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HIGH LEVEL POLICY ADVICE ON THE APPLICATION OF GENETIC ENGINEERING TECHNIQUES TO THE DEVELOPMENT OF NATIONAL INDUSTRY

SI/JAM/92/801/11-51

JAMAICA

Technical report: Findings and recommendations*

Prepared for the Government of Jamaica
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. Joseph Martial
Expert in Genetic Engineering

Backstopping officer: Ms. M. Sanchez-Osuna, Chemical Industries Branch

United Nations Industrial Development Organization

Vienna

* This document has not been edited.

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I. INTRODUCTION

Upon arrival in Jamaica, the expert met Dr. Arnoldo Ventura from the Prime Minister's office.

They had a very fruitful discussion which clearly indicated that key persons at the level of Jamaican Government are well aware of the importance of Science and Technology for the adequate economic and social development of their country.

This awareness is well documented in a leaflet entitled "Science and Technology, A National Policy", edited by the Ministry of Development, Planning and Production of Jamaica.

The expert is in a full agreement on the specific aims and objectives of this policy. He also agree with the priorities which have been chosen in function of the national context. Among these priorities, one can find agriculture and food, nutrition and health, biotechnology, natural resources including mineral and marine resources, the environment, energy, etc. in fact, distinct facets of what is today named "Biotechnology"

This obviously tends to indicate that the part of the work as UNIDO expert on biotechnology which would have consisted in convincing Jamaica that biotechnology is important for its future is unnecessary. Jamaica is already conscious that biotechnology is essential and even prioritary for its development.

Given these premises, the report will thus consist of the following topics : a brief recall of biotechnology and few of its successes with a particular emphasis on what the expert considered as the key factors which have made these successes possible; then a survey of what he had seen in Jamaica (university, public institutions, private sector, etc.) considered in function of those key factors defined above; finally the conclusions, recommendations, proposals for future development and use of biotechnology/genetic engineering in Jamaica.

II. BIOTECHNOLOGY - DEFINITION, EXAMPLES OF SUCCESS AND KEYS TO SUCCESS

A. Definition:

Biotechnology is the use of biological processes towards industrial or environmental goals. These processes utilize either microorganisms (bacteria, yeast, etc.) animal cells, animal themselves or substances extracted from them (such as enzymes). Biotechnology thus is not new. There are more that 2000 years that cheese, wine, beer are made (and consumed) and that agriculture and stock farming are common practices.

After thousands of years of "artisanial" biotechnology, industrial biotechnology awakened in the 19th century, in Europe, with the first works on fermentation; and it is only more recently (around 50 years ago) that the bioindustry established itself with the production of antibodies followed by the development of the industrial microbiology.

Despite these efforts and many processes in the fermentation techniques, the possibilities of the "classical" biotechnology is still limited in the early seventies. Actually, at that time, nobody talks about biotechnology.

In 1973, genetic engineering is discovered by 2 university scientists of California. This new technique allows the precise recombination, in the test tube, of the chromosomes from different organisms. This technique can thus be used to introduce desirable characteristics in existing biological species more rapidly and more precisely than had been previously possible. In some cases, these advances could not have been achieved using other techniques.

Genetic engineering has pulverized the limits of biotechnology. Today, 20 years after its discovery, we are still unable to precisely evaluate all the potentialities opened by this new breakthrough and we can easily understand why one of the oldest technology in the world is today the focus of so many interests.

Two points needed to be emphasized:

1. One should distinguish the new from the old biotechnology. The first integrates the various in vitro recombinant DNA techniques while the latter does not.

2. The new biotechnology is not a product, an industry or a science. It is a powerful set of tools which are and will be used increasingly to develop and produce medicines, agricultural products, foods and many other goods for everyday personal consumption, industrial use, or the environment.

B. Few examples of biotechnology success:

The benefits of biotechnology are no longer a distant dream. Current developments, mostly in developed countries, hold enormous promise of direct benefit tc the world population.

1. **Human health care products** already available and on sale are:

- human growth hormone to treat dwarfism;
- human insulin to treat diabetes;
- tissue plasminogen activator to treat blood clots and heart attacks;
- interferons to treat leukemias, viral diseases and cancer;
- factor VIII to treat hemophilia A;
- vaccines for hepatitis A, B and other diseases;
- others

2. **Agriculture and Food:**

- diagnostic agents for plant and animal diseases;
- bovine somatotropin to improve milk production;
- porcine somatotropin to decrease fat to protein ratio in meat;
- heat stable alpha amylase for improved enzymatic depolymerization of starch;
- aspartame, a new non caloric sweetener;
- microbial rennin for cheese manufacture;
- BT toxin as bioinsecticide.

