THE UNIVERSITY
OF THE WEST INDIES

IICA

WORKSHOP PROCEEDINGS

CARIBBEAN BIOTECHNOLOGY AGENDA FOR THE VALORIZATION OF GENETIC RESOURCES

October 15 – 16, 1991
Port-of-Spain, Trinidad and Tobago

PROGRAM II: TECHNOLOGY GENERATION AND TRANSFER

WHAT IS IICA?

The Inter-American Institute for Cooperation on Agriculture (IICA) is the specialized agency for agriculture of the inter-American system. The Institute was founded on October 7, 1942 when the Council of Directors of the Pan American Union approved the creation of the Inter-American Institute of Agricultural Sciences.

IICA was founded as an institution for agricultural research and graduate training in tropical agriculture. In response to changing needs in the hemisphere, the Institute gradually evolved into an agency for technical cooperation and institutional strengthening in the field of agriculture. These changes were officially recognized through the ratification of a new Convention on December 8, 1980. The Institute's purposes under the new Convention are to encourage, facilitate and support cooperation among its 32 Member States, so as to better promote agricultural development and rural well-being.

With its broader and more flexible mandate and a new structure to facilitate direct participation by the Member States in activities of the Inter-American Board of Agriculture (IABA) and the Executive Committee, the Institute now has a geographic reach that allows it to respond to needs for technical cooperation in all of its Member States.

The contributions provided by the Member States and the ties IICA maintains with its 13 Permanent Observer Countries and numerous international organizations provide the Institute with channels to direct its human and financial resources in support of agricultural development throughout the Americas.

The 1987-1993 Medium Term Plan, the policy document that sets IICA's priorities, stresses the reactivation of the agricultural sector as the key to economic growth. In support of this policy, the Institute is placing special emphasis on the support and promotion of actions to modernize agricultural technology and strengthen the processes of regional and subregional integration. In order to attain these goals, the Institute is concentrating its actions on the following five Programs: Agricultural Policy Analysis and Planning; Technology Generation and Transfer; Organization and Management for Rural Development; Trade and Agroindustry; and Agricultural Health.

The Member States of IICA are: Antigua and Barbuda, Argentina, Barbados, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Dominica, the Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St. Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, the United States of America, Uruguay and Venezuela. The Permanent Observer Countries of IICA are: Arab Republic of Egypt, Austria, Belgium, Federal Republic of Germany, France, Israel, Italy, Japan, Netherlands, Portugal, Republic of Korea, Romania, and Spain.

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Compiled by:

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PROGRAM II: TECHNOLOGY GENERATION AND TRANSFER

REPORTS, RESULTS AND RECOMMENDATIONS
FROM TECHNICAL EVENTS SERIES
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CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

BIOLAC	Biotechnology Programme in Latin America and the Caribbean
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CARIRI	Caribbean Industrial Research Institute
CBN	Caribbean Biotechnology Network
CCST	Caribbean Council for Science and Technology
CFCS	Caribbean Food Crops Society
CIRAD	Center for International Cooperation in Agricultural Research for Development
CRU	Cocoa Research Unit
ECLAC	Economic Commission for Latin America and the Caribbean
GRM	Genetic Resource Management
IBPGR	International Board for Plant Genetic Resources
IICA	Inter-American Institute for Cooperation on Agriculture
INRA-AG	National Institute of Agronomic Research - Antilles/Guyane (French)
IRFA	Fruit Research Institute (French)
IRAT	Tropical Agronomic and Horticultural Research Institute (French)
SCMA	Standing Committee of Ministers (responsible for) Agriculture
UWI	University of the West Indies

1. FOREWORD

The Workshop on **Caribbean Biotechnology Agenda for the Valorization of Genetic Resources** was organized and hosted by the University of the West Indies and IICA, with the collaboration of a large number of institutions from the public and private sectors interested in the capitalization of biotechnology to foster agricultural development, diversification, and sustainability in the Caribbean.

It sought to define a framework for regional action in biotechnology research/development, focussed on the management of genetic resources. This objective was attained beyond expectation.

After taking stock of current and proposed efforts for the valorization of genetic resources through biotechnology, the Workshop participants drew up a set of realistic recommendations, including concrete strategy and identification of means for their implementation. Moreover, even before the Workshop ended, commitments for inter-institutional cooperation had already been swapped among interested parties. The task ahead centers on materializing the contents of the agenda as set in the recommendations herein.

To save time and space, appendices and drawings presented in some of the papers are omitted, but can be obtained from the authors directly or through IICA. Technical editing of originals is minimal.

The organizers of the Workshop appreciate the technical, logistic and financial assistance received direct or indirectly from the institutions represented. Special thanks are given to the Representative of the IICA Office in Trinidad and Tobago, Dr Joan Wallace, and her staff for their sustained support to the organizing and holding of this Workshop from beginning to end.

W Jaffe
AM Pinchinat

2. RECOMMENDATIONS

1. POLICY

1.1 Priority Setting

The Caribbean Agenda on biotechnology should focus on genetic resource management as a first line of priority.

1.2 Action at the Regional level

An inventory of current institutional efforts on genetic resource management in the Caribbean should be undertaken as soon as possible, followed by analysis of constraints and proposals for joint action to overcome the weaknesses. The net result should be optimized utilization of the most valuable genetic resources available for socio-economic development and agricultural sustainability in the countries of the region.

1.3 Time frame for Short-term Implementation

- By May 1992, have a draft document which will be presented in its final form by IICA at the CFCS Meeting in the Dominican Republic (August 1992) for discussion and follow-up.

- In the interim, an advance report on the results of the inventory will be presented at a proposed meeting of the Caribbean Society of Biotechnology, on March 25, 1992, in Puerto Rico.

1.4 Strategy

- A Consultant will be hired by IICA to carry out the inventory.

- The exercise is to be planned and conducted in close collaboration with CARIRI/CBN, CARDI, UWI, ECLAC/CCST, and other relevant institutions including IBPGR.

- The Ministries of Agriculture and CARICOM Secretariat will be duly informed by IICA on the development of this undertaking.

- The institutions which have pledged technical and logistical support through their representative at the Workshop: CARIRI/CBN, CARDI, UWI/CRU, CIRAD (IRFA, IRAT) and INRA-AG will be involved in the implementation and follow-up of the inventory.

- The inventory will be Caribbean-wide in scope.

- Institutional activities on all available genetic resources (crop, livestock, microorganisms) will be considered.

- Specific recommendations for regional cooperation on germplasm resource management will be based on the findings and conclusions of the inventory. A

Commission on GRM could be considered.

- Special documents (articles and position papers) on biotechnology and its impact on GRM will be prepared by IICA and cooperating institutions for attention by the general public, institutions, SCMA and Heads of Government in the region.

