

# From GERDAT To CIRAD

1983-1985

Translated from the French: Du GERDAT au CIRAD. 1983-1985.

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# FROM GERDAT TO CIRAD Jacques Poly, Chairman of CIRAD

French agricultural research for the tropics was recently restructured. In December 1985, the eight organizations that previously formed the Groupement d'Etudes et de Recherches pour le Développement de l'Agriculture Tropicale (GERDAT) were dissolved and became departments of the Centre de Coopération Internationale en Recherche Agronomique pour le Développement, CIRAD—a center for international cooperation in development-

oriented agricultural research. CIRAD was created by an ordinance of 5 June 1984 as a state-owned industrial and commercial body.

This report covers the years 1983 to 1985, a period of changes in the general structure of tropical agricultural research; it seeks to briefly explain the goals, phases, and scope of these changes.

The successful achievements of the French organizations over nearly 40 years of research on a commodity or group of commodities have been recognized and highly commended by their cooperating countries overseas.

The decision to replace the individual institutions that together formed GERDAT by a single state-owned body showed the determination of the French administration to secure the future of a vital instrument of its technical cooperation policy. The 1982 law on orientation and programming for technological development described its role in French research. One of the seven main programs in this law focuses on scientific research and technical innovations for Third World development. CIRAD is playing a decisive role in this field.

In an effort to harmonize scientific programs and policies of tropical agricultural research, CIRAD was given new statutes compatible with those of other French research organizations such as the Institut National de la Recherche Agronomique (INRA) and Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM).

Changes in CIRAD's national and international cooperating organizations have created a need for a new type of research based on regional networks that link national, international, and French institutions. Finally, closer cooperation with the EEC countries is indispensable considering the importance of the issues and the resources involved in this effort.

To attain these objectives, discipline- and farming systems-based research had to be intensified in order to complement the traditional agricultural commodity-based research structure.

The general plan of this reorganization was presented in a public statement issued by the government after the meeting of the Council of Ministers on 18 May 1982 and in the CIRAD statutes. The procedure for implementing the statutes was determined together with the staff and a seminar was held in July 1983 in Montpellier to prepare the organizational and scientific programming groundwork of the new establishment.

CIRAD is organized into three closely interelated parts:

— 11 departments including the 8 institutes that previously belonged to GERDAT, to which were added CEEMAT (tropical agricultural machinery), DSA (agrarian systems), and GERDAT (Gestion, Recherche, Documentation, Appui Technique) in a completely different capacity as a department for management, research, documentation and technical support (comprising general administration; centers and agencies; an autonomous research unit, PRIFAS; technical and scientific support laboratories).

— permanent centers such as those at Montpellier, Maisons-Alfort, and Nogent with visitors'

services and research support services;

— discipline-based scientific coordination groups to coordinate departmental research in the hfollowing fields: environment studies, plant improvement, crop protection, food technology, economics and sociology, animal biology. These groups receive support from the common research laboratories and collaborate closely with the other research organizations.

Governed by a Board of Trustees and a Chairman appointed, respectively, by the ordinanances of 14 and 21 December 1984, CIRAD is run by a management group composed of the Director General, Secretary General (in charge of administration, finance and personnel) and a Director of Research (in charge of programming and relations with organizations).

A Scientific Advisory Committee was established and its members appointed by an order dated 14 December 1984. The agenda for this committee is prepared by a scientific coordination and programming committee composed of the deputy research directors from the departments and scientific coordinators. Since it is responsible for program evaluation, the Scientific Advisory Committee organizes a quinquennial review of each department by external experts.

All these management units have been established. Others have been created recently, e.g., the industrial liaison and development service. Such a service is of vital importance in an organization that generates 40% of its turnover. Efforts should be made to stabilize and even increase these internally generated resources not only to maintain a balanced budget but—and this is even more important—because such contracts stimulate research and keep it in contact with industry.

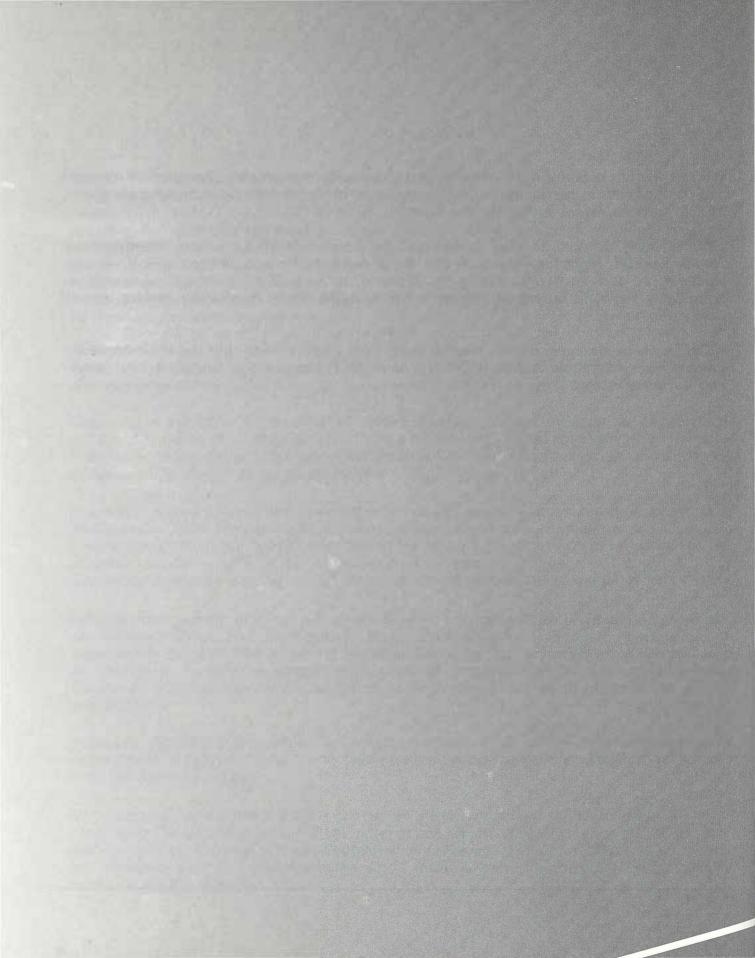
Bylaws for CIRAD staff were drawn up in agreement with labor unions and under supervision of the Board of Trustees. Work is now under way to provide proper job classifications for staff from the former institutes.

The reorganization started in 1982 is not yet completed; much remains to be done especially concerning CIRAD staff regulations. We need to achieve a certain coherence to facilitate staff mobility within CIRAD and between CIRAD and other French scientific institutions. Negotiations are under way with staff representatives, and I sincerely hope that they will be successfully completed in the very near future.

We still need to organize department program committees to provide opportunities for users and professionals to participate in the formulation and implementation of research programs, as was previously done in the institute boards.

However long the road ahead, I believe that the longest stretch has already been covered-French tropical agricultural research has been permanently consolidated. CIRAD is now stuctured so that each department has retained its area of expertise and autonomy in conducting scientific programs without jeopardizing the unity needed for making general policy decisions.

CIRAD gives tropical agricultural research the arsenal it will need to meet the challenge of the coming years, so that our country will always remain in the vanguard of the fight against hunger and for development.



Organization

# Boards and committees

#### **Board of Trustees**

#### Chairman

Jacques Poly

#### **Government Representatives**

Louis Caudron Representing the Minister of Research and Technology

Emmanuel Salmon-Legagneur Representing the Minister of Technical Cooperation and Development

Alain Weil Representing the Minister of Economic Affairs, Finance and Budget

Bertrand Hervieu Representing the Minister of Agriculture

Jean-Yves Sommier Representing the Secretary of State for Overseas Departments and Territories

# External Personalities Selected for their Expertise

*Jean-Paul Bastian*Vice-President, Centre National des
Jeunes Agriculteurs

*Menotti Bottazzi* Secretary General, Comité Français pour la Campagne contre la Faim

Roger Chaufournier
Former Vice-President of the World
Bank, responsible for Europe,
Middle East and North Africa

Jacques de Chateauvieux President and Chairman of the Board, Sucreries de Bourbon Pierre Lavau Chairman, ORSTOM

Yves Rolland-Billecart Director General, CCCE

#### **Elected Staff Representatives**

Jean-Pierre Gaillard André Garrigues Pascal Marnotte Jean-Claude Monnet Jean Pichot Laurent Schmitt

#### **State Comptroller**

Gilbert Peyroles

## Scientific Advisory Committee

#### Chairman

André Berkaloff Biology Professor, University of Paris-XI

# Non-CIRAD Scientific Personalities

Jacques Chonchol Director, Institut des Hautes Etudes de l'Amérique Latine

Alain Coleno Professor of Plant Pathology, Institut National Agronomique de Paris-Grignon

Philippe Couty ORSTOM

Jean Nya Ngatchou Inspector General, Ministère de l'Enseignement Supérieur et de la Recherche Scientifique de la République du Cameroun

Jean-Pierre Raison Director of Studies, Ecole des Hautes Etudes en Sciences Sociales

Giuseppe Valentini European Economic Community, DG 12

Bertrand Vissac Head, Département de Recherches sur les Sytèmes Agraires et le Développement, INRA

#### **CIRAD Scientists**

Nicolas Barre CIRAD Research Center, Montpellier

Jean-Claude Delwaulle Director, CTFT, Congo

# Staff Representatives (temporary)

Daniel Babre CIRAD Research Center, Montpellier

Henri Calba CIRAD Research Center, Montpellier

*Charles Egoumenides* IRAT-CIRAD, Montpellier

Jean-Louis Jacob IRCA-CIRAD, Montpellier

Marcel Tissot CTFT, Nogent-sur-Marne

#### **Steering Committee**

This is a consultative coordination body presided over by the Director General and composed of the Secretary General, the Director of Research, Department Directors, and the Director of the CIRAD Research Center, Montpellier.

# Administrative and Financial Coordination Committee (CCAF)

This is a body for administrative and financial coordination presided over by the Secretary General. Meetings of this Committee are attended by:

— Department Directors, administrative and financial executives from the department concerned:

I. Billod (IRFA)

M. Toussaint (IRCA)

J.L. Caminade (IRCC)

C. Thevin (IRCT)

R. Jouanique (IRHO)

R. Tuffery (IRAT)

C. Malvos (CTFT)

A. Garrigues (IEMVT)

D. Prince (CEEMAT)

C. Carreras (DSA);

- service heads from the Office of the Director General and the CIRAD Research Center, Montpellier;
- a representative of the Director of Research.

# Scientific Coordination and Programming Committee (CPCS)

This Committee is responsible for coordination between the CIRAD scientific executives.

It is presided over by the Director of Research and is composed of:

senior scientists from the departments:

E. Laville (IRFA)

P. Gener (IRCA)

R. Muller (IRCC)

M. Braud (IRCT)

M. Ollagnier (IRHO)

J. Pichot (IRAT)

C. Bailly (CTFT)

M. Chabeuf (IEMVT)

M. Lemoigne (CEEMAT)

J. Lefort (DSA);

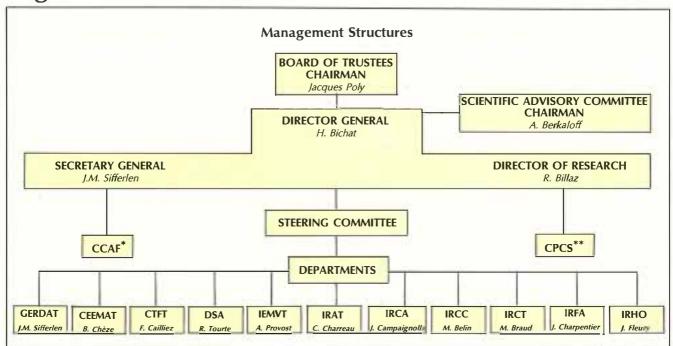
- heads of the scientific coordination groups;
- a representative of the Secretary General.

#### **Program Committees**

In compliance with the CIRAD statutes, each department has a program committee to advise and assist the executives in preparing and implementing its activities.

This is where the needs of research users are discussed. The composition of the committees varies according to the departments. IRCA is the first department that appointed its committee in 1985.

# **Organization Chart**



	Main Services	
ADMINISTRATION AND FINANCE	EXTERNAL RELATIONS	SCIENTIFIC COORDINATION GROUPS
ADMINISTRATIVE AND LEGAL	LATIN AMERICA AND FRENCH OVERSEAS	MICAM
AFFAIRS	DEPARTMENTS AND TERRITORIES	C. Pieri
P. Herbin	J. Servant	
		MICAP
PERSONNEL	AFRICA	J.P. Gascon
D. Bonneau	B. Bachelier	
	Dr Baerrener	MIDEC
BUDGET AND FINANCE		P. Baudin
B. Reder	ASIA	
4.0004.0.170	B. Simon	MITAA
ACCOUNTS	INTERNATIONAL ORGANIZATIONS	J.C. Vincent
M. Roth	INTERNATIONAL ORGANIZATIONS	AAFGDIA
	P. Dubreuil	MESRU
AUDIT		G. Raymond
F. Azuelos	DEVELOPMENT AND	ANIMAL BIOLOGY
	INDUSTRIAL LIAISON	ANIMAL BIOLOGY
PHYSICAL PLANT AND PURCHASE	A. Weil	A. Provost
J. Paré		CIDARC
	DUBLIC DEL ATIONS	
COMPUTER SERVICES	PUBLIC RELATIONS	J.F. Giovanetti
J.P. Petit	A. Hebert	TRAINING
*Admistrative and financial coordination committee		J. Dubernard/J. Gruvel
*Admistrative and financial coordination committee **Scientific programming and coordination committee		j. Dabemard/). Graver

#### **REPRESENTATIVES**

**REGIONAL DIRECTORS** 

MONTPELLIER R. Huet

**GUADELOUPE** *Darthenucq* 

FRENCH GUIANA J.Y. Praquin

> MARTINIQUE P. Daly

NEW CALEDONIA P. Bourdin

FRENCH POLYNESIA J.L. Reboul

**REUNION** *A. Derevier* 

REPRESENTATIVES

BRAZIL A. Perraud

BURKINA FASO R. Nicou

CAMEROON
J.L. Messager

CENTRAL AFRICAN REPUBLIC

L. Richard

COTE D'IVOIRE F. Pointereau

MADAGASCAR R. Guis

MALI Huu Haï Vuong

MAURITANIA D. Martinez

NIGER C. Lenormand

**SENEGAL** *G. Pocthier* 

VANUATU C. Calves **CORRESPONDENTS** 

BENIN L. Seydoux

CHAD M. Yehouessi

CONGO J.C. Delwaulle

COSTA RICA M. Ribard

> ETHIOPIA M. Vigier

GABON J. Meunier

INDONESIA F. Rognon

MOROCCO F. Bertin

PARAGUAY J.C. Follin

**PHILIPPINES** M. Arraudeau

> TOGO Y. Maire

# **B**UDGET

The Board of Trustees approved CIRAD's projected budget for the 1985 fiscal year (see table below) on 24 June 1985. It was drawn up for 750.6 million French francs representing an increase of 9.5% compared to the 1984 GERDAT budget.

The subsidy from the state R&D budget (BCRD), excluding funds earmarked for taxes, rose from 355.9 million French francs in 1984 to 399.7 million French francs in 1985. This 12-percent increase, considering present circumstances,

evidences the determination of the French administration to maintain cooperative research at a high level.

Close to 50% of the projected income comes from other resources such as agreements and contracts (68%), and the sale of agricultural products (29%). Between 1984 and 1985 this figure rose by 6.9%.

It should be pointed out:

— that the increase in self-generated

resources is satisfactory, considering the worldwide economic situation, but it is not sufficient to compensate the drop in subsidies from the states where CIRAD works, particularly the African states that are hard-hit by the crisis;

— that CIRAD must pursue its efforts to obtain financial support through agreements and contracts in order to maintain a balanced budget; its income-generation activities not only support hundreds of jobs but also help keep the organization dynamic and maintain its global outlook.

#### PROJECTED BUDGET OF INCOME AND EXPENDITURE FOR 1985\*

(Expressed in thousands of French francs)

	expenditures			INCOME	
BUDGET CODE	ITEM	AMOUNT	BUDGET CODE	ІТЕМ	AMOUNT
60	PURCHASES	96 514	70	SALE OF GOODS AND SERVICES	289 971
61/62	SERVICE EXPENDITURE	121 290	72	FIXED ASSET FORMATION	4 031
63	RATES AND TAXES	6 708	74	OPERATING SUBSIDIES**	423 032
64	PERSONNEL EXPENSES	481 459	75	MISCELLANEOUS INCOME	576
65	GENERAL OPERATING EXPENSES	569	76	INTEREST EARNED	10 048
66	INTEREST CHARGES	2 227	77	NONOPERATING INCOME	353
67	NONOPERATING CHARGES	650	78	DEPRECIATION AND PROVISIONS WRITTEN OFF	2 775
68	DEPRECIATION AND PROVISIONS	21 369	07	INVESTMENT SUBSIDY	19 800
06	INVESTMENTS	19 800			
	TOTAL EXPENDITURE	750 586		TOTAL INCOME	750 586

<sup>\*</sup>Excluding provisions for taxes

<sup>&</sup>quot;Including subsidy from state R & D budget : 379 929 FF

# PERSONNEL

In 1985, CIRAD had a staff of 1718 employees, 909 of whom were scientists and technicians. This figure does not include staff employed on local contracts outside France. The following table indicates the distribution of scientists and technicians according to specialization and department.

#### BREAKDOWN OF SCIENTIFIC AND TECHNICAL STAFF ACCORDING TO SPECIALIZATION AND DEPARTMENT (AS OF 31 DECEMBER 1985)

DEPARTMENTS	CEEMAT	CTFT	DSA	IEMVT	IRAT	IRCA	IRCC	IRCT	IRFA	IRHO	GER	DAT	TOTAL
SPECIALIZATION	CEEMIAT	CIFI	DSA	IEIVIV I	IKAT	IKCA	IRCC	IKCI	IKFA	IKHU	PRIFAS	Labora- toires	TOTAL
Agroclimatology		11							2				3
Agronomy, fertilization, land preparation			11		90	17	26	14	41	57		6	262
Agropastoralism				16									16
Animal biology: entomology				4									4
Animal biology: nutrition				6									6
Animal biology: physiology				7							1		8
Animal husbandry				18									18
Animal pathology: microbiology				20									20
Animal pathology : parasitology, nematology				8									8
Biometrics, mathematics		2			3		1	2	3				11
Cartography, geography, photo-interpretation, remote sensing		1		7	3			1					12
Chemistry		12		1			5	1	4	6		8	37
Crop protection: pathology		1			7	1	12	5	8	8		1	43
Crop protection: weed control					2			1					3
Crop protection: zoology, entomology, nematology		2			11		5	15	5	8	4	1	51
Data processing		3	1	2	1			1	1	5		5	19

Continued

DEPARTMENTS	CFFLAAT	CTET	DSA	(F) (A) (T)	IRAT	IRCA	IRCC	IRCT	IDE A	INLIC	GERI	DAT	TOTAL
SPECIALIZATION	CEEMAT	CTFT	DSA	IEMVT	IKAT	IKCA	IKCC	IKCI	IRFA	IRHO	PRIFAS	Labora- toires	TOTAL
Documentation		1	1	. 4	6	1	4	1	7	3		3	31
Ecology											2		2
Farming systems			2	3									5
Farm mechanization, industrial technology	27	3	1	2	1	1	1		1			1	38
Fiber technology								11					11
Fish breeding		6								9			- 0
Food technology					4	5	10		9	3		2	33
Forestry		65										1	66
Plant improvement, breeding, cytogenetics, electrophoresis, <i>in vitro</i> culture		3	1		31	8	12	20	6	18		3	102
Plant physiology		1		1	2	6	1	2	8	2		1	24
Rural economics and sociology, agricultural economics		1	2	1	6		2	4	2				18
Scientific administration		1			5		1		1			2	10
Soil sciences					5				3	1		1	10
Training			1	1			1					2	5
Water management, agricultural hydraulics					6							2	8
Wood industry technology		19											19
TOTAL	27	122	20	101	183	39	81	78	101	111	7	39	909

# CIRAD AROUND THE WORLD

Between 1983 and 1985, tropical agricultural research was completely restructured, its operating horizon widened as it increased the range of its counterparts.



- to maintain the research potential in Africa and distribute the activities more evenly between the humid tropics and arid zones;
- to develop activities in Latin America, the Far East, and the South Pacific region;
- to assign permanent representatives, with authority to negotiate, in the main cooperating countries around the world.

# **Key Counterparts**

## **Operations**

In order to comply with the instructions laid by the law on orientation and programming of research and technology development in France, CIRAD is being reorganized: — to strengthen operations in France, especially at the CIRAD Research Center in Montpellier, and the centers located in the French Overseas Departments (DOM) and Territories (TOM) since they play an important role in training young scientists;

#### **National Cooperation**

CIRAD cooperates with a wide range of counterparts, chiefly:

— ministries concerned with CI-RAD's field of activities; public research organizations such as the Institut National de la Recherche Agronomique (INRA), Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM), Centre National de la Recherche Scientifique (CNRS), and university laboratories. Cooperation was strengthened through the establishment of interorganization thematic research projects (ATP) similar to the US CRISP programs and of joint laboratories;

- public and private companies and organizations working abroad in related fields such as agro-industry, agricultural mechanization, regional development;
- R&D services, banks, associations, and even professional syndicates sharing the same concerns as CIRAD, such as planters, farm machinery manufacturers.

#### **Bilateral Cooperation**

Priority is still being given to bilateral cooperation. CIRAD's main counterparts are:

— national research organizations linked to CIRAD through agreements for joint research programs;

— development organizations such as state enterprises established to promote the development of agricultural, forestry, and animal products or to implement regional development projects. Such organizations form the most important client group;

— training services that have over time become a priority for CIRAD, since it considers training as a vital element of its research.

#### **International Cooperation**

In compliance with the law on research orientation and programming, CIRAD is committed to a policy that ensures closer cooperation with:

 international research centers (seminars and meetings, joint projects, assignment of scientists);

— the European Economic Community, especially the European Development Fund.

CIRAD participated actively in creating international research networks in specific fields such as drought control and banana and plantain research.

### **France**

Initially, all the tropical agricultural research institutes were located in the Paris region. They were unstable and not very efficient or adaptable to change.

Much needed reorganization and decentralization were started in 1975 when a large research center was built in Montpellier.

CIRAD now provides support for field operations and scientific impulse from its Paris headquarters and Montpellier station.

# The Paris Region

- Headquarters of CIRAD and the six departments—IRAT, IRCA, IRCC, IRFA, IRHO, IRCT—whose laboratories were transferred to Montpellier.
- CEEMAT is still in Antony but will move to Montpellier when construction of the food technology workshop will be completed.
- CTFT in Nogent-sur-Marne has, in addition to its laboratories, a seed bank and sizeable facilities for tropical timber research, e.g., log yard, workshops, and a sawmill. Fifty senior scientists work together with 80 assistants and technicians in four major divisions: administration and finance (with support services such as documentation, publications, biometrics), forestry and fish breeding research, timber research, consulting services.

• IEMVT in Maisons-Alfort has the following divisions: administration and finance, documentation, training, laboratories to serve five major research units—agropastoralism, food and nutrition, animal husbandry and economics, infectious diseases, parasitology.

## Montpellier

The CIRAD Research Center is part of the Agropolis complex that houses most of the management and scientific services in modern premises covering 13 000 m² of laboratory and office space to accommodate 120 scientists and 180 technicians and administrative staff.

These premises are occupied by:

— research units belonging to IRAT, IRCA, IRCC, IRCT, IRFA, IRHO, and CEEMAT;

 — DSA that works closely with the Laboratoire des Etudes Comparées des Systèmes Agraires (LECSA) and INRA;

— the Scientific Coordination Groups for environmental studies, plant improvement, crop protection, food technology, rural economics;

— the PRIFAS applied research unit for acridology and operational ecology;

the training service;

 CIDARC that centralizes the main CIRAD documentation and publication services;

 a food technology workshop used jointly by CIRAD and Agropolis technologists for developing and testing food technologies for tropical countries; — general and specialized laboratories (see box below).

In addition, there are also remote sensing and computer facilities; a biomodelling laboratory is under construction.

#### **General Laboratories**

Plant mineral analysis Soil and water analysis Organic elements analysis

Crop protection: fauna, insect rearing, bacteriology

Crop improvement: *in vitro* culture, cytogenetics, biochemical analysis (electrophoresis).

