Source: http://www.biotech-monitor.nl/2007.htm

Will Cuba's Biotechnology Capacity Survive the Socio-economic Crisis?

By
Miriam Elderhorst

Biotechnology and Development Monitor
No. 20, September 1994

Keywords: Cuba; Policies/Programmes; Human health; Trade; Intellectual property rights; Public institute.

Correct citation: Elderhorst, M. (1994), "Will Cuba's Biotechnology Capacity Survive the Socio-economic Crisis?" *Biotechnology and Development Monitor*, No. 20, p. 11-13/22.

In the 1980s, Cuba went through a phase of profound and rapid development of modern biotechnology. This development took place within a centrallyplanned economy which had been strongly dependent on the former Eastern Block countries. Cuba's crisis following their disintegration not only accelerates the application of biotechnology in agriculture, but also impedes its further development.

After the successful revolution in 1959, Cuba's new leadership was confronted with an open economy predominantly depending on the USA. More than half of the best agricultural land was owned by the US *United Fruit Company*. One and a half million Cubans were unemployed. It was after the Bay of Pigs invasion in April 1961 that the Cuban government tried to increase its control over the economy through the nationalization of the most important private companies. Newly defined policy objectives included the rise of income levels, the increase of employment, land reforms, supply of basic products and free access to education and health care for the entire Cuban population. Self sufficiency in food, industrialization, diversification of the agricultural sector and economic independence were mid and long term objectives.
The US government reacted to the new socialist regime with the establishment of a trade embargo against Cuba. As a consequence, Cuba had to look for new markets for its main export product, sugar. In 1964, a contract concerning the export of sugar was signed with the USSR, a country with which Cuba had kept economic and political relations since 1960. Trade relations were extended in the 1960s while in 1972 Cuba became a member of the East European *Council for Mutual Economic Assistance* (Comecon). Cuba benefited highly from the contracts in which sugar was exchanged for oil at a higher value than the ruling world market price. The gradual integration of its economy into Comecon's five-year production allocation plans stimulated Cuba's complete changeover to a centrallyplanned economy. Consequently, the development of biotechnology in Cuba has taken place in the framework of a centrallyplanned economy.

Biotechnology development in a centrallyplanned economy
From the start of the revolution, Cuba's leadership emphasized science as the important basis for economic development. As in many other 'socialist' developing countries, Cuba also turned to science as an instrument of societal transformation. This was not only due to the prominent place of science and technology in the Marxist analysis of the movement of history, but also because science was expected to provide rational means to achieve development goals which would legitimatize the regime.
In early 1980 the Cuban government launched a series of programmes (see box) aimed at applying new biotechnologies to the health care sector. The new biotechnologies were expected especially to facilitate product diversification and import substitution. Besides, the development of a national capacity of biotechnology was seen as a strategy to increase sovereignty and independence from transnational companies of the industrialized countries, especially in the medical sector, principles that Cuba has always advocated within the movement of nonaligned developing countries.

- The Cuban government assumed that the stateled system would offer the conditions for a coherent science and technology policy, forming an intrinsic part of their economic strategy. Indeed, the following conditions are considered to have contributed to Cuba's rapid development of biotechnology:The central planning of the development of highly qualified personnel and their channelling to priority sectorsThe longterm central planning of R&D activities, in accordance with the socioeconomic policy.
- The development of the educational sector and the health care sector, of which the quality and accessibility increased significantly. This resulted in a large reservoir of scientific personnel specialized in biochemistry and microbiology, and in the establishment of a biopharmaceutical industry.
- The creation of an internal demand for biotechnology and developed products.
- The financial support for these developments.

Cuba has received substantial international support to develop its biotechnology in the form of training, knowledge and technology. Cuban students and specialists were educated and trained in the USA, France, Japan, Switzerland, Canada, Mexico, England, former USSR and East Germany, and Finland. Furthermore, the biotechnology developments in Cuba have been partly based on copying existing foreign technology and products. Cuba's first success in producing a modern biotechnological product was achieved in 1981, when, with the support of the US cancerspecialist Randolph Lee Clark, the production of interferon was realized.
According to Elena Siméon, the director of the *Academía de Ciencias de Cuba* (ACC), approximately 8,000 people worked in scientific research relating to biotechnology in 200 research institutes in 1993. In the period 198892, more than US$ 300 million was invested in medical and pharmaceutical industrial biotechnology.

