Cloning Better Futures?

What role can biotechnology play in Muslim countries? Munawar Ahmad Anees tries to answer the question by looking at how expatriates managed to establish an advance centre for molecular biology in Pakistan

CONTEMPORARY criticism of the 'heroic' science has yielded a few new terms, most heard of which is perhaps the 'appropriate technology'. This term has often been used in the context of economic progress as linked to scientific and technical development, especially in relation to Asian and African regions.

Appropriate technology was proposed as a labour-saving, environmentally safe, need-related way of doing things scientific. For these countries, it was also viewed as an alternative to avoid the cultural impetus that was supposedly a part of technology transfer from the North. Till recently, debate on appropriate technology has remained a theoretical show with little practical results either for the western science or its southern users. Progress was restricted to areas such as the development of solar energy, biogas, gasohol, and to some extent, increased use of bio-degradable insecticides for agricultural productivity. Biotechnology, morphologically giving a sense of modern day high-tech, is perhaps the only 'appropriate technology' that almost meets the criteria estab1ised by proponents of the alternative science. With much ado with high-speed, computerized, electronic gadgetary, or causing any major environmental disruptions', it can be gainfully employed in a number of technical pursuits to bolster economic progress.

Within a short span of less than a decade, it has become a lucrative industry, attracting trading on the stock market. By the end of next decade, biotechnological products are projected to fetch a $100-150bn market every year.

Biotechnology has very ancient roots. For centuries, human societies have employed the technique of hybridization. The development of new strains of plants and varieties of many domesticated animals through cross-breeding has been a common feature of agricultural settlements. These early attempts to alter the genetic make-up of living organisms were carried out without an exact idea of the mechanism of genetic transmission. Hybridization thus continued as one of the folk practices in both primitive farming and animal husbandry. In many parts of Asia and Africa, it is still pursued in the light of traditional practice. While mules were still being sought as a hybrid, a powerful new inter-disciplinary tool was coming of age that would 'completely revolutionise many of the age-old practices in medicine, agriculture, forestry, animal husbandry and industrial production. This new hybrid of modern science is

Nasim: taking biotechnology to Pakistan

variantly known as genetic engineering, biotechnology, gene cloning, or recombinant DNA technology.

Since the discovery of the molecular configuration of DNA (Deoxyribo Nucleic Acid) nearly three decades ago by J D Watson and F H C Crick, spectacular advances have been made in the area of genetic engineering. Some of these landmarks are: the discovery of DNA-regulated/RNA-mediated mechanism of protein synthesis, artificial synthesis of the first functional DNA, commercial production of human insulin by genetic engineering of bacterial cells, and more recently, the construction of first functional artificial chromosome.

The genetic blueprint of living organisms is carried by their DNA. The unfolding of its macromolecular structure determines the genetic train of biological species. Any change in the DNA structure is later translated as genetic mutation that is inherited by the progeny. The power of biotechnological procedure lies in that it gives an almost free rein to gene tinkering, ranging from micro-organisms to human beings.

Employing techniques from a number of scientific disciplines such as biochemistry, microbiology and enzymology, the biotechnological method commences with the splitting up of specific segments of molecular strands of DNA. This is achieved with the help of special chemicals known as restriction enzymes. Another family of enzymes, ligases, are next utilized to incorporate the DNA segments into the naturally-occurring extra-chromosomal DNA particles (plasmids). The plasmids are then injected into a suitable host micro-organism which starts producing the desired item under the command of inserted DNA. The final product of this cloning method is isolated as a bio-product made possible through genetic engineering.

The procedural simplicity of biotechnology only betrays the awesome power of genetic engineering. In recent years, ample evidence has accumulated to show the application of genetic engineering in solving problems of human concern. For instance, the hormone somatostatin is considered one of the agents effective against insulin-dependent diabetes and acute pancreatitis. The chemically synthesized hormone has a price of nearly $30,000/gram. Genetically engineered production of somatostatin has brought down the price to a mere $300/gram.