1.5 Funding

IICA will seek funding for carrying out the inventory and presenting its results and ensuing recommendations to interested parties, especially the CARICOM Secretariat.

2. BIOTECHNOLOGY DEVELOPMENT AND TRANSFER

2.1 Priority Setting

- Expansion of a data base to include a directory of institutions, current and proposed technical activities, and opportunities for training.

- Diffusion of information, especially through CBN Newsletter, CFCS Newsletter, CCST Newsletter and other relevant media.

- Concentration of institutional efforts on most socio-economically important areas of research, technology development and technology transfer for the capitalization of genetic resources.

2.2 Action at the Regional level

Prepare a project proposal for each of the following priority areas:

2.2.1 Crop and animal improvement and multiplication

- Fruit crops (papaya, pineapple, passion fruit, golden apple)

- Root and tuber crops (yam)

- Ornamentals (anthuriums, orchid)

2.2.2 Characterization of germplasm (through morphological, biochemical, genetic means)

2.2.3 Germplasm conservation

2.2.4 Development of institutional capability for embryo transfer in livestock

2.3 Time Frame for Short-term Implementation

By April 1992, project ideas will be identified by IICA in consultation/cooperation with

relevant/interested institutions, to be followed by preparation of project outlines and feasibility studies as the case may be.

2.4 Strategy

IICA through its Projects Unit (based in Barbados) will assist the cooperating institutions in the formulation of project ideas and outlines and negotiation of completed project proposals in those four priority areas.

2.5 Funding

- The short-term action will be funded within normal budget limitations of IICA and cooperating institutions.
- External funding will be sought as needed.

3. TRAINING

3.1 Priority Setting

- Capitalize on training opportunities available in the Caribbean and cooperating institutions outside the region.
- Include a training component in the regional biotechnology development and transfer project proposals formulated for external funding.
- Expand/intensify diffusion of information on training opportunities within and outside the region.

3.2 Action at the Regional level

- The cooperating institutions will promote development of appropriate curricula in their basic fields leading to adequate academic preparation for advanced training in biotechnology.
- Means to increase/facilitate training will be included in the proposals for regional biotechnology development and transfer projects submitted for external funding.

3.3 Time frame for Short-term Implementation

This area of action will begin immediately.

3.4 Strategy

- Priority target beneficiaries are Junior research/extension professionals and

students.

- Action proposals will capitalize on existing training schemes in the region and explore access to new ones outside the region.

- Action proposals will cover both formal and informal training programmes including reciprocal visits, distribution of documents and organization of informal training events such as seminars and specialized training workshops.

- Training proposals will be linked to priority research/development programmes and projects.

3.5 Funding

Support activities to training development will be funded within current budget limitations of IICA and other concerned institutions, and through the projects proposed for external funding in the four priority areas for biotechnology development and transfer.

3. PRESENTATIONS

REMARKS FROM IICA

J S Wallace

I wish to add my welcome statement to those of Dr Ali and Dr Spence. The IICA Office in Trinidad and Tobago is pleased to co-host this workshop with the University of the West Indies.

Let me bring you greetings from the Director General of the Inter-American Institute for Cooperation on Agriculture (IICA). IICA, as you know, is an International Organization with offices in 32 nations of the hemisphere, from Canada to Argentina. IICA has a strong interest in the topic under focus in this Workshop through its Program II (Generation and Transfer of Technology). I am pleased that we have Dr Walter Jaffe from IICA's Headquarters, Costa Rica, to share with you IICA's experience and action as deemed relevant to the Workshop's purpose.

Adding value to Caribbean Genetic Resources by using biotechnology as a tool for agricultural development is extremely important. The new Biotechnologies are not only a methodology which will yield exciting results, but they will impact on policies that govern agricultural technology. For example, there may be strong feelings in the United States of America about approving research which will help cows produce more milk, since milk is overly abundant there. However, research of this kind may be needed in other countries as, certainly, root crops such as cassava and dasheen will receive little priority in temperate countries. It is therefore quite important to protect and valorize the precious genetic resources available in the region.

In addition, biotechnology offers tropical countries shortcuts, thus allowing them to miss some of the stages which agriculture of the temperate countries is obliged to go through, making research more profitable. This applies for example, to the rapid propagation of planting material and plant or animal improvement programs.

It has been said that biotechnologies offer developing countries a chance to create and control variability; to conserve and exchange germplasm; as well as to diagnose plant diseases and breed pathogen-free plants.

Biotechnology is radically different from previous technologies because, for the first time, commercially relevant technical information is close to the frontiers of basic research in molecular and cell biology. New work is being done by universities, research centres and commercial laboratories with no experience in agriculture. Therefore, we cannot claim this methodology as only ours in agriculture.

There are many players in the field. Some are only interested in the market place and will focus on commodities which will make money. We are pleased that in Trinidad and Tobago, advanced rum biotechnology makes money. But if research is demand-driven, this should be relevant to other Caribbean countries.

We are still at the dawn of a new era, preparing to cross new frontiers. The Caribbean

must have its own strategy for not only utilizing biotechnology as a methodology, but in gaining access to the results of biotechnology utilized in other settings. The field is moving rapidly, we must define our goals. We do not wish to be simply onlookers with nothing to say about priorities or policies.

The region is rich with genetic resources. These must be protected and enhanced. The cocoa collections in Trinidad and Tobago are excellent models of what must be done to conserve genetic resources.

You have attended many meetings on biotechnology. The question is what happens after the meeting?

We know that CARIRI has begun a biotechnology network which has a newsletter and conducts or supports a small biotechnology research/development program in the Caribbean. If we begin where we are, we need to consider what can be done to enhance that.

We want this meeting to be different. Different because we want you, the decision makers, to make a commitment to develop an agenda, to deal with the difficult issues of policy, national and regional; to plan training by looking at all the opportunities and options. Most of all, we want you to follow up with a regional strategy for cooperation, looking at the various models which have been tried in the region. It is important to be action-oriented and get something accomplished.

We need to move together. Like the fingers on a hand we are all different. Each finger alone is of little use, but moving together and in relation to each other, they can pick up things, hammer, play an instrument or make a fist.

It is up to you to keep them working together for science, your nation and the region.

BIOTECHNOLOCY RESEARCH, DEVELOPMENT AND TRAINING AT THE ST AUGUSTINE CAMPUS OF THE UNIVERSITY OF THE WEST INDIES

J Duncan

One of the features common to most Member States of the Commonwealth Caribbean is the high food import bill characteristic of their economies. Any effort to redress the existing imbalance must include increased food production. This calls for effective management and conservation of our genetic resources, both plant and animal. As is characteristic of the tropical region, there is great diversity in the genetic resources yet to be gainfully exploited.