3. **Environment:**

- Several enzymes produced by recombinant microorganisms help significantly reduce the envircnmental impact of industrial processes and products.

  This is true in the diagnostic field (glucose-6-phosphate dehydrogenase), the antibiotic field (enzymatic conversion of penicillin G), the detergent field ("enzyme" detergents), the leather production (for shaving the hair from animal hides and to treat chrome shavings), the paper production (to separate lignin for cellulose), etc.

- Several modified microorganisms efficiently synthesize "bioplastics" and "biopolymers", etc.

C. Few key factors that made these successes possible:

1. Most of these products have been brought to the market by an efficient collaboration between 3 parties: University / new

biotech company / big multinational company. The driving force has generally been provided by the strong entrepreneurial spirit of the new biotech company which for its first steps (research and development) used the university expertise and for the last steps (production, authorization, marketing) used the big industry expertise.

It is also important to note that most of these new biotech companies were born around the best university centres, the only ones which could provide the minimal critical mass of scientists to sustain their birth and their development.

2. The time needed to put a new biotech product on the market varies from 7 to 15 years depending on the field concerned. All the parties involved and their financing partners (the government in the case of the universities) should be aware of and ready to cope with these enormous delays. Long term commitment and long term financing are an absolute requirement for the biotech projects.

3. Many biotech products must go through long approvals by national and international authorities (such as FDA, USDA, CEE, etc.) before they can enter and be sold in many countries. These approvals require standards of fabrication, deep field trials and throughout quality controls often underestimated by young biotech companies.

4. Public pressure has led all developed countries to adopt specific regulations for the new biotechnology. Since these regulations may have an important impact on the competitiveness of the bioindustry of a given country, their absence is generally considered as a deterrent by the investors.

5. Public acceptance of biotechnology is essential since it may directly affect not only the regulations but also the commercialization of the new products. High quality, reliable and well thought information has been essential to the success of several new biotech products.

III. ASSESSMENT OF THE BIOTECHNOLOGY AND GENETIC ENGINEERING CAPABILITY OF THE UNIVERSITY OF THE WEST INDIES

The expert spent one full day and two visits on extra days at the Mona Campus of the University of the West Indies. He met several persons among which:

- Prof. K. MAGNUS, Dean of the Faculty of Natural Sciences;
- Dr. D. PRASAD of the Botany Department;
- Prof. T. DASGUPA and Dr. REESE from the Department of Chemistry;
- Prof. D. KING, from the Department of Microbiology, Faculty of Medicine;
- Dr. M. AHMAD and Dr. W. McLAUGHLIN from the Biotechnology Centre

The University of the West Indies has 3 campuses on three distinct islands : Jamaica, Trinidad and Barbados. Some faculties are present on the 3 campuses : Art, Social Sciences, Natural Sciences and Educational Sciences. The Medical Sciences is only present at Mona and Trinidad. Engineering and Agriculture are only on the Trinidad Campus and Law only on the Barbados Campus.

A first drawback of the 3 campuses situation is that the various ingredients that constitute biotechnology are dispersed on distinct islands.

This undoubtedly hampers the discussions between these different but complementary university fields and deprives the public and private sectors of Jamaica of easy access and contact with the university specialists of all biotechnology sectors.

A second point to be noted is that, visiting only Jamaica, the expert had only visited the Natural Science and the Medical Science faculties. Actually, this report will only deal with the first of these faculties since it is obvious from the expert's visit that the Medical Science Faculty is not at all involved in modern biotechnology . On the contrary, it totally depends on the Natural Science Faculty for entering this field which - as it recognizes it - is absolutely vital for its development.

The Mona Campus has 6000 students among which 1200 graduates and 100 post-graduates in the Natural Sciences Faculty.

The high proportion of graduates vs. post-graduates may be explained by an important proportion of the graduates ending up in Medicine.

The Faculty of Sciences offers Ms. D. and Ph.D programmes. After these degrees, some students find jobs in Jamaica, others (the majority in some branches) go abroad for postdoctoral training. Many "post-docs" do not come back to Jamaica, not for salary reason, but rather for job reason: it seems that the type of scientific career they are offered in Jamaica is not at the level of their expectations.