#### **Specialized Services and Laboratories**

Plant pharmacology and weed control Virology (ORSTOM, INRA, and CIRAD) Nematology

Nuclear agronomy and study of root systems

Rhizobiology

Soil science and cartography, remote sensing

Water management, agrometeorology, biomass energy

Coffee and cocoa technology and biochemistry

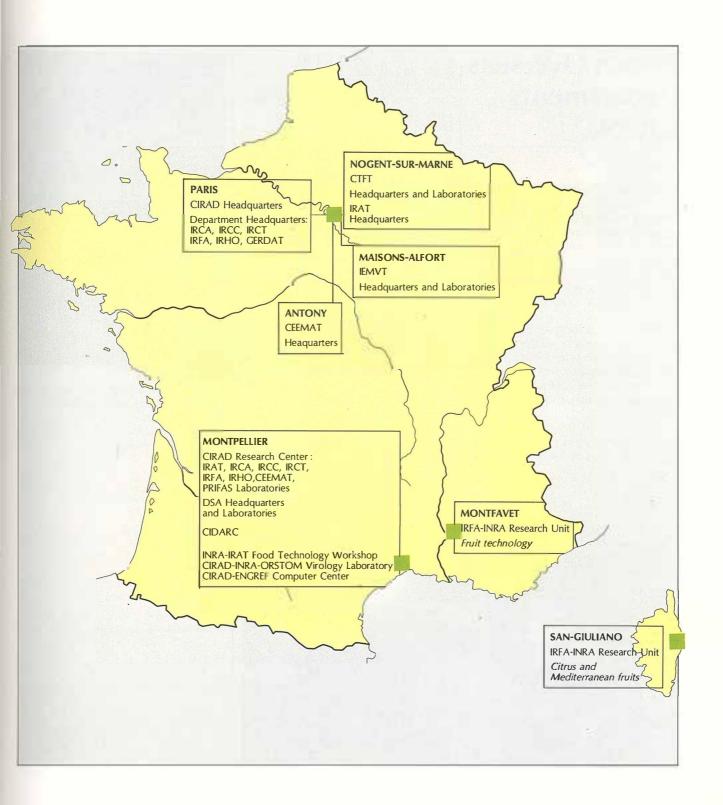
Flour technology and biochemistry

Latex technology and biochemistry

Fats and oils technology and biochemistry Physiology, quality of fruits and related products, essential oils

Microspinning and technology of cottonseed and fiber

Crop protection: entomology and plant pathology for each field.



# French Overseas Departments (DOM)

The French Overseas Departments are of significant importance for national research (for specific development problems), international research (for joint research and training programs together with tropical countries), and for scientific reasons (vast ecological diversity found in tropical island systems).

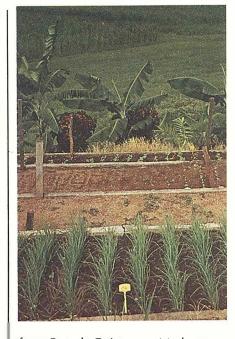
CIRAD accounts for over half of the French agricultural research effort in the French Overseas Departments. Nine CIRAD departments have about 85 scientists, including about 20 volunteer scientists and research fellows.

CIRAD mainly works on food and vegetable crops in the French West

Indies and Réunion, citrus and other fruits in all the French Overseas Departments, livestock and veterinary medicine in Guadeloupe, forestry and timber technology in French Guiana, farm machinery in Réunion. IRCT, IRCC, IRCA, and IRHO work in common facilities with resources from various departments, e.g., germplasm and live collections, humid tropical tree crop plantations, and *in vitro* cultures.

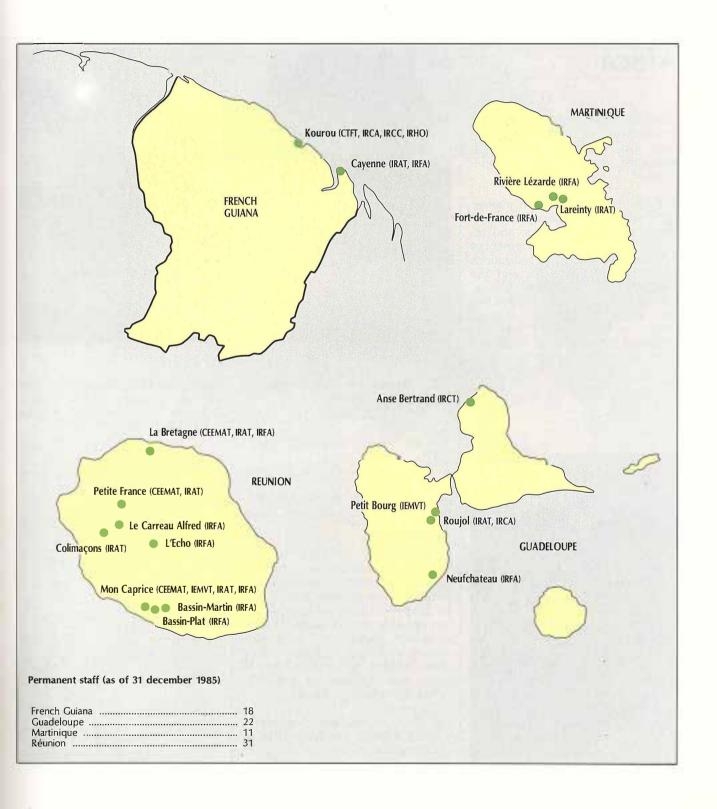
Since 1981, GERDAT (the future CIRAD) is participating in interorganization programs financed by CORDET, a special fund for the DOM-TOM. Collaborative work is developing with ORSTOM, CNRS, and especially with INRA. Since 1985 CIRAD is involved in specific programs funded by state and regional subsidies.

Its potential in the DOM is a major advantage for regional cooperation. It can expand to the Caribbean and Central America from the French West Indies; to the Amazon basin



from French Guiana, to Madagascar and the islands in the Indian Ocean from Réunion.

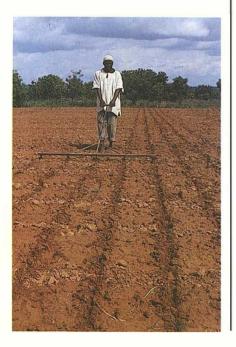




## **Africa**

Africa, especially francophone Africa and Madagascar, holds an important place in CIRAD's development assistance and scientific cooperation.

The last 3 years have been marked by changes in cooperation procedures, scientific programs, and research facilities. The development of national research organizations established in the 1970s and the integration of young highly-trained national scientists has led CIRAD to also adapt its activities. Further, France and its partners are concentrating more on food crops and farming systems research, in response to the new priorities.





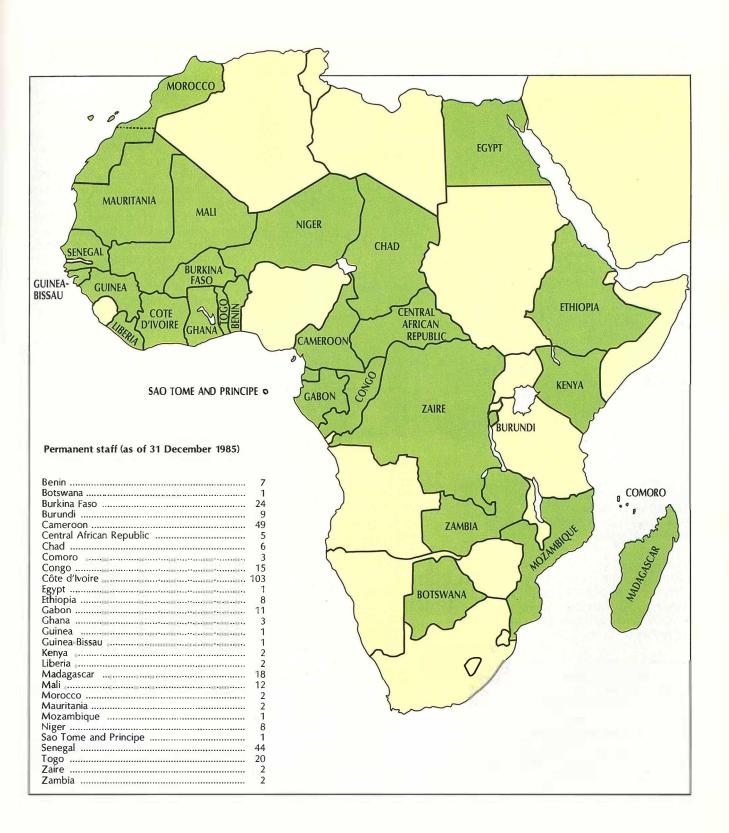
Many cooperation agreements have been signed between:

- CIRAD and Madagascar in February 1983;
- Côte d'Ivoire and France in April 1984:
- CIRAD and Congo in October 1984;
- CIRAD and the Institut des Savanes (IDESSA), in Côte d'Ivoire in May 1985.

CIRAD directs its efforts towards multiannual contracts for scientific programs or scientific development projects designed to overcome major problems in Africa, e.g., water management and drought control, integrated approach to rural economics and cash and subsistence crops systems, soil fertility sustainability, labor productivity and facilitating agricultural operations.

CIRAD scientists are intensifying training activities and supervision of young scientists, as well as their documentation support.

Among the new cooperating countries are Zambia, Liberia, Ghana, Bostwana, Mozambique, Angola, and Cape Verde.



## **Latin America**

#### South America

In this region, CIRAD is trying to consolidate its position by establishing or renewing links with countries that, for a variety of reasons, have been neglected. Twenty-five CIRAD scientists are stationed in Brazil, the Andean Pact countries, and Paraguay.

#### Brazil

The main focus has been on Brazil. Between 1982 and 1985 the number of long-term assignments rose from 11 to 18, and the number of cooperative programs from 9 to 13. Franco-Brazilian research teams have been formed in cooperating organizations such as the Centro Nacional de Pesquisa e Tecnologia (CNPq), Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), Empresa Brasileira de Assisténcia Técnica e Extensão Rural (EMBRATER), and the SUDHEVEA rubber program.

During the same period, the number of annual expert visits rose from 12 in 1982 to 26 in 1985. Further, CIRAD received 17 Brazilian scientists in 1985 in France or Africa compared to 10 in 1982.

Research programs conducted in Brazil in 1985 focused on the following themes:

— rice- and bean-based farming systems;

- varietal improvement of upland rice;

— farm machinery for small farmers;

oil palm improvement;coconut improvement;

 crop protection, in coordination with the oil palm and coconut improvement programs;

timber technology;

Hevea improvement;

banana improvement;

operational ecology;forestry in the Amazon Basin;

— farming systems in the semi-arid tropics.

CIRAD also sent experts on shortterm assignments for two other research projects for pineapple improvement and scientific information and documentation.

#### Other Countries in South America

Cooperative activities continue in Colombia (three oil palm and *Hevea* scientists), Ecuador (one oil palm scientist), Peru (one coconut scientist), Paraguay (three cotton scientists), and Venezuela (two farming systems scientists).

Lastly, following expert visits, relations were developed with Bolivia (three R&D missions), Chile (two R&D missions), and Argentina (six expert visits for cotton).

## Central America and Mexico

CIRAD has assigned six scientists to three countries in Central America (Costa Rica, Nicaragua, Guatemala). Their work concerns development and modernization of coffee cultivation, cocoa pathology, food grain crops, and agroclimatology. CIRAD also provides technical assistance to Nicaragua to help develop cotton cultivation and farm machinery. All these efforts receive support from

the CIRAD core services and research facilities available in the French West Indies.

In Mexico, the Laboratorio de Investigacion y Desarrollo Regional (LIDER) program is conducted in central Veracruz State where coffee is grown. The multidisciplinary project started in 1983 brings together French and Mexican organizations. Initially, the work was devoted to identifying appropriate farming systems and to situate the coffee problem in the regional, national, and international economic context. At present, the effort is directed towards development work.

Four French scientists—including one from CIRAD—on long-term assignments are working with Mexican teams. Several expert missions have been sent there since 1983.

One CIRAD scientist is assigned to the maize program at the Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT).



## **Southeast Asia**

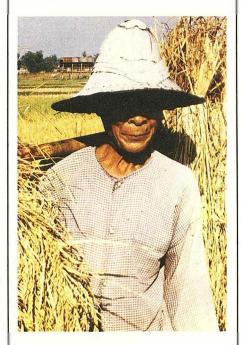
Between 1982 and 1985 CIRAD's main effort to expand outside Africa concentrated on Southest Asia. But durable relations take time, and results can only be expected in the next two years.

CIRAD has been giving, and will continue to give priority to Indonesia and the People's Republic of China. In 1982, CIRAD had four scientists posted in Indonesia; by 1985 the figure had doubled. CIRAD has concluded agreements with the Agency for Agricultural Research and Development (AARD) which is part of the General Directorate for Plantations in the Indonesian Ministry of Agriculture, and, at the regional level with the UN Economic and Social Commission for Asia and the Pacific (ESCAP). The CIRAD scientists participate in research programs on coconut (five scientists), oil palm (one scientist), Hevea (one scientist), and in a regional soybean program (one scientist).

China received 20 experts' visits between 1982 and 1985, and sent the same number to France and Africa. As a result, three technical cooperation agreements signed with the South China Academy (tropical crops—Hevea, coconut, oil palm, and coffee), the Cotton Research Institute, and the Southwest Agronomy Institute (citrus fruits). A scientist was scheduled for assignment at the South China Academy of Tropical Crops by end 1986.

CIRAD's cooperation with the other countries remained stable. Of the five scientists stationed in the Philippines, two work on upland rice at the International Rice Research Institute (IRRI), two on cotton, and one on coconut. In Thailand, a scientist participated in the development and management of a forage seed production farm as part of a technical cooperation agreement that ended in 1984. Two livestock production cooperatives are still receiving assistance from a scientist on long-term assignment.

In Burma, work on oil palm had to be delayed because of local circum-



stances, and a scientist on longterm assignment was replaced by periodical visits by experts.

In India, despite several visits (6) made between 1982 and 1985, no agreement has materialized as yet. A research scientist was, however, posted at the French Institute of Pondicherry in 1985 to develop a soil research program.

Contacts were initiated with the following countries but have not yet developed into well-defined long-term cooperation programs.

— Pakistan: three visits to discuss

cotton production;

 Sri Lanka: two visits to discuss farm machinery and gasogene development;

— Vietnam: two tours to assist national services working on *Hevea*, cotton, coconut, and forestry;

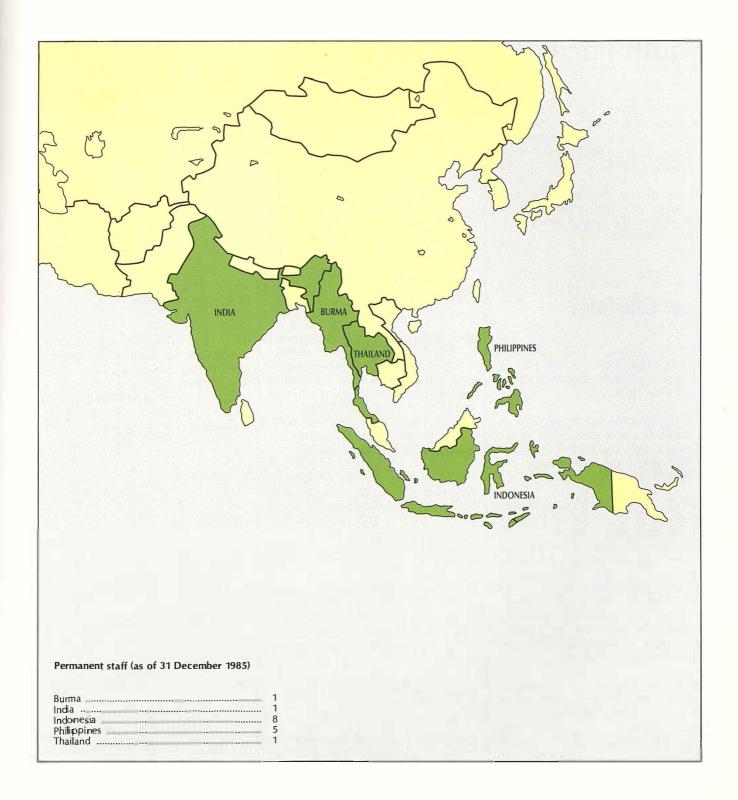
 Laos: two visits to discuss cotton production;

— Malaysia: five visits for fruit crops, coffee, cocoa, *Hevea*, coconut, and oil palm.

Lastly, three visits to Japan and two to Taiwan were organized to share information and knowledge.

The principal themes linking CIRAD with Southeast Asia are becoming clearer and more definite. The main focus is on *Hevea*, coconut, and forestry; followed by citrus fruits, oil palm, cotton, and coffee.

But interest is growing in cocoa and, perhaps, food crops other than rice, for which cooperation with IRRI is developing satisfactorily.



## **South Pacific**

CIRAD is present in Tahiti, Wallis, New Caledonia, and Vanuatu through several departments including IEMVT, IRAT, IRFA, IRCC, IRHO, and CTFT.

About 20 scientists including three volunteer scientists are stationed in this region; the largest group is in New Caledonia.

### **New Caledonia**

CIRAD is linked to New Caledonia and its dependency, Loyalty Islands, through a general convention signed on 7 May 1979.

CTFT is responsible for programs on the genetics and production of the *Pinus caribaea* and studies on natural forests and local tree species, i.e., araucaria, hoop pine, tamanou.

IEMVT, that has the most important program, is in charge of livestock production improvement through programs on animal husbandry, nutrition, agropastoralism, bacteriology, virology, and parasitology. It was commissioned to carry out an animal health survey and the establishment of a veterinary laboratory to serve the whole territory. IEMVT also has a veterinary station in the Wallis and Futuna Islands.

IRAT has detached a scientist to conduct research and trials funded by territory subsidies. The program concerns tubers (cocoyam, sweet potatoes, cassava), cereals (upland rice and maize), grain legumes, and food crop systems for the Melanesian communities. IRAT has also assembled cassava and sweet potato collections.

IRCC conducts genetic and support research for the coffee program operated by the rural services. A scientist was posted at the Ponerihouen Station on the east coast of New Caledonia.

IRFA has assigned a scientist to direct the fruit program (citrus fruits, avocado, pineapple, litchi, etc) for the rural territorial services.

## Polynesia

IRAT is the only CIRAD department in Polynesia. It conducts various activities as part of agreements with local authorities and has a station at Papara 40 km from Papeete, and trial locations in Taravao, Tahiti, and other islands (Moorea, Raiatea). IRAT is also working in the Touamotous (Rangiroa) and Austral Islands.

The main programs are devoted to vegetable and food crops (tubers). IRAT, with assistance from IRFA and IRHO (Vanuatu), also works on fruit crops and coconut. IRAT participates in a vanilla program for the whole territory.

This team is made up of a plant pathologist, chemist, and an experiments officer. An ORSTOM entomologist is based in Papara and works on coconut pests, especially pyralids.

### Vanuatu

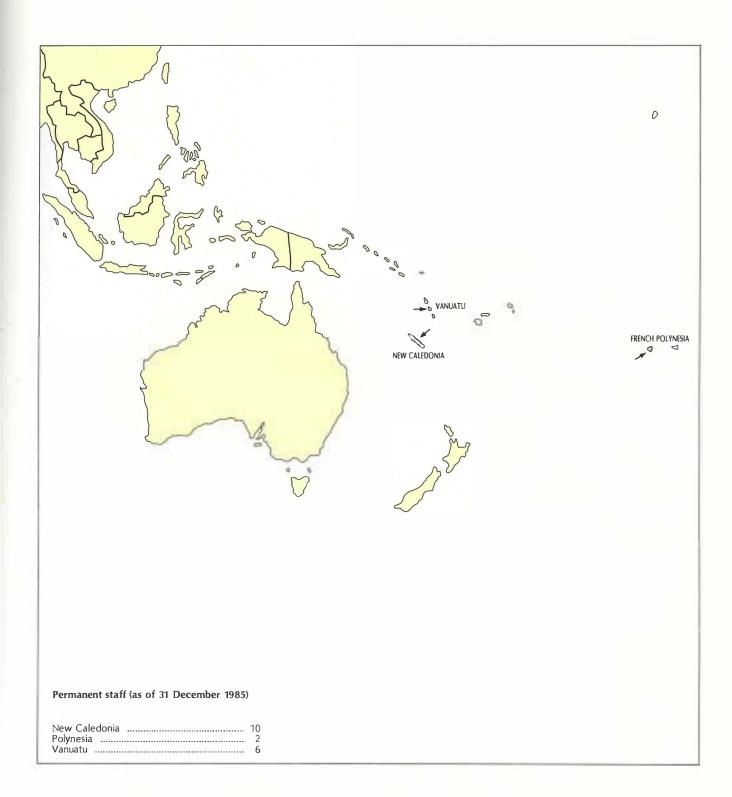
The IRHO Station at Saraoutu is a leader in the region. Its status has

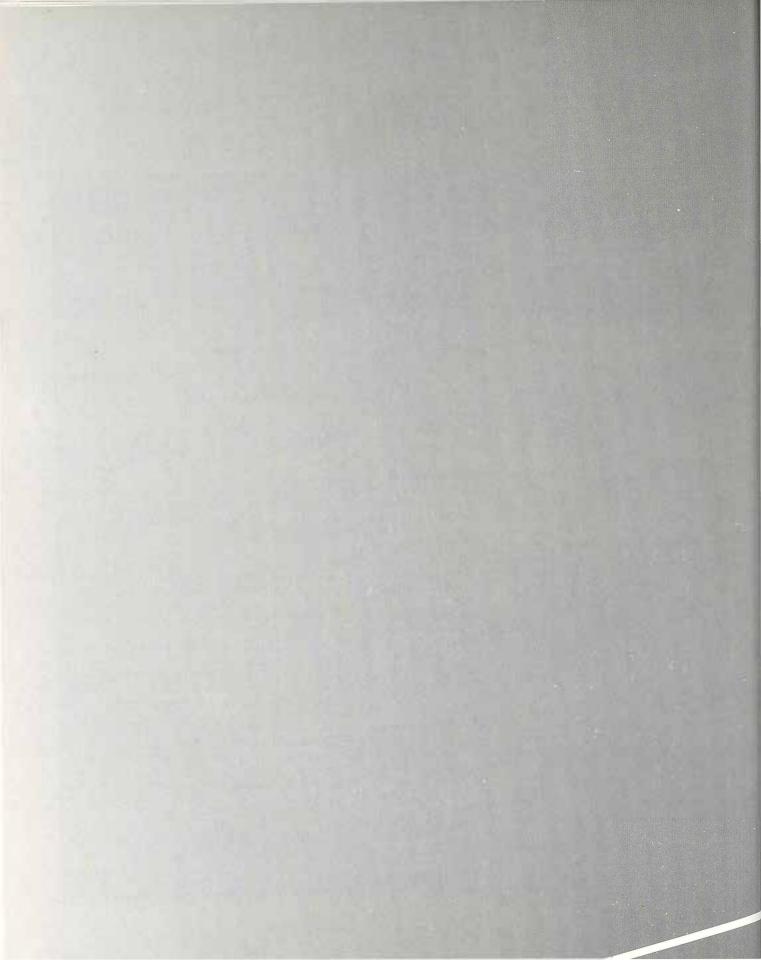
been recognized in recommendations of the second South Pacific coconut meeting held in Saraoutu from 23 to 27 July 1984.

The Saraoutu Station covers 500 ha with nurseries, performance trials and seed gardens. The team works on genetic improvement (hybrid development), entomology (Myndus taffini), and village level development (EDF project).

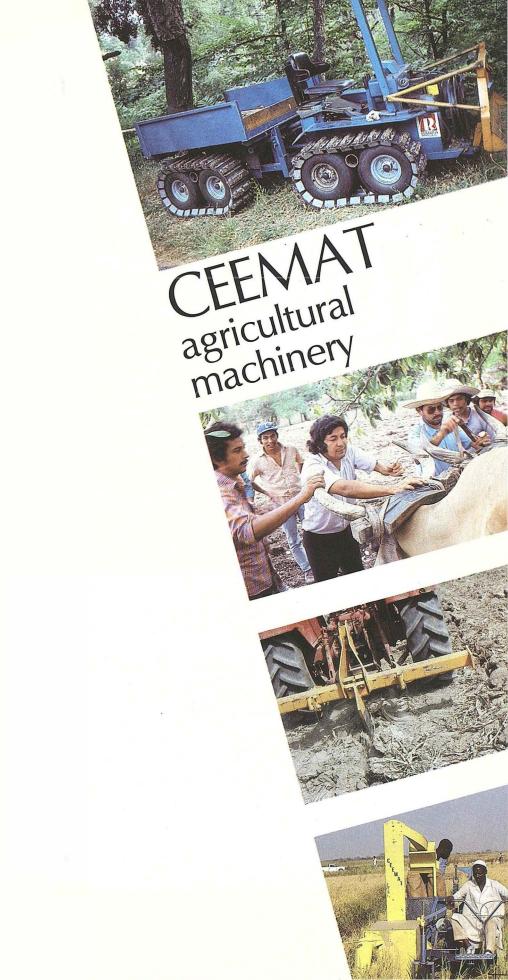
The IRHO station in Vanuatu, with 60 000 ha of coconut plantations, has been well selected, its findings serve as examples for the whole area where IRHO plays a leading role in training technicians from different countries.

IRCC has a 64-ha coffee-cocoa station on flat land at Valeteruru, overlooking Saraoutu. Some plots will be used for new crops such as pepper, vanilla, cardamom, and ginger. The program has agronomy, technology and training components.





Departments



# **CEEMAT**

The Centre d'Etudes et d'Expérimentation du Machinisme Agricole Tropical was founded in 1962 and became the agricultural machinery research department of CIRAD in Jannuary 1985. CEEMAT's headquarters are located in Antony, near Paris, not far from the Centre National du Machinisme Agricole, du Génie Rural, des Eaux et des Forêts (CEMA-GREF). CEEMAT has an outreach station in Reunion and research facilities in Montpellier. The major activities in Montpellier are training in collaboration with the Centre National d'Etudes Agronomiques des Régions Chaudes (CNEARC), and research on the problems of postharvest processing and food technology. The completion of the food technology workshop in Montpellier is expected to expand the present research facilities.

CEEMAT's work is divided into the following fields:

agricultural machinery: development, testing, and evaluation of farm equipment; and production of prototypes;

 covering not only the mechanical, but also related socioeconomic aspects.

 technology: the GTA foodtechnology and -engineering program.

The Center has a total staff of about 50 including 32 scientists and engineers.