The problem at hand calls for the adoption of both long and short-term strategies. While there are traditional methods for every aspect of manipulation of genetic resources, these are all at best slow in taking effect and thus making an immediate impact. Biotechnology however, offers methodologies at both cellular and molecular levels which can be employed effectively to meet some of the demands. It is in the light of the foregoing, that a programme in biotechnology has been developing at the St Augustine Campus of the University of the West Indies.

The programme has been developing on a phased basis and includes elements of training and research. Training is effected at the Undergraduate level through an optional course for final year students in the Faculty of Natural Sciences which until recently was called Plant Propagation and Improvement. The course is now restructured as an Introduction to Plant Biotechnology and is offered also as an elective to students in the Faculty of Agriculture. At the postgraduate level, students read for the M.Phil and PhD degrees in the programme. Research to date has focused principally on plant biotechnology with two objectives:

i) micropropagation and

ii) crop improvement

In addition to the foregoing, a project in isoenzyme analysis by starch gel electrophoresis to identify the 2,000 *Theobroma cacao* accessions held by the Cocoa Research Unit (CRU) in the International Cocoa Genebank, Trinidad (ICGT) is in progress.

The research is conducted principally by the Department of Plant Science and the CRU.

Protocols have been adapted to suit locally available varieties of sweet potato (*Ipomoea batatas*), cassava (*Manihot esculenta*), pineapple (*Ananas comosus*) and sugar cane (*Saccharum officinarum*), while the development of protocols for the propagation of *Artocarpus spp* (breadfruit, breadnut, jackfruit) and yam bean (*Pachyrizus erosus*) is in progress with some measure of success.

Among horticulture species, protocols have been adapted for Anthurium species and various species of orchids, while protocols have been developed for the propagation of *Mussaenda erythrophylla "rosea"* and *Alpinia purpurata* and are being developed for *Aechmea naudicaulis, Aechmea dichlamydea var trinitensis*, and *Heliconia spp.*

In conjunction with the Cocoa Research Unit, a project is in progress which seeks to achieve:

- *in vitro* propagation of clonal cocoa material;
- *in vitro* conservation of germplasm; and
- cryopreservation of cocoa germplasm

Improvement of crop species has been attempted to date in sugar cane and banana only. Both selection from among somaclonal variants and screening of plantlets regenerated from meristems that have been subjected to mutagene physical (gamma rays) and chemical (sodium azide, ethylmethanesulphonate and diethyl sulphate) means have been the methods adopted. Streams of sugar cane tolerant of high levels of herbicide and variants of Highgate (Gros michel) banana tolerant to *Fusarium oxysporum f.sp. cubense* race 2 have been obtained and have stood up to tests at both laboratory and greenhouse levels. Field evaluation is now in progress.

It is planned to approach improvement through transformation of an area that will be handled by Drs Grace Sirju-Charran and P Umaharan. Efforts at improving cocoa, possibly through transformation will be attempted in conjunction with the Cocoa Research Unit.

Developing in parallel with the plant biotechnology programme is a programme in Food Technology in the Department of Crop Science. This programme seeks to develop through post-harvest studies, methods of preservation of food crops and of those that in general extend the shelf-life of products of plant origin.

In the isoenzyme programme at the Cocoa Research Unit, the polymorphism and variation of six enzyme systems involved in metabolic pathways are being investigated. Thus far, accessions showing similar phenotypes which could not be distinguished by morphological descriptors were separated into groups based on this biochemical technique. The uitimate aim of the project is to describe each of the 2,000 accessions with isoenzyme fingerprints.

Isoenzyme markers have been used not only for the characterization of many crop cultivars, but are also used as markers when linked to agronomic traits such as disease resistance and yield.

However, two of the major problems associated with germplasm characterization by isoenzyme analyses are variations in isoenzyme banding patterns due to physiological and environmental control of isoenzyme expression, and misinterpretation of banding patterns due to lack of knowiedge of the genetic control of the enzyme systems. A more definitive and constant method for fingerprinting is based on a DNA polymorphism assay.

The Random Amplified Polymorphic DNA (RAPD) technique which has already been used in Scotland for fingerprinting of cocoa accessions, will also be attempted.

In the Department of Livestock Science, plans are afoot for the initiation of a programme of reproductive physiology including embryo transfer technology in dairy stock.

These are the current lines of investigation which along with those proposed in the Faculties of Agriculture and Natural Sciences seek to address through biotechnologies the problems of food security in the countries of the region.

BIOTECHNOLOGY RESEARCH/DEVELOPMENT AND TRAINING AT THE UNIVERSITY OF THE WEST INDIES, MONA, JAMAICA

M H Ahmad

Biotechnology has emerged as a powerful tool towards the development of many aspects of human life. The spectacular advances in Molecular Biology and Biotechnology in recent years have led to an explosion of ideas on their applications to overcome a variety of problems and for the improvement in production over a wide range of areas like agriculture, industry, energy, mining, health and environment.

Realizing the role which Biotechnology is to play in national and regional development in coming years, the University of the West Indies has taken a lead role in setting up a Centre of Biotechnology at the Mona Campus. The Centre aims to be one of excellence for research and training in Biotechnology. This centre is one of the most modern and sophisticated in the region in scientific equipment and research facilities.

The Objectives of the Centre are

. To formulate and implement a regional plan of research, education and training in Biotechnology.

. To establish linkages with the private sector for promoting the role of Biotechnology in industry, agriculture and health.

. To give training in various disciplines of Biotechnology.

BIOTECHNOLOGY R/D ACTIVITIES

The Biotechnology Centres activities in Research and Development (R&D) either independently or in coordination with the Private Sector have been focused in the following sub-sectors and projects.

Agricultural and Plant Biotechnology

. Feasibility studies on the commercial production of Sweet and Yellow Yam by using modified minisett technology.

. Examining genetic diversity in Yams by using isoelectric focusing gels and by RFLP analysis.

. Production of transgenic hot pepper virus resistant plant.

. Breeding of red peas for disease resistance and enhanced biological nitrogen fixation.

- Molecular characterization of gemini mosaic virus of red peas.
- Use of VA Mycorrhiza to increase productivity in vegetables and legumes
- Development of legume innoculant
- Molecular approach to studying bacterial blight disease in anthurium
- Production of disease resistant varieties of cacao plants by tissue culture

Animal Biotechnology

- Recycling of agricultural wastes for the production of animal feed ingredient and organic fertilizer
- Use of microbes in animal feed as a substitute for antibiotics

Fermentation Biotechnology

- Production of citric acid from molasses
- Fermentation of sorghum for food and feed
- Uses of waste yeast from fermentation industry

TRAINING

The Centre has been giving training in the basic techniques of molecular biology and biotechnology and also in later stages, the students are involved in the application of biotechnology by working with the private sector. So far, fifteen postgraduate students (for M.Phil and Ph.D degrees) have been actively working in various areas of biotechnology.