This feeling is well in line, in fact, with the contradictory impression at the Department of Botany and Chemistry at the University. The individuals met were very literate, intelligent and knowledgeable in their field. And with their research activity: "they have too much teaching duties, too much administrative work, insufficient funding, no interest from the industry ...."

Consequently, in these departments, no strong enthusiasm, or entrepreneurial spirit for going into biotechnological ventures. No real desire to go to the industries and to "sell" them modern biotechnology in general and any given project in particular. They are not either ready to go and convince the politicians responsible of the Science and Technology financing to invest more in biotechnology.

The expert did not see many laboratory facilities and did not receive any list of publications (although promised). From the little he saw, he believed that there is no real molecular biology nor genetic engineering going on today in these departments, and thus anywhere on the campus (except in the Biotechnology Centre, see later). Nevertheless, several lines of research (on the natural products and on the degradation of the pesticides) of the chemistry department look quite interesting.

The Biotechnology Centre:

The research in the Natural Sciences Faculty is essentially basic although recently more applied topics have been approached. The opening of the university towards more applied preoccupations has really taken shape, in fact, with the setting up of the Biotechnology Centre. This trend will be further confirmed by the establishment, in the coming months, of a Science Park.

A complete tour of the Biotechnology Centre and also a list of recent publications were given. The Centre is pursuing many lines of research. All are applied and concern Jamaican problems. The work seems to be carried out seriously and to meet international standards. This is documented by the good number of articles published by this group in international journals. The techniques used are up to date and belong most of time to classical biotechnology. A few experiments are now beginning in the field of genetic engineering. This is encouraging but obviously much still

remains to be done in this area.

The facilities of the Centre seem adequate and the personal density in the laboratory was reasonable. Nevertheless, this laboratory remains small and has barely the critical mass necessary to function adequately. Considered at the University level, the research task force in biochemistry, biology, genetic, biotechnology reaches the necessary critical mass. This will be a point to be discussed further (see recommendation section). Contrarily to what is felt in the other university departments, Dr. Ahmad appeared to be very dynamic, motivated and eager to interact with the private sector. This sort of "entrepreneurial" spirit was so essential at the first stages of biotechnology in the USA, 15 years ago.

In brief, the Sciences laboratories of the University of the West Indies seem to be of a good level when compared to their international counterparts : the professors are highly intelligent and knowledgeable in their field of expertise. In the biotechnology sector, as it could be expected, the Biotechnology Centre seems to be the only one really committed to go towards modern technologies. In addition, this group has the desire and the will to play an active role in the industrial reconversion of Jamaica.

It should also be mentioned that several public and private sectors visited criticized the university:

- "I proposed a research programme at the University but found nobody interested or competent."

- "The biotechnology centre works essentially with students. They have a lot of goodwill but they do not really understand the industry interest."

- "The university does not provide enough practical training on real applied biotechnology; there are no structured classes at the graduate level."

- "Money given to a project is lost, for a good part, in the administrative paperwork of the university."

Several people working in the plant business regret not having contact with the university because the agronomy faculty is far away in Trinidad.

IV. ASSESSMENT OF THE PUBLIC SERVICES AND INSTITUTIONS VISITED DURING THE MISSION

Generally speaking, the individuals met during the visits were very intelligent, literate, motivated by their field of interest and their responsibilities.

They were very open with their work, giving many information on what had been done in biotechnology (classical biotechnology) in their sector. This obviously proves that biotechnology is known and that the background is set if the modern biotechnology should be brought in. In a few instances, services in the field of modern biotechnology have been brought abroad (in foreign genetic engineering companies). The end result has not always been satisfactory.

Two entities need further emphasis:

1. The Bodles and Grove Place Agriculture stations:

   Despite the valuable work and services rendered to the farmers in the past, the efficiency of these stations is quite low. Given the importance of the buildings and of the personnel employed, these stations are very much underused. This is not due to a lack of enthusiasm from the direction but rather to the lack of funding and of a critical mass of adequately prepared scientists motivated by the real field problems.

2. The Scientific Research Council (S.R.C.)

   The S.R.C. was presented as the "interface" between the university and the industry, the link between a research and the product. Again as above, despite the quality and motivation of the direction and its valuable past, the SRC had became an extremely heavy institution with quite a low efficiency. The main reason: lack of funding. Significant in this respect, it was noted that SRC employs 110 persons (much more than many high performers in the developed countries) but has not been able to buy a single new equipment in the last 15 years.