CEEMAT, Centre d'Etudes et d'Expérimentation du Machinisme Agricole Tropical Parc de Tourvoie, 92160 Antony

Tel.: (1) 46 68 61 02 — Telex: 201296 F

Director: Bernard Chéze

# TROPICAL AGRICULTURAL MACHINERY AND FOOD TECHNOLOGY

In the tropics, agricultural machinery requirements are conditioned by the particular soil, climate, and crop characteristics of the zone. The equipment used in industrialized countries cannot always offer a feasible solution, as in the case of harvest equipment for cereals, oil palm, and cotton. Mechanization sometimes requires the adoption of competely new farming systems; a case in point is the mechanization of cassava cultivation. Even when machinery can be transferred, it has to be tested and possibly modified before use.

CEEMAT's work concerns all the mandate crops of CIRAD. It also includes energy problems and crop processing and conservation.

Although there is an urgent need for mechanization, its introduction in the rural context raises many problems. The mechanization process is studied carefully at every stage—from conception to evaluation—of development projects. There are different degrees of mechanization: draft cultivation, intermediate mechanization, and conventional mechanization. This is also valid for storage, drying, processing, and handling of crops.

### PAST ACHIEVEMENTS

CEEMAT holds a key position as intermediary between agricultural research, development, and the agricultural machine industry. The Center publishes manuals, advises industry and tests their products, and trains technicians. It also has a large collection of trade literature from 3000 manufacturers that it has identified.

Normally, its role is to test equipment from various manufacturers or to develop new machines based on proposals from development agencies. This is how CEEMAT contributed to the development of the ultra-low volume (ULV) sprayer.

The Center is increasingly involved in designing and developing its own machines, such as the prototype of the rice harvester-stripper and the equipment for mechanized cassava cultivation.

CEEMAT has gained a vast experience in the area of renewable energy resources, including biofuels (for low-powered gasogenes and oil or alcohol engines) and solar energy (for dryers).

Cassava lifting trial in French Guiana.



# RESEARCH HIGHLIGHTS

## Mechanization and **Driving Units**

Mechanization research is concerned with the identification and adaptation of driving units and farm equipment, including the modification of farming systems according to the required level of mechanization.

In late 1982, a long-term program on land-preparation techniques for mechanized sugarcane cultivation was established in Reunion. Notillage with herbicide application apparently gives the best results, while subsoiling depresses yields.

Current farming systems energy-saving methods for cotton crops are being examined in collaboration with HASYMA, Madagascar, and the Compagnie Française pour Développement des Textiles (CFDT), Paris. This may lead to modifications of cultural practices and the use of new implements and equipment, with the main objective of reducing energy consumption.

### testing of cassava planting and harvesting equipment

After extensive tests in French Guiana and Côte d'Ivoire, modifications were suggested for cassava planting and harvesting equipment.

Trials of a driving unit, the Normandia wheeled tool carrier, were undertaken in Reunion for vegetable

crops. Seedbeds prepared with a front-mounted spring-tine harrow were found to be satisfactory. The EBRA-MSI planter was adapted for planting chicory, onions, and carrots under local conditions; the multicrop seeder now gives good results.

Field trials of ultra-low volume sprayers for vegetable crops were continued. A study initiated in 1982 was extended to Reunion in 1984 for herbicide treatments of geranium and vegetable crops. Four knapsack centrifugal sprayers were also tested in the workshop.

Driving units were tested for their performance on slopes. Two Bouyer walking tractors, a Normandia wheeled tool carrier, and a Kubota



Planting beans in Réunion.

minitractor were tested for transport on 15, 20, and 28% slopes in Ré-

Prototypes of reapers and animaldrawn sprayers were built in Brazil.

## Soil Tillage

CEEMAT studies land-preparation and tillage operations for sugarcane

The wheeled tool carrier Normandia in Réunion



crops. In Réunion, normal land-clearing techniques cannot be applied on the waterlogged soils in the east where the andosols are prone to erosion due to heavy rains (3500-6000 mm). A combination of scrub clearing using wheeled tractors, no-tillage with herbicide treatments, simultaneous furrow opening and planting, was tested to overcome this problem. This package not only controls erosion effectively, but also offers definite economic advantages.

The mechanical characteristics of sandy and sandy-clayey soils of the West African semi-arid tropics were studied and the desired soil conditions following dry tillage were specified. A prototype roller that sinks into the soil through its own weight was produced.

In Gampela, Burkina Faso, CEEMAT conducted a study (1981-1984) in collaboration with the University of

Effect of subsoiling in Burkina Faso.

Ouagadougou and the Institut Burkinabé de Recherche Agronomique et Zootechnique (IBRAZ), on drytillage techniques for improved water infiltration.

### in West Africa, dry subsoiling has a significant effect on yields

Results after 4 years of testing confirm that dry subsoiling has a significant effect on yields.

Use of disc equipment for regenerating forage-crop areas, exposes the soil to erosion; it also consumes much energy. The use of rotary cultivators with vertical shafts for surface tillage (maximum depth 10 cm) followed by planting gives good results in Reunion. No-tillage combined

with herbicide treatment was also tested.

CEEMAT conducted several studies to prepare a technology and equipment package for the upland soils and slopes in Réunion. Various planters were compared and a study on no-tillage has led to the development of a prototype 2-row planter mounted on a medium-powered tractor (less than 40 hp).

CEEMAT has developed a research program on soil physics in collaboration with the Ecole Nationale Supérieure d'Agronomie de Montpellier (ENSAM) and IRAT.

### Harvesting

CEEMAT is designing prototypes of cereal harvester-strippers. The study was initiated in 1982 and is aimed at the development of a simple, sturdy, small-sized and low-powered machine for small paddy fields to harvest grain in one pass, leaving the field free for subsequent operations.

### a prototype harvests rice grain in one pass without cutting the stalks

The originality of this technique is that the harvester does not cut the stalks; only the top portion of the stems is in contact with the threshing device. In the CEEMAT model, the shaft of the thresher is parallel to the line of motion of the machine. The working width of each unit is only about 50 cm, but several units can be mounted in a row.

The second prototype built in 1983 has a harvest output of 1000 kg/h at





Field trial of the rice harvester-stripper in Camargue, France.

a speed of 4 km/h and a working width of 45 cm. The equipment uses a 6-hp engine. In 1984 and 1985, the prototype was tested in farmers. fields in Senegal, in cooperation with the Société d'Aménagement et d'Etude du Delta (SAED), and in Cameroon, with the Société Expérimentale de Modernisation Rizicole de Yagoua (SEMRY).

Preliminary tests of a geranium harvester initiated in 1981, revealed the need to modify the traditional farming system. In 1984, a modified Japanese tea harvester was used for the trials. A self-propelled harvester prototype is also being developed.

# Postharvest Operations, Storage, Drying

A detailed study was carried out on cereal grain that is bulk stored in

steel bins under tropical conditions. In northern Cameroon, a trial was conducted in collaboration with SODECOTON for storing 50 t of rice grain. This field study was combined with laboratory analyses and container storage studies at the Institut National de la Recherche Agronomique (INRA), Nantes. Modifications of the steel bins were proposed for long-term storage.

# solar dryers for fruits and vegetables were tested

CEEMAT has designed and developed a solar dryer based on the natural convection principle. This unit can be used at farm level and has a capacity to handle 50 kg of fresh fruits or vegetables. About ten dryers are being tested in different countries.

In July 1983, CEEMAT started work on designing a prototype of a solar dryer for timber to be used in French Guiana, in collaboration with CTFT.

## Food Technology

An innovation-assistance program aims to design and develop a small-capacity (500 kg gari/day) unit for producing cassava gari. Various grating techniques were studied and specifications were established for suitable cookers. This activity is expected to develop further with the completion of the food technology workshop in Montpellier.

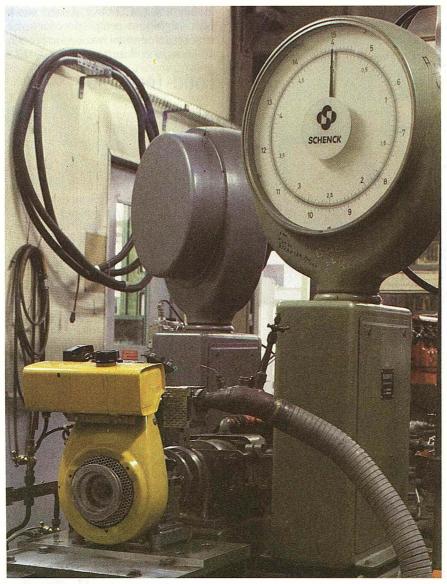
### **Energy**

CEEMAT has initiated or carried out research on alternate fuels (alcohol and vegetable oils) and small gasogenes. Research on carbonization techniques was transferred to CTFT in 1983.

For alcohol, several diesel engines ranging from 14 to 75 hp were converted to operate on ethanol (95%) according to the process developed by the French Moteur Garo company. It was observed that the high investment cost becomes effective only for higher-powered engines (over 50 hp).

### diesel engines that run on crude vegetable oils

For nontransformed vegetable oils, three types (5, 8, 25 hp) of diesel engines were tested using different types of oils—coconut, oil palm, groundnut, cottonseed. One out of three engines passed the durability test after a total trial run of 1500 hours and is functioning without major problems.



A vegetable-oil driven engine undergoes tests.

In 1984, a 100-hour trial using 100% cottonseed and coconut oils, was conducted in French Polynesia on a Renault 11 diesel engine.

The program on gasogenes for electricity production concerns:

— the development of a 30-kw electric generator operated by a gasifier

using wood and other biosources for feedstock;

— trial of a prototype 45-kw electric generator using low-heat value gas produced by a gazifier from coconut husks and shells. The results are encouraging and comparable to those obtained from a dry wood gasifier. The gas is tar- and dust-free,

and fuel requirement is 1.37 kg/kwh. In 1984, a complete unit was sent to the Centre d'Etudes Atomiques (CEA), French Polynesia, for producing electricity on the atolls. Another unit was sent to Seychelles along with a gas-driven van. Modification of the models for Seychelles were carried out in France, jointly with trainees who will be the future users of this equipment;

optimization of a dual-fuel unit to operate a 50-kw generator that enables maximum fuel saving of 85%.
 establishment of a test rig at Antony, jointly managed by CEMA-GREF and CEEMAT.

For wood carbonization, several types of transportable metal ovens with air clips were tested in Cantal, France

In 1984, a study was initiated under Egyptian socioeconomic conditions, on the production of substitute feedstock by briquetting crop residue.



The CEEMAT-CEMAGREF test rig for gasogenes in Antony.

Two independent electronic measuring systems, for on-field use and adapted to local conditions, were designed and sent for trials after identification of possible problems. One of them was sent to Sudan in 1984 to monitor trials on mechanized cultivation. A second unit was sent to Brazil for draft cultivation trials as well as tests of gasogenes, intermediate mechanization equipment, and similar experiments.

# CONTRIBUTION TO DEVELOPMENT

#### Draft Cultivation in Brazil

This project was undertaken in collaboration with the Empresa Brasileira de Assisténcia Técnica e Extensão Rural (EMBRATER) and the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA). It is focused on:

— experiments on animal-drawn equipment;

 development of new or modification of existing equipment;

 research on mechanization of farming systems for the Nordeste and southern regions in Brazil;

 socioeconomic studies on the effect of the introduction of new equipment and techniques;

— training of extension agents. The research and development method involves the participation of the Centro de Pesquisa Agropecuária do Trópica Semi-Arido (CPATSA), Petrolina; as well as farmers, manufacturers, and extension agents. Inservice courses are organized and manuals published to acqaint participants with draft-cultivation techniques.

The main results of this project include:

— transfer of technology of the multipurpose animal-drawn chassis based on the invention by the French engineer, J. Nolle. In 1983-1984, about 2000 units (including 700 Policultor 1500) were sold by a manufacturer;

— development of prototypes for forage-crop equipment, such as planters (manual and animal-drawn), special seed harvester, animal-drawn mower, side-delivery rake, large-capacity cart, small low-density baler:

— development of soil-tillage equipment, such as tied ridgers and other special ridgers;

- development of equipment for irrigated crops such as a deep-

placement fertilizer applicator and disk harrow;

— eight training courses were organized; in 1983, these were attended by 94 engineers and technicians bringing the total to 1300 in 5 years.

#### **Technology Transfer in Egypt**

A World Bank-sponsored project was set up in early 1983 in collaboration with the National Institute of Agricultural Engineering (NIAE), UK, for local manufacture of equipment suited to the Egyptian conditions.

The studies were focused on mechanization of potato cultivation and on the comparison of different machines for wheat harvesting and threshing.

CEEMAT also participated in the establishment of a Franco-Egyptian center for mechanization.

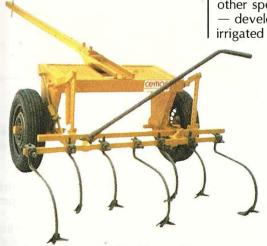
# Farm-level Mechanization in Côte d'Ivoire

In 1983, CEEMAT completed a research and development project on mechanization for small farmers.

CEEMAT collaborated with the Centre Ivoirien du Machinisme Agricole (CIMA) to design new machines, test various equipment, and provide theoretical and practical training to extension agents.

#### Short-term Assignments

CEEMAT engineers are sent on short-term assignments to resolve problems related to farm equipment and mechanization. They often work together with social scientists, mainly from the Société d'Etudes pour le Développement Economique et Social (SEDES), Paris; however, there is increasing collaboration with French agriculture experts including agricultural machinery users' cooperatives.



The Policultor 1500 built by CEMAG (Ceara Maquinas Agricolas) in Brazil.

# **T**RAINING

CEEMAT's training program includes courses organized in France and training provided by its engineers in other countries.

Two courses are offered regularly in France. The first, on "Rational Use of Agricultural Machinery in the Arid and Intertropical Zones," is a 9-week course organized each year between April and June and is open to francophone engineers and technicians. The course is mainly taught by CEE-MAT engineers; regional organizations also participate. Technical visits are organized to manufacturers, experiment stations, agricultural machinery users' cooperatives. Each year, 9-12 trainees attend the course.

The second course organized biannually deals with "Grain Storage Techniques in Tropical Countries." The duration is 12 weeks between September and December. It is meant for those in charge of grainstorage programs or facilities in the tropics. The course is taught by

CEEMAT engineers assisted by the Fédération Française des Coopératives Agricoles de Céréales (FFCAC), the Institut Technique des Céréales et des Fourrages (ITCF), and CEMAGREF.

CEEMAT also provides individualized training tailored to the trainee's qualifications and requirements. Since 1984, there is great interest in gasogene technology (design and experiments) and studies on gasification and carbonization; these areas show considerable potential for the future. In order to meet this demand CEEMAT has installed a trial and demonstration rig in Antony, in close collaboration with CEMAGREF. Among those who have undergone training in this field are: a French engineer on an overseas assignment, engineers from Latin America and Seychelles, and students from agriculture schools.

High-school or university students

also come to CEEMAT to carry out various practical assignments for dissertations required during the course of their studies.

CEEMAT engineers also undertake teaching assignments at various agricultural training institutes, universities, and schools (CNEARC-ESAT-CEAT, ENSAM, ESEM, IEMVT, IS-TOM, MASEC-CEMAGREF, SIARC) in France. In Burkina Faso, courses were given at the inter-state schools sponsored by the the francophone West African countries (Ecole des Ingénieurs de l'Equipement Rural, Ecole des Techniciens Supérieurs de l'Hydraulique et de l'Equipement Rural) and at the Institut Supérieur Poly-Ouagadougou. technique, Congo, a specialized course on crop-protection equipment and techniques was given at the Institut du Développement Rural, Brazzaville. In Thailand, a training seminar was organized on the efficient and safe use of pesticides.

# **PUBLICATIONS**

CEEMAT publishes a quarterly journal in French *Machinisme agricole tropical* (English and Spanish summaries) and a newsletter *MAT Information*.

The following books were also published:

**CEEMAT.** 1974. Aide-mémoire du moniteur de culture attelée. Antony: CEEMAT. 178 pp. 2 vol.

**CEEMAT.** 1976. Aide-mémoire pour l'utilisation des motoculteurs dans la zone intertropicale. Antony: CEE-MAT. 116 pp.

Two other CEEMAT manuals were published by the French Ministry for Cooperation:

**CEEMAT.** 1974. Manuel de motorisation des cultures tropicales. Paris: Ministère de la Coopération. Vol 1,

660 pp; Vol 2, 474 pp.

**CEEMAT.** 1977. Maintenance du matériel agricole. Paris: Ministère de la Coopération. 122 pp.

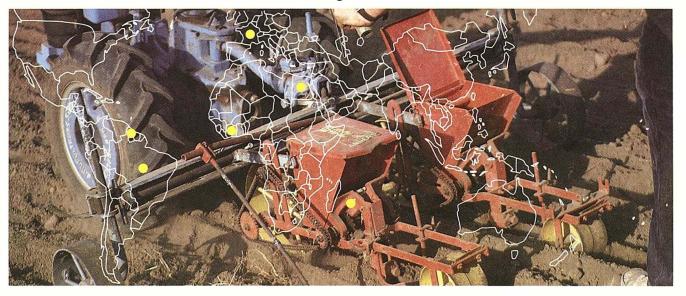
Two other publications are in print:

— Manuel de conservation des produits agricoles tropicaux.

— Manuel de construction mécanique rurale. (In collaboration with CINAM).

# CEEMAT AROUND THE WORLD

# **Outreach Centers and Short-term Programs**



BRAZIL\*\*

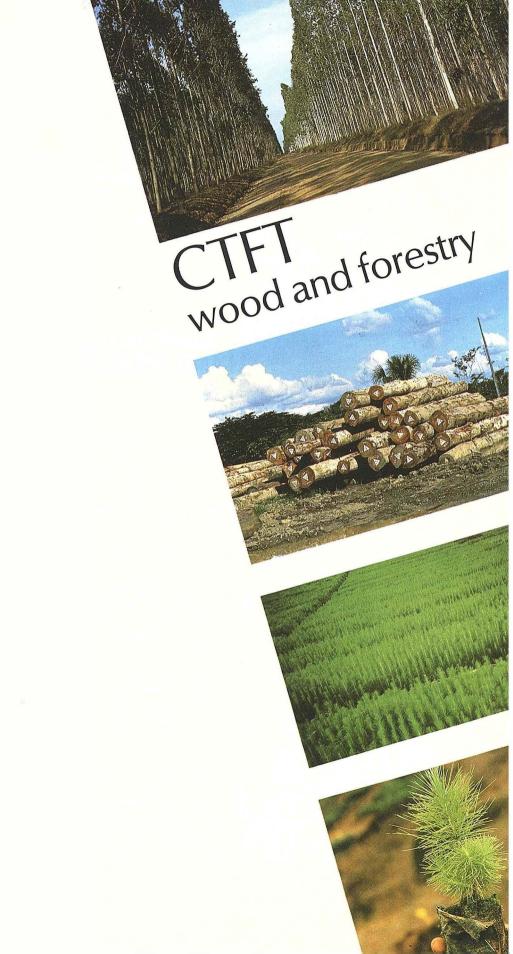
FRENCH GUIANA (1985-1986)\* COTE D'IVOIRE (1981-1984)\*

EGYPT\*\*

**REUNION\*\*** 

<sup>\*\*</sup> Outreach centers.

<sup>\*</sup> Short-term programs.



# **CTFT**

The Centre Technique Forestier Tropical, the tropical forestry department of CIRAD, was established in 1950 when it took over from the laboratories that specialized in the study of tropical timbers since 1917.

CTFT has the mandate to carry out applied research, and to develop and supervise projects on tropical forestry and woods. Its program also includes tropical fisheries, tropical fish breeding, and soil conservation.

CTFT is one of the few organizations in the world whose research concerns both forestry and woods, ranging from the young seedling in the nursery or forest up to the semifinished industrial product and its use. Geographically, its area of interest extends throughout the tropics.

CTFT's core program is organized into the forest and fish culture research division, wood research division, operations department, and logistic units. The Center conducts research in various countries including: Brazil, Burkina Faso, Cameroon, Congo, Côte d'Ivoire, French Guiana, Madagascar, New

CTFT
Centre Technique Forestier Tropical
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94736 Nogent-sur-Marne Cedex
Tel: (1) 48 73 32 95
Telex: 211085 F
Director: Francis Cailliez

Caledonia, Senegal, in collaboration with the national research programs. Fixed-term projects were also undertaken in about 40 countries.

CTFT has a staff of 200 including 60 scientists.

TROPICAL FORESTRY AND WOODS

It is since World War I that woods other than the traditional high-value woods (e.g. mahogany, rosewood, ebony) for cabinetwork, are being utilized for various other purposes. Today, their use has been diversified and includes plywood, structural timber, railroad sleepers, harbor installations, containers for chemicals, external and internal woodwork, etc.

Currently, there are about 170 species on the world market, with variable tonnage. Ordinary wood can also be used for making paper pulp or for fuel.

Forestry research has enabled a more accurate determination of the role of forests in maintaining the environmental balance.

The ways of harvesting this resource have also changed. Earlier, the timber sites were abandoned once the best trees were felled. But now there is an increasing effort to reconstitute forest preserves either by encouraging natural regeneration or by establishing conversion plantations.

In the arid intertropical zone, due to heavy exploitation, woodlands are receding further away from urban centers or have sometimes been cleared away completely. There is an urgent need to reconstitute this resource in order to satisfy the domestic demand for wood. The solution lies in better agroforestry management.

### PAST ACHIEVEMENTS

The complex and fragile nature of the tropical forests has given rise to a special forest science, that has benefited greatly from the contribution by the CTFT scientists, for both the humid and arid regions.

Research on the humid zones concerns natural formations and the possibility, in certain cases, of replacing them by shortor medium-rotation species.

The potential and evolution of dense rain forests and their role in maintaining the ecological balance, were assessed through forest inventories and silvicultural experiments. CTFT also planned the establishment of artificial short- or medium-rotation stands, such as those of *Terminalia superba* and eucalyptus.

In the arid zones, the depleting wood supply has caused a serious fuel crisis. Since 1964, CTFT is studying the possibility of nonirrigated reafforestation and, since 1983, of irrigated plantations.

CTFT has also carried out various experiments and studies for soil and water conservation.

Research on tropical woods is conducted simultaneously, to improve utilization of the different species.

The physical, mechanical, chemical, and energy properties of a large number of woods were assessed. Studies on the processing, maintenance, and use of these woods have provided answers to several inquiries from professionals.

CTFT is also actively promoting species considered secondary since they are not well known. In fact, less than 200 species of, the 30 000 in CTFT's reference collection are being marketed at present.

Since 15 years, CTFT is carrying out feasibility studies on techniques for producing paper pulp from woods of natural heterogeneous forests.

Since 1973, CTFT is studying ways to increase the efficiency of fuelwood by developing special techniques such as, carbonization, direct liquefaction, torrefication of wood.

Studies on fisheries and fish breeding led to the development of reliable fishbreeding techniques and improved use of water courses, dams, and other water bodies for fishing.

The operations department (BET) was established in 1962. It is involved in conducting studies, project implementation, research application, and other interventions, requested by governments; national, regional, and international organizations; and the private sector. These assignments are related to the different activities of the Center. Seven hundred contracts were signed and completed for studies and projects in 40 countries.

The results of CTFT's research are published in its quarterly *Bois et forêts* des tropiques established in 1947. Other publications include manuals, data sheets of marketed species or those to be promoted, identification sheets of existing natural forest species and the main reafforestation species.

# RESEARCH HIGHLIGHTS

### **Forest Production**

#### **Tropical Rain Forests**

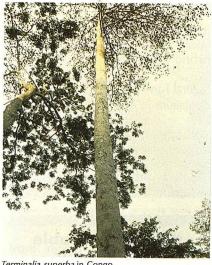
For its extensive forest inventories, CTFT combines modern electronic data processing and remote sensing techniques. A total of 50 million ha were surveyed in 15 tropical countries. Recently, the Center was called upon to survey 7 million ha of dense forest in southern Cameroon, in view of their management.

CTFT is also concerned with studies of the environment, productivity, and regeneration of tropical rain forests. Experimental sites were established in dense forests in Africa (Central African Republic, Côte d'Ivoire) and in French Guiana.

Research on the possibilities of reafforestation using long- and medium-rotation species resulted in the establishment of cost-production data. Studies on the physiology and genetic improvement of Terminalia superba, were initiated in collaboration with the Centre National de la Recherche Scientifique (CNRS) and the Institut National de la Recherche Agronomique (INRA), Paris.

A pilot project for afforestation using limba species was developed in Congo.

The main fast-growing species were studied on a large scale, with confirmation of the results. A study on soil mineral exports and sustained yield of short-rotation trees was started in collaboration with INRA and certain universities.



Terminalia superba in Congo.

Superior clones of eucalyptus were produced and in 1984, the Unité d'Afforestation Industrielle du Congo

Preparation of PF1 eucalyptus cuttings kept under shade and mist irrigation at the Kissoko nursery, Congo.



### superior clones of eucalyptus were produced

(UAIC) undertook the plantation (more than 20 000 ha) of superior hybrid clones developed by CTFT.

## Natural Formations and Plantations in Arid Zones

The forest inventory that is under way in southern Mali, combines standard methods for on-site counting with the experimental use of satellite images.

# the most suitable local species were identified for fuelwood plantations

Research on natural formations and plantations in the arid zones is of considerable importance to the Sahelian countries that were severely affected by the recent drought. This research includes a study of natural formations and the identification of the most suitable species for plantation.

Natural formations were studied to gain a better understanding of productivity and conditions that check their degeneration. These studies were required for cooperative projects in Senegal, Niger, Burkina Faso, and other countries that receive technical support from CTFT.

