseless escalation of human population and the even greater augmentation of human needs and cravings. Perhaps this is too philosophical a question to be posed to geneticists and biotechnologists. But then are not geneticists like particle physicists playing in those extreme border regions of science that are nearest to philosophy and metaphysics? Let us hope that the scientists from this ancient Asian region will keep this thought at the back of their minds in the midst of their dedicated efforts to find solutions, through biotechnology, for some of the current crying needs of our people for food and energy.