   During the visit, some group leader of the SRC told the expert: "We decide to work on the project 'X' because we are convinced that product 'x', when we will get it, will be excellent for the industry. After 2 years of work, we go to the industry and they do not want it. So, we have to stop, we have lost 2 years of work and it is very frustrating".

   This demonstrates what not to do in the interaction with the industry, specially in biotechnology where at least 10 years are needed to put a product on the market (see recommendation section).

V. ASSESSMENT OF THE PRIVATE INDUSTRIES VISITED DURING THE MISSION

The individuals representing private companies and various industrial boards met during the mission were very impressive. They were extremely dynamic and very knowledgeable of their sector, not only in the Jamaican context, but also in the world competition market. Many of them were perfectly aware of the new biotechnological developments going on abroad and they are ready to collaborate with the "specialists" (university or not/Jamaican or not) provided their conviction that the project was industrially sensible.

VI. RECOMMENDATIONS FOR A FUTURE POLICY AND STRATEGY FOR JAMAICA IN BIOTECHNOLOGY AND GENETIC ENGINEERING

1. Human Resources in the University

Given the limitations in the number of biotechnology specialists currently in Jamaica, the first priority should be to reinforce drastically and in a very significant way, the critical mass of scientists who, at the Faculty of Sciences, are working in the areas of importance for biotechnology.

1.1 The first area covers molecular biology.

A possibility would be to create a new laboratory of Molecular Biology directed by an international expert in the field. Another possibility would be to allow the existing laboratories to hire several PhD.s who have had postdoctoral training in molecular biology. These newcomers with the personnel currently in place should immediately create a top level curriculum in molecular biology and genetic engineering. The theoretical classes should be updated and new research projects (basic at first / more applied later) should be initiated.

1.2 A cell culture facility should also be set up, for both procaryotes and eucaryotes. The latter should ideally specialize in plant cell culture, the first in the fermentation of recombinant microorganisms.

1.3 The Biotechnology Centre should be reinforced and helped in the recruiting of a few extra experienced investigators.

1.4 Some mechanisms should be imagined to allow the return or the collaboration of expatriate Jamaicans living in developed countries.

2. Financing:

2.1 Basic research should be financed adequately by the government in priority in these university laboratories, key to the development of biotechnology : biochemistry, biology, microbiology, genetic engineering, chemistry, fermentation engineering, etc.

2.2 Applied research should be financed by the government under very strict conditions, as for example the following:

2.2.1 Only applied projects presented jointly by a research laboratory (such as the Biotechnology Centre or the SRC) and an industry should be considered.

2.2.2 The industry should participate in the financing of the project (20% for the years 1 and 2; 40% for years 3 and 4; 60% for years 5 and 6; etc. The government should pay the rest.

2.2.3. The results would be the property of the industry. If possible, the results should be patented before any other publications or oral presentations.

2.2.4 If a product is finally commercialized out of this research, the industry should pay a royalty to the research laboratory which should retrocede part of it to the investigators who did the research (incentive).

Remark: This way of approaching applied research is totally different from the current thinking found at the SRC (see above IV.1)

i) no project should be initiated without the full support of an interested industry.

ii) the initial investigator(s) remain(s) involved and interested until a product comes out of the research he/they initiated. There is no need of an intermediate organization which would cut him out of the final steps and, in fact, destroy all his/their incentive.

2.3 The government and the financial institutions of the country (with, maybe the support of UNIDO) should provide seed capital for the spin off of biotechnology ventures.

3. <u>Collaborations:</u>

3.1 Government should promote university-industry links, public-private collaborations, technology transfer from abroad.

An example of these collaborations would be to allow the private sector to use, on a rental basis, the facilities of Bodles which are not fully utilized today by the

public sector.

This is very important not only for the concrete result that can be obtained or for increasing the initial investment return, but also for the image of biotechnology and for the driving force that such measure could induce at the level of a currently underused facility.

3.2 Government should favour and support the temporary transition of academics into the industry and vice-versa.

3.3 Support should be sought from UNIDO and more particularly from I.C.G.E.B. for:

a) the training of young students

b) the organization of special courses , workshops, meetings, symposia

c) the realization of specific research programmes

d) the research of funds from international agencies

e) the dissemination of information concerning worldwide biotechnology achievements

f) the establishment of regulation corresponding to both the specific Jamaican needs and worldwide recognized common principles.