The Biotechnology Centre welcomes sponsored projects which may be either for short-term training or as a fellowship for postgraduate or postdoctoral training. Last year, the Centre organized a workshop on Biotechnology for Science Teachers. In the future, the Centre plans to organize a seminar for people involved in agro-industries.

STATEMENT BY CARDI

St C Forde and G Muller

The Caribbean Agricultural Research and Development Institute (CARDI) was established in 1975 to provide an appropriate agricultural research and development service to the Member States of the Caribbean Community and Common Market (Antigua and Barbuda, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Montserrat, St Kitts/Nevis, St Lucia, St Vincent and the Grenadines and Trinidad and Tobago).

Its Mission is: **To contribute to agricultural development through the generation and dissemination of appropriate technology that benefits the Caribbean people** in fulfillment of which, the Institute has given priority to the production of **clean** planting material of improved crop varieties. One of the methods used to produce such material is tissue-culture or micropropagation.

This statement focuses on the applications of tissue-culture in the following areas:

- crop improvement of yam and tannia
- germplasm conservation and micropropagation
- technology transfer

1. Crop Improvement

a) Yam (*Dioscorea alata*)

CARDI's involvement in Tissue Culture began in 1979 in Barbados with the Yam Virus Research Project which was initiated to eradicate the virus causing Internal Brown Spot (IBS) of yams, a major economic disease (especially of the cultivar White Lisbon) which reportedly reduced the marketability of the White Lisbon in Barbados and overseas by up to 50 per cent.

A multidisciplinary project team developed techniques of chemotherapy and apical meristem culture for the production of IBS-free setts.

Following the successful application of these techniques, a yam seed production scheme was implemented to ensure the availability of virus-tested yam planting material to growers, mainly in Barbados. This led to the initial production of 650,000 virus-tested plants from a single parent within ten months.

In the course of this scheme, the present Tissue Culture Laboratory was established at Diamond Valley, St Philip, Barbados.

By 1984, the Laboratory had produced and distributed approximately one million kilograms of planting material to farmers. This improved material was responsible for yield increases of 35 - 90 %.

b) Tannia (*Xanthosoma sagittifolium*)

In response to the outbreak of Tannia Leaf Burning Disease in Dominica, caused by the fungus *Pythium myriotylum*, CARDI developed a technological package for its control.

A crucial element of the techpak was the use of disease-free planting material. Using limited facilities, CARDI's scientists pioneered the use of a two-phase system to produce healthy corms to satisfy the demands of farmers in the Windward Islands.

The rapid clonal multiplication of disease-free corms involves a combination of:

(a) *in vitro* propagation of selected tannia cultivars, and

(b) *in vitro* minisetting of the corms developed from plantlets

This technique improves tannia germplasm stock and, at the same time provides a practical and economically viable system for rapid multiplication.

These case studies illustrate problem-driven applications of tissue-culture.

2. Germplasm conservation/micropropagation

The Tissue Culture Laboratory in Barbados operates, not only as a repository for the original virus free yam material, but also as a germplasm storage unit for other selected crop species, viz.:

- Yam (*Dioscorea alata, D. trifida, D. cayensis, D. rotundata*)
- Sweet potato (*Ipomoea batata*)
- Cassava (*Manihot esculenta*)
- Pineapple (*Ananas comosus*)
- Banana/Plantain (*Musa spp*)
- Anthurium (*Anthurium spp*)

This germplasm is used to provide Member States with plantlets on request. To date, Barbados, Grenada, St Kitts, St Lucia, St Vincent, and Trinidad and Tobago have received plantlets for weaning and hardening.

3. Technology Transfer

Apart from the production and germplasm collection functions, CARDI is actively involved in the transfer of technology. The Institute has trained regional technicians in the fundamentals of tissue-culture and, specifically, on the weaning and hardening of plantlets.

CARDI also provided management and technical consultancy services to the National Agricultural Research Institute (NARI) in Guyana and to the Ministry of Agriculture, Industry and Labour, in St Vincent and the Grenadines. Additionally, the Institute hosted a regional workshop on Virus Diagnostics at which state of-the-art techniques including ELISA, were introduced to the practitioners.

In collaboration with the CFC, CARDI has reviewed the status of tissue-culture facilities in the region and proposed a strategy for their rationalization.

4. Prospects for Development

CARDI is seeking to rationalize its tissue-culture operations to bring them more into line with the changing economic environment in the region and examining more/other appropriate biotechnology applications. Currently, CARDI's strategy is based on two components:

- production, and
- developmental/adaptive research

This strategy represents a more realistic approach to the environment in which the Institute now operates and is more in tune with the needs of the CARICOM Member States. It also makes for more tangible returns on investments.

During the next few years, CARDI will be conducting research into the development of commercial in vitro protocols for some economic species/varieties of ornamentals, particularly Anthurium and Heliconia.

With the reappearance of symptoms of IBS, yam virus research has resumed focusing on the purification and identification of the virus using ELISA and other appropriate techniques.

In collaboration with researchers at the UWI (Cave Hill Campus) and Wye College (United Kingdom) CARDI will be investigating the introduction of anthracnose resistance into *Dioscorea alata L.* by gene transfer and mutagenesis and on somatic variation.

Taken together, these two projects seek to provide to the region's growers planting material which would be both virus-tested and anthracnose resistant.

As an ongoing service, the CARDI Tissue-Culture Laboratory will continue to provide micropropagation services on request to interested parties.

In meeting its commitment to the region, CARDI collaborates with other institutions on activities of regional interest. It is a member of the Caribbean Biotechnology Network and has linkages with the following institutions:

- UWI, Cave Hill, St Augustine, Mona
- NARI, Guyana
- SRC, Jamaica
- Biotechnology Centre, Jamaica
- Wye College, United Kingdom
- INIVIT, Cuba
- CIP, Peru
- CIAT, Colombia
- University of Minesota, United States of America

In support of the Agricuitural Research and Extension Programme (AREP) and the West Indies Tropical Produce Support Project (TROPRO), CARDI has been mandated to develop and adapt improved technologies for diversified agriculture. These technologies include the micropropagation of fruit and tree crops, especially plantain and pineapple.

BIOTECHNOLOGY RESEARCH AND DEVELOPMENT AT IRAT/CIRAD IN GUADELOUPE

B Courtois and P Feldmann

CIRAD is a French Organization of applied research whose vocation is to work on tropical crops, in cooperation with countries which have requested such collaboration. CIRAD is structured by plant groups. IRAT is the department specializing in food crops.

IRAT undertakes in Guadeloupe, research programmes on sugar cane, rice, maize (in collaboration with INRA) and on ornamental plants (Anthurium, Orchids, *Alpinia sp*, *Alocasia sp*, *Heliconia sp* and *Strelitzia sp*). To complete these programmes, IRAT has an experimental station of about ten hectares and a tissue culture laboratory of 300m^2.