The socioeconomic crisis
From 1988 onwards, Cuba's economic relations with the Eastern Block countries deteriorated because of the economic and political changes in those countries. Eventually this culminated in the abolition of the Comecon in 1990. Finally, the disintegration of the USSR in December 1991 definitely revealed the vulnerability of Cuba's development model. Its economy was based predominantly on the monoculture of sugar cane and depended on a heavy, energyintensive industry and a largescale, mechanized agriculture. Inputs, such as fuel, fertilizers, pesticides and herbicides were

imported mainly from the Comecon countries. Between 1986 and 1988 Cuba imported on average 82 per cent of its pesticides and herbicides and 48 per cent of its fertilizers. In addition, at the end of the 1980s Cuba imported between 44 per cent and 57 per cent of its per capita caloric consumption from the Eastern Block, including essential foodstuffs such as wheat, vegetal oils, beans and milk.
The loss of economic support and favourable trade conditions with the Comecon countries resulted in a drop of Cuba's national income by an estimated 45 per cent between 1989 and 1992, while the import of food decreased by more than 30 per cent between 1989 and 1991. Besides, Cuba lost its credit resources, 80 per cent of its trade market and half of its oil deliveries. The lack of spare parts and inputs for the sugar sector caused a dramatic drop in the annual raw sugar production from an average 7 million tonnes to 5.2 million tonnes in 1992 to 4.3 million tonnes in 1993.
Cuba is confronted with an increasing unemployment rate, caused by closing inefficient factories. While state expenditure on social security rapidly increases, the government has difficulties to maintain the level of the other social services: free education suffers from a lack of paper and books; free health care experiences a decreasing availability of medicines, while the distribution of basic food products is impeded by a lack of imported foodstuffs.

Cuba's survival strategy
Facing the continuing trade embargo of the USA and the unexpected collapse of the Eastern Block, the Cuban government was forced to develop a new socioeconomic strategy to overcome the crisis.
In August 1990, the government launched a national emergency programme by announcing the *Special Period in Peacetime*. Three economic sectors were chosen for priority investments: biotechnology, tourism and again sugar. The development of biotechnology aimed at import substitution, the creation of new export products, and at supporting the *National Food Programme* (NFP)
The development and application of biotechnology relating to the agricultural sector had to be accelerated. It turned out that the transfer from the highly developed human medical biotechnology to agriculture did not pose many problems. However, current Cuban genetic engineering is not so advanced in agriculture as it is in the medical field.

Changing the decision making
The scarcity economy has led to a more stringent centralization of decisionmaking at the national level. Since 1990 fiveyear planning has been changed to yearly planning, which is readjusted monthly. Because of the crisis, emergency interventions and ad hoc decisions have become more common. At the same time, however, the announcement of the *Special Period* has contributed to a more open and dynamic planning process at lower levels. In May 1990, the *Frente Biológico* was established, in which the directors of the most important agricultural research institutes and the director of the *Academía de Ciencias de Cuba* (ACC, an institute with an authority comparable to a ministry) join once a month to coordinate agricultural research to avoid overlapping. Besides, *Polos Científicos*, aiming at the promotion of the development of the economy, science and production, operates at the provincial level since 1991. This means a form of decentralization aiming at increasing efficiency and rationality, a new organization of scientific work based on interdisciplinary cooperation and exchange of knowledge, information and instruments, and the rapid implementation of results. Both groups are coordinated by the ACC whose policy proposals are generally approved by the State Council, the highest decisionmaking body within the government.