Biotechnological procedure has been employed in other health-related fields, such as the production of interferon for treating breast cancer, hepatitis and influenza, or chemicals effective against lung and brain cancer. Vaccines against some of the infectious diseases like malaria could not be far away.

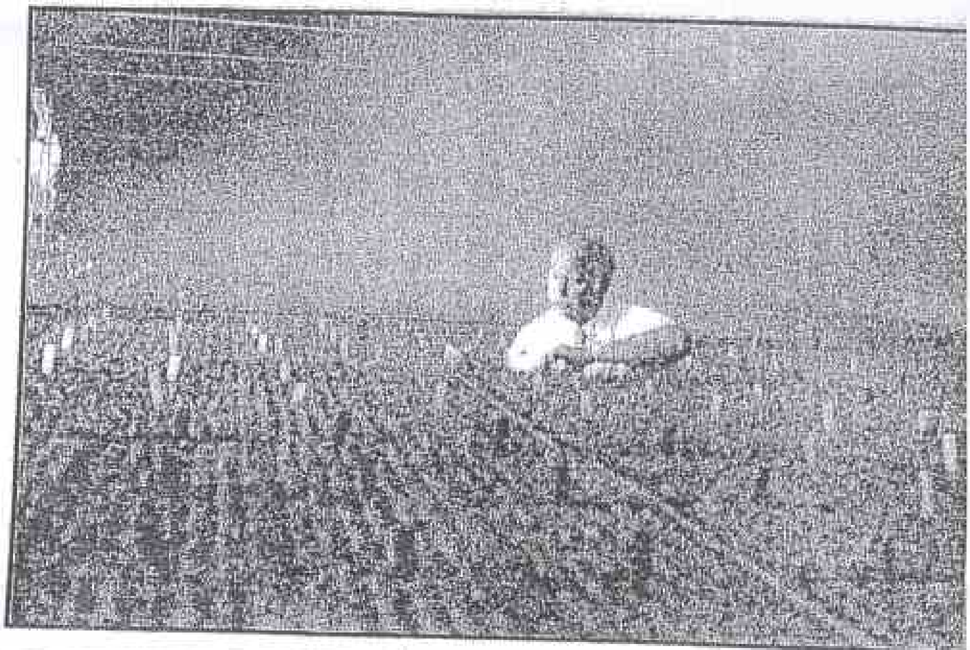
In boosting agricultural productivity, one of the prime targets for application of biotechnology is the production of bacterial strains for nitrogen fixation. In the United States, where nitrogen fertilisers alone cost nearly $2.5bn every year, a genetically engineered supply of atmospheric nitrogen could make agriculture more cost-effective and far less injurious to living environments.

Success has been achieved in producing salinity-tolerant DNA that will find wide application in agriculture. For example, bacteria could be genetically programmed to stimulate tomato growth in sea water. Similarly, programmed micro-organisms could be incorporated for the production of high-yield, disease-resistant crops. Among many of the industrial applications of genetic engineering, micro-organisms are being utilised for the extraction of commercially important elements. Success has been reported for the initial enrichment of precious metals like uranium and gold. An oil-eating microbe has already been produced as a result of genetic engineering, boosting safeguards against environmental pollution. In a number of laboratories, work continues for more ingenious applications of genetic engineering in greatly diversified fields.

With all its glamour, does genetic engineering offer any realistic solution to the problems of economic development in Asian and African regions? Is it a technology appropriate for new initiatives in economic production? Do these countries have an adequate infrastructure to support research and development in the field of genetic engineering? Answers to these questions appear to be in the affirmative, if one looks at the example of Pakistan where a bold new effort has jsut been launched to capitalise on the gains of biotechnology.

Like the technique of biotechnology itself, the idea of its promotion came to Pakistan from abroad – but from Pakistanis living in foreign countries who, in consultation with a few locals, conceived the potential of genetic engineering for national development. The rapidity with which this idea has been translated into reality is a marvelous achievement, given that bureaucratic reluctance scored its own fatality when the world's first international centre for genetic engineering and biotechnology, sponsored by the United Nations Industrial Development Organisation (UNIDO), failed to be established because Pakistan could not meet even the basic conditions laid down by UNIDO.