Experimental sites for irrigated forestry were set up in Senegal and Niger. Studies on the establishment and adaptation of forest species for nonirrigated plantations focused on local species. In Burkina Faso, the Centre National de Semences FoThe seed laboratory supplied seed of known provenance to research institutes and reafforestation projects. This seed was collected in the centers of origin and kept in cold



Localized irrigation of 3-month eucalyptus trees in Lossa, Niger.

restières became operational in 1983 with technical support from CTFT. A CNRS-CTFT biotechnology laboratory for tropical forest symbiotic systems was established and will initially concentrate on arid-zone species.

#### Germplasm

Tree-improvement studies were conducted in various countries in collaboration with the national programs, for:

- species producing hardwoods such as limba, framiré, teak, gmelina, in dense forest zones;

 fast-growing species, especially pines and eucalyptus, in humid savanna zones;

 local or introduced species best suited to the local growing conditions and requirements, in arid zones. storage. It is tested periodically for changes in germination capacity.

Fruit and seed of *Eperua grandiflora* from French Guiana



Research on the conservation and germination of certain species was conducted jointly with CNRS and the Muséum National d'Histoire Naturelle, Paris.

In 1984, 848 seed lots were sent to 22 countries.

In 1985, the gene bank was enhanced with more than 5000 seed lots, representing 100 genera, 300 species, and 1500 provenances.

# Understanding and Improving the Environment

Research on the impact of the transformation of forest ecosystems is conducted in French Guiana as part of a multidisciplinary and multiorganization operation ECEREX. In 1983, following the initiative of the Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM) and CTFT, a workshop was held in Cayenne, French Guiana; it was attended by scientists from neighboring Latin American countries and France. A report of CTFT's research on soil and water conservation was published in 1984.

# Logging of Forest Resources and Forest Economics

This research concerns the available potential, appropriate logging systems and equipment, and improvement of the cost-benefit balance of forest industry.

The effect of forest logging operations on the environment, design and efficient use of the road network and transport, were some of the aspects that were studied.

Forest economics studies dealt with the forest and wood sector inside

the producing countries, marketing and prices of tropical woods, competition with indigenous French species, economic problems related to the utilization of wood and forests in developing countries, especially those in the African arid tropics.

### Technology of Tropical Woods

The objective of wood technology research is a more efficient use of tropical wood through appropriate technology and a better understanding of the anatomical, physical, mechanical, chemical, and fuel characteristics of different species. It is based on the use of wood as structural timber and as raw material.

#### Structural Timber

This research involved the identification of species, technical tests of woods of different origin, and practical projects.

CTFT's reference collection received 1200 new samples, bringing the total to more than 30 000 accessions.

### 1200 tropical wood samples added to the collection (30 000 accessions)

The woods used for technical tests are mainly those from Benin, Brazil, Burundi, French Guiana, French Polynesia, Guadeloupe, New Caledonia, as well as eucalyptus and *Hevea*. The possibilities of using coconut trunks were also studied. Data sheets on woods from Africa, French Guiana, Guadeloupe, Mada-

gascar, and New Caledonia were published following these studies.

The possibilities of using reconstituted solid wood for making various items or for construction, and of producing glued-laminated beams



Framework of glued-laminated composite wood (*Paraberlina bifoliolata*) in the Bois de Boulogne bowling, France

from mixed woods, were determined. A prototype house made from panels of reconstituted solid wood, was built in French Guiana and in Nogent, France.

In rheology, the study of stresses and behavior of structural timber, work has advanced further with the installation, in 1984, of a testing machine.

In French Guiana, various devices were set up either on standing trees or logs to study growth stresses. Similarly, drying stresses were measured in Nogent, France.

Woods from Africa, South America, and the French Overseas Departments and Territories continued to be tested for natural durability and preservation treatability. The efficiency of various treatments on finnished wood products (particle boards, plywood, reconstituted solid wood) was tested. Methods were also developed to improve durability of roofs traditionally made from plant material in tropics.

Practical results include the development of a blueprint for a house of wood (French Guiana), installation of a solar dryer for timber (AFME-CEEMAT-CTFT), sensors to measure stresses in standing trees, and termite counters.

#### Wood as Raw Material

Tropical woods were studied for use in paper, chemical, and fuel production.

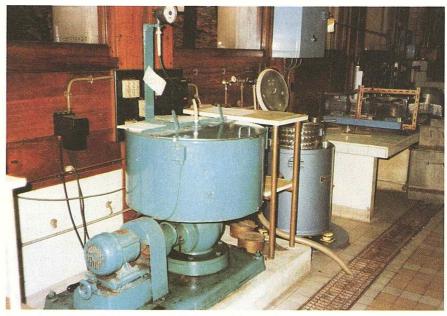
The energy value and possible end uses were determined for woods and crop residue that were rarely or not used until now, such as, logs left after thinning, oil palm shells and kernels, wood-processing wastes, softwoods, coconut shells and husks. Peats and fossil woods from Senegal were also examined.

#### a new source of energy, torrefied wood

Torrefied wood is a new source of energy that is being studied since 1984. An intermediate stage between normal wood and charcoal, it produces more energy than that obtained through carbonization.

Studies on direct liquefaction of wood and its transformation into fuel, were conducted jointly with the University of Sherbrooke, Canada.

For cellulose, experiments dealt with the quality assessment of reafforestation species planted in Congo and Gabon and with inter- and intraclonal variability. In a usersponsored research project, the cellulose division also tested eucalyptus



Jokro refiner at the Cellulose and Chemistry Division at CTFT, Nogent.

Catch of commercial-size Tilapia in a breeding pond in Côte d'Ivoire.

rayon pulp and pulp from the Madagascar *Pinus kesiya* for cement bags.

Techniques were developed to analyze the compounds found in the

wood and bark (extracts, exudates) and those, such as tar and gas, produced during thermochemical processes. The use of some of these products as substitutes for chemical

preservatives is still being studied; preliminary results are positive.

Collaboration between the CTFT laboratories and the French scientific organizations has been strengthened with the formation of working groups and the development of inter-organization thematic research projects (ATP). CTFT also organizes programs for university students and trainees. The Center has close links with institutes in other countries, such as, INPA, Brazil; CENADEFOR, Cameroon; FOFIFA, Madagascar.

# Fisheries and Fish Breeding

CTFT's research priorities for this area were specified in 1984. Work is concentrated on *Tilapia* in collaboration with other French research institutes working on the same subject, mainly INRA. An important objective is the development of small-scale fish farms to be integrated with existing farming systems.

The main programs conducted at the Bouaké aquaculture center in Côte d'Ivoire, concern:

— fish breeding in ponds (*Tilapia, Clarias*, and African species);

— production of *Tilapia* hybrids that can grow under favorable conditions in brackish waters.

Two main research and development projects are being carried out by CTFT. The first is the development of fish breeding in Benin through the establishment of hatcheries and commercial production in brackish water pens and fresh water ponds. The second is a fish breeding development project in Niger, based on hatcheries and commercial fish production in floating cages in the Niger river.

# CONTRIBUTION TO DEVELOPMENT

CTFT's research priorities are mainly determined by the requirements of developing countries in the area of forest production, technology of tropical woods, environmental balance (soil and water conservation), fisheries and fish breeding. National programs can avail of these research results and CTFT's expertise in various ways, through:

— technical support to pilot operations supervised by CTFT, such as forest management projects (Côte d'Ivoire), afforestation and reaffor-

estation operations (Burkina Faso, Burundi, Congo, Gabon, Senegal, Togo, etc.), and fish breeding projects (Benin, Côte d'Ivoire, Niger); — support research for large-scale forest projects (Cameroon, Niger, Senegal) funded by international agencies and implemented by national organizations;

— operation-related studies (development of forest and fish breeding projects), or those for inventories of natural formations (Cameroon, Mali).

Nursery of hybrid eucalyptus cuttings under mist irrigation at UAIC, Congo.



# TRAINING

CTFT trains foreign scientists and technicians in or outside France, as well as French students and professionals.

In France, foreign trainees are assigned to various divisions or laboratories at CTFT for specialized training or to complete research for university degrees. This is complemented by theoretical studies in various schools or universities.

About 10 courses are organized each year in French Guiana, New Caledonia, and in other countries, mainly in Africa.

For example, in 1984, CTFT organized a 2-week course in China on preservation techniques and the possibilties of using *Hevea*, and a 3-week course in Indonesia on quality control of plywoods.

Each year, about 15 French students undergo practical training at CTFT before leaving university or prior to an assignment in another country.

Two or three courses are organized each year for professionals, in response to requests from members of the wood industry.

# **PUBLICATIONS**

CTFT's quarterly *Bois et forêts des tropiques* is distributed in 109 countries. Thirteen issues were published between 1983 and 1985, containing a total of 66 articles, 27 tree identification sheets, and 10 technical data sheets.

Analyses or abstracts of the articles appear in *Forestry Abstracts, Agritrop*, and *Bulletin du Centre Technique du Bois*.

Other CTFT publications include:

Briane, D., and Doat, J. 1985. Guide technique de la carbonisation. La fabrication du charbon de bois. Aix-en-Provence, France: Edisud. 178 pp. In collaboration with Association Bois de Feu.

CTFT. 1983. Information sheet. Nogent, France: CTFT. Available in English and Spanish. **CTFT.** 1983. Plan directeur 10. Nogent, France: CTFT.

CTFT. 1983. Rapport annuel. Nogent, France: CTFT. 374 pp.

CTFT. 1984. Rapport annuel. Nogent, France: CTFT. 234 pp.

CTFT. 1985. Rapport annuel. Nogent, France: CTFT. 302 pp.

CTFT and CTBA (Centre Technique du Bois et de l'Ameublement). 1985. Guide pour le choix des bois en menuiserie. Paris: CTBA. 162 pp.

**Detienne, P., and Jacquet, P.** 1984. Atlas d'identification des bois de l'Amazonie et des régions voisines. Nogent, France: CTFT. 640 pp.

Groulez, J., and Wood, P.J. 1984. *Terminalia superba*. Monographe. Nogent, France: CTFT. 85 pp.

Parant, B., Chichignoud, M., and Curie, Ph. 1985. Les bois de Guadeloupe. Nogent, France: CTFT. 16 pp.

Certain earlier publications were reprinted:

Aubreville, A. 1950. Flore forestière soudano-guinéenne. Reprint. Paris: Société d'Editions Géographiques, Maritimes et Coloniales. 523 pp.

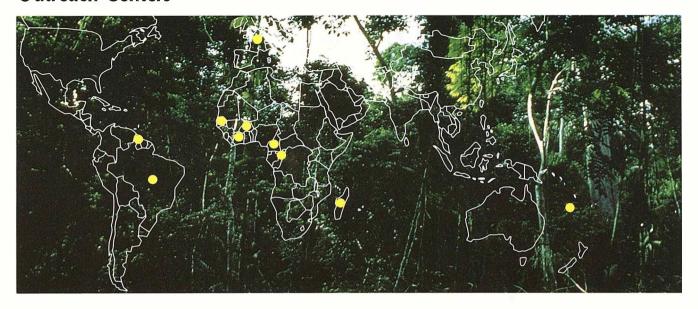
CTFT. 1983. Bois tropicaux. 5th ed. Nogent, France: CTFT. 143 pp.

**De St. Aubin, G.** 1963. La forêt du Gabon. Nogent: CTFT. 208 pp.

Letouzey, R. 1982, 1983. Manuel de botanique forestière. 2nd ed. Nogent: CTFT. Vol 1, 191 pp; vol 2 a and b, 461 pp.

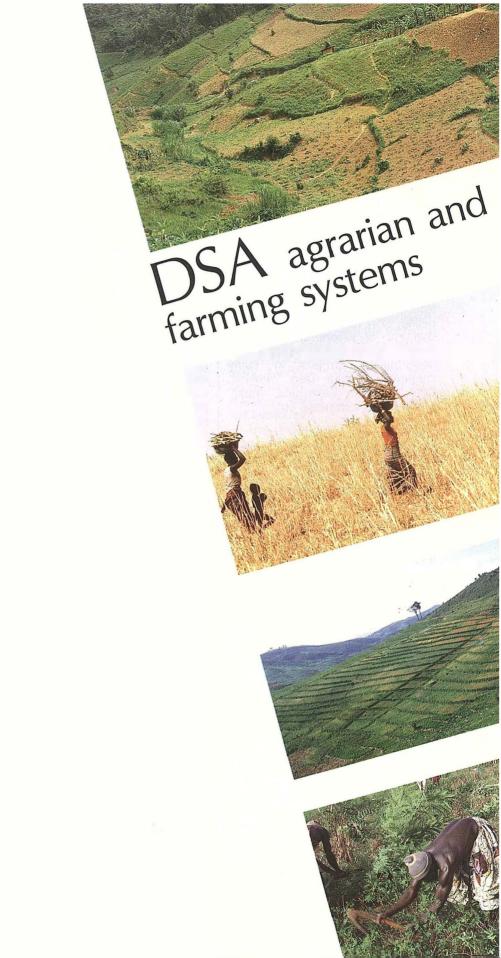
# CTFT AROUND THE WORLD

## **Outreach Centers**



BRAZIL FRENCH GUIANA BURKINA FASO CAMEROON CONGO COTE D'IVOIRE MADAGASCAR SENEGAL

**NEW CALEDONIA** 



# **DSA**

The Département Systèmes Agraires, the agrarian and farming systems research department of CIRAD was established in 1984. Based in Montpellier, DSA has 20 scientists on its staff, 12 of whom are on long-term assignments for research and development projects in many countries—Burkina Faso, Senegal, Côte d'Ivoire, Venezuela, Brazil, Madagascar, Indonesia, etc.

DSA's goal is:

— to initiate, conduct, and coordinate agrarian and farming systems research in collaboration with specialized teams from the other CIRAD departments;

— to strengthen links with devel-

opment operations;

in the research and development approach.

# AGRARIAN AND FARMING SYSTEMS RESEARCH

The failure of several development projects has raised questions on the relevance of research to development. The CIRAD departments are fully aware that these failures were due to the fact that the technical innovations were not adapted to the physical and socioeconomic environment of the farmers. Research should be based on a better

understanding of rural communities and endeavor to respond to the actual needs of the small farmer.

These are the thoughts and concerns that led to the establishment of DSA, whose aim is to enable farmers to make the changes that will improve their agriculture. Its efforts focus on:

— apprehending the mechanisms and dynamics of agricultural systems in order to determine the handicaps and opportunities for technological changes in rural communities;

— designing and testing changes and innovations to improve the organization and techniques of existing systems, depending on the physical constraints and farmers' capacity to adopt changes.

DSA has adopted three basic approaches: systemic approach, interand multidisciplinary approach, and participation in research and development (R&D) operations.

#### Systemic Approach

Applied to agricultural production, the systemic approach attempts to apprehend the biophysical, technical, and socioeconomic factors involved in production and their interactions. In other words, it tries to identify and consider all the factors that influence the decisions and practices of farmers at different levels: field (cropping systems), farm (farming systems), village and region (agrarian and farming systems). This approach enables the collection of relevant information required to lay down recommendations for farm and agrarian spatial economics.

#### Inter- and Multidisciplinary Approach

Studies and experiments of the possibilities for changing the agrarian and farming systems involve several

disciplines. DSA's objective is to provide, through thematic research, viable solutions suited to the conditions and requirements of extension activities. That is why DSA has mobilized expertise from the other CIRAD departments to work on joint projects.

#### **Downstream and Upstream Operations**

DSA is not the only organization to adopt this method. But it stresses field research where farmers, development workers, and scientists study together specific problems, for a more efficient use of the local resources. Such field operations are a vital component of DSA's research. They provide practical and theoretical feedback on the mechanisms and improvement of agrarian and farming systems, and serve as a basis for the development of appropriate research methodology.

DSA Département Systèmes Agraires Centre de Recherches du CIRAD Avenue du Val de Montferrand B.P. 5035 34032 Montpellier Cedex Tel: (16) 67 63 91 70 Telex: 490294 F Director: *Jacques Lefort* 

# RESEARCH HIGHLIGHTS

### The R&D Approach

Basically, this approach consists of four phases, although the actual procedure may vary for individual cases:

— A study of rural communities: the interaction between the technical and socioeconomic aspects of agricultural production, use of available resources (land, labor, etc). Thus major handicaps and opportunities experienced by the community are identified.

— Understanding the farmers' decision-making process, particularly the factors that determine their

major decisions.

— Development of solutions relevant to the constraints, through on-farm experiments with farmer participation. The resulting recommendations are therefore compatible with the local conditions as well as the economic and technical capacities of the farmers.

— Organization of the farming community to ensure a coherent use

of the innovations.

### **R&D Projects**

Some of the ongoing projects could serve as examples to illustrate the objectives and methodology of this approach.

# R&D Program in the Maradi Region, Niger

Niger's rural development policy stresses farmer participation for an integrated approach to development. Initiated in 1984 by the Maradi rural development project, with support from DSA, the R&D program is intended as a practical application of this policy.

The first step was devoted to the analysis of the variability of agropastoral systems. It was further divided into three phases: a zoning of the entire district in order to select agriculturally representative areas, surveys on about 20 selected villages, typology of village-level agrosystems based on easily identifiable variables that are valid for a generalized characterization of the rest of the project area. These variables include aridity, land availability for cropping and grazing, farmers' level of technology, potential area for irrigation, and ethnic groups. These results were discussed with farmers. They were subsequently adjusted, following an analysis of the different types of farms in each village. However, the global village-level analysis was found to be adequate in determining the priorities for applied research, extension activities, and community organization.

The second stage was centered on the development of appropriate recommendations:

— The extension services discussed with the farmers the proposals derived from the analysis, in order to formulate a program for the village

and R&D ways to implement it. This included the selection of farmers who will participate in the tests, organization of priority community operations, etc.

— The applied research team tested innovative techniques in the villages. Such tests aim to check the technical innovations without major modification of the existing crop management practices. The results were presented to the farmers and their reactions noted for the following 1985 program.

— The follow-up and evaluation team conducted additional surveys to determine how the options should be diversified according to the types of production units.

This project shows that systemic and thematic research are complementary approaches. DSA has thus contributed to the valorization of some of IRAT's research results.

# R&D Operation in Ségala, Aveyron, France

Ségala does not normally belong to CIRAD's area of concern, but the development of this region is of significant importance to systems research. The fundamental changes in this region's agriculture have led to a remarkable improvement of its farming situation. It is of particular interest for analyzing the mutations in a changing agricultural community and to identify the factors that are conducive to these changes. In Ségala, the local farming organizations themselves undertook the

development of their region. Their experience shows how a rural community can direct and implement the changes needed for the advancement of its agriculture.

A research on the spatial distribution, evolution, and present organization of the agrarian and farming systems has enabled the evaluation of the impact of development actions. A typology of the farms, based on their origin and evolution since 1950, provided information on the technical recommendations made to farmers and the mode of operation of the development committee.

Ségala is a training ground for scientists from CIRAD and other organizations for the integrated development approach.

#### R&D Project in Arid and Semi-arid Zones (PIDZAR), State of Falcon, Venezuela

The program integrates several Venezuelan research and development organizations that, along with DSA, constitute the core team. The analysis of livestock systems is an important concern of the program. Livestock production (open grazing) represents a substantial source of income and saving to smallholders.

In the animal husbandry survey, open-grazing herds were monitored for a characterization of the different systems.

Preliminary results on goat grazing systems show a definite pattern of flock organization and management that facilitated accurate monitoring of the animals. Certain improvements were proposed including the

development of forage crop species, organization of watering places, and health care measures in order to adapt forage resources to herd requirements.

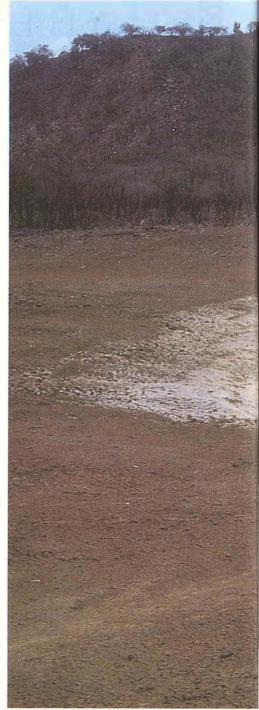
#### Farm-level Microeconomic Study in the Groundnut-growing Area in Senegal

This program was conducted in collaboration with the International Food Policy Research Institute (IFPRI), and the Institut Sénégalais de Recherches Agricoles (ISRA). Studies on cereal production, consumption, and exchange in the groundnutgrowing area in Senegal have helped to understand the decision-making process of farmers as they strive to overcome the drought problem.

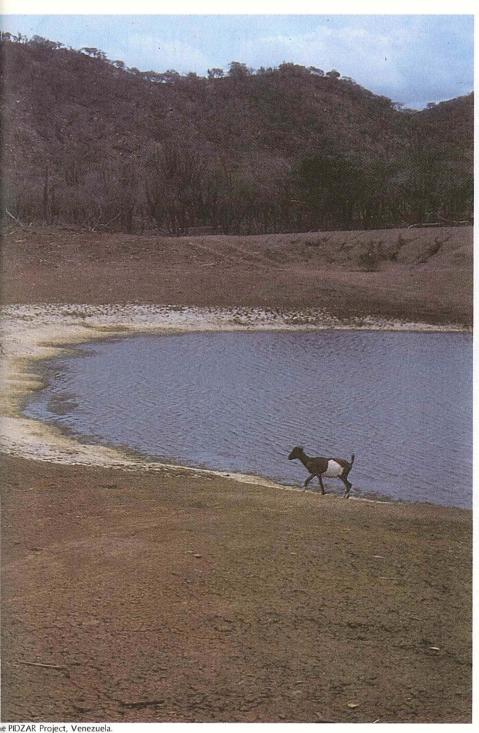
During these studies, the investigators were able to try out a new interview method. Farmers were more forthcoming and provided valuable information when asked about how they met their food and budget reguirements. Preliminary results show a growing need of cereals compensated by purchase and transfer (from relatives in cities, food aid) rather than from local production. Farmers choose between selling their cattle, diversifying agricultural activities, and extra-agricultural activities (trade, transport), to obtain money for purchasing cereals. The decisions vary according to the village or type of agricultural activity. As a last resort, they move to the cities.

#### R&D Program in Yatenga, Burkina Faso

For the past few years, scientists from different institutes—mainly



Easy access to ponds makes pasture management more efficient at



Chaudes (IFARC), now part of DSA—have been working on an R&D project in the Yatenga province. IRAT is testing techniques and varieties in a village, and is involved in preextension work and monitoring of certain technical recommendations.

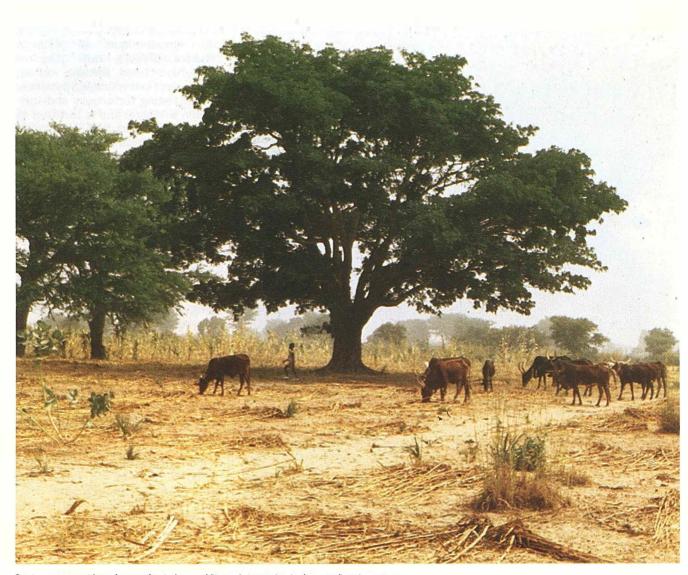
IRAT and the Institut pour la Formation Agronomique en Régions

The R&D program conducted at present by DSA includes a multilocation experiment and analysis of the systems in three villages. Technology options are being prepared based on trials in farmers' fields. These trials examine different varieties, cultural practices for manual cultivation and animal traction, fertilizer management, off-season crops, storage of crop residue, and postharvest processing. Preextension testing and monitoring of the different techniques are carried out on parcelles completely managed by volunteer farmers. The monitoring of the farms and parcelles enable the verification of the efficiency of trials and methods.

Certain improvements were introduced as a result of these trials; these include: short-duration varieties, weeding yokes and single-animal traction, soil protection and soil regeneration, family gardens.

Study of the Effect of an Unstable National Economy on Farming Systems in Veracruz, Xalapa, Mexico

DSA is carrying out this study in collaboration with the Institut National de la Recherche Agronomique (INRA), as part of a regional R&D project.



Grazing on crop residue, a feature of agriculture and livestock integration in the Maradi region, Niger.

Smallholder coffee growers of the Xalapa region are in an unstable economic situation due to the lack of equipment and capital-investment funds. They are not able to overcome the crisis in the coffee-growing areas of the region.

In some villages, the research team helped by an NGO supports the

collective management of coffee dryers. It is testing wood dryers, and has installed a fuel dryer in one village and small dryers in two other villages where they are managed by the coffee growers. Intervillage management of modern dryers is also being studied. IRCC and IRAT have sent one scientist each to participate in this project.

# CONTRIBUTION TO DEVELOPMENT

DSA's activities, including collaborative efforts, are aimed towards results that are of direct relevance to development. Right from the start, its work is carried out in farmers' fields, villages, or agricultural regions. Technical and organizational changes are developed and tested with farmer participation in the rural context.

DSA participates in R&D projects at the request of governments, development, financial, and research organizations. It either establishes an R&D operation or provides support to an ongoing project.