Apart form their research activities, many scientists actively take part in politics. Various scientists are members of the national or one of the provincial parliaments. Most strikingly some important scientists, such as the directors of the *Centro de Ingeniería Genética y Biotecnología* (CIGB), of the *Finlay Institute* (where vaccines are produced) and of the ACC, are members of the State Council. Cuba's biotechnology policy is mainly determined by these people.
The fact that Cuban scientists play such an influential role in decision making could be interpreted as a scienceled development of biotechnology. Cuba's focus, however, has been on applied biotechnology research rather than on basic science. In fact, the lack of basic research is likely to limit Cuba's potential to create new technology. Another often mentioned problem in Cuba is the scalingup of the production of research results from laboratory to industrial level. Especially in the situation of the current crisis, it is felt that the industrial production of available applicable products is carried out too slowly.

Biotechnology to support the National Food Programme
Within the framework of the NFP the development of biotechnology has different aims:
(1) *The enhancement of food production and the nutritional value of food*. Cuba is facing the problem that it has to increase food production without reducing the level of sugar production since sugar is still its main source of foreign currency. Therefore, research to increase yields per year, production per yield, and resistance to environmental stress (drought and salt) and diseases in sugar cane and foodcrops is carried out.
In the 14 'biofábricas' in Cuba, new varieties of sugar cane, bananas, potatoes, tomatoes, cassava and soya beans have been developed by means of somaclonal variation, which are already under cultivation. Besides, the biofábricas are active in the mass micropropagation of diseasefree plant material of bananas, sugar cane (total production 6 million plantlets in 1990), pineapple, potato, citric and tobacco, and in the conservation of germplasm. Additionally, the enhancement of agricultural production by means of genetic engineering in sugar cane, rice, tomatoes, fruits and potatoes is reported to be under investigation.
The industrial production of *Single Cell Proteins* (SCP) from molasses, a sugar cane by-product, takes place by revaluating the traditional fermentation processes. SCP, until now only used as animal feed but possibly in the future also as human food, enables the enhancement of the nutritional value of the diet and could substitute for the import of soya beans and fish meal. In Cuba, 12 factories produce an estimated 11,000 tonnes of SCP per year. Because the raw material represents 65 per cent of the total costs of SCP and Cuba is using a byproduct as molasses for it, the SCP can be produced economically.
(2) *The production of biological fertilizers, herbicides and pesticides*. To substitute for the formerly imported chemicals, an integrated programme on biological pest control was launched. By the end of 1991, about 56 per cent of the cultivated area was protected by domestically produced biopesticides. In addition, one tonne of *mycorrhiza*, a biological fertilizer, was produced in 1991. Also *Rhizobia* and *Azotobacter* are used to substitute for chemical nitrogenous fertilizers (see also Monitor, no. 17).

Export diversification in medicines
Biotechnology is also applied to the medical sector in order to diversify export. Cuba exports some competitive biotechnologically produced medical products, mainly to Latin American and Caribbean countries. One of the most important export products is the meningitis B vaccine, commercialized as *VAMENGOCBC*. Since 1986, it has been

administered in Cuba reaching to an immunity of 97 per cent of the vaccinated children and adults. This product has not only been registered in Brazil, Uruguay, Bolivia, Paraguay and Nicaragua, but also in Asiatic, European and African countries. In 1989 an important contract was signed with Brazil for the export of 8 million doses of the meningitis vaccine, worth US$ 80 million. Recently another 7.5 million doses were sold. A potential epidemic of meningitis in Colombia in 199091 was controlled by the same vaccine. While Chili started a one year experiment with the vaccine this year, Argentine is expected to register and import this product soon.
Another export product is the hepatitis B vaccine *HEBERBIOVACHB*, manufactured since 1987. Colombia imported this vaccine early 1993 and it was recently registered in Venezuela. It has been reported that this vaccine is also exported to some European countries. Other potential export products are PPG, epidermal growth factor, streptokinase, SUMA equipment and interferon (see box). According to Lía Añé, a Cuban researcher, two enzymes 'beta galactosidase' (aids in the digestion of dairy products by those who are lactose intolerant) and 'recombinant rennet' (critical factor in cheese making) show considerable promise for cooperative production with enterprises in other Latin American Countries. The scientific and production facilities for these enzymes already exist in Cuba and various investment options are being considered.