4. Information/Regulation/Intellectual property rights

4.1 As already mentioned earlier, a timely, accurate and high quality information is essential to the public acceptance of the new products coming out of modern biotechnology. It is recommended that an official information system be set up the national level. This system should aim at targeting the information at the Jamaican public consumer underlining the benefits to society (see collaboration with UNIDO).

4.2 Once the public is well informed, the government should collaborate with competent scientists and with the industry to set up regulations and safety guidelines for biotechnology activities. These should be scientifically based, flexible, and integrate the notion of risk. UNIDO should be able to help significantly in this matter.

It is strongly insisted the necessity of these regulations/guidelines. A country without them, although

seemingly attractive to foreign investors, is in fact totally unattractive for the lack of long term guarantees.

4.3 The same reasoning holds for the intellectual property rights. Jamaica should devise appropriate strategies in the field of intellectual property rights and patents to create a good climate for international collaborations and investments.

VII. FUTURE APPLICATIONS OF BIOTECHNOLOGY AND GENETIC ENGINEERING AND ANY NICHE SECTORS FOR JAMAICA

This chapter of the report shall be brief and preliminary. For two reasons: first, with just one visit, programmed in advance by others (and nicely programmed, actually), it is impossible to have a clear view of the global situation and all the cross checkings that one would like to have in order to clearly express his view regarding this chapter's matter. Second, as an individual, the expertise level varies quite substantially from one biotechnology sector to the other, and should therefore restrain from making too concrete propositions at this stage.

1. Given the fact that Jamaica's economy is essentially based on agriculture and farming, the first niche sector should be centered on these areas : plant biotechnology, agro-food biotechnology and veterinary medicine.

1.1 A priority should be to set up a plant cell culture facility where mass propagation techniques could be developed.

1.2 A second priority would be to set up the RFLP (Restriction Fragment Length Polymorphism) analysis method for typing new strains, new crosses of plants.

These two techniques, if they were controlled, can greatly accelerate many processes which today take several years. Examples: testing of seeds received from abroad and multiplication of the selected ones for distribution to the farmers. This is directly applicable to some vegetable/fruit industries in Jamaica (sugar cane, potatoes, banana) and to the floriculture sector (antherium, orchid, chrysanthemum, etc.).

1.3 Many plants grown in Jamaica suffer from various pests and diseases which greatly limit not only the productivity per se, but also the possibility to export these vegetables/fruits to the developed countries. This problem was illustrated to me for various industries, among which the sugar-, coffee-, pimento-, coco-, banana-, papaya-, mango-industries. The industry tries currently to solve this problem by using (often in a hides fashion) various chemical pesticides. Jamaica uses much more pesticides than any other country in the region. This massive use causes an additional problem towards the environment (see further point 3).

Biotechnology should be suitable to approach many of these pest control problems. First, it should be feasible to design diagnostic tests for many of these pests (for some diagnostics, samples had to be sent to England). Second, strains, resistant to the pests could be selected (or

constructed). Finally, biopesticides could be produced to replace the chemical ones.

1.4 In the veterinary field, classical biotechnology has already allowed Jamaica to select cattle breeds specifically adapted to its geography and to its climate (through the "tropicalisation programme" sponsored by the Ministry of Agriculture). Modern biotechnology can also bring a lot to this field. A first example appeared in the newspapers during the visit in Jamaica (We could read in The Gleaner of Friday, May 28, 1993: New drug to increase milk production available).

Indeed, BST (bovine somatotropin, a product of modern biotechnology and genetic engineering) increases the milk production average of a cow in Jamaica from approximately 150 to 350 milking days. In addition, it can also create between 10 and 40 per cent increase in the efficiency of milk production on each of these milking days. Extensive testing in developed countries has demonstrated that this product is totally safe for the cows and for the consumers.

This remarkable success of modern bictechnology illustrates, in fact, another problem. BST has been indeed available in the developed countries for about 5 years. However, its use has never been authorized in the US of in the EEC for political reasons : in these countries there is a huge excess of milk, whose production is furthermore heavily subsidized by the government. One should understand therefore that the American and European politicians did not want to further increase their milk production.

This situation is of course specific to the US and to the EEC and other countries such as Russia, South Africa, etc. have readily accepted BST.