# Establishment of Projects or Participation

Such projects were carried out in Niger (Maradi rural development project), Burkina Faso (Yatenga project), Mexico (LIDER project in the Xalapa province), and Senegal.

In Madagascar, an R&D project was set up as part of a regional program directed by the Société Malgache d'Aménagement du Lac Alaotra (SOMALAC), in collaboration with a research-extension organization (FOFIFA), IRAT, and DSA with funding from the World Bank and the Caisse Centrale de Coopération Economique (CCCE).

In Brazil, DSA is collaborating with the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), and in Venezuela with the Fundacion para el Desarrollo de la Region Centro Occidental de Venezuela (FUDECO).

In the Zou province, Benin, IRAT and DSA are providing support for methodology and evaluation to the Centre d'Action Régionale pour le Développement Rural (CARDER), a development project, also sponsored by the World Bank and CCCE.

#### **Scientific Support to Ongoing Projects**

DSA also participates in ongoing projects through: short-term assignments (Fara Poura Project, directed by IRAT in Burkina Faso), expertise in programming and evaluation (establishment of a development project and a support network in southern Tunisia), contribution to research programs (ISRA, Senegal; CGPRT, Indonesia).

R&D projects	Results obtained		
Maradi (Niger) Yatenga (Burkina Faso) PIDZAR (Venezuela)	<ul> <li>technical improvements: improved seed, fertilization</li> <li>establishment of an R&amp;D cell of the regional development organization, ORD</li> <li>adoption of short-duration sorghum varieties</li> <li>flexible planting dates</li> <li>cultural practices, tillage techniques, animal-drawn equipment</li> <li>modification of criteria for allocating credit to live-</li> </ul>		
CPATSA (Brazil) LIDER (Mexico)	stock producers  • health care for animals  • plowing techniques using animal traction  • use of light draft equipment adapted to animal power  • fertilizer recommendations  • plowing and liming techniques for maize  • fertilizer recommendations for maize		

# TRAINING

One of the main functions of DSA is training in R&D work. The current programs aim to initiate French and foreign scientists to a more integrated approach to development and to planning and management of R&D operations.

Two types of training programs were conducted in 1984 and 1985—introductory training and advanced in-service training.

#### **Introductory Training**

DSA participates in the training program offered by the Centre National d'Etudes Agronomiques des Régions Chaudes (CNEARC), Montpellier; introduction to the systems approach (Cycle d'Enseignement d'Agriculture Tropicale, CEAT); courses at the Ecole Supérieure d'Agriculture Tro-

picale, ESAT, for analysis of cropping and farming systems, water management and farming systems.

#### **Advanced In-service Training**

This training, designed for scientists and development officers, is organized in France and other countries.

In France, the main courses offered in 1984 and 1985 were:

— the fourth training session on R&D and the systems approach. The main objective of this 6-week course is the introduction and practical application of the concepts, analytical methods, strategies development. It also offers trainees the opportunity to exchange ideas and experiences. — the sixth and seventh courses (9 months) on management of agricultural projects, organized jointly with CCCE, were designed for senior

staff from developing countries who hold key positions in the agricultural sector.

DSA participated in workshops in other countries especially those organized by ISRA, Senegal, on the systems approach in agriculture and methodology for food crop marketing studies in Senegal.

In Cameroon, DSA organized an FAO-sponsored training seminar on research management for senior research staff in francophone countries.

DSA organized training seminars in Brazil, Cameroon, and Venezuela. These dealt with project monitoring and evaluation, and integration of agriculture and livestock production.

Students and scientists also receive training for their thesis research.

# **P**UBLICATIONS

DSA publishes a periodical *Les Cahiers de la Recherche-Développement* founded by the Research and Development Network. It presents work on R&D methodology and experiments to scientists, development professionals, government officials, and international organizations. Six issues were published in 1984 and 1985, the most important being "La recherche-développement, quelques expériences, quel-

ques idées" (No. 2), and "Diagnostics sur le fonctionnement des systèmes agraires" (No. 3-4).

DSA also publishes the *Gazette des systèmes*, that gives information on methods, projects, programs, activities, news on systems research, and R&D findings.

Results of DSA's research are also published regularly and a list of

these publications can be obtained on request.

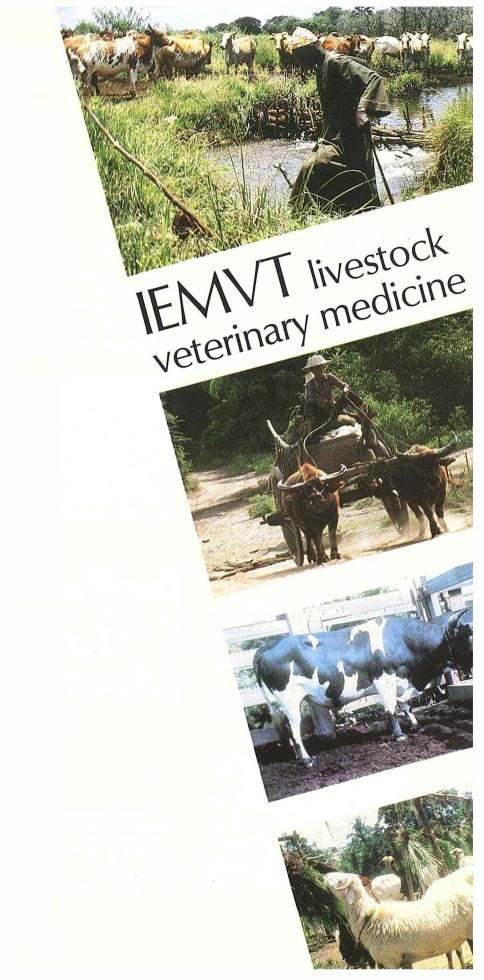
The DSA publications fulfill a key function in the dissemination of scientific and technical information required for ongoing programs. They constitute a specialized data base "Systèmes agraires, recherche-développement."

# DSA AROUND THE WORLD

# **Long-term Assignments**



BRAZIL MEXICO NICARAGUA VENEZUELA BENIN BURKINA FASO COTE D'IVOIRE MADAGASCAR RWANDA SENEGAL INDONESIA



# **IEMVT**

The Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux for tropical livestock and veterinary research was founded in 1948 and became a department of CIRAD on 1 January 1985. It was originally the Cours de Médecine Vétérinaire Exotique established in 1921, that later became the Institut de Médecine Vétérinaire Exotique in 1928. IEMVT is located in Maisons-Alfort, near Paris, and has close links with the neighboring Ecole Nationale Vétérinaire. The Institute's 90 scientists are based at headquarters or in other establishments, or they are on assignment in various tropical countries including Burkina Faso, Burundi, Cameroon, Central African Republic, Ethiopia, Gabon, Morocco, Senegal, Zaire.

IEMVT's research concerns all aspects of livestock production—environment, breeding, animal health, technology, and economics. Training, however, is the primary objective of IEMVT and the Institute offers a formal degree course. Documentation, dissemination of scientific and technical information, and publication are also major activities.

# LIVESTOCK AND ANIMAL PRODUCTS

In the tropics, people generally suffer from a serious lack of animal proteins in their normal diet, except in the case of pastoral populations who live off a milk-based diet. There is an urgent need to develop livestock production in order to reduce food deficiencies and to keep pace with population increase in the developing countries.

This development is confronted with several constraints; climate is the major limiting factor as it causes wide fluctuations in food-resource availability and encourages parasite development. Improvement of livestock production is also faced with physical problems, particularly the inadequate infrastructure in this immense zone, as well as human and economic problems (low prices).

IEMVT's activities cover all stages and areas of livestock production: understanding the environment, resources, and animals; development of effective disease-control methods; training; distribution of documentation required by scientists and professionals.



N'dama herd in a pasture in Côte d'Ivoire.

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### PAST ACHIEVEMENTS

Detailed studies on rinderpest have enabled the development of an efficient and low-cost vaccine and vaccination methods. This vaccine is produced with technical assistance from IEMVT in Chad since 1963, and in Ethiopia since 1968. The Teschen disease of swine in Madagascar was brought under control with the development of a unique vaccine that is being produced at the Tananarive laboratory, the only place in the world to produce it industrially. Mass rearing of tsetse flies, vectors of trypanosomiasis, has led to the development of a biological-control method to induce male sterility through irradiation. The eradication of breeding sites in Burkina Faso has confirmed its efficiency.

IEMVT has the largest modern herbarium with 5000 species and 55 000 samples from pastures in the arid tropics north of the equator. Original methods were developed for the description, evaluation, and mapping of tropical pastures. IEMVT has contributed largely to the study of *Stylosanthes* and the spread of high-yielding forage grasses.

Small-scale and industrial fattening systems were developed following cattle fattening studies.

The major West African races were studied with emphasis on trypanotolerance. Zebu from Cameroon and Madagascar and N'Dama were improved through crossbreeding.

# RESEARCH HIGHLIGHTS

### **Animal Protection**

IEMVT gives high priority to the improvement of animal health. The studies concern both infectious and parasitic diseases.

#### **Infectious Diseases**

IEMVT concentrates its efforts on hemorrhagic bovine septicemia and mycoplasmosis among the bacterial diseases, on rinderpest and blue tongue among the virus diseases. The IEMVT microbiology laboratory was designated by FAO as the world reference laboratory for hemorrhagic septicemia and mycoplasmosis of ruminants.

Hemorrhagic septicemia. Scientists have obtained a second streptomycin-resistant strain of *Pasteurella multocida* through selection. A batch of the experimental vaccine was tested on mice and rabbits and gave encouraging results.

Mycoplasmosis. Several strains of mycoplasma were studied and determined using the Elisa technique for serological analysis.

Blue Tongue. An international network was established to study the blue tongue disease. A total of 22 viruses were assembled in a collection and more than 4000 serum samples from different countries in Africa and the Indian Ocean region were analyzed.

### research on an improved vaccine against rinderpest continues



Rinderpest epidemic in Cameroon, in 1983.

**Rinderpest.** Research on an improved vaccine against rinderpest continues and high virus titers were obtained in interferon-defective cells.

Epidemiology surveys. In 1983, the surveys studied brucellosis in Tahiti, diseases of wild animals in France, diseases of camels in Niger, and bovine mycoplasmosis in Senegal. In 1984, a study on arbovirus and causes of abortion among small ruminants was undertaken in Mauritania in collaboration with the Laboratoire National de l'Elevage et de Recherches Vétérinaires (LNERV) and Institut Pasteur, Dakar. Incidence of hemorrhagic fever was confirmed in Mauritania and a serological study revealed that it is endemic along the Senegal river.

The disease situation is entirely different in New Caledonia where the most common disease is bovine leptospirosis which is also common among human beings.

#### **Parasitic Diseases**

Research in this field is concerned with parasitic worms, mites, and protozoans and their insect vectors. These studies were mainly carried out as part of joint projects or through international or African networks.

A study conducted in Niger and Senegal has concluded that the optimum period for intestinal parasite treatments of small ruminants and camels is at the end of the rainy season.

# screening of seven new molluscicidal plants confirms the effectiveness of *Jatropha curcas*

Jatropha curcas proved to be effective in a trial of seven new molluscicidal plants.

Pyrethroid-impregnated ear tags were found to be effective in preventing ocular thelaziosis.

Cattle are dipped for tick disinfestation in Cameroon.



Research on ticks and tick-transmitted diseases was intensified in the Caribbean, Africa, and Oceania. In the French West Indies the ecology and biology of *A. variegatum* and the epidemiology of heartwater, were determined in a col-



Trypanosomes (T. vivax) seen through a microscope.

laborative project with the US Department of Agriculture.

In Zaire, epidemiology studies were carried out on tick-transmitted disseases. Hematological analyses reveal that primary infection is a critical stage and the outcome depends on the conditions under which the calves are raised.

Seasonal variation in tick infestation was studied in Cameroon and revealed the significant effect of acaricide treatments.

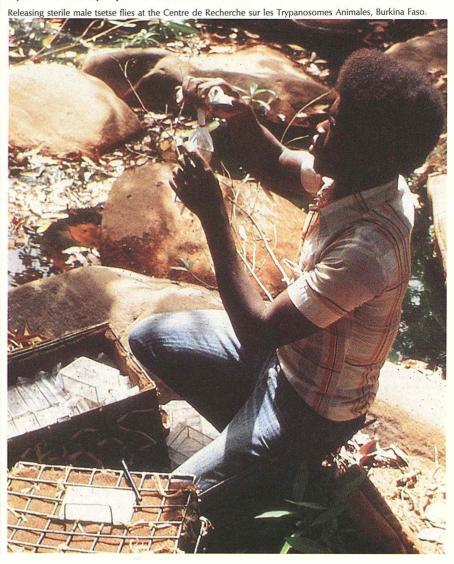
Heartwater. According to a study on the distribution of this disease in Guadeloupe, half of the communes are affected. Immunofluorescence diagnosis proved to be a reliable method. A study was initiated on the genetic resistance of Guadeloupe creole goats to heartwater.

### in Burkina Faso, tsetse flies completely eradicated over 30 000 ha

**Tsetse flies and trypanosomes.** 1984 was the final year of the tsetsefly eradication project in the Sidera-

dougou zone in Burkina Faso. Males sterilized by irradiation were released on a large scale (850 000 in 18 months) the vector was successfully eradicated in the area covering 30 000 ha.

Trypanotolerant bulls bred at the Banankeledaga ranch were used to identify Baoules and N'Dama breeding animals that are susceptible or tolerant to the disease. An exam-





Forage crop (Panicum maximum) at the Côte d'Ivoire experimental station.

ination of marker genes (albumin) and an analysis of the major histocompatibility system demonstrated the role of these factors in the identification of trypanosomiasis-resistant strains. The effect of class-1 antigens were studied in 150 animals using reagents supplied by the genetic biochemistry laboratory of the Institut National de la Recherche Agronomique (INRA), Paris; the International Laboratory for Research on Animal Diseases (ILRAD), Kenya; and the Animal Breeding Organization (ABO), Scotland; as part of a joint research project.

It was observed that many animals in Africa do not have the antigens specific to serums prepared in Europe.

### **Animal Nutrition**

IEMVT surveys, evaluates, and, if possible, improves food resources for animals. Current studies are focused on the evaluation of forage production, feed value, and animal diets.

### **Evaluation of Forage Production**

Research on the methodology for estimating forage production using satellite imagery was carried out in southern Niger in collaboration with the Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM), INRA, and the Institut National de la Recherche Agronomique du Niger (IN-RAN). This should enable the use of SPOT satellite images for subsequent studies of grazing lands in the arid zone.

The botany laboratory at the IEMVT headquarters completed the determination of 672 samples. The IEMVT herbarium was enhanced with the addition of 1112 species, bringing the total to 5400.

In New Caledonia, local and introduced forage crops were studied before being added to the collection and to compare forage yields. Toxic plants from Oceania are studied jointly with the IEMVT-Port-Laguerre and ORSTOM-Nouméa laboratories.

In Wallis Island, 28 new forage grasses and legumes were introduced.

#### Feed Value and Animal Diets

The programs mainly concern ruminants and, to a lesser extent, swine and poultry.

In 1984, 51 digestibility tests were carried out using cereal stalks, natural or cultivated grasses.

The feed value, in terms of protein supply to diets of ruminants, of 31 samples of woody plants belonging to 14 species was determined following chemical and enzyme analyses.

The effect of mineral fertilization was studied in 317 samples of natural forage material collected at the end of the rainy season and at the start of the dry season following fertilization. It was observed that leaves were richer in phosphorus and calcium than the rest of the plant and that

mineral content was lower in the dry season.

### sunflower is superior to maize as maintenance feed during drought

A comparison of silage in New Caledonia proved that sunflower is definitely superior to maize as maintenance feed during drought.

Santa Gertrudis cattle gave the best results for Kobe beef production on condition that the animals are older and that fattening is extended beyond 18 months.

Studies on swine production economics confirmed the feasiblity of using high levels of cassava for fattening porkers.

## Breeding

Research is concentrated on the analysis of livestock production systems, evaluation of local breeds, and improvement of milk production. It is based on field studies and those under controlled conditions in the IEMVT centers and stations.

### **Analysis of Production Systems**

The main economic parameters were determined for cattle (Thailand, Guadeloupe), camels (Niger), and small ruminants (northern Cameroon, Burkina Faso). These are: fertility, mortality, reproductive age, length of reproduction cycles.

In New Caledonia, three strains of broiler chickens were compared under controlled conditions. Two breeds—Sussex and Wyandotte—of

broiler-layer poultry were introduced in the region.

Programs are being developed for computer processing of data collected during the animal surveys.

#### **Evaluation of Landraces**

In Mali and Gabon, a simple method is being developed for collecting data on the N'Dama race.

In northen Cameroon, short-horned Sahelian zebu have shown the best weight-gain ability (750 g/day) at an optimum age between 3 and 6 years.

#### **Increased Milk Production**

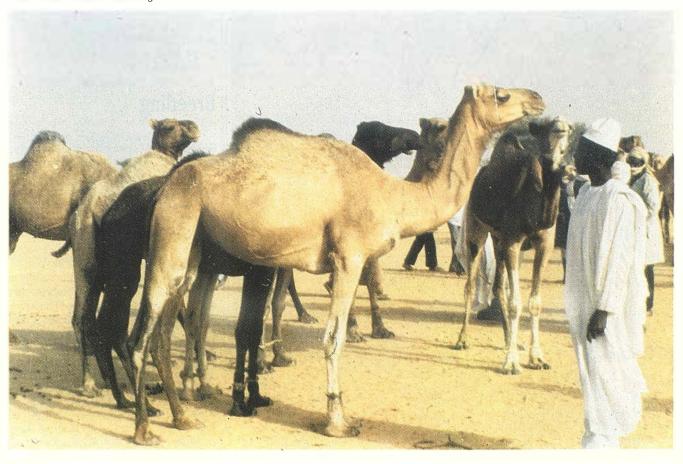
In Senegal, 151 pedigree Montbeliard cows and 47 from Pakistan were supplied to producers. The main problem is to provide adequate feed to these animals.

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# **Economics of Animal Production and Production Systems**

Research on this aspect is concentrated in Senegal where IEMVT scientists work with the team from the Institut Sénégalais de Recherche Agricole (ISRA) to analyze the production systems in an essentially rice-growing area. Interactions between livestock and agriculture, animal population, and herd structure were described.

Toubou camels in central-eastern Niger.



The program on the productivity and diseases of small ruminants in traditional systems covers three zones: the agropastoral Louga zone, the agricultural Sine-Saloum zone, and the silvopastoral zone. Ten investigators monitor 9000 animals. In the north, the main cause of dry-season mortality is the lack of food, whereas in the south—where it is generally higher—it is due to infectious diseases, mainly sheep pox (sheep) and peste des petits ruminants (goats).



Lingual erosion in sheep, in Senegal.

Mobile laboratory for on-site sampling and testing in Senegal.



# CONTRIBUTION TO DEVELOPMENT

IEMVT scientists and experts devote one-third of their activities to development work, based on agreements and contracts with funding institutes as well as national and international development organizations.

#### **Technical Support to Livestock Projects**

Short-term assignments include studies for project identification, feasibility, or evaluation (Comoro, Mali, Sultanate of Oman, Thailand, Togo, etc). Long-term support is provided for project supervision (Burundi, Cameroon, Côte d'Ivoire, Gabon, Niger, Senegal, Thailand, Zaire, etc).

# Scientific and Technical Support to National Veterinary Laboratories

Such support may be offered in the form of assistance on breeding ranches (Mali) or veterinary assistance (Comoro, New Caledonia, Wallis and Futuna Islands). Other countries receiving this support are Cameroon, Chad, Ethiopia, Morocco, Niger, and Senegal.

# Scientific and Technical Support for Disease-control Projects

The major projects are tsetse-fly eradication (Burkina Faso), tick control (Burundi, Cameroon, French West Indies, New Caledonia), and the trypanotolerance program (Kenya).

# Studies on Animal Production, Nutrition, and Improvement

Several studies were undertaken: animal survey in New Caledonia, agrostological and agropastoral studies (Burundi, Mali, New Caledonia, Uganda, etc), camel research (Egypt, Morocco, Somalia, Sudan), study on small ruminants (Côte d'Ivoire, Burkina Faso), estimation of forage resources using satellite imagery (Niger).

#### **Publication and Updating of Manuals**

Ten manuals were published for livestock producers and development workers, with funding from the French Ministry of Foreign Affairs. They deal with nutrition, pastures, farm buildings, poultry farming, swine production, cattle hygiene, leather and pelts, etc.

In addition, IEMVT publishes a series *Etudes et synthèses de l'IEMVT* that is, at present, made up of 18 publications on livestock production and veterinary medicine in the tropics.

# TRAINING

Since its inception, IEMVT has provided training to about 3000 veterinarians and technicians in France and the developing countries.

At Maisons-Alfort, the courses are intended for postgraduate students and technicians. Several types of programs are offered.

# Training for the Development of Animal Production in the Hot-climate Countries (DPARC)

This postgraduate course is of 1-year duration and has been established in

collaboration with the Department of Sciences, University of Paris-XII. It is officially recognized as a DESS-level (= M.S) course. More than 1500 veterinary doctors, including 700 from other countries, have graduated from this course. In 1983-1984, out of the 47 students who enrolled for training, 21 came from developing countries.

#### **Specialized Training for Research**

This program concerns several sectors mainly microbiology, animal

husbandry, agropastoral studies, parasitology, livestock economics, entomology, marine fishing, etc. In 1983-1984, 45 students—40 from developing countries—attended this course.

# Technical Training for Technicians from Cooperating Countries

Almost all the 12 students who attended this course in 1985 came from developing countries.

# **P**UBLICATIONS

The Institute publishes a quarterly Revue d'élevage et de médecine vétérinaire des pays tropicaux (abstracts in English and Spanish) that is sent to 1500 subscribers. About 50 articles are published each year.

Other publications include the IEMVT-authored manuals published by the French Ministry of Foreign Affairs and the series published by IEMVT Etudes et Synthèses de l'IEMVT.

#### Etudes et Synthèses de l'IEMVT

**Audru, J.** 1982. Quelques figuiers d'Afrique de l'Ouest (genre Ficus, Moracées). Maisons-Alfort: IEMVT. 142 pp.

**Barral**, H., et al. 1983. Systèmes de production d'élevage au Sénégal dans la région du Ferlo. Maisons-Alfort: IEMVT. 172 pp.

Camus, E., and Barre, N. 1982. La cowdriose (Heartwater). Revue générale des connaissances. Maisons-Alfort: IEMVT. 147 pp.

Hoste, C., Peyre de Fabrègues, B., and Richard, D. 1984. Le dromadaire et son élevage. Maisons-Alfort: IEMVT. 162 pp.

Kintz, D., and Toutain, B. 1981. Lexique commentéé peul-latin des flores de Haute-Volta. Maisons-Alfort: IEMVT. 44 pp.

Landais, E. 1983. Analyse des systèmes d'élevage bovin sédentaire du nord de la Côte-d'Ivoire. Maisons-Alfort: IEMVT. 759 pp.

**Lefèvre**, **P.C**. 1982. Peste des petits ruminants et infection bovipestique des ovins et caprins. Maisons-Alfort: IEMVT. 95 pp.

Lefèvre, P.C. 1983. La variole ovine

(clavelée) et la variole caprine. Maisons-Alfort: IEMVT. 171 pp.

**Lepissier**, **H.E.** 1983. Campagne panafricaine contre la peste bovine. Organisation et exécution logistique. Maisons-Alfort: IEMVT. 117 pp. Also available in English.

**Pugliese, P.L.** 1983. Les graines de légumineuses d'origine tropicale en alimentation animale. Maisons-Alfort: IEMVT. 186 pp.

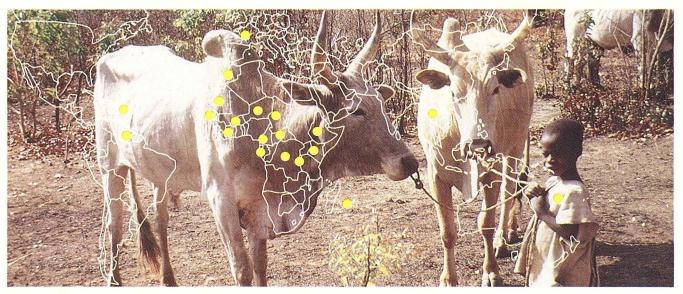
**Richard, D.** 1980. Bibliographie sur le dromadaire et le chameau. Maisons-Alfort: IEMVT. 137 pp. Out of print.