Cuba's shift to new markets
The production of biotechnological products for export has become increasingly critical to replace lost aid and trade. However, control of the scientific fundaments of biotechnology has turned out to be insufficient to enter the world market. Cuba is confronted with the following obstacles:

- Controlled *world markets*. The market of biotechnologically produced medicines is controlled by transnational companies from industrialized countries. These enterprises not only dominate the advanced and protected technologies but also have the experience and capacity for production, worldwide marketing and distribution. Their control hinders the entry of Cuban products:
- Intellectual *property rights*. Cuba developed its biotechnology sector partly by copying patented processes and products. The export of the derived products is limited to those countries that do not recognize intellectual property rights. In the future, Cuba's recognition of patents seems unavoidable. When Cuba will have to pay for the use of patented technology and products, its production costs will rise, while its access to new biotechnological developments might be affected.
- US *embargo*. Potentially the USA is Cuba's most nearby and lucrative market. The US trade embargo means that its market is closed to Cuban products. More specifically, the US *Cuban Democracy Act* of 1992 prohibits the export to Cuba of anything that might aid the development of biotechnology. Besides, the embargo impedes Cuban access to international credit.
- Solid *reputation*. Cuba lacks an image of reliability on the market for biotechnology products. Notwithstanding the multiple confirmation that biotechnological research and production in Cuba are based on international (National Institutes of Health, USA) standards, Cuba lacks the solid reputation.

In order to improve its access to the world market, Cuba is promoting the establishment of joint ventures with foreign enterprises to use their reputation, technology and distribution network. Cuba focuses firstly on small and medium businesses in Latin

America where Cuba itself has a better reputation. However, transnational corporations also move their attention increasingly to the growing markets in the South, which will make these corporations serious competitors on this market.

Cuban biotechnology research centres

In 1964, the *Centro Nacional de Investigaciones Científicas* (CENIC) was established. At this institute, students were educated in biochemistry and biomedical research, directed to the development of the healthcare sector, which had priority in Cuban politics. Cuban students were also trained in countries as France, Japan, Switzerland and the USA.
In 1982, the *Centro de Investigaciones Biológicos* (CIB) was founded. In this centre the production and testing of interferon took place. First the CIB produced interferon by using (human) cell culture, but since 1985 it is produced by the use of genetically modified bacteria and yeasts. Cuba devoted a new research centre to the production of interferon not only because of the potential of interferon to treat cancer and viral diseases, but also because production of interferon served as a model system for further research in genetic engineering. This research takes place partly in interaction with European research institutes including the *Institut Pasteur*, France.
In 1986, the newly established *Centro de Ingeniería Genética y Biotecnología* (CIGB) replaced the CIB. At the centre the following activities take place:

- The *production of proteins and hormones* by the use of recombinant DNA techniques for applications in the areas of human and veterinary medicine.
- The *development of vaccines*. The aim is to develop vaccines against diseases prevalent in Cuba and other tropical and subtropical areas. A meningitis B vaccine and the hepatitis B vaccine are commercialized. At the moment vaccines against cholera, haemophilia and AIDS are under investigation.
- The *development and production of diagnostics*. The entirely mechanized *ultra-microanalytic (enzyme linked immunosorbent) system* (SUMA) is applied for diagnosing human diseases, such as HIV, hepatitis B, herpes simplex, chagas, dengue, leprosy, and congenital defects. These diagnostics tests are exported to Brazil, Spain, Colombia and several republics of the former USSR. With funds provided by the UN *Development Programme* (UNDP), the *Immunology Centre* develops and manufactures monoclonal antibodies for the diagnoses of human diseases. The same Centre is also active in the production of monoclonal antibodies for the detection of the fungous disease *ojo de mancha* in sugar cane, and in DNAprobes for plant diseases.
- The *production of enzymes*. More than 50 different enzymes include *streptokinase* used against bloodclots and for the prevention of heart and vascular diseases and only manufactured in Cuba. Most of the enzymes are used for inversion processes in the sugar, food and textile industry.
- Research on *genetic engineering* of microorganisms, plant and animal cells. The improvement of plant varieties by the use of other biotechnologies such as tissue and cell culture is worked on.
- The *transformation of various kinds of biomass* via the use of chemical methods and enzymes. Special attention is paid to the production of proteins for animal feed on the basis of byproducts of the sugarcane industry, such as molasses (sugar syrup) and bagasse (xylonite rich waste), by the use of enzymes. Small-

scale production takes place in pilot factories.
- More than *160 medical and pharmaceutical products* have been developed including *PPG* (ateromixol, a medicine to reduce the cholesterol level) which is currently commercialized.