The situation of Jamaica is different again. The increase of milk production brought in by BST will lower the Jamaican milk production costs to a level comparable to the ones of the imported milk. This should, on one side, strongly stimulate the local diary industry and, on the other side, reduce the current import level and therefore save some valuable foreign exchange.

Other products issued from modern biotechnology include, for example, PST which is the equivalent of BST, but from pork. Administered to the pork, it very significantly reduces its fat production in favour of its protein production. This results in a much leaner meat, much healthier for the consumer. Other modern biotechnology products include diagnostic kits and vaccines for various bacterial and viral diseases. Finally, given its geography and climate and the easy availability of sea and fresh water all around the

country, an area foreseen as a good future for Jamaica is aquaculture. Fish farms and more generally aquafarms (including for example oyster culture, shrimp culture) should be highly successful. Several fish species seem to grow well in Jamaica : tilapia, carp, colosoma, etc. Modern biotechnology is currently preparing a series of new products which could, for example, help the reproduction, the growth, the adaptation to salt/fresh water, the resistance to stress, to diseases of the fish, improving so the productivity of the farms.

2. About 99% of the commercial energy of Jamaica is produced from imported fuel, imposing a very heavy load on the country's economy.

   Biotechnology can propose a series of alternative sources of energy which, in fact, are already tested in some instances in Jamaica : biogas from farm wastes, municipal wastes, sugar industry wastes (bagasse) or from biomass specifically destined for that purpose (ex. leucaena). Some Jamaican specialists should follow the new developments in this field and evaluate their transposition to the Jamaican model.

3. Finally, a very important field of application of biotechnology is the environment.

   In Jamaica, as in many other countries, there are many sources of contamination for the environment : the pesticides (see above), the tourist industry, the bauxite industry, the rum industry, the oil spills, etc. Obviously, today a waste management programme is necessary, programme that would integrate various biotechnological approaches.

   For example:

   - chemical pesticides should be replaced by biopesticides or by strains resistant to the pests.

   - various wastes could be biologically transformed in animal feed or in biogas.

   - it should be mandatory for the hotel industry to biologically treat its waste. (In this respect, I have seen and been nicely impressed by the biodigestor of one of the big hotel resort on the north coast).

VIII. PROPOSAL FOR FUTURE COLLABORATION IN BIOTECHNOLOGY AND GENETIC ENGINEERING WITH OTHER COUNTRIES (WITHIN OR OUTSIDE THE REGION)

The first priority for Jamaica is to increase the critical mass of scientists involved in biotechnology, through a reinforcement and a deepening of the university capacity in its Sciences Faculty. This process may be long and laborious. To accelerate it, Jamaica should collaborate as much as possible with the exterior. The UNIDO ICBGG of New Delhi and Trieste should be the first contacts (see above).

Once the university will have been reinforced and once the regulations and guidelines will have been set up, Jamaica could then proceed with collaborations with either the developing or developed countries. Special attention should be given to the countries of the region which have a good level of expertise in a given field such as Cuba in human medicine, Mexico in some agricultural problems, etc.

This progressive programme should not however impede some Jamaican entities (private or public) to establish some punctual bilateral relationships on specific biotechnological problems with foreign partners. These early experiences could be very valuable in the future development of more important biotechnological ventures and at least establish some contacts with key actors on the international scene.

**SCHEDULE OF MEETINGS FOR THE VISIT OF DR. JOSEPH MARTIAL
26 MAY TO 9 JUNE 1993**

THURSDAY 26 MAY 1993

8:30 a.m. **Dr. A. Ventura**
Office of the Prime Minister
Jamaica House, 2 Devon Road, Kingston 10

9:30 a.m. **Mr. Barry Crowston, UNIDO Country Director**
Dr. D. Benn, UNDP Resident Representative
UNDP, 1 Lady Musgrave Road, Kingston 5

11:00 a.m. **Prof. K. Magnus**
Dean, Faculty of Natural Sciences,
University of the West Indies,
Mona, Kingston 7
Tel: 927-1660/9 ext. 2401 927 5293 (direct)
Fax: 927-5578/927-1640 927 1566 (voice fax)