Four years ago, under the National Talent Pool scheme, a Pakistani-Canadian, Dr Anwar Nasim, travelled to Pakistan for a five-week visit to the Nuclear Institute of Agriculture and Biology (NIAB), Faisalabad, on a teaching assignment related to genetic engineering and recombinant DNA. While Dr Nasim was engaged in these scholarly pursuits, he envisioned a national institute of generic engineering for Pakistan. Dr Nasim enlisted the support of Dr Mujtaba Naqui and Dr Sheikh Riazuddin, both of NIAB and Dr Amir Muhammad of Pakistan Agricultural Research Council. He went on to impress upon Dr Muhammad Afzal (presently Minister for Education, the then Chairman of the University Grants Commission) the need for such an institution to promote a specific type of research and development with relevance to national economic progress. Academicians were receptive to his ideas but it would take a couple more years for Nasim's dream to become reality.



Back at the National Research Council of Canada, where Nasim engages in research on DNA insertion into yeast for the development of industrially useful strains, he continued to pursue his idea of promoting genetic research and development in Pakistan. In the US, he found another Pakistani, Dr Ahmed I Bukhari of Cold Spring Harbor Laboratories, New York, who fully shared his vision. Having gathered a few like-minded persons and generated a genuine interest in biotechology, Nasim and Bukhari were well on their way to creating a national forum. In December 1983, Dr Bukhari organised the International Workshop of Bacteriophage MU as a prelude to genetic research in Pakistan. Unfortunately Dr Bukhari died two weeks after the

One more tool for exploitation?

John Madeley looks at a new study which warns developing countries about the dangers inherent in the biorevolution

ACROSS western Europe and north America today, a new type of business company is starting up. The title of these firms is likely to include the three letters "bio" and they have one overriding aim in mind: to take advantage of a revolution of the 1980s – the enormous opportunities that biotechnology is presenting.

Many of the firms are specifically concerned with agriculture; for it is here where the biorevolution is likely to have its most profound impact. A recently launched British firm says, "the company has been launched to exploit the fast growing area of biological products for crop protection and pests, which carry human disease."

Joining the new independent firms are the transnational agro-chemical giants: Shell, Monsanto, Dupont, Pfizer, Upjohn and Sandoz have all formed specialist departments to exploit biotechnology. In the US, 83 of the 500 largest transnational firms have now become involved in biotechnology.

Whether they are large or small, most firms have their sights beyond their own national boundaries. A growing number of western firms will this year be knocking at the door of the Third World governments and suggesting that they might be able to help them overcome some pressing agricultural problems.

In Third World countries by contrast, there are few indigenous enterprises, either public or private, that have geared up for the technology revolution, although some governments have launched programmes involving universities, public sector institutions and state-owned companies.

Biotechnology is now developing very fast and is likely to express itself in a growing wave of applications. The biorevolution has "the potential to bring about major changes in technology to help solve some of the most crucial problems that face the Third World, particularly shortages of food", say David Dembo, Clarence Dias and Ward Morehouse of the New York-based International Centre for Law in Development.☆

The danger of the biorevolution, however, is that the technology gives rise for new possibilities of exploitation – not just of new products but, far more important, of the people of the developing countries.

"The Third World is confronted by a vexing dilemma in biotechnology", say Dembo, Dias and Morehouse. "On the one hand, applications of this technology offer important and significant opportunities to increase agricultural productivity and meet human needs. On the other hand, the path along which biotechnology is developing, primarily in the industrial countries, makes it very likely that the diffusion of these technologies will have adverse impacts on Third World countries."

They believe that one of the most disturbing aspects of biotechnology is the way it is being "privatised" and becoming withdrawn "from that very large body of technologies which are part of the public commons." Methods of privatisation involve a variety of processes, they say, that result in a resource, a product, or a technology being moved from out of the public domain and into the control (and often the ownership) of private hands, individual or corporate.

Privatisation inevitably creates problems of access. What was once freely accessible becomes accessible only under restricted conditions which are often onerous and costly. For the Third World, this could mean even greater technological dependence – western firms have the secrets and the patents; Third World governments, farmers etc will be offered packaged technologies which may be expensive and inappropriate.