All the research programs are concerned with breeding. This implies having access to collections of varieties which are representative of the variability of the studied species, using them for creating new variability and selecting into this variability. The main biotechnology tool used is vitroculture.

1. Sugar Cane

This programme is aimed at creating varieties with wide adaptability for Africa or the French West Indies.

The basic Guadeloupean collections are of two kinds:

- a field collection of 1100 clones including clones of *Saccharum spontaneum*, *S. officinarum*, *S. robustum* and *Erianthus arundinacearum*.

- an *in vitro* collection of 50 accessions to which can be added, when necessary, the 400 accessions of Montpellier (France) *in vitro* library. It is planned to duplicate this library in Guadeloupe.

This collection is regularly enriched with introductions of varieties, in the form of cuttings or vitroplants, coming from the quarantine station of Montpellier through which must pass all the material introduced into Guadeloupe.

The exploitation of the variability to create new varieties is done using hybridization (150 crosses each year), and field selection.

Besides these classical techniques, the genetic improvement of sugar cane involves *in vitro* culture techniques: somaclonal variation, *in vitro* germination of hybrid seeds and *in vitro* propagation of the selected clones.

The methods for creating genetic variability in plants via tissue culture have played a large part in this programme. Several thousand somaclones from different varieties have been studied

in vitro and in the fields since 1978. The variability obtained is always similar to the usual intraclonal variability.

This research has enabled us to develop reliable techniques for sugar cane multiplication. The *in vitro* introduction is done through:

- callogenesis from leaf tissue,
- stem bud culture (most used technique),
- apex culture,
- meristem culture (increasingly used technique).

These *in vitro* explants can be used later to produce vitroplants on a fairly large scale (through liquid medium culture), to set up disease-free sugar cane nurseries. This is now the case for all new nurseries established in Guadeloupe. All exchanges of varieties with the outside systematically use vitroplants.

A new program of production of haploid plants through anther culture is going to be undertaken in Guadeloupe. This will benefit from the experience of an already established programme on rice and from new ones on banana at IRFA/CIRAD in Guadeloupe and coffee at CATIE (Costa Rica). With sugar cane, the main interest of haploid plant production is to simplify the genetic studies of some characters and then to understand the transmission of these.

To better understand the organization of genetic variability and to be able to define a comprehensive strategy to choose crosses, the study of the available variability is also made using enzymatic and RFLP studies. The technical work is done in the CIRAD Molecular Markers Laboratory situated in Montpellier. The results are to be used in Guadeloupe.

2. Rice

The IRAT rice collection is stored in Montpellier as seeds. This collection is duplicated at IRRI (Philippines), the institute whose vocation is to preserve the world rice collection. This IRAT collection includes 7300 entries of different species, mainly the cultivated species *Oryza sativa* and *O. glaberrima* but also some accessions of the wild species *O. breviligulata* and *O. longistaminata*.

The sativa species is largely made up of tropical upland rice of japonica type, originating in West Africa, Brazil and the Malagasy Republic (90% of the total) but it also includes a few indica varieties adapted to aquatic culture (10% of the whole). It includes notably all the traditional African ecotypes brought together through the prospections financed by IBPGR (2400 accessions).

The team in Guadeloupe is responsible for the rejuvenation of the collection, which is undertaken during the dry season (with 1500 to 2000 varieties multiplied per year). Guadeloupe

is not a rice growing country, but the conditions are favourable for the maintenance of a collection: appropriate climate, absence of disease (notably biast) and few pests.

The exploitation of the existing variability is made through crosses within or between groups. The most commonly used selection method is genealogical selection, which is, since the discovery of a male sterility gene, an important development of recurrent selection techniques. Although a program of creation of F_1 hybrids is also developing in French Guiana, the main cultivated genetic structure is still pure line. The fixation of these lines is made either by successive selfings or by in vitro anther culture.

Anther culture is the part done in Guadeloupe which supplies the French rice growing area, French Guiana, and the African Network on Upland Rice with fixed lines. The main advantage of anther culture is that lines may be fixed more rapidly. This can take a year, whereas four to five years are generally required when using traditional methods. Our goal is large-scale production of plant material (an average of 500 doubled haploid lines per year).

The IRAT researchers propose the use of crosses that originate from their own programmes. The F1 seeds are produced at Roujol and exploited through anther culture. The doubled haploid lines are returned to those who request them to be screened in the situation of their future use. As IRAT is more involved in upland and lowland rice breeding, these lines are mainly of *japonica* type or of intermediate *japonica* x *indica* type.

These lines are used either directly as varieties, or for genetic studies, using morphological or enzymatic markers.

3. Ornamental Plants

The program of ornamental plants is mainly devoted to the perfection of techniques of *in vitro* culture, this with the goal of multiplication of genus whose importation constitutes a non negligible risk for the cultivated crops.

The studied species are anthurium (15 hybrid varieties *in vitro*) for which the technique is already operational; and *Alpinia vitata*, *Alpinia purpurata*, *Alocasia macrorhizos*, *Heliconia caribaea* and *Strelitzia reginae* for which the technique is still to be defined.

4. Orchids

IRAT owns an *in vitro* collection of orchid species (one hundred genotypes). About thirty species are wild orchids of Guadeloupe, now threatened with extinction, for which the setting up of an *in vitro* multiplication technique from seeds constitutes the only means of protection.

Some species, of strictly horticultural interest (about sixty accessions) are also being multiplied to respond to the needs of local professionals and private individuals.

BIOTECHNOLOGY RESEARCH/DEVELOPMENT AT IRFA/CIRAD
An Overview of Biotechnology Activities of IRFA/CIRAD in the West Indies

F Bakry

There are two IRFA/CIRAD research stations in the West Indies (one in Guadeloupe and the other in Martinique). Both stations are working in close relation with the CIRAD Centre laboratories based in Montpellier (France) under control of the central direction in Paris (France). The IRFA/CIRAD staff in the Caribbean constitutes of 17 scientists with the support of about 137 persons elsewhere.

Research in agronomy, phytopathology (pests and diseases) and physiology, is planned to respond to the problems of the local producers. Long-term studies are currently developed also in plant genetics with more fundamental objectives. Three main plant improvement projects are carried out in the IRFA stations: banana, pineapple and citrus.

Because of specific sterility and triploidy problems, the banana improvement programme is the most dependent on biotechnology techniques.

I. Biotechnologies for Evaluation of Genetic Resources

IRFA/CIRAD maintains in the Caribbean four collections of international vocation: pineapple and citrus in Martinique, banana and others tropical fruits in Guadeloupe.

These collections are evaluated by different types of descriptors.

For banana, evaluation proceeds through morphological description of 123 characters and computer-assisted identification (MUSAID software) and on a more genetical ground, through isozyme electrophoresis and systematic fertility estimates, complemented to some extent by cytogenetic studies (e.g. ploidy level).