1:30 p.m. **Dr. M. Ahmad**
Dr. W. McLaughlin
Biotechnology Centre
U.W.I., Mona

2:30 p.m. **Dr. D. Prasad**
Botany Dept
U.W.I., Mona

3:15 p.m. **Prof. T. Dasgupta**
Dr. P. Reese
Chemistry Department
U.W.I., Mona

4:00 p.m. **Prof. D. King**
Dept. of Microbiology
U.W.I., Mona

FRIDAY 28 MAY 1993

10:30 a.m. **Mr. C. Franklin, Permanent Secretary**
Dr. R. Baker, Director, Research & Dev. Div.,
Ministry of Agriculture,
Old Hope Road, Kingston 6
Tel: 927-1731
Fax: 927-1904

1:00 p.m. Depart Kingston for Bodles Agric. Station

2:00 p.m. **Mr. Maxwell**
Bodles Agric. Station,
Bodles, Old Harbour

MONDAY 31 MAY 1993

9:00-11:00a.m. A joint meeting of Jamaica Bauxite Institute, Geological Survey Dept., and Underground Water Authority will be held at the JBI Conference Room, Hope, Kingston 6 The following persons will be in attendance:

Ja. Bauxite Institute Tel: 927-2073, Fax: 927-1159
Mr. D. Morrison
Mr. P. Lyew-Ayee

Underground Water Auth. Tel:927-0077 Fax:977-0179
Mr. T. Hardware, Director

Geological Surv. Dept. Tel:927-1936, Fax:927-0350
Mr. R. Bryce
Mr. C. Baxter
Mr. N. Harris

2:00 p.m. **Mr. Falloon**
Sugar Ind. Research Inst.
Kendal Road, (Off Winston Jones Highway. Turn left at the church) Mandeville
Tel: 962-2241
Fax: 962-1288

TUESDAY 1 JUNE 1993

10:30 a.m. **Mr. Aaron Parke**
Director, Agro-Industries
JAMPRO,
35 Trafalgar Road, Kingston 10
Tel: 929-9450
Fax: 924-9650

1:00 p.m. **Mr. A. Lynch**
Director
Food Technology Institute
4 Winchester Road, Kingston 10
Tel: 926-8622
Fax: 927-5347

WEDNESDAY 2 JUNE 1993

8:30 a.m. **Mr. A. Wildish, Co-Mgr. Director***
Jamaica Broilers
15 Hope Road, Kingston 10
Tel: 926-3670
Fax: 926-8509

11:00 a.m. **Mrs. M. Henriques,**
Deputy Director General
Planning Institute of Jamaica
39 Barbados Ave., Kingston 5
Tel: 926-1480
Fax: 926-4670

2:00 p.m. **Mr. Devon Reynolds**
Managing Director
West Indies Synthetics Ltd.,
Twickenham Park, Spanish Town
Tel: 984-3081
Fax: 984-3151

4:00 p.m. **Mr. Franklin McDonald**
Director,
Natural Resources & Conservation Authority
53 1/2 Molynes Road, Kingston 10
Tel: 923-5155, 923-5166
Fax:923-5070

5:30 Dr. Venn

THURSDAY 3 JUNE 1993

8:00 a.m. **Dr. Lindsay**
Caribbean Agricultural Research Inst. (CARDI)
Mona, Kingston 7
Tel: 9271231

11:30 a.m. **Mr. B. Rodney***
Fisheries Division, Min. of Agriculture
Twickenham Park

Tel contact - Mr. Andre Kong, Marcus Garvey Drive, 923-8811

1:00 p.m. **Mr. P. Robinson***
Deputy Solicitor General
Attorney General's Office
79 Barry Street, Kingston
Tel: 922-6140, 922-4658
Fax: 922-5109

3:00 p.m. **Ms. Bevon Morrison**
Min. of Public Utilities, Mining & Energy
36 Trafalgar Road, Kingston 10
Tel: 926-9170
Fax: 926:2835

FRIDAY 4 JUNE 1993

7:00 a.m. Leave for:

- Grove Place - Manchester
- Aquaculture Jamaica Lrd. St. Catherine
- Montpelier Station, St. James

3:00 p.m. Jamaica Hotel/Runaway Bay

MONDAY 7 JUNE 1993

9:30-12 Noon **Meeting with Agricultural Boards and Director of SALADA Foods** at the UNDP Conference Room, 1 Lady Musgrave Road, Kingston 5.