**Saliki, J.T., Thiry, E., and Pastoret, P.P.** 1985. La peste porcine africaine. Maisons-Alfort: IEMVT. 145 pp.

**Tacher, G.** 1985. Pathologie animale tropicale et économie. Maisons-Alfort: IEMVT. 62 pp.

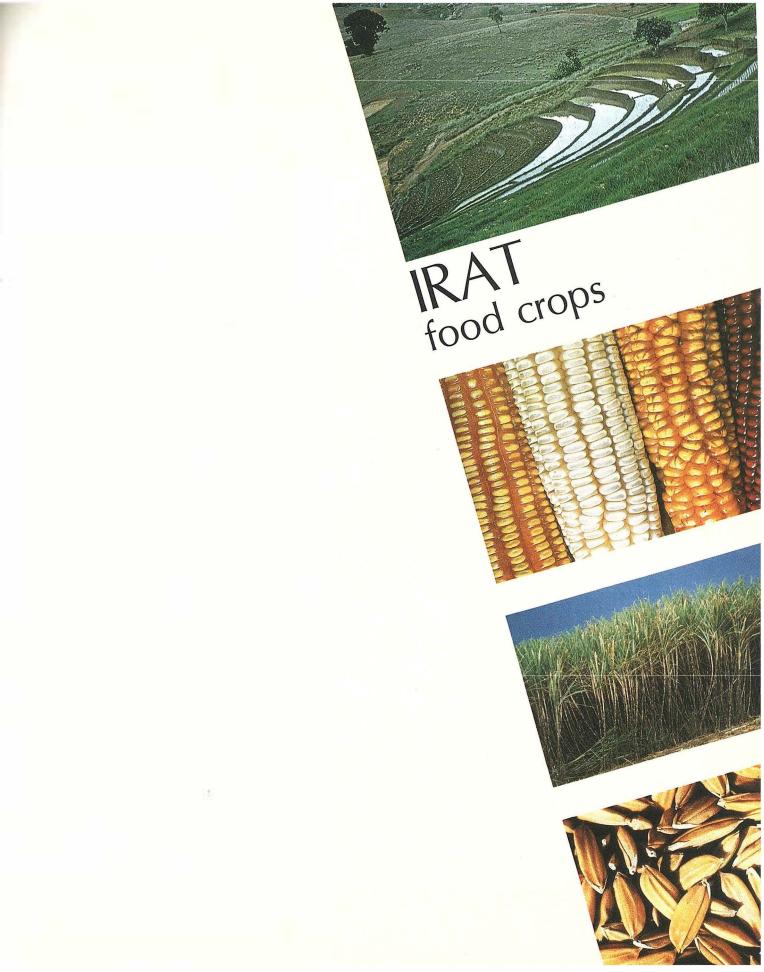
# EMVT AROUND THE WORLD

### **Outreach Centers or Long-term Projects**



French Guiana Guadeloupe BURKINA FASO BURUNDI CAMEROON CENTRAL AFRICAN REP. CHAD COTE D'IVOIRE ETHIOPA GABON

KENYA MAURITANIA MOROCCO NIGER REUNION SENEGAL ZAIRE NEW CALEDONIA THAILAND WALLIS & FUTUNA ISL.



### IRAT

The Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières was founded in 1960 to meet the food crop research requirements in Africa, and operated from the research facilities that existed before independence in the host countries. In 1985, IRAT became a department of CIRAD.

With the development of national research programs in certain African countries in the 1970s, IRAT's responsibilities shifted from direct execution of research programs to scientific cooperation.

IRAT's activities include crop-based programs (rice, maize, sorghum and millet, sugarcane, cassava, yam, soybean, market-garden crops, etc) and interactive programs (study and improvement of the physical environment, farming systems research). The interactive programs aim at a global understanding of the environment and attempt to integrate the research with development activities.

#### **FOOD CROPS**

#### Rice

Rice closely follows wheat as the second most important cereal crop in the world. Out of the world production of 450 million t in 1983, only about 11.5 million t entered the market. In Africa, local production is insufficient and several countries

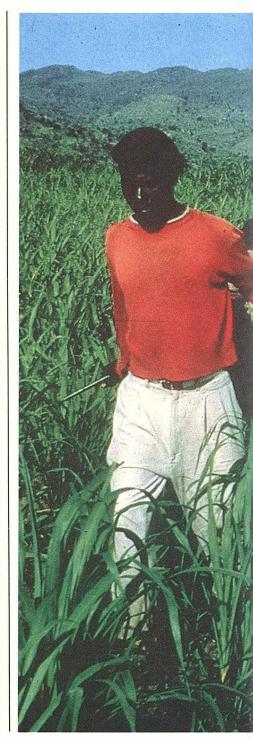
such as Côte d'Ivoire-although self-sufficient at one time—Liberia, Madagascar, Nigeria, and Senegal are sometimes compelled to import large quantities of rice. Only 50% of the rice is grown under controlled irrigation conditions, the rest is cultivated as lowland (35%) or strictly rainfed (15%) crops, as in countries not having an adequate irrigation system. Even under rainfed conditions, yields higher than 3 t/ha can be obtained by farmers using recommended varieties and techniques (Brazil, Cameroon, Côte d'Ivoire, Gabon, Madagascar, Senegal, etc). IRAT's multidisciplinary teams have earned international repute in this field.

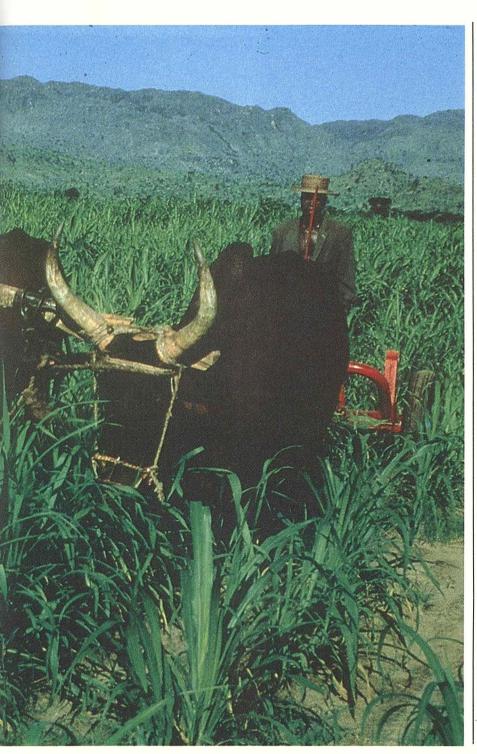
#### Maize

Originally a high-altitude tropical plant, maize has become one of the most important temperate crops. Over the past decade, production has risen by a spectacular 50%, so that with a total of 448 million t in 1984, maize has caught up with wheat and rice. In the tropics, where it is grown for human consumption, maize is a component of lowyielding production systems based on traditional technology. In Africa, yields are low and unstable with an average of 1.3 t/ha compared to 2 t/ha in Latin America; and liable to fall below 500 kg/ha when maize is grown as an intercrop.

#### Sorghum

World production of sorghum is about 70 million t. It is, like millet, a subsistence crop in Africa and Asia. In Africa, production is decreasing in





spite of an expansion of the cultivated area and average yields are less than 0.7 t/ha. The recent drought in the sorghum-growing areas has seriously curtailed its development. In several Latin American countries, however, the expansion in cultivated area has been often followed by substantial yield increases (average 3 t/ha).

#### Sugarcane

An industrial and perennial sole crop, sugarcane is mainly used for sugar production. Other important by-products are noncentrifugal sugars (10 million t), bagasse (fiber, fuel), and alcohol (liquor, industrial use). Two-thirds of the world production of sugar (100 million t) is obtained from sugarcane. Sugar production figures are: Latin America, 29 million t; Asia, 22 million t; Africa, 7 million t. In most francophone African countries, the sugar industry is a recent development of the 1970s and IRAT has always been involved, in some way or another, in its establishment. Burkina Faso, Cameroon, Chad, and Côte d'Ivoire are all self-sufficient. But on the whole, production cannot meet the demand in this region.

#### **Tuber and Root Crops**

Tuber and root crops are the staple food in the African humid tropics where cereals other than rice are only of minor importance. These crops are normally used for domestic consumption and rarely appear on the world market. Africa's cassava production of 50 million t accounts

for 40% of the world total. The 15-percent increase during the past decade is due to an expansion of the cultivated area. However, yields have not improved, the average being 6 t/ha in Africa, compared to a realistic target of 30 t/ha.

#### Vegetables

In Africa, the rapid growth of urban centers has led to the development of green belts around cities and of large irrigated areas that supply fresh and preserved vegetables. Export possibilities are also explored wherever the necessary commercial infrastructure (packing, preservation, transport) can be established; for example, in Senegal, that now exports beans, potatoes, and tomatoes to Europe in winter.

#### IRAT

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### PAST ACHIEVEMENTS

#### Rice

Of the 125 varieties listed in the IRAT variety catalog, several are well known and widely promoted, e.g., IRAT 10 and IRAT 13.

Several cultivars (I Kong Pao, Moroberekan, Taïchung Native 1, etc) identified by IRAT are very popular among farmers. Techniques for studying the root system, including the use of <sup>32</sup>P-labelled fertilizer, were developed to screen varieties for drought resistance.

An in-depth study on nitrogen nutrition of upland rice was conducted using <sup>15</sup>N-labelled fertilizers.

#### Maize

Population varieties were developed from local material for most of the francophone African countries, e.g., Tiémantié for Mali.

Hybrids such as NH 1 (Benin) were developed for intensive agriculture.

Cultivation, fertilization, and weeding techniques were developed for high-altitude zones in Madagascar, the clayey "terres de barre" in Benin and Togo, and other areas.

#### Sorghum and Millet

Among the improved millet populations, P3 Kolo gave excellent results, producing 1.5 t/ha on only 300 mm of rainfall in Niger.

Three semidwarf varieties were developed for more intensive cropping: IRAT P10, P15, and P16 (2-3 t/ha).

A short sorghum variety, C 90, with good grain quality was developed.

#### Sugarcane

In order to avoid introduction of diseases, IRAT supplied basic quarantinecontrolled plant material to almost all the plantations in francophone Africa.

Soil surveys were carried out for selecting the sites of sugar-production complexes in Borotou (Côte d'Ivoire), Banda (Chad), N'Zoia (Kenya), etc.

Adaptation studies were conducted to prepare a technology package (crop cycles, varieties, fertilization, irrigation) that will be used in most of the francophone African countries for the development of their sugar industry.

#### Market-garden Crops

Improved varieties of tomato were selected for Burkina Faso, and of eggplant for the French West Indies.

Two onion varieties, Blanc de Galmi and Violet de Galmi, with good keeping quality during the hot season, were developed in Niger.

#### Cassava

Two high-yielding (60-80 t/ha) semisweet varieties, H58 and H60, were developed.

#### Soybean

High-yielding (1.5-2 t/ha) cultivars Davis, Jupiter, and Hardy were identified in Madagascar, Senegal, and Cameroon.

The need for *Rhizobium* inoculation was demonstrated for most regions except western Cameroon.

### Study and Improvement of the Environment

Frequential analysis of the climate was carried out and used for upland rice- and sugarcane-growing areas.

Techniques for detecting mineral deficiencies and determining fertilizer dosage to improve and maintain soil fertility, were devised for each crop, based on its mineral exports.

The morphopedological analysis method was developed for mapping soil-topography relationships.

#### **Farming Systems**

In recognition of the socioeconomic constraints to agricultural development, "experimental units" were established in Senegal, to bring agricultural research to farmers' fields.

A new method for designing cropping systems based on farmer participation was implemented for the first time in the Brazilian Nordeste region.

# Research Highlights

#### Rice

IRAT's efforts are concentrated on two types of rice crop-production systems that have benefited from very little research but hold a vast potential—upland and flooded rice. Although they have a higher risk rate compared to irrigated rice, these crops do not require high investments and warrant further development.

#### **Crop Improvement**

Four new genetic groups, other than indica and japonica, were identified by examining the enzyme variability of *O. sativa* through electrophoresis and factor analysis of correspondences. This should guide breeders in selection of appropriate parent material.

Innovative programs were launched including *in vitro* androgenesis for rapid fixing of lines, recurrent selection for successive intercrossing to enable selection of breeding material, use of cross-pollination characters for large-scale development of  $F_1$  hybrids at moderate cost.

In 1983, 52 varieties developed in French Guiana, Côte d'Ivoire, and Brazil were entered in the IRAT catalog; and in 1984, 10 new varieties were added.

upland rice varieties developed by IRAT confirm their potential



IRAT 157, a rice variety derived from a double haploid.

Upland varieties developed by IRAT confirmed their potential; yields obtained were: IRAT 112, 4 t/ha as an industrial crop (Gabon); IRAT 109, 3.5-4.5 t/ha in farmers' fields with mechanized techniques (Côte d'Ivoire); IRAT 134, 3-4 t/ha in farmers' fields (Madagascar). In 1983, IRAT 112 and IREM 190 yielded 2.6-2.9 t/ha in spite of the severe drought conditions in Brazil.

For rainfed lowland rice with flood tolerance, two parallel programs were undertaken in Mali and Madagascar based on work on upland (japonica broad sense) rice.

Rice blast is a very serious disease that warrants the immense research



Clearly visible stigmas, a character of a good female parent.

effort to identify genetic resistance. IRAT recommends the use of varieties with horizontal resistance that are apparently more stable than those with vertical resistance. Varieties such as Moroberekan and Makouta have demonstrated a high level of stable resistance.

Among the physiological criteria for drought resistance, the presence of deep-root systems is now commonly used for varietal screening. The transfer of oxygen from the aboveground parts to the roots could be a good indicator of adaptation to aquatic conditions.

A breeding program for cold resistance was initiated in 1985 for rice grown in high-altitude regions.

#### Agronomy

The selection of an appropriate crop production system is based on an understanding of the soil and climatic conditions.

Zonation projects are under way in Brazil (upland rice), Togo and Burkina Faso (upland and lowland rice), and Madagascar (upland rice).

#### rice yield gains of 1.5-2 t/ha were obtained in Brazil using an early-warning agrometeorological system

Yield gains of 1.5-2 t/ha were obtained in Brazil by using an early-warning agrometeorological system.

#### **Cropping and Farming Systems**

A study that analyzes existing systems in the Senegal river valley is nearing completion.

Technology packages are being prepared under controlled conditions in Cameroon, Côte d'Ivoire, French Guiana, Gabon, Madagascar, and New Caledonia.

New systems are being tested in farmers' fields (Brazil, Cameroon, Madagascar). For example, in the lake Alaotra region of Madagascar, they range from upland rice on the hills to irrigated and flooded rice on the lakeshore. Technology packages (varieties, planting or transplanting dates, weeding techniques, etc) for each system are at preextension stage in participating farmers' fields selected on representative toposequences.

#### Maize

IRAT's work on this crop is beginning to bring in results. For example, in Burkina Faso, it was demonstrated that the varieties recommended for release in 1985 were twice as productive as those released in 1970. Smallholder production and seed multiplication are priority concerns of the maize program.

#### smallholder production and seed multiplication are priority concerns of maize research

#### **Varieties**

In the Sudanian Zone, improved populations (CJB, Tiémantié, IRAT 80) were released to farmers using traditional techniques. Selected varieties—including some developed in collaboration with the Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT)—such as BDS, IRAT 171, La Posta, Ferké 7928, are recommended for more intensive farming with technical supervision. Complex hybrids such as IRAT 81 and IRAT 83, that yield more than 5 t/ha in Côte d'Ivoire, are recommended for agro-industrial use.

IRAT 81, a hybrid maize variety for intensive crops.



A large number of trials are under way in high-altitude regions in Réunion and Madagascar.

#### Virus Diseases

Virus diseases are a serious threat to maize crops and an extensive research program was initiated in Réunion that focuses on the biology of insect vectors and mass-rearing techniques. Inoculation trials are conducted to identify the most resistant varieties.

#### Insect Pests

Varieties were screened for susceptibility to weevils in collaboration with the Tropical Development and Research Institute (TDRI), London.

Hyperparasites of stem borers, mainly *Chilo partellus*, are mass reared in Montpellier for the biological control program. Several releases of these hyperparasites were undertaken in Comoro.

#### Agronomy

A combination of compost and nitrogen fertilizer has increased yields to more than 5 t/ha in Côte d'Ivoire.

Detailed studies on maize-pulse and maize-cotton combinations revealed that rotation of pulses in a maize-based system enables fertilizer saving of up to 30-50 units N/ha.

In Mexico, problems of maize cultivation are studied in collaboration with CIMMYT on the basis of surveys and experiments in farmers' fields.

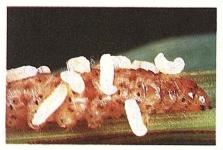
#### Food Technology

A unique process for making pasta is now in its final stage of develop-



Maize stem damaged by larvae of Chilo partellus.

Biological control using *Apanteles flavipes* larvae, seen emerging from a *Chilo partellus* larva.



ment. IRAT is seeking partners to develop the process in Senegal, Togo, and Cameroon.

a unique process for making maize pasta enters its final phase of development

### Sorghum

Improved photoperiod-insensitive sorghums gave outstanding results under rainfed and irrigated conditions.

#### Varietal Improvement

Early varieties recommended to farmers for the difficult Sahelian conditions are ISRA-IRAT 202 and 204. ISRA-IRAT 204, with excellent grain quality, has a yield potential of 4 t/ha under rainfed conditions; it generally yields twice as much as the local control. In Burkina Faso, farmers were also able to grow it in the bottomlands under extreme drought conditions (200 mm).

#### ISRA-IRAT 204, an excellent sorghum variety for rainfed and irrigated crops

In Burkina Faso, the semilate varieties IRAT 277 and IRAT 222 were found to be superior to those recommended earlier.

In Senegal, a hybrid (612A x 75-4) and a line (75-14) can be released for the cold off-season crop under irrigation. ISRA-IRAT 204 also appears to be a promising variety—with a yield potential of nearly 7 t/ha—for irrigated crops in Senegal, Niger, and Mauritania.

Genetic characterization of sorghums by electrophoresis of isozymes, revealed that their variability is related to geographic origin rather than botanic type.

#### Agronomy

Tillage has a significant effect on crop yields. Normal and tied ridging have a definite effect under drought conditions. Flat plowing alone ensures a two-fold increase in yields.

Land-preparation techniques, plant density, and fertilizer requirements were determined for crops under rotary sprinkler irrigation in Libya. It was demonstrated that plowing of crop residues into the soil is not recommended in desert soils.

#### **Crop Protection**

The major pathogens of grain mold and smut were determined and resistant varieties identified. Methods for efficient seed disinfection were proposed.

Early sorghum variety ISRA-IRAT 204 is recommended both for rainfed and irrigated crops.



#### Food Technology

Sorghum proteins were characterized mainly by isozyme electrophoresis and the technological qualities of different varieties were determined.

It was found that k-othrin improves keeping quality of sorghum and it breaks down during cooking at high temperatures.

### Sugarcane

IRAT is supporting the development of the sugar industry, through its research, expertise and advice, to plantations in different countries.

#### Variety Development by In Vitro Culture

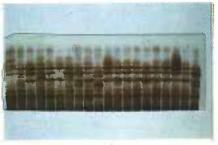
The varietal development program mainly uses the *in vitro* culture method. The techniques are being constantly improved and are used for two different purposes—development of genetic variability and maintenance of genetic conformity.

# the sugarcane variety development program mainly uses the in vitro culture method

The development of genetic variability using somatic tissue cultures is mainly aimed at the rectification of defects in plant material. The somaclones have already shown considerably improved disease resistance. There is also evidence of increased shoot vigor at planting. Research on the use of more complex plant struc-

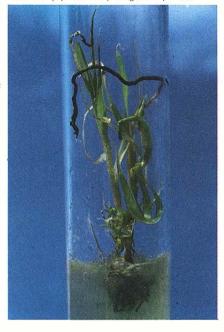
tures—cells and protoplasm—was started in collaboration with the University of Paris-Orsay.

Maintenance of genetic conformity by *in vitro* culture enabled the establishment of a plantlet collection and efficient use of rapid multiplication techniques. As a result, plantlets could be promptly delivered to Chad for planting.



Electrophoresis of isozymes, a new method for identifying sugarcane varieties.

A smut whip produced by a sugarcane plantlet.



### Variety Development by Traditional Methods

Several clones of the first series (FR 80), produced after eight generations of crosses, performed well in Guadeloupe and Martinique. They are undergoing observation trials in Côte d'Ivoire.

#### Identification of Varieties

A rapid and accurate method for identifying desirable varieties by isozyme electrophoresis was developed recently. It will be very useful to sugarcane breeders and planters.

#### **Pathology**

Serological analysis is now commonly used for diagnosis of ration stunting disease and leaf scald.

*In vitro* tests for resistance to smut, rust, and leaf scald have proved to be very efficient.

### Market-garden Crops

Research on these crops covers not only a large number of crops but also a wide range of producing areas and their specific problems.

#### Crop Improvement

**Tomatoes.** Breeding for varieties resistant to *Pseudomonas solanacearum* continues. Since the test material already possesses a high level of resistance, research is focused on agronomic characters (Martinique, Burkina Faso). In Tahiti, six commercial varieties were identified as resistant.

Eggplant. In Martinique, 12 lines are

being studied for their reaction to bacterial wilt. Grafting on *Solanum torvum* was proposed as a temporary solution.

Other vegetables. Several other types of vegetables (potato, onion, cucumber, carrot, lettuce, cabbage, beans) are undergoing selection in different countries for adaptation to local conditions.

#### **Crop Protection**

A pathology laboratory was established in Réunion where work has begun on *P. solanacearum*.

#### a pathology laboratory for market-garden crops was established in Réunion

Entomologists are studying integrated methods to control *Lyriomiza trifolii*, a serious insect pest that attacks several crops.

#### Cassava

Cassava research attempts to determine the requirements for intensive production, in response to requests concerning this field.

#### Crop Improvement

About 15 varieties—including CB, B33, Taboucca—developed from the Côte d'Ivoire collection and suitable for intensive crops, are being released to farmers.

Clones that are more tolerant to hydromorphic soils were identified

for the slow-drainage soils in French Guiana.

Clones with resistance to bacterial diseases are sought in order to check the deteriorating disease situation of crops in Africa.

#### Agronomy

Weeds can be controlled effectively by chemicals (oxyfluorfen or metribuzin-diuron mix) or mechanized methods with supplementary manual weeding.

Farming systems for mechanized cultivation are being developed or have been finalized in several countries. In Côte d'Ivoire, yields of about 20 t/ha can now be obtained using these systems, in spite of the recent increase in parasite incidence (bacterial diseases, mites, scale insects).

# systems for mechanized cassava cultivation were developed in several countries

In New Caledonia, research is aimed at improving the productivity of traditional village farming.

Stem regenerations from a yam (*Dioscorea alata*) callus produced by *in vitro* culture of petiolesections (variety Florido).



#### Yam

The integration of yam in modern cropping systems depends on a radical genetic transformation that will improve its structure and reproduction rate, and also facilitate cultivation and reduce harvest losses

#### Genetic Improvement

Genetic modification of this vegetatively propagated crop is attempted by several methods including callus formation. Regenerations were obtained for *Dioscorea alata*.

Florido is a high-yielding variety, suited to mechanization, resistant to viral diseases, and with excellent taste quality. Its popularity among farmers in Côte d'Ivoire has led to its rapid spread, to the detriment of the traditional varieties.

Studies are being conducted to make production nonseasonal, so that it can be spread over the year.

#### Stock Protection

Insect pests can destroy up to 50% of the harvest. In Côte d'Ivoire, almost all the pests in the Bouaké region were identified. Pest resistance varies greatly among varieties. It was observed that dipping in a solution of deltamethrin and pyrimiphos methyl effectively protects the varieties Florido and Bete Bete. Different storage methods are being compared.

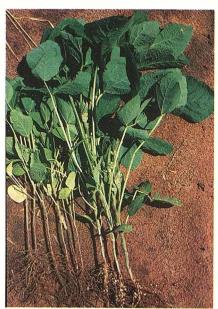
### Soybean

Soybean is rich in proteins; adaptation of its varieties and agronomic characteristics to tropical conditions is of primary importance.

#### Varietal Improvement

The variety G 121 obtained from IRHO (Burkina Faso center) gives good yields of 1.5-2.2 t/ha in Mali. It has proved its hardiness under difficult conditions. In Burkina Faso, the varieties ISRA 44A/73 and ISRA 26/72 gave comparable results to G 121 in IRHO trials. These two varieties were registered in the IRAT catalog as IRAT 273 and 274. In Gabon, they showed good resistance to frogeye leaf spot. IRAT 274 with a yield of 3 t/ha in high-altitude regions was recommended for release in Cameroon.

In the Sudano-Sahelian Zone, plants grown for seed must be harvested at maturity. Any delay beyond 5 days after the plant has attained maturity,



Noninoculated (left) and inoculated soybean with clearly visible nodules (right), to show that inoculation improves nitrogen fixation.

reduces the germination capacity of the seed by 3%/day. Storage conditions were specified.

#### Agronomy

The cereal-soybean rotation system for the Sudano-Sahelian Zone was finalized. Restitution of raw or composted crop residue can help increase yields.

#### a cereal-soybean rotation system was developed for the Sudano-Sahelian Zone

The need to improve nitrogen fixation has led to the study of *Rhizobium japonicum* strains from Africa and Madagascar and to supplemental inoculation with endomycorrhiza (*Glomus mossae*). Inoculation and seed dressing techniques were established.

### Other Crops

In response to requests from governments and agriculture organiza-

Irrigated rice fields in a bottomland in Madagascar.

tions, IRAT has conducted research on crops for local use that are not necessarily included in its mandate.

These crops include off-season wheat (on-station yield of more than 4 t/ha) and brewing barley (exceeding 3 t/ha) in Madagascar, geranium for character improvement through hybridization in Réunion, and anthurium for rapid multiplication in Guadeloupe.

# Study and Improvement of the Physical Environment

In order to improve its potential, the physical environment and its mechanisms must be studied at macro (landscape or region) and micro (plot) levels.

#### Macro-level Studies

The objective of a survey of the physical environment and its con-



straints is either the agricultural development of the entire region or the introduction/expansion of a particular crop. Madagascar is a case in point for such studies that were carried out in the lake Alaotra region extending over 5000 km². Ecological units were mapped and their agricultural potential was determined. IRAT then identified locations suited to growing brewing barley within the high plateau area.

Bottomlands offer a particular environment that is of increasing importance to agriculture in drought-prone areas. These were also characterized to determine their potential.