Isozyme electrophoresis is unavoidable, as it is the easiest and cheapest way to quantify the genetic relations between accessions. As demonstrated by a wealth of isozyme literature, it is of considerable value to the genebank itself and the valorization of genetic resources (Simpson & Withers, 1986). Polyacrilamide and starch gel procedures are commonly applied to genetic resource management of Musa species at the electrophoresis laboratory of IRFA/CIRAD in Guadeloupe.

Recently, collaboration has been initiated with INRA in Guadeloupe for variety identification of yam cultivars. Many other crops, of great interest in the Caribbean area (such as sugarcane and pineapple), are identified by the use of isozyme electrophoresis.

For pineapple, morphological evaluation is carried out through the description of characters. Pollen studies and cytogenetics are simultaneously developed to support the classification of new accessions.

For citrus, the collection is evaluated by numerical taxonomy. A set of characters has been selected and a calculation method has been devised to determine the validity of citrus classification. The study of affinity relations in citrus and close relatives is possible with this technique as complement of traditional methods of analysis.

The rapid development of DNA technology has provided a new approach to the use of genetic resources. RFLP methods are applied at the CIRAD Centre in Montpellier (France) to many tropical crops, including bananas, pineapple, citrus, sugarcane and cocoa. Studies are carried out to develop the most appropriate methods to be used in tropical countries (PCR/RAPD).

II. In Vitro Culture Applied to the Valorization of Genetic Resources.

The *in vitro* culture laboratory of the IRFA/CIRAD in the French West Indies is located at the Neufchateau station in Guadeloupe. This small research unit supports the needs of the IRFA breeding programmes in the region. It is not a laboratory of rapid mass propagation of vitroplantlets. This work is ensured by VITROPIC, a production laboratory based in France near the city of Montpellier.

2.1 Shoot Culture and Germplasm Exchange

For obvious sanitary reasons, all the germplasm of banana or pineapple must be introduced in the form of vitroplantlets. The material is previously indexed for main diseases in the CIRAD Montpellier centre far from the production regions.

For pineapple, a basic collection of representative clones is currently established *in vitro* in the Caribbean to facilitate future exchanges (with the best sanitary guarantees) with our partners in this region.

Banana germplasm cannot be exchanged in the same way. All this germplasm must transit by the international center of INIBAP (International Network for the Improvement of Banana and Plantain) located at Katholieke University of Leuven (Belgium).

On the other hand, shoot tip culture of bananas is used in our IVC laboratory to propagate on a small scale (about 200 plants) new clones to be tested in real conditions.

Mangosteen (*Garcinia mangostana L*) praised as the queen of tropical fruits is still difficult to propagate by classical horticultural means, showing low seed germination level or similar bad results with cuttings.

A method of *in vitro* rapid propagation was developed in Guadeloupe two years ago. After sterilization, superficial tissues of apomictic seeds were allowed to bud on a cytokinin medium. Shoots were isolated and rooted on an auxinic medium.

There are no problems in maintaining the culture, but transfer of plantlets to the greenhouse is more difficult. About 80% of the transferred shoots die and only 40 plants could be well established in that case. Mangosteen *in vitro* plantlets seem to be very sensitive to

inappropriate external conditions. Efforts are still maintained to find out ideal conditions for a good growth in the nursery.

2.2 Banana Embryo Rescue

Seed setting is extremely low in the cultivated banana clones (1 - 10 seeds/bunch). Moreover, germination is very bad (0 to 20%) after classical sowing. Because banana seeds do not conform to the standard wild type, embryo shape is often irregular. Some seeds do not contain any albumen (or very little). In other varieties, whereas the fruits are fully ripe, seeds do not reach full maturity (embryo in globular shape, liquid albumen) at harvest.

Embryo-rescue culture is routinely practiced in our laboratory at Neufchateau Station. The *in vitro* germination level has been notably increased (up to 60 - 95%) depending on the type of cross. So, the use of zygotic embryo rescue allowed the obtention of hybrids from seeds, which was very difficult before.

Embryo-rescue culture is also very important in planning progeny testing. In fact the parents rarely flower at the same time. So it is very difficult to get simultaneously a sufficient number of individuals for comparative trials. For this reason, a simple method has been devised for hybrid conservation: after *in vitro* germination, hybrid embryos are placed on the same medium at 14°c and 15 h daylight to reduce growth rate. When the number of individuals is sufficient, they are placed back in normal conditions (MS medium, 27°c, 16 h daylight) to resume normal growth.

2.3 In Vitro Duplication of Diploid Clones of Banana by Colchicine Treatment

The IRFA banana breeding scheme is based on the improvement of diploid clones with the synthesis of triploids as the final target. Triploid varieties are obtained by intercrossing diploid and tetraploid plants (Vakili, 1967). The latter derive from duplicated diploid clones treated with colchicine.

Previous work on wild diploid bananas showed that duplication was possible in seeds. Nevertheless, this technique does not offer any advantage with parthenocarpic diploid varieties which are quite sterile. Moreover, duplicating untested seed-derived individuals is not very useful.

At Neufchateau Station, we have devised a method of duplicating diploid clones, applying the colchicine treatment on *in vitro* bananas in the proliferation phase. It gave good results with *M. acuminata*: at least, one tetraploid plant was obtained from each of the seven treated clones.

This technique will be applied very soon on *M. acuminata x M. balbisiana* hybrids which are sterile at the diploid level.

4. In vitro Androgenesis in Banana

The obtention of homozoygous diploid clones is an essential step in our banana breeding scheme. The plants are self pollinated with little success (very high female sterility). We are now trying to develop an androgenesis technique on bananas to get pure lines rapidly. Preliminary

positive results have already been obtained with the wild type *M. acuminata burmannica* in our station. Doubled haploids were grown from cultured anthers and their microsporial origin confirmed by electrophoresis.

These results will now be developed by a Ph.D degree student in Guadeloupe, to extend the technique to cultivated varieties.

References

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VAKILI, N G. 1967. The experimental formation of polyploidy and its effects in the genus Musa. Amer J Bot 54 (1):34 - 36.

MANAGEMENT OF PLANT GENETIC RESOURCES AT THE INRA CENTRE FOR ANTILLES-GUYANE (GUADELOUPE, FRENCH WEST INDIES)

L Degras

The Institut National de la Recherche Agronomique for Antilles-Guyane (INRA-AG) is active in the management of genetic resources through its Plant Breeding Station first, but also through its stations of Physiology-Biochemistry, Plant Technology and Plant Pathology.

At the Plant Breeding Station, following an important activity in forages, which brought wide resources of Guinea grass (*Digitaria*) and other perennial grasses, programmes had turned towards legumes (essentially *Stylosanthes*) and principally, towards annual cereals (maize and sorghum).