Western seed companies, for example, have already patented new high yielding varieties of seeds – making them available to Third World countries but only at a cost.

Privatisation also means that most of the research and development into biotechnology is being directed to the commercial products and processes for which a profitable demand exists. There is less concern for products of interest primarily to developing countries because even though the demand may be great, they cannot pay enough.

Many of the pressing needs of developing countries are ideal subjects for modern biotechnology – vaccines against tropical diseases, protein-rich food sources, alternative energy etc. Biomass conversion technologies are, at present, not economically attractive to biotechnology companies in the industrialised countries, even though they are of great importance to developing countries.

If biotechnology can help developing countries, it might also lose them export markets. Sugar producting countries, for example, will lose out due to the growth in the use of high fructose corn sweetener, which has been developed with enzyme technology. It is estimated that by 1985, corn sweeteners will have captured 10% of the world sweetener market. The current world sugar glut will continue and worsen; the result will be the displacement of an export crop for sugar producing Third World countries and hardship for people who work in the sugar fields.

As development in biotechnology proceed, the markets for many of the Third World's primary products will be eroded, expect Dembo, Dias and Morehouse.

Yet another form of displacement seems particularly inequitable, they say – when tissue culture technology displaces a traditional industry in which plants are the source of a chemcial or pharmaceutical. Often the developing country will produce the compound through tissue culture. But they will not usually reap any of the monetary benefits resulting from its use. On the contrary, the traditional industry in such a country will see its share in the world market dwindle and the final result might even be that the original producer contry may be forced to import from the developed country producers a commodity that it formerly exported!

The biorevolution could allow for technologies to be developed that benefit the poorest – high yielding strains of cassava, for example. Third World countries could receive considerable benefit here from the international research organisations. The application of biotechnology at the Nigerian-based International Institute of Tropical Agriculture is leading to the development of new cassava seeds.

Cassava normally yields farmers about six tons a hectare. Using biotechnological knowledge, several thousand different seedlings of cassava were cloned at IITA to develop strains that was both high yielding and disease resistant. The new strains are showing great promise and in tests without fertiliser are yielding between 15 and 25 tonnes per hectare.

"Third World governments may be tempted to feel that they want no part in the biorevolution", say Dembo, Dias and Morehouse. "This however would be impractical and undesirable. There can be few "innocent bystanders" as far as this revolution is concerned – countries will be affected, even if they choose not to have anything to do with it. To meet the challenge, Third World governments must give high priority to developing indigenous capabilities. Public sector institutions must be strengthened to enable them to be on equal terms with foreign TNCs."

Policies and strategies must be devised by Third World governments which help their countries and people to obtain maximum benefit, say Dembo, Dias and Morehouse, and they point out that some factors are in their favour. "The scientific barriers to entry are less with biotechnology than they are in many other areas. A Third World government is in a relatively strong bargaining position with TNCs – if foreign companies want to develop biotechnology in a developing country then it is up to the government of that country to name its terms."

The international system needs strengthening, they believe, to enable it to act as an alternative to the private sector for Third World access to biotechnology. A key component of such an international system would be an international agreement that governs access, on equitable terms to all countries to plant genetic resources. Third World countries need to be active in promoting strategies to preserve and strengthen international agricultural research centres, including the newly formed International Centre for Genetic Engineering and Biotechnology.

Given the character of biotechnology, it is important that developing countries have access to the information which can help them make the best possible choices, say Dembo, Dias and Morehouse. Western governments and TNCs will have access to that information; Third World institutions must be able to match them. "The problem of bringing the benefits of biotechnology to the Third World remains acute and seems unlikely to be solved unless the Third World can develop indigenous biotechnology capabilities."