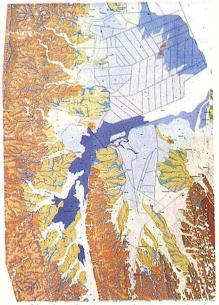
In an effort to check further desertification in Mauritania, IRAT has located the affected areas and analyzed the pattern of desert encroachment. Biological techniques such as the establishment of windbreaks were recommended to protect oases.

In an ORSTOM-ISRA-CIRAD project, circulation of water in cropped watersheds was studied in the Sine-Saloum region, Senegal. Farm-scale soil-management systems were devised to check erosion.

Remote-sensing satellite images need to be interpreted for use in agricultural development. A method for mapping the surface status was developed in collaboration with the Centre d'Etudes de Géographie Tropicale (CEGET), IBM France, Institut Géographique National (IGN), and the University of Khon Kaen, Thailand, and applied in Thailand and Burkina Faso.

#### Micro-level Studies

Intercropping is generally considered as an excellent technique for



Map of the physical environment showing agricultural potential of the lake Alaotra region, Madagascar; an example of the use of cartography for agriculture.

humid regions. In Cameroon, maize-soybean intercrops produced a high yield gain (+30%) compared to sole crops. Another study revealed that farmers' intercropping practices were closely related to food strategies.

The influence of different tillage techniques on the efficient use of rainfall can be objectively assessed by calculating the water balance. In Burkina Faso, for example, flat plowing is an excellent method for cereal crops, increasing maize yields by more than 84% compared to those from untilled plots.

Irrigation and water-management techniques were devised for various situations: supplemental irrigation for crops such as sugarcane or vegetables, rotary sprinkler irrigation pattern for industrial crops in Libya, gravity irrigation for terrace cultivation in Niger, improvement of the water-retention capacity of coral soils in French Polynesia.

Research on fertilization stresses on the use of local resources such as rock phosphates, dolomite, manure, and compost, for more economic fertilization.



Small-scale irrigation on a farm in the Fara Poura region on the Black Volta river, Burkina Faso.

A basal dressing of rock phosphates found in Niger and Mali remains effective for about 10 years. But their use in powder form raises practical problems, nor are they efficient as granules. IRAT is studying the possibility of partial acidulation of the rock phosphate to compensate for this loss of efficiency.

#### rock phosphates are being studied for efficiency in several potential producing countries

In Senegal, incorporation of crop residues in the form of compost combined with minimum fertilization increased yields by 50% for rice and by 70% for maize.

# Farming and Agrarian Systems

IRAT believes that realistic agricultural policies are based on an understanding of farming and agricultural

systems. It is therefore carrying out application-oriented research that often covers an entire region.

#### Village-level Studies

In eastern Senegal, an analysis of the changes in cultivated area over the years revealed that land pressure due to population increase and expansion of cotton cultivation have led to a greater integration of less fertile marginal lands. Studies are also being carried out on the structure of farm lands (terroirs) belonging to different ethnic groups.

#### Farm Equipment and Mechanization

IRAT is examining the impact of agricultural policies on behalf of certain governments. In Senegal, an extensive survey studied the changes in on-farm draft equipment and the results are being analyzed. In Côte d'Ivoire, the study of farming systems in the forest zone aims to assess the productivity of labor for food and industrial (coffee, cocoa) crops, as this is an important factor for establishing prices.

A World Bank-funded study seeks to establish the scientific and sociological conditions for a successful introduction of mechanization, including intermediate technology, in Senegal, Burkina Faso, Côte d'Ivoire, and Cameroon.

#### **Population Migration**

IRAT was commissioned to implement a large-scale integrated development program in the Fara Poura region, Burkina Faso, in order to rehabilitate migrants who were forced to leave their lands because of the drought. The studies covered various sectors including land ownership, formation of village associa-

tions, choice of cropping systems, erosion control, etc.

#### **Irrigated Crop Systems**

In areas with unpredictable rainfall, crops are often grown in the bottom-

lands. Irrigated crop systems were developed with farmer participation in Burkina Faso (banks of the Volta rivers) and Niger (terraced lands of the river bank). The results will be implemented as part of the BRGM-GERSAR-CIRAD program.

# Contribution to development

In 1985, IRAT was involved in 140 projects directly related to development. It is difficult to report all of them; however, the following examples will give an idea of the wide range of activities and domains covered by the projects.

#### Support Research

Support research helps determine the cropping systems or techniques to be adopted for a development operation. Farmers are increasingly involved in these activities.

In Togo, the Société Nationale pour la Rénovation et le Développement de la Cacaoyère et de la Caféière (SRCC) has the mandate to strengthen coffee and cocoa production and also develop food crops. IRAT is conducting a survey covering a sample of 1500 farms and 70 variables, that will lead to the establishment of model farms for different groups of farmers. Factors liable to increase production will also be identified.

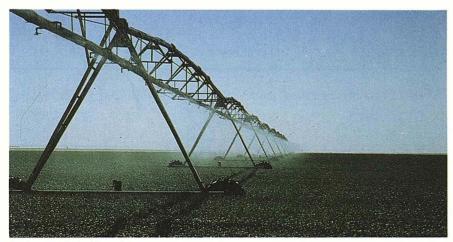
In Benin, as part of a development project covering a cultivated area of 150 000 ha in the Zou province, IRAT provides support research for food crops (maize, groundnut, cowpea, tubers), organizes seed production, and carries out research and development work. A dialog was established with farmers from test villages.

IRAT is also preparing technical guidelines for upland and irrigated rice crops in Cameroon (M'Bo plain) and Madagascar (SEMRY-SOMALAC project).

### Research and Support for Agro-industrial Complexes

In Libya, since 1979, wheat and sorghum are being grown on desert land (8000 ha) that is irrigated by fossil groundwater. IRAT carried out the preliminary studies, determined the cropping methods, and directed the entire operation. Yields have by far exceeded the target of 5 t/ha. IRAT participated in a similar project (1800 ha) in Saudi Arabia where high yields averaging 7.7 t/ha were recorded right from the second year of the project.

IRAT scientists are assigned to sugar companies, as in Côte d'Ivoire (IRCPS) and Madagascar (SIRA-



A wheat crop in the Libyan desert.

NALA), where they direct the cropping operations. They also offer consulting services to companies such as SOSUCAM and CAMSUCO, Cameroon; SOSUCO, Burkina Faso; CSS, Senegal; SUCO, Congo; etc.

#### Distribution of Plant Material

IRAT supplies breeders' seed (cereals) used by development or seed-production agencies to produce seed. In certain countries, IRAT also participates in actual seed multiplication activities or advises specialized farms, as in Benin, Burkina Faso, Central African Republic, Madagascar, and Togo for maize. In Côte d'Ivoire, quality control tests were carried out on 2500 t of selected rice seed produced at the BETPA farms.

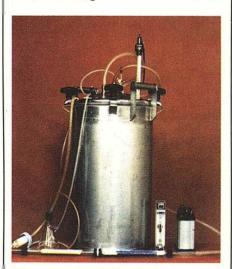
The quarantine greenhouse at Montpellier supplies about 100 guaranteed healthy sugarcane varieties each year to sugarcane planters and scientists worldwide.

#### **Technology Development**

This activity concerns a wide range of techniques and equipment de-

signed or developed by IRAT to meet the specific requirements of the tropics.

UPIL, a pulse inoculum production unit, was designed to function under



UPIL, an inoculum production unitforpulse crops, is being used in several countries.

adverse conditions. This simple and hardy unit is already being used in several countries with FAO support.

Transpaille is a fermentor machine that continuously processes hay from

cowsheds to produce biogas for running equipment (irrigation pumps, flour mills) as well as organic fertilizer. It was designed for village communities. The 1985 prize for the best innovation for Africa was awarded to IRAT for the Transpaille process.



Transpaille, a fermentor that continuously processes hay to produce energy and compost.

A large-scale program for hydroponic vegetable crops (tomato, lettuce, cucumber) was successfully carried out in the Libyan desert. The green houses with controlled conditions, substrate, and nutrient solution have proved to be reliable for long term intensive crops. About 30 t of vegetables can be produced each year on less than 1000 m<sup>2</sup>.

Hydroponic cultivation of vegetables in the desert, producing 30 t/year over an area of 1000 m<sup>2</sup>.



# TRAINING

Various types of training are provided by IRAT each year:

— for trainees sponsored by IRAT's scientific programs, with scholarships for 1 or 2 years:

— for trainees sponsored by various organizations or institutes such as CNEARC and FAO. Programs ranging from a few weeks to 1 year in duration enable trainees to carry out

research for a degree or thesis under IRAT supervision.

In 1984, 83 scientists received training at IRAT. Of these, 40 were from Africa, 12 from Latin America and the Caribbean, 4 from Asia, 3 from other European countries, and 24 from France. The disciplines studied were: breeding and selection, agronomy

(soils), water management, biogas technology, biometrics, and cropping systems.

IRAT scientists also teach regular degree courses at the Centre National d'Etudes Agronomiques des Régions Chaudes (CNEARC).

## PUBLICATIONS

Between 1983 and 1985, IRAT published 120 articles in its Frenchlanguage quarterly L'Agronomie Tropicale (abstracts in English and Spanish). Reports of IRAT's research activities are also published in external journals. Mémoires et travaux de I'IRAT is a collection of more detailed technical documents and reports. The annual report describes research results obtained by the scientific programs each year. Books authored by IRAT scientists are published by Ed. Maisonneuve et Larose and the Agence de Coopération Culturelle et Technique (ACCT), Paris. The following is a list of major publications produced between 1983 and 1985:

**Betbeder-Matibet, M.** 1983. *Eldana saccharina,* foreur des tiges de canne à sucre en Afrique. Mémoires et travaux de l'IRAT No. 1. Paris: IRAT. 192 pp.

**Brenière**, J. 1983. Principaux ennemis du riz en Afrique de l'Ouest et leur contrôle. The principal insect pests of rice in West Africa and their control. Monrovia, Liberia: West

African Rice Development Association (WARDA). Second English and French edition. 87 pp.

Clément, G., and Poisson, C. 1984. Analyse des croisements intra et intergroupes chez *O. sativa.* Application à la sélection du riz pluvial en Côte-d'Ivoire. Mémoires et travaux de l'IRAT No. 8. Paris: IRAT. 78 pp.

**Coquard, J.** 1984. *Goniozus procerae.* Biologie et fécondité en laboratoire. Mémoires et travaux de l'IRAT No. 6. Paris: IRAT. 44 pp.

Glazmann, J.C. 1985. Variabilité enzymatique du riz (*Oryza sativa* L.). Son importance pour la compréhension de la structure écogéographique de l'espèce. Mémoires et travaux de l'IRAT No. 9. Paris: IRAT. 126 pp.

**IRAT.** 1983. Lutte contre la pyriculariose du riz. Mémoires et travaux de l'IRAT No. 2. Paris: IRAT. 55 pp. Also available in English.

**IRAT.** 1984. Les systèmes de culture du riz pluvial. Mémoires et travaux de l'IRAT No. 7. Paris: IRAT. 98 pp. **IRAT.** 1985. Fiches techniques sur les principaux ravageurs des cultures vivrières tropicales. Paris: IRAT. 10 data sheets with color plates.

**IRAT.** 1985. La traction animale, bibliographie. Mémoires et travaux de l'IRAT No. 10. Paris: IRAT. 194 pp.

Jacquot, M., and Courtois, B. 1983. Le riz pluvial. Le Technicien d'agriculture tropicale 1. Paris: Ed. Maisonneuve et Larose, ACCT. 135 pp.

**Rouanet, G.** 1984. Le maïs. Le Technicien d'agriculture tropicale 2. Paris: Ed. Maisonneuve et Larose, ACCT. 143 pp.

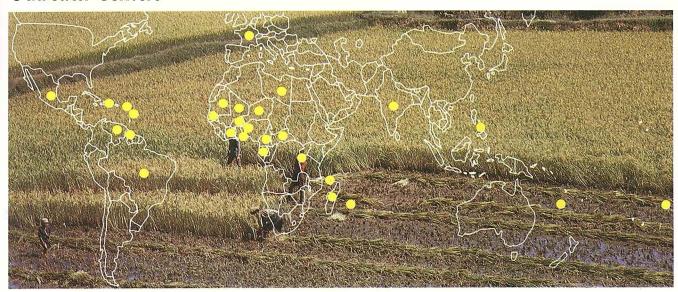
Silvestre, P., and Arraudeau, M. 1983. Le manioc. Techniques agricoles et productions tropicales XXXII. Paris: Ed. Maisonneuve et Larose, ACCT. 262 pp.

Vandevenne, R. 1983. Production et contrôle des semences de riz en zone tropicale. Mémoires et travaux de l'IRAT No. 4. Paris: IRAT. 497 pp.

Vandevenne, R. 1983. Production et contrôle des semences de maïs en zone tropicale. Mémoires et travaux de l'IRAT No. 5. Paris: IRAT. 545 pp.

# RAT AROUND THE WORLD

### **Outreach Centers**



BENIN: M, Sy

TOGO: M, En, Sy

BRAZIL: R, En, Sy FRENCH GUIANA: R, C, So, En, Sy GUADELOUPE: R, M, Sc, MG HAITI: S, Sy MARTINIQUE: Y, MG MEXICO: M, Sy VENEZUELA: Sy

BURKINA FÁSO: S, MG, Sc, En, Sy NEW CALEDONIA: R, C, Y, Sy CAMEROON: R, So, Sc, MG, En, Sy PHILIPPINES: R CENTRAL AFRICAN REPUBLIC: R, M, C, S TAHITI: MG COMORO: M, Sy COTE D'IVOIRE: R, M, C, Y, Sc, En, Sy GABON: R, So, En, Sy LIBYA: W, S MADAGÁSCAR: R, M, W, B, Sc, So, En, Sy MALI: R, Sc, M, S, En MAURITANIA: S, MG, R NIGER: S, MG, En, Sy REUNION: M, Sc, MG, En, Sy RWANDA: M, W, MG, Sy SENEGAL: R, M, S, So, Sc, En, Sy

INDIA: En

#### Legend:

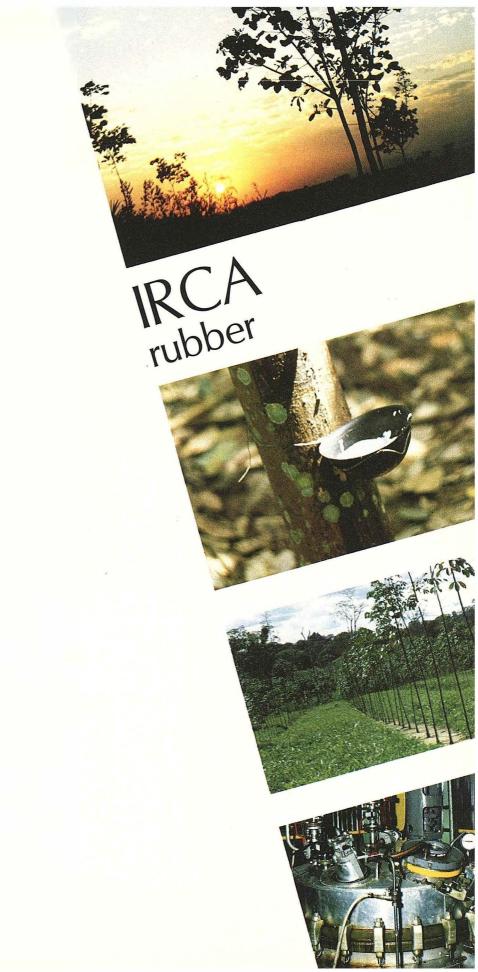
B : Barley C : Cassava M : Maize

MG: Market-garden crops

R: Rice S: Sorghum Sc: Sugarcane So: Soybean W: Wheat

En: Improvement of the physical environment

Sy: Farming or agrarian systems



### **IRCA**

Member of the International Rubber Research and Development Board (IRRDB)

The Institut de Recherches sur le Caoutchouc, the French rubber research institute, was established in 1956 and became a department of CIRAD in January 1985. The Institute's headquarters are located in Paris and its laboratories in Montpellier and in cooperating countries. IRCA's main outreach center is in Côte d'Ivoire, where the research program includes all disciplines concerning Hevea cultivationagronomy, physiology, technology; experimental plantations covering 1000 ha have already been established, with plans to add another 1500 ha.

Rubber is an agricultural crop used in industry. IRCA's research therefore encompasses the entire range of operations from *Hevea* cultivation to the use of rubber.

An advisory committee, Comité Scientifique et Technique du Caoutchouc (CSTC), was constituted about 10 years ago and meets once a year to orient IRCA's activities. Its members include technicians, realtors, planters, industrialists and scientists, who represent diverse interests in the area of rubber production and use.

The Institute has 50 scientists on its staff.

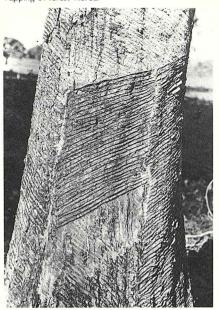
#### NATURAL RUBBER

The objective of IRCA's research is to promote the use of natural rubber by increasing plantation yields and improving rubber quality. Rubber is used by many industries, the best known being the tire industry.

World consumption of rubber is increasing constantly. There is a large potential demand in the developing countries where average per capita consumption does not exceed 1 kg annually, compared to 15 kg in USA and 10 kg in Europe.

Rubber-production techniques have evolved very rapidly since the turn of the century. Until 1914, it was still at collection stage, but soon afterwards rubber plantations developed rapidly in the Southeast Asian countries. Synthetic rubber was developed in Germany around 1939. Its production has increased consid-

Tapping of forest Hevea.



erably over the past few decades, and has overtaken natural rubber production since 1960. In 1983-84, world synthetic rubber production was twice that of natural rubber.

Although the percentage of natural rubber has decreased, production, in absolute terms, has risen. Increased plantation yields and improved quality of natural rubber enable it to withstand competition from synthetic rubber. Natural rubber is also a substantial source of income for the developing countries. Moreover, unlike synthetic rubber, its production is pollution free, nor does it depend on nonrenewable petroleum resources.

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### PAST ACHIEVEMENTS

#### Hevea

All the *Hevea* varieties cultivated today have been derived from only 23 plants that were brought from Brazil in the late 19th century. The available germplasm collection needs to be enhanced to enable the development of new genotypes. IRCA as well as other institutes working on this crop are endeavoring to collect new germplasm. While developing new varieties, breeders have to consider the genetic description of these genotypes. In order to select appropriate parent material for crosses, IRCA uses electrophoretic and biometric techniques to obtain this genetic information.

In the generative selection method, new genotypes are obtained by crossing two existing clones through artificial pollination. The superior genotypes are then multiplied by grafting. As it takes 6 years for a plant to reach the production phase, IRCA has adopted the early-evaluation method in order to accelerate the selection process.

The standard method for multiplying clones is through grafting, but there is often a yield loss of 10 kg/tree per year between the high-yielding mother tree and the clonal progeny. Since 1978, IRCA is using the tissue-culture method to avoid grafting and to completely reconstitute the original material true to type. The methods used are microcutting and somatic embryogenesis.

IRCA is conducting fundamental research in biochemistry-physiology in order to better understand the biological mechanisms involved in rubber production and to control them to improve tree productivity, especially in the case of yield stimulation.

Crop protection studies focus on controlling diseases of roots (*Fomes*, occurring in Africa) and leaves (*Gloeosporium* and, recently, *Microcyclus ulei* that is specific to South American rubber trees).

IRCA's technology research aims not only to help natural rubber keep its place on the world market, but also to improve it by identifying new uses and by developing a raw material that adequately meets the requirements of industry.

#### Guayule

Guayule is a shrub that grows wild in the North Mexican deserts; 10% of its dry weight is made up of rubber. It could be grown in the semi-arid tropics such as the Nordeste region in Brazil and northern Africa. IRCA is developing farming systems for guayule cultivation and is considering economic methods for extracting rubber.

# RESEARCH HIGHLIGHTS

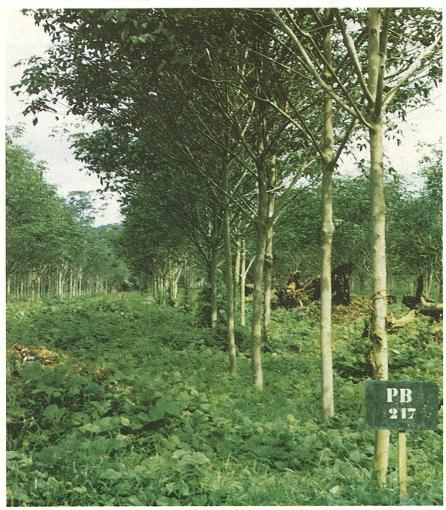
#### Hevea

#### **Plant Breeding**

Collection expeditions were organized in the Amazon region in co-

operation with the Brazilian authorities in 1974 (IRCA) and 1981 (IRRDB), with the objective to broaden the *Hevea* genetic base. IRCA-Côte d'Ivoire, that houses the collection for Africa, received seed of 2500 new genotypes. Material collected as budwood was sent to

Field of Hevea clones in Côte d'Ivoire.

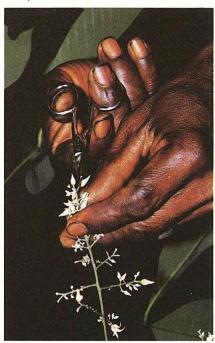


the intermediate quarantine station in Guadeloupe to avoid spread of the South American leaf disease, and later distributed among the IRRDB member countries

Some information on these genotypes is required before using them in breeding programs. It is impossible to make direct observations as this would take almost 20 years. Preliminary characterization of the new genotypes was done in the same way as for the earlier material. It is based on the genetic description by electrophoretic analysis and on the morphological characteristics (biometrics). The purpose of this exercice was to identify parents with wide genetic differences.

Observation trials were conducted for preliminary screening of more than 5000 seedlings obtained through artificial pollination. Some

Hand pollination of Hevea.



of these entries include a parent from the material collected recently in the Amazon region. Of these seedlings, 125 clones were selected for small-scale comparative trials. Fifteen clones that had already been tested on a small scale were entered for large-scale trials.

In order to reduce the normal selection period, IRCA has adopted the method of early evaluation. Breeders study the reliability of certain parameters (anatomy, physiology, yield of stimulated or nonstimulated early tapping) that are supposed to be



Tissue culture of Hevea.

correlated to the value of a mature tree, and can be measured in the young seedling trees.

Tissue-culture studies on somatic embryogenesis and microcutting yielded some useful results. Embryoid calluses were obtained from the internal seedcoat of young *Hevea* fruits. Microcuttings can now be obtained from explants of young seedlings and attempts are being made to extend this method to clonal material that has been previously rejuvenated.

embryoid calluses
derived from
the internal seedcoats
of young *Hevea* fruit,
and microcuttings

#### Crop Management

Encouraging results were obtained for the preparation of planting material by two methods. The first involves very early grafting at 10 weeks of polybag plants and transplanting at 2-whorl stage after cutting back the budgrafts in the nursery. In the second method, the bags are replaced by a new type of container. This is a biodegradable cellulose envelope containing a nutrient substance, that can be rolled around the plant to form a sort of soil core.

Eupatorium odoratum is a very common weed in smallholder plantations. Various systemic herbicides were observed to be efficient even when mixed with very little water. Research on eradication of bamboo weeds using herbicides has progressed further.

Fertilizer recommendations following leaf analysis can be made more accurate by monitoring the plantations. Data from check plots are recorded for subsequent computer storage and processing.

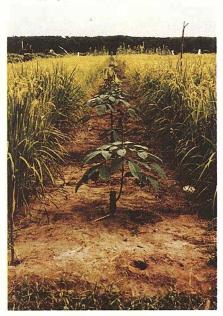


Fertilizer application in young Hevea trees.

Crown budding often causes substantial reduction of production; however, yields per hectare are still quite satisfactory. This finding is of major importance for rubbergrowing areas such as Brazil, that are prone to serious leaf diseases. Other factors should also be examined to explain the cause of low yields—in case they occur—in 3-part trees.

Various intercropping trials with food crops (rice, maize, groundnut,

Intercropping food crops (rice) with Hevea.



#### the development of systems for short- or long-term intercrops of *Hevea* is an important objective

yam) showed that this system can be feasible after making certain adjustments (varieties, fertilization, etc.). Although food-crop yields may not be of economic importance, *Hevea* benefits greatly, in terms of improved growth, from intercropping.

#### **Crop Protection**

Tests for calixin treatment of trees with root diseases (*Fomes*) and of surrounding trees, continue to give good results for a 2-liter solution with 0.5% a.i., applied at the base of the trees. This treatment may not completely eradicate the disease, but it is able to hold it at a tolerable level.

Some genotypes showed consistent resistance to artificial inoculations of the root-disease pathogen over 2 years.

For leaf-disease (*Gloeosporium*) control, ethrel was successfully tested for inducing artificial defoliation in a commonly used clone, so that refoliation occurs at a time when conditions are unfavorable for disease attack. Young leaves are particularly susceptible to this disease.

artificial defoliation trials gave encouraging results for *Gloeosporium* control The South American leaf blight (*Microcyclus ulei*) is a serious disease confined to the South American continent and is an obstacle to the development of *Hevea* cultivation in



Aerial spraying to induce defoliation.

this region. A pathology section was established at the CIRAD center in Kourou, French Guiana—where it occurs as well—to examine this disease that could spread to Asia and Africa.

Yield stimulation of Hevea.



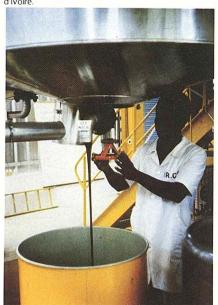
#### Physiology and Exploitation

Fundamental research on rubber biosynthesis has enabled a better understanding and control of two key production factors, viz, latex flow and regeneration.