But one of the most important breeding activities of the station is still its vegetable selection. This had led to the screening of hundreds of genotypes of Eggplant, Tomato, Bean and Cowpea. A less important approach concerns okra.

The work on Root Crops undertaken since 1964 at INRA in Guadeloupe is perhaps the most characteristic of the Centre. Nowhere, except in IITA, has so much attention been given to yam. There, connection with modern biotechnology is increasing due to the interest found in the plant by temperate laboratories. Some screening and accumulation of genetic resources have concerned sweet potatoes, and to a lesser the Aroids and Arrowroot.

The station of Physiology-Biochemistry has chosen the yam bean as a model in its search of the metabolic path of glucid. Besides the basic findings, the plant appears as an interesting crop for our area.

At the Plant Technology Station, wide collection of local yeast races contributes to the traditional biotechnology in rhum fermentation and to modern biotechnology in gas transformation of sugar mill waste.

A noticeable part of these activities implies participation of French stations in Europe and of international centres, namely International Centre for the Improvement of Maize and Wheat (CIMMYT), International Centre for Tropical Agriculture (CIAT) and International Centre for Research in Semi-Arid Tropics (ICRISAT).

In the near future, new facilities are hoped for in Guadeloupe. A wide collection of yams is planned with a biochemical taxonomy approach, and the computerization of data now in progress will be completed.

IICA BIOTECHNOLOGY PROGRAMME FOR THE VALORIZATION OF GENETIC RESOURCES IN LATIN AMERICA AND THE CARIBBEAN

W Jaffe

Background and Justification

Biotechnology as it is well known, is a group of technologies which will have great impact on the economy, and especially on agriculture worldwide, in the medium and long term. A whole new industry has been created to exploit the commercial potential of biotechnology and many traditional companies and corporations are substituting processes and products by these new ones. These developments are concentrated in a few developed countries and particularly in the U S, which has a leadership position in this field.

Biotechnology has had, as yet, only marginal importance in Latin America and the Caribbean (LAC). Some research/development (R/D) capabilities exist, basically in the more traditional areas like tissue culture and fermentation, and an incipient industry can be identified in the relatively more developed countries like Brazil, Argentina, Mexico, Uruguay, Chile, Colombia, Venezuela and Costa Rica. But, compared to the worldwide efforts, these investments are too small to have a significant impact on the international scientific and commercial development of biotechnology. On the other hand, the impact on the economy, and especially agriculture, of the countries of LAC, could be great if the local efforts are adequately channelled to exploit the potential comparative advantages they have in this field.

The region of Latin America and the Caribbean is well known for its biodiversity. Several centres of origin and diversity of many important crops are located there. Biotechnology has increased the potential value of these genetic resources, as genes are the prime material for the development of new agricultural products. It has also provided the means for turning this potential value into reality. Techniques like tissue culture, genetic mapping and genetic engineering have eased considerably the task of converting, characterizing and using germplasm.

These activities are essential for the development and strengthening of plant breeding capabilities as well as for the conservation of these genetic resources within a strategy of sustainable agriculture. The existence of strong scientific and technological capabilities for the application of biotechnology for the conservation, characterization and use of genetic resources is therefore of strategic importance to the development prospects of most countries of the region with economies heavily dependent on agriculture.

Institutional Context

The themes of genetic resources and biotechnology were included in the Plan for the Reactivation of Agriculture in Latin American and Caribbean Countries (PLANLAC), approved by the Inter-American Board of Agriculture, because of their strategic importance. A broader project in support of the development of biotechnology policies in LAC, financed by the Canadian International Development Agency (CIDA) has partially provided the means to support

the IICA Biotechnology Program for the Valorization of Genetic Resources in Latin America and the Caribbean.

Description

The Program for the Valorization of Genetic Resources, in its first phase, supports the creation of sub-regional horizontal cooperation initiatives for the development and strengthening of the institutional and technical infrastructure for the collection, characterization, conservation and use of plant genetic resources.

The following initiatives have been supported to date:

- The creation of the Mesoamerican Plant Genetics Resources Network (REMERFI), which was decided in a meeting held in July 1991, in Costa Rica. Participating countries are Panama, Costa Rica, Nicaragua, El Salvador, Honduras, Guatemala and Mexico.

  The objectives are the creation and support to National Plant Genetic Resources Commissions (in the countries which do not have them) and the facilitation of technical cooperation, training, cooperative research and information exchange between member countries.

- The establishment of the Genetic Resources Program of the recently established Cooperative Agricultural Research Program for the Tropical South American Region (PROCITROPICOS), which links the national agricultural research institutes of Brazil, Bolivia, Peru, Ecuador, Colombia, Venezuela, Guyana and Suriname.

  This Program is headed by the Genetic Resources and Biotechnology Centre (CENARGEN) of EMBRAPA (Brazilian National Agricultural Research Institute).

- A proposal for the creation of an Andean Genetic Resources Network, within the framework of the Cooperative Agricultural Research Program of the Andean Region (PROCIANDINO), is being discussed right now with the IBPGR.

With the creation of similar networks in the Caribbean and the Southern Cone countries, an organizational structure would exist for the strengthening of the regional technical capabilities in Valorization of Genetic Resources through biotechnology and the sharing of experiences. But it would serve also for the discussion and harmonization of crucial related-policy issues, such as the intellectual property rights of genetic resources and the safety of biotechnology for public health and the environment.

CARIBBEAN SOCIETY OF BIOTECHNOLOGY INC.

S Salas Q

Background

It is a non profit society whose primary objective is to stimulate the development of biotechnology in the Caribbean region.

The Society was founded through the initiative of a group of university professors, students and industrial investigators after attending a course in the biotechnology of plants at the University of Puerto Rico Regional College of Utuado.

This organization promotes the interchange and publication of information in the areas of biotechnology.

The Society was incorporated as a non-profit organization under the Commonwealth of Puerto Rico on August 10, 1990. In its first meeting, a Board of Directors was elected and a constitution and ethics code were approved.

Objectives

- Contribute to the advancement of biotechnology and related sciences in the Caribbean.
- Establish relations with similar societies or associations.
- Serve as a consultant to member nations, associations, societies, agencies or individuals.
- Stimulate professional, social and cultural interchange between members.
- Serve as consultant to universities and technological institutions of the member nations in relation to the content of their higher education programmes.

Society Structure

The General Assembly is made up of all members of the Society.

The Board of Directors is made up of the President, President-Elect, Secretary, Treasurer, the members of the Board and a Representative of each Member Nation.

Members

The Society recognizes four types of members.

Active Member

Professionals admitted who pay annual dues and actively participate in the activities of the Society.

Associate Member

Graduate students who pay annual dues and actively participate in the activities of the Society.

Affiliate Member

Any public or private educational or research institution that pays the corresponding annual dues and actively participates in the activities of the Society.