CIGB is equipped with the best German, Swedish and Japanese machinery.

The CIGB forms the core of a network of institutes that participate in biotechnology research in Cuba. The other three institutes of the network are the *Centro de Immunoensayo* (CIE), addressing computer software, the development and production of equipment, and the production of reagents; the *Centro Nacional de Biopreparados* (CNB), focusing on the production of biopreparations and diagnostic means; and, the *Centro Nacional para la producción de Animales de Laboratorio* (CENPALAB), which is directed to research on the reproduction of animals of genetic high quality.

Potential versus obstacles

In the last decade Cuba developed a significant national capacity of biotechnological knowledge and infrastructure. The centrallyplanned economy served well to redirect and mobilize resources to make rapid development possible. However, the socio-economic crisis revealed the deficiencies of this model: investments were at the expense of consumption, and wastes, overstaffing and decreasing workmotivation resulted in low levels of productivity. The higher workmotivation because of better working conditions and better access to food in the biotechnology centres has come under pressure since the sector has to finance its own investments now. Moreover, bureaucracy and inflexibility of the system impedes the realization of new activities such as upscaling of production and the commercialization of biotechnology products. Will Cuba's biotechnological capacity be sufficient to overcome the current crisis, or will biotechnology development itself become victim of reduced imports and disinvestments? Problems related to the earning of foreign currency with the export of biotechnological products have been described above. The aim to reduce imports is also suffering from the crisis. Before the *Special Period* an estimated 82 per cent of the national medicine consumption was produced domestically. The crisis, however, has caused a shortage in medicines, because Cuba now lacks the foreign currency to buy the necessary inputs.

On the other hand, the agricultural applications of biotechnology are directed to alleviate the effects of the presentday crisis. The crisis has also stimulated interest in biological and sustainable agriculture, and in the contribution of biotechnology to this development. Biotechnology has stimulated the development of the sugar byproducts industry. The production of animal feed, organic and biological fertilizers and pesticides, energy and medicines (PPG, antibiotics) on the basis of molasses and bagasse has been realized. This result can be seen as a strategic revaluation and diversification of the sugar sector.

Notwithstanding all pros and cons, the profound crisis has increased confidence in the potential of biotechnology in Cuba. The fact that Cuba is strongly isolated at the moment increases the status of biotechnology: by proving its capabilities in the area of biotechnology, the Cuban government hopes to gain more appreciation and confidence both within and outside its national borders.

Miriam Elderhorst

Sources

J. Feinsilver (1993), "Can Biotechnology Save the Revolution?" *Report on the Americas*, NACLA, Vol. XXVI, No. 5, May 1993, pp. 710.

L.F. Montalvo (1992), *Política Científica y Tecnológica y Ventanas de Oportunidad*. Brazil: Universidad Estatal de Campinas.

L. Añé (1993), "Looking for a Biotech Fix.Ó *Cuba Business*, Vol. 7, No. 1, January/February 1993.

M. Fransman (1991), *BiotechnologyGeneration, Diffusion and Policy: An interpretative survey*. Development Economics Seminar Paper. The Hague: ISS.

C.D. Deere (1992), *Socialism on One Island? Cuba's National Food Program and its prospects for food security*. Working Paper Series No. 124. The Hague: ISS.

Personal communications with M.A. Fernández (Frente Biológico), G. Galvez (Sugarcane Breeding Programme, Ministry of sugar), and Julie M. Feinsilver (Pan American Health Organization).

The Network University
Wibautstraat 224
1097 DN Amsterdam
The Netherlands

phone +31 20 5618 163
fax +31 20 5618 164
email monitor@biotech-monitor.nl