**The authors detailed study "The Biorevolution and the Third World" can be obtained from: The International Centre for Law in Development, 777 UN Plaza, 10016 New York USA*

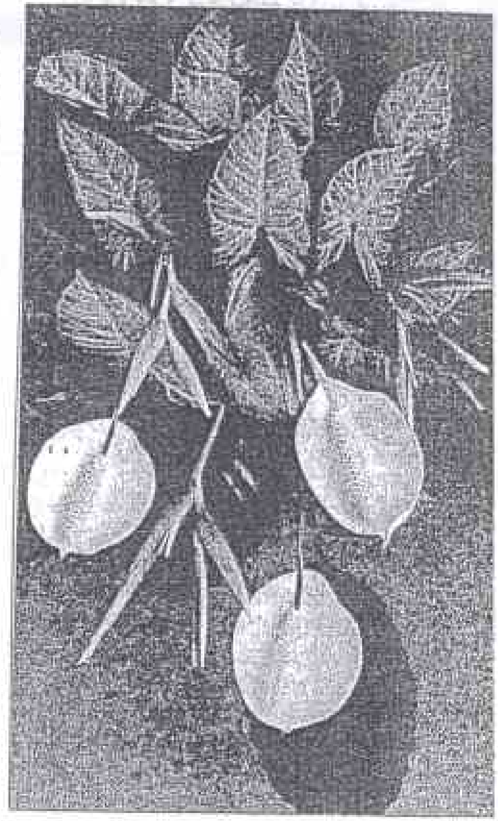
workshop.

Nasim and others soon realised that lack of adequate scientific manpower and resources would block the way to their rather ambitious project of a national institute. They then settled for less, in the hope that a smaller beginning would ultimately grow while proving its worth on the way. This time, support for a centre for advanced study in molecular biology was forthcoming, bringing recognition to the gigantic efforts of these few. The University of Punjab formally established the centre on the occasion of its centenary celebrations in 1983, with its library named after Dr Ahmed Bukhari. The library was inaugurated in October 1984 by the Nobel Laureate, Dr J D Watson.

Within a period of less than two years, the centre has achieved a great reputation. In October 1984, a week long international symposium-workshop on the applications of genetic engineering to basic biology and agriculture was held in Lahore, with the participation of renowned scholars from many countries. The keynote address was delivered by Dr J D Watson, the co-discoverer of the helical structure of DNA. The papers centre on the subject of DNA replication and repair, restriction modification and their implications for agricultural research. General Muhammed Zia-ul-Haq, President of Pakistan, has been very supportive of the project and even took the time to greet the symposium participants. Dr K M Ibne Rasa (presently one of the directors at ISESCO, Rabat, the then vice-chancellor of the university) fully backed the centre by providing complete logistic support.

The Centre for Advance Study in Molecular Bioloy is now equipped to conduct doctoral research and training courses and to embark on frontiers of research in genetic restiction, modification, enzymology, gene function, nucleic acids and the development of genetic transfer materials for bacterial and viral insertions. Its research programme is geared to find applications of genetic research for agricultural and wide industrial uses.

Thoughtful planning seems to be working behind the centre's research and administrative structure. A five-year action plan for biotechnology is ready, with a committee for the determination of national priorities, headed by Dr Anwar Nasim. Overall control of the centre is in the hands of a board of governors, inclusive of five prominent scientists, two expatriate scientists, two industrialists and the director.



Prior marriage between industry and research and development establishments in Pakistan, as exemplified by the Pakistan Council of Scientific and Industrial Research (PCSIR) has not been a happy one – perhaps because of financial constraints or a general apathy and disbelief in science. The present re-marriage with new faces is a great challenge for a mutually beneficial existence between science and industry and science and government in Pakistan – a tradition that is not so well established in that country.

Pakistan's future economic progress is now linked to how she fares in the area of genetic engineering and how soon the burden of economic futures is transferred from mules to molecular biologists and genetic engineers. The application of biotechnology will not stay confined to the economic domain. It will have its impact on other societal structures, especially the value-related issues involved in genetic experimentation on human beings.

Pakistan has been successful, against many odds, in establishing an important centre for research in molecular biology that needs to be supported by other Muslim countries as well as emulated on their own soil. An international debate among Muslim scientists on value clarification in genetic engineering could be a good starting point for such international cooperation.