Sponsoring Member

Any business organization or individual who contributes economically and actively participates in the activities of the Society.

Members Obligations

- Attend meetings and activities; comply with designated functions; inform Society about project outcomes that can be shared with the membership at large.
- Collaborate in interdisciplinary research sponsored by the Society.
- Stimulate the development of a healthy environment in the Caribbean community.
- Maintain a neutral political posture.

Participating Countries

Participating countries so far are:

- Puerto Rico
- Dominican Republic
- St Lucia

Participating is open to other countries forming the Caribbean Area.

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HISTORY AND ACTIVITIES OF BIOLAC

C Daza R

The United Nations University (UNU), in cooperation with the Government of Venezuela, examined various possibilities for the establishment of a Biotechnology Programme in Latin America and the Caribbean (BIOLAC), leading eventually to a full fledged research and training centre or programme in biotechnology. Agreements for the development of BIOLAC with headquarters in Caracas, Venezuela were signed between the UNU and the Government of Venezuela in early 1988.

After establishing the Programme, the Scientific Advisory Committee comprising researchers from Argentina, Brazil, Canada, Colombia, Jamaica, Spain and Venezuela was created. The inaugural meeting of the Committee took place in Caracas in January 1989 and proposed three areas of concentration for BIOLAC:

a. Vaccine development and improved diagnostic methods for human and animal diseases.

b. Plant genetic engineering, with special reference to disease and pest resistance and improvement in nutritional quality.

c. Microbial fermentations of industrial interest.

The Programme is devoted to improving the human resources of the research centres within Latin America and the Caribbean. The opportunities in which those results will be used will depend on the research strategies of each of the different countries in the region.

Since biotechnology is an interdisciplinary science, with social and economic objectives, BIOLAC is intimately related to the activities of many Institutes, Centres and Programmes in the region.

The target groups and organizations/institutions of the Programme's activities are those research centres which are improving the skills of their scientific personnel to support their industrial development.

The training of junior scientists within a South-South Cooperation framework is one of the most important activities of the Programme, and in this sense, the United Nations University has signed with Brazil, Cuba and Venezuela, General Agreements of Cooperation in which those countries will pay the Fellowship stipends, tuition, fees and other training-related costs. The cost of international round-trip travel (including insurance), related to the Fellowships will be met by UNU.

The duration of the Fellowship will normally be for a period of twelve months. Short-term Fellowships for a period normally no less than three months may also be provided.

During 1991, BIOLAC financed two advanced courses:

- I Advanced Course on Biotechnology Scaling Process at UNAM, Mexico
- I Advanced Course on Diagnostics of Human Disease at IVIC, Venezuela.

As a result of the experience acquired, the Program decided to increase the number of courses to cover the major areas of interest and to have visibility in the region. The courses planned for this year (1991) are:

- II Advanced Course on Biotechnology Scaling Process, UNAM, Mexico
- Advanced Course on Food Biotechnology, ICAITI, Guatemala
- Advanced Course on Recombinant DNA, UCV, Venezuela
- Advanced Course on Plant Genetic Manipulation: Transfer and Gene Expression, CEFOBI, Argentina
- Experimental Technical Course in Molecular Bases of the Diagnostics of Human Diseases, IVIC, Venezuela.

This Programme, since 1990 took under its umbrella the Brucellosis Research Network. This network supported by UNU and the Government of Canada, began its activities in 1984 with its Scientific Coordination in Canada.

The Programme has established two other Research Networks: one in Diagnostics and Vaccines and the other in Plant Genetic Engineering, with their Scientific Coordination in Venezuela and Argentina respectively. Studies for the creation of a fourth Research Network in Microorganisms of Industrial Interest are being undertaken.

Each of these networks includes scientists from at least six different countries of the region. The networks count on the scientific support of the researchers from developed countries such as Canada, Spain, the Netherlands and the USA.

ANNEXES

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ANNEX 2. TECHNICAL PROGRAMME

October 15

0800 - 0830	:	Registration
0830 - 0900	:	Opening Statements (Chair, UWI, IICA)
0900 - 0915	:	Biotechnology Research/Development at CARIRI/UNDP
0915 - 0930	:	Biotechnology Research/Development and Training at UWI, St Augustine Campus, Trinidad and Tobago
0930 - 0945	:	Biotechnology Research/Development and Training at UWI, Mona Campus, Jamaica
0945 - 1000	:	Biotechnology Research/Development at Cave Hill Campus, Barbados
1000 - 1015	:	Biotechnology Research/Development at CARDI
1015 - 1030	:	Biotechnology Research/Development at IRAT/CIRAD
1030 - 1100	:	BREAK
1100 - 1115	:	Biotechnology Research/Development at INRA-AG
1115 - 1130	:	Biotechnology Research/Development at IRFA
1130 - 1145	:	IICA Biotechnology Programme for the Valorization of Genetic Resources in Latin America and the Caribbean
1145 - 1215	:	Discussion
1215 - 1230	:	Synthesis (Chair)
1230 - 1400	:	Lunch
Afternoon	:	PROPOSALS FOR REGIONAL COOPERATION ON VALORIZATION OF GENETIC RESOURCES THROUGH BIOTECHNOLOGY (GROUP LEADER)
1400 - 1700	:	Biotechnology Policy (IICA)
1400 - 1700	:	Biotechnology Generation and Transfer (CARDI)
1400 - 1700	:	Training in Biotechnology (UWI)
1400 - 1700	:	Mechanisms for Cooperation on Biotechnology for Genetic Resource Valorization in the Caribbean (CARIRI)

October 16

Morning	:	GROUP WORKSHOP PRESENTATIONS AND DISCUSSIONS (UWI, Chair)
0830 - 0915	:	Policy
0915 - 1000	:	Research/Technology Development and Transfer
1000 - 1030	:	BREAK
1030 - 1115	:	Training
1115 - 1200	:	Regional/Extra Regional Cooperation
1200 - 1230	:	LUNCH
Afternoon	:	CARIBBEAN BIOTECHNOLOGY AGENDA FOR THE VALORIZATION OF GENETIC RESOURCES (IICA, Chair)
1300 - 1500	:	General Discussion
1500 - 1530	:	BREAK
1530 - 1630	:	Synthesis of Group Recommendations and Plenary Discussion (Chair)

1. Policy
2. Research/Technology Development and Transfer
3. Training
4. Regional/Extra Regional Cooperation

1630 - 1645	:	Follow-up Agenda (Chair)
1645 - 1700	:	Closing Remarks (CARIRI, IICA, UWI)


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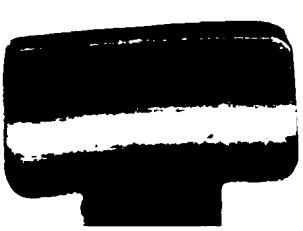
Nombre del solicitante



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