In attendance will be:

Cocoa Industry Board
Mr. B. Topper
Mr. I Carrington
Ms. V. Wright
Marcus Garvey Drive, Kingston 15
Tel: 923-6411,
Fax: 923-5837

Coconut Ind. Board
Mr. R. A. Williams, Gen. Mgr.
(and his delegation)
18 Waterloo Road, Kingston 10
Tel:926-1770,
Fax: 968-1360

Min. of Agric. Export Div., Pimento Warehouse
Mr. M. A. Richardson, Gen.Mgr.
Marcus Garvey Drive, Kingston 15
Tel: 923-8878,
Fax: 923-7579

Banana Board,
Dr. Jean Dixon, Res.Dept.
10 South Ave., Kingston 4
Tel: 922-2083,
Fax: 922-5437

Coffee Ind. Board,
Mr. J. Pickersgill, Gen. Mgr.
Marcus Garvey Drive, Kingston 15
Tel: 923-7211,
Fax: 923-7587

Mr. John Fletcher, Mgr. Dir.,
SALADA Foods,
20 Bell Road, Kingston 11
Tel: 923-7114
Fax: 923-5336

1:00 p.m. **Dr. A. Gordon, Director***
Grace Food Processors, (Meat Div.,)
7 1/2 Retirement Road,
Kingston 5
Tel: 929-8411
Fax: 929-8411

3:00 p.m. **Dr. G. Taylor**
Executive Director
Scientific Research Council
Hope, Kingston 6
Tel: 927-1771/4
Fax: 927-5347

TUESDAY 8 JUNE

9:00 a.m. **Major A. Robinson***
President
Jamaica Manufacturers' Assn.
85A Duke Street, Kingston
Tel: 922-8880/1
Fax: 922-9205

11:00 a.m. **Dr. G. Wilson, Director**
Dr. L. McLaren
Ja. Agricultural Research Programme
17 Ruthven Road, Kingston 5
Tel:
Fax:926-8654

3:00 p.m. **Mr. Stephen McKay**
Technical Manager
SEPROD Ltd.,
3 Felix Fox Blvd., Kingston
Tel: 922-1220
Fax: 922-6948

Wednesday 9 June

10:00 a.m Dr. Omar Davies
Office of the Prime Minister, Kingston

2:00 p.m. Dr. Arnoldo Ventura
Office of the Prime Minister, Kingston

UNIDO comments on expert's mission report

The advisory services offered by Dr. Joseph Martial to the government of Jamaica towards the future application of genetic engineering techniques for the industrial development of the country have been satisfactorily evaluated by the national authorities. Several important recommendations towards the improvement of the research and development activities and their application on specific industrial sectors have also been presented by the expert.

One of the activities which prompt implementation could bring immediate benefits to the country is the establishment of coordination links between the university and the new biotechnology companies in order to speed the rhythm of new developments and to have the desired products in the market within the shortest possible period of time. Having optimal working connections among the concerned bodies, it will be possible to perform the necessary field trials, to guarantee the requested quality control analysis, to assure the validation of processes and installations and to speed the introduction of the selected products in the market.

The establishment of the recommended coordination links will contribute to create the necessary "entrepreneurial spirit" among the researchers from the University and National Biotechnology Centre as well as among the small producing enterprises, allowing to improve the utilized techniques and to replace those "classic biotechnological processes" by modern applied genetic engineering techniques.

Through its different sections, UNIDO could assist on the establishment of a cooperation programme between the above mentioned institutions and on the preparation of an integrated programme of cooperation addressed to contribute to the industrial development of the country via application of biotechnology and genetic engineering techniques.

Aspects such as organization of training programmes on specific subjects, participation on workshops, conferences, etc. should be taken into consideration as a measure to improve the qualification of the personnel and for the establishment of the necessary contacts with scientists and industrialists from other countries working in the field.

Another possibility to promote the application of modern biotechnology in the country is the inclusion of Jamaican National Committee on Biotechnology as a participating member of the network for Latin America and Caribbean region on Biotechnology and Genetic Engineering which has been successfully working for the last 7 years with the membership of 13 Latin American countries. The mentioned Regional Programme has dedicated special attention to activities related to agriculture biotechnology which is considered as one of the priority directions also for Jamaica.

Special attention must alsc be given to the application of biotechnology for the protection of the environment and treatment of effluents. The establishment of an appropriate waste management programme in which biotechnology might play a leading role could be considered by the government.

Based on the above mentioned facts, it is recommended that the joint preparation of an integrated programme for the future development of the modern biotechnology in Jamaica wherein the experience accumulated by UNIDO in the implementation of similar projects and programmes could be applied for the benefit of the national economy.