It was demonstrated that ethrel stimulation effectively compensates the reduced intensity of tapping. A reduction of tapping frequency (once weekly or fortnightly, instead of the current practice of two tappings weekly) does not affect yields greatly, when combined with adequate yield stimulation. Daily tap

over- or under-exploitation of plantations can be evaluated by latex analysis

Pilot unit for producing liquid natural rubber in Côte d'Ivoire



yield per worker can thus be increased two-, and even, three-fold.

Whether a plantation is over- or under-exploited can now be determined by latex diagnosis based on levels of certain physiological parameters of latex. Tapping can thus be easily monitored. This method is beginning to be used on a large scale.

Comparative physiology studies of healthy and dry-bark trees revealed a certain number of correlations between measurable parameters of latex and yield. Dry bark can be checked by modulating exploitation intensity, particularly the frequency of yield stimulation of affected trees. Trials for prevention of dry bark by the addition of a substance to the stimulant for protecting the membrane of lutoid particles, have given promising results.

#### **Technology**

Studies on the application of techniques for preparing constant viscosity rubber to field coagulums, indicate that with suitable clones, it is possible to obtain with polybag coagulum, the degree of viscosity required by industry.

Drying of rubber is an energy-consuming process. An experimental dryer that electronically monitors and records the different drying parameters, was installed for drying granules. In this IRCA dryer, leaven is added to the latex to produce a spongy structure; this feature combined with the reduction in granule size (1/2 in. screen) and a temperature level of 100° C, has led to more efficient and more energy-saving (by 30%) drying.

In France, a pilot unit was built for depolymerization of field latex using phenylhydrazine according to a method patented by IFC-IRCA. After rigorous testing at the manufacturing site, the unit will be installed in Côte d'Ivoire. The semi-industrial unit will process field latex directly to produce 200 kg liquid rubber/week. Certain practical problems that could arise due to the projected installation, such as viscosity measurement, were studied.

#### importance of clay masterbatch for products using high-quality rubber

Clay masterbatch has a definite advantage over carbon black for products using high-quality rubber. The price of rubber remains the same, but clay is much cheaper than carbon black. This is useful for the production of certain parts of tires for heavy-load and passenger vehicles. Some of the clays confer an adequate tearing strength to the masterbatch.

### Guayule

Progress has been made in solving problems related to germination, polybag nurseries, and field transplantation.

Other rubber-bearing plants are also being studied including *Landolphia*, euphorbia, manicoba tree.

Creping of coagulum from rubber-clay masterbatch.



# CONTRIBUTION TO DEVELOPMENT

IRCA's involvement in the development process follows two approaches: preliminary technical studies before the start of a project or assistance during the projects, and cooperation with rubber research institutes in other countries.

#### **Technical Studies**

IRCA conducts experiments on rubber plantations in Côte d'Ivoire, Cameroon, and Gabon. In order to determine the potential of new sites, performance blocks are laid out on the new plantation sites before cultivation (Côte d'Ivoire, Gabon, Ghana).

Technical assistance to existing plantations is also provided for fertilization (foliar diagnosis), exploitation system (latex diagnosis), disease status, specifications of the rubber produced on the plantation.

IRCA is participating more actively in the development of rubber projects for smallholders.

### Cooperation with Research Institutes in Other Countries

In southwestern Côte d'Ivoire, IRCA completed a feasibility study for a 1500-ha experimental plantation that has been added to the existing 1000 ha of experimental plots in the southeast.

In Cameroon, preliminary work was done for the establishment of the IRA rubber improvement station. IRCA experts were seconded to assist in the establishment and management of the Rubber Research Institute of Liberia, to be based on an existing 250-ha plantation.

In Gabon, technical support is provided for the implementation of the Gabon *Hevea* Plan.

In Senegal, an IRCA scientist was seconded to the Institut Sénégalais de Recherches Agricoles (ISRA) to supervise trials for the establishment of guayule in the Sahelian zone.

The Sembawa Research Institute in South Sumatra, Indonesia, is working on the problems of smallholders. An IRCA agronomist was assigned to this Institute and will soon be joined by a technology expert.

An FAO-UNDP project is under way to strengthen the Vietnamese rubber research institute and IRCA provides technical assistance on request.

In Brazil, a geneticist was assigned to the Empresa Pernambucana de Pesquisa Agropecuária (IPA), Recife, to the Sudhevea program on guayule plantation trials in the Nordeste.

IRCA agronomists, physiologists, and technologists visited several countries to provide technical assistance: Cameroon, Central African Republic, Congo, Gabon, Ghana, Côte d'Ivoire, Liberia, in Africa; Indonesia, People's Republic of China, Thailand, Vietnam in Asia; Brazil, Colombia, French Guiana, Mexico in South America; and Guadeloupe and Martinique in the West Indies.

# TRAINING

Depending on the requirements, training is provided:

— in France, at various organizations, including IRCA's laboratory in Montpellier; ESICA-IFOCA, Paris; IRAP, Le Mans; and the Universities of Maine and Montpellier;

— at outreach stations where IRCA's scientists are carrying out their work, such as Bimbresso, Côte d'Ivoire; Ekona, Cameroon.

During 1983-1985, IRCA received a total of 121 trainees from Africa

(Côte d'Ivoire, Cameroon, Gabon, Ghana); Asia (Vietnam, Indonesia, China, Thailand); and South America (Brazil, Colombia, Nicaragua). Close to two thirds of the total came from Africa.

# **PUBLICATIONS**

Every month, one or two articles by IRCA scientists appear in the *Revue générale des caoutchoucs et plastiques* (7000 subscribers). Between 1983 and 1985, about 50 articles were also published in other journals such as: *Physiologie végétale, Comptes rendus de l'Académie des Sciences de Paris, Zeitschrift für Pflanzenphysiologie, Revue générale de Botanique, Adansonia, European Journal of Forest Pathology, Revue de cytologie et de biologie végétale,* 

Phytochemistry, European Journal of Biochemistry, Biochimie.

Other recent IRCA publications are:

**Compagnon, P., et al.** 1986. Le caoutchouc naturel. Biologie, culture, production. Paris: Ed. Maisonneuve et Larose. 600 pp.

**IRCA.** 1984. Compte-rendu du colloque Exploitation, Physiologie et

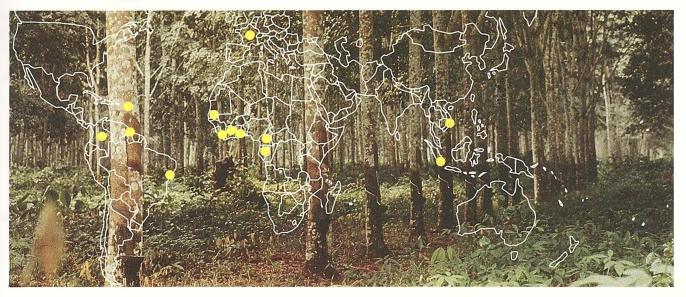
Amélioration de l'Hévéa. Workshop Proceedings, IRCA, 9-12 July 1984, Montpellier, France.

Van Dyk, A., and Serier, J.-B. 1983. Index *Revue Générale des Caoutchoucs et Plastiques*, 1924-81. Paris: IRCA. 138 pp.

Each year, IRCA publishes an annual report that presents results of all its research programs.

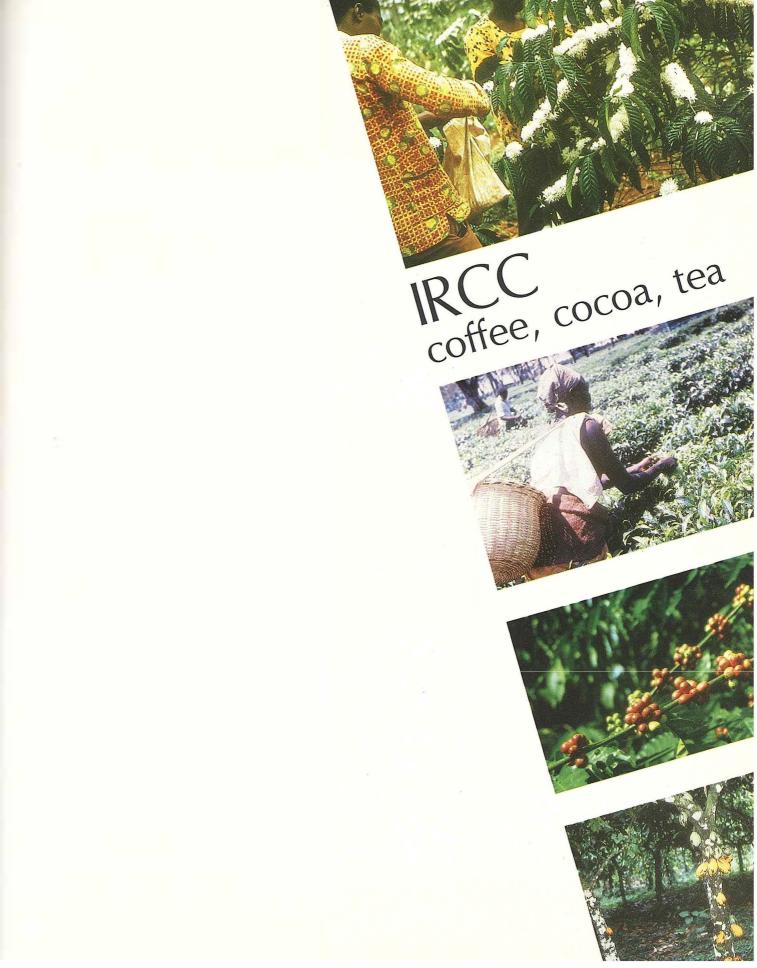
# RCA AROUND THE WORLD

### **Outreach Centers**



BRAZIL COLOMBIA FRENCH GUIANA GUADELOUPE CAMEROON COTE D'IVOIRE GABON GHANA LIBERIA SENEGAL

INDONESIA VIETNAM



### IRCC

The Institut de Recherches du Café, du Cacao et Autres Plantes Stimulantes- the coffee, cocoa, and stimulant crops research institute—was established in 1958, with a mandate to prepare the scientific and technical base for the development of these crops. The Institute designs and carries out its research (plant breeding, cultural methods, crop protection, postharvest processing and storage) in close collaboration with producing and user countries. Scientific and technical cooperation involves assistance to producersupport organizations and collaboration with professional and government bodies, international and national organizations that work on coffee, cocoa, tea or kola.

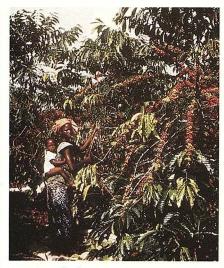
IRCC's headquarters are located in Paris and the laboratories in Montpellier, with nearly 100 staff members in France or on assignment in the tropical regional centers.

### **STIMULANT CROPS**

#### Coffee

Coffee production has increased by 60% over the last 20 years and in 1983, world production reached 5.6 million t, of which 3.3 million t entered the export market.

The two coffee species grown in the world are:



Harvesting coffee berries in Côte d'Ivoire.

— Arabica, the most popular and widespread species, accounts for three-quarters of the world production. It is grown in medium-altitude zones in Latin America, Africa (Ethiopia, Kenya, Burundi, Rwanda, Cameroon), and India. It is known for its full aroma and has a relatively low caffeine content (1-2%).

— Robusta is cultivated in hot, wet, low-altitude zones. Major producing countries include Côte d'Ivoire, Indonesia, Uganda, Cameroon. Caffeine content varies between 2.5 and 3.5%. Robusta is mainly used for manufacturing instant coffee.

#### Cocoa

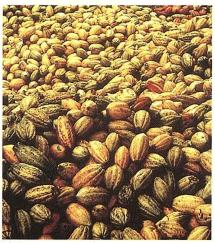
In 1983, world cocoa production was 1.6 million t, of which 1.25 million t were exported.

There has only been a slight increase of 13% in cocoa production over the last 20 years. Côte d'Ivoire with 500 000 t in 1984, is the leading producer in the world. Production in Ghana has fallen from 500 000 t in 1965 to 180 000 t in 1984, while in

Malaysia production has increased steadily to 120 000 t/year. Cocoa ranks third in importance after coffee and sugar on the international commodity market.

#### Tea

World production of tea in 1983 was 1.9 million t of which 860 000 t were exported.



Cocoa pods.

Eighty percent of the tea produced in the world comes from Asia; India and China, the two leading producers, account for 50% of world production. The quality of tea is closely related to altitude. There are only a few countries in Africa, such as Kenya, Rwanda, and Burundi, where tea production is an important commodity in the national economy. With increased domestic consumption in the producing countries, supply is not adequate to meet demand on the international market.

#### Kola

Kola nuts are produced in the forest areas of tropical Africa. The fruit is

consumed as a masticatory in the Sahelian regions where there is a large local demand for it.



Teaplots protected by a eucalyptus hedge in Cameroon

#### PAST ACHIEVEMENTS

#### Coffee

Canephora (Robusta). In Côte d'Ivoire, nine high-yielding clones were selected and seed gardens were established. This has enabled the production of selected hybrids with very high resistance. Mineral fertilization tests produced excellent results including a doubling of yields in some cases.

Arabica. Attempts were made to overcome the problems of low yields and diseases (coffee berry disease, coffee leaf rust) through plant breeding. Suitable coffee plants were first identified and their desirable traits (mainly disease resistance) were transferred by crossing with susceptible but high-yielding varieties.

Arabusta. The objective of the robusta x arabica interspecific hybrid program is to improve the qualities of robusta. The robusta chromosome number was doubled by colchicine treatment in order to facilitate hybridization. The resulting hybrid was named Arabusta. Its gene

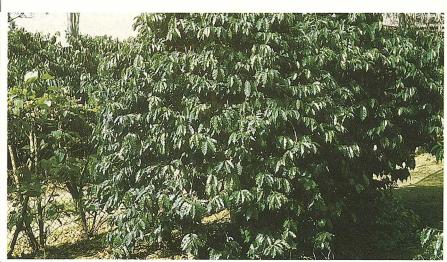
pool has yet to be enhanced; cultural and processing techniques also need to be established for this new type.

#### Cocoa

Initially, cocoa research efforts were focused on breeding programs. Hybrids from crosses between local and Amazonian populations showed remarkable vigor and earliness with a yield potential of 2 t/ha of raw cocoa. Cropmanagement studies show that shading, a common practice, is not necessary. A new soil-analysis method was developed by IRCC to determine the optimum fertilizer dosage for a given soil. An effective low-cost method was developed for controlling mirids and another for *Phytophthora* pod rot.

The available range of cocoa trees needs to be diversified and expanded by modern breeding techniques including tissue culture.

Current agronomy research is focused on the development of methods for cultivation in full sunlight. Pest- and disease-control techniques need to be made more effective and economical.



Arabusta coffee plants.

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Director: Marc Belin

# Research Highlights

#### Coffee

#### Arabica

The most important results were obtained for plant improvement, mainly selection of clones with resistance to coffee leaf rust (*Hemileia vastatrix*) and coffee berry disease, combined with high productivity.

The Cameroon collections were screened for coffee berry disease and rust susceptibility as well as productivity. Thirty-nine clones were selected and are likely to be used



Artificial pollination of coffee in Cameroon.

as parent material for intraspecific crosses.

In varietal trials carried out at various altitudes, caturra types showed good



Coffee leaf showing rust (*Hemileia vastatrix*) symptoms. performance even under severe drought conditions.

In the artificial hybridization program, a diallel cross was established involving 15 cultivars. The cultivars were also tested in Montpellier for their reaction to coffee leaf rust. Results indicate that rust resistance in *Coffea arabia* can be measured accurately.

#### rust resistance in *Coffea arabica* can be measured accurately

Interspecific hybridization of java x arabusta and java x Hibrido de Timor was completed and should provide

substitute java progeny with resistance to rust and coffee berry disease.

#### Canephora (Robusta)

Research was focused on plant breeding and cultural methods.

New clones identified locally were introduced into the Côte d'Ivoire and Cameroon collections.

Breeding material produced by vegetative propagation is performing well. The clones released in Côte d'Ivoire, Togo, and Cameroon are expected to yield more than 2 t/ha under normal conditions. In Togo, certain clones produced high yields in spite of the unfavorable drought conditions in 1983-84.

Breeding by seed propagation enabled the development of promising progeny by controlled crosses.

Parent material for future hybridization programs, can now be selected more accurately using the electrophoresis method developed by the Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM), Paris. This crossing program will be undertaken jointly by IRCC and ORSTOM.

Studies were conducted on the use of haploids to obtain progeny from homozygous parents.

Coffee plants obtained from tissue cultures by somatic embryo formation were tested for conformity in collaboration with the tissue culture laboratory in Montpellier.

Agronomy research was aimed at combining the following cultural practices:

— Increased plant density. Studies confirmed the importance of high densities. An inter-row spacing of 3 m has the added advantage that it allows planting of intercrops.

 Pruning. In the equatorial zone, pruning every 5 years gives the best

results.

— Mineral fertilization. Nitrogen application in the form of ammonium sulphate on slightly or moderately desaturated soils, enables substantial yield increases, when it is combined with the other two practices.

#### Arabusta

Research was directed towards the selection of parent material and the development of appropriate cultural methods.

Breeding work advances with the development of hybrids from controlled crosses. In 1983, 150  $F_1$  crosses were made. Four thousand plants obtained from crosses completed in 1982 were transferred to the field in 1983.

# the arabusta gene pool was enhanced with the introduction of 27 arabica lines selected in Costa Rica

The gene pool was enhanced mainly with the introduction of 27 lines of the arabica type selected in Costa Rica.

Attempts were made to introduce *Coffea congensis* through successive crosses, in order to increase plant

fertility and, similarly, the Nana population for improved growth habit.

The cultural methods recommended by research for arabusta coffee are: no cover crops and clean weeding using herbicides, a 3-stem structure topped at 1.65 m, and a plant density of 2000 plants/ha.

#### **Chemistry and Food Technology**

Chemical studies were carried out on the sterols in robusta seed oil. Changes in the physical, chemical, and taste qualities of arabica coffee during fermentation, storage, and roasting were also studied.

Technology studies were concentrated on roasting procedures using fluidized beds. A design for an arabusta wet-processing unit was tested and used in a coffee-processing plant in Côte d'Ivoire. The unit has a capacity to handle 3 t cherries/h and can be adjusted depending on the quantity to be processed.

#### Cocoa

IRCC's cocoa research is mainly concerned with plant breeding and selection, crop management, and plant protection.

#### Breeding and Selection

In an on-station clone trial, high yields of up to 5 t/ha of raw cocoa were obtained from superior material. These clones include Amelonado IFC5, Upper Amazon Na 32, and T 79/501, an Upper Amazon progeny.

Two hundred and twenty hybrids were evaluated in comparative and local adaptation trials that

were conducted as part of the generative-selection program.

Scientists are seeking wild haploids belonging to the Trinitario and Up-



Flower of a cocoa plant.

per Amazon populations. The use of electrophoretic analysis should enable genetic characterization of the populations and accurate selection of parent material.

Floral biology experiments have demonstrated that the growth habit of cocoa trees should be carefully controlled. Formation pruning that allows better light penetration, stimulates flowering and fruiting. Crop-management systems with low plant densities or fertilizer application also improve flowering and fruit-bearing.

#### the new soil-analysis method is useful for calculating fertilizer requirements

The new soil-analysis method is useful for calculating fertilizer requirements at regional level. The area around the tree for fertilizer placement was determined as well as the mineral exports by the crop. This should help reduce the quantity of mineral fertilizer to be applied as well as the percentage of potassium in the fertilizer.

#### **Plant Protection**

The evaluation of cultivar susceptibility to insect pests showed a close correlation between certain aspects of crop management (e.g. method of insecticide application) and pest incidence. Results also indicate that fine-spray irrigation tends to encourage parasitization, unlike drip irrigation.

In Cameroon, a multidisciplinary team was formed in 1982 whose objective is to design methods for controlling *Phytophthora*, the most harmful pathogen of cocoa. Interesting results were obtained concerning the epidemiology of the disease as well as the biochemistry and physiology of resistance.

A method was developed to test various fungicide formulations by using random targets. A computer program was established to quantify the effect of fungicide treatments and removal of infected pods on disease development.



Cocoa pods affected by the Phytophthora pod rot.

In Togo, research on swollen shoot is aimed at the purification of the virus and an inventory of different scale species that serve as vectors for the virus. Early tests of disease resistance were conducted to study inheritance of resistance characters.

a computer program
to quantify the effect of
fungicide treatments
and removal of
infected pods
on disease development

#### **Chemistry and Technology**

Chemical studies examined changes in phenols and individual protein fractions in cocoa beans during growth, maturation, and fermentation. Laboratory studies on the 3-phase fermentation of cocoa beans in fluidized beds were continued. This technique gives a product similar to that obtained through a traditionally cured control, but with lower acidity.



Mechanized turning of cocoa beans during fermentation.

Mature dehiscent kola (Cola nitida) follicles.



# fermentation in fluidized beds gives a product similar to traditionally cured cocoa, but with lower acidity

The use of selected fermenters that can regulate the fermentation process is also being examined.

#### Kola

Observations carried out on the collections in Côte d'Ivoire enabled the identification of 29 new clones that produce more than 100 follicles per tree.

A new progeny trial was initiated in 1983 to compare the performance of 27 hybrids.

Studies are under way to examine vegetative growth of the plant, improvement of the germination capacity of kola seed, fertility and compatibility of clones in the collection.

#### Tea

IRCC is providing scientific and technical assistance to the Cameroon Development Corporation for its activities in breeding, and development of cultivation and fertilization techniques.

# CONTRIBUTION TO DEVELOPMENT

IRCC contributes to research development through dissemination of information, short-term assignments for assistance or study, various other services, and secondment of its experts.

#### **Extension of Research Results**

Extension of research results is supplemented by support studies in close collaboration with development organizations such as SODE-CAO and CDC in Cameroon, SO-NADECI in Gabon, SRCC in Togo, SATMACI in Côte d'Ivoire.

## Short-term Assignments for Assistance and Survey

These are undertaken during the formulation of development projects

or prior to the installation of processing equipment or plants in various countries (Côte d'Ivoire, Cuba, Gabon, Haiti, Indonesia, Jamaica, Malaysia, São Tomé, Togo, Zaire) as well as the French overseas departments and territories (Guadeloupe).

#### **Other Services**

These services include supply of plant material and training of extension staff, especially in Côte d'Ivoire.

#### **Assignment of Experts**

IRCC scientists are seconded to national development organizations for the establishment and monitoring of projects (Costa Rica, Gabon, Togo, Vanuatu).

# TRAINING

The development of stimulant crops and the improvement of processing facilities in producing countries is closely linked to the training of national scientists as well as those in charge of development projects.

Since its inception in 1958, IRCC has offered training to a large number of scientists either on location by inte-

grating them in research programs conducted in their country, or in France. About 20 of them continue to work with IRCC teams in outreach centers.

IRCC has strengthened its training activities over the last few years, and they now include:

- training of extension staff, mainly

in Côte d'Ivoire. Each year, about 300 rural extension agents receive training or reorientation at the Divo experimental station;

about 30 students and technicians attended university-level and

technical courses at IRCC's Montpellier center;

 practical and theoretical technology courses of 1-week duration are organized regularly for roasting and chocolate specialists;  IRCC scientists also collaborate with training institutes in France such as ENSAM, CNEARC, IFARC, SIARC, ISTOM.

# **PUBLICATIONS**

IRCC publishes a quarterly Café, Cacao, Thé with summaries in English, German, and Spanish. A list of articles appearing in this periodical is supplied on request. Major publications, including a series of bulletins, are listed below:

#### Books

**Forestier, J.** 1969. Culture du caféier Robusta en Afrique centrale. Paris: IRCC. 206 pp.

**Lavabre, E.M.** 1961. Protection des cultures de caféiers, cacaoyers et autres plantes pérennes tropicales. Paris: IRCC. 268 pp.

**Lavabre, E.M. (ed.).** 1977. Les mirides du cacaoyer. Paris: IRCC and Ed. Maisonneuve et Larose. 366 pp.

#### **IRCC Bulletins**

IRCC. 1963. Les principes de la sélection des caféiers canéphoroïdes et libério-excelsoïdes. Leur application aux travaux des Centres de recherches de l'Institut du Café et du Cacao en Côte-d'Ivoire, à Madagascar et en République Centrafricaine. Collection of articles published in *Café, Cacao, Thé* in 1962. IRCC Bulletin No. 5. Paris: IRCC. 48 pp.

IRCC-ORSTOM. 1978. Etude de la structure de la variabilitée génétique des caféiers : résultats des études et des expérimentations réalisées au Cameroun, en Côte-d'Ivoire et à Madagascar sur l'espèce *Coffea arabica* L. collectée en Ethiopie par une mission ORSTOM en 1966. IRCC Bulletin No. 14. Paris: IRCC. 100 pp.

**Leguizamon, J.** 1985. Contribution à la connaissance de la résistance incomplète du caféier Arabica à la rouille orangée. IRCC Bulletin No. 17. Paris: IRCC. 123 pp.

**Loué**, **A.** 1961. Etudes des carences et des déficiences minérales sur le cacaoyer. IRCC Bulletin No. 1. Paris: IRCC. 54 pp.

**Loué**, **A.** 1962. Etudes des carences et des déficiences en potassium, calcium et magnésium chez le caféier Robusta. IRCC Bulletin No. 4. Paris: IRCC. 48 pp.

Muller, R.A. 1964. L'anthracnose des baies du caféier d'Arabie (Coffea arabica) due à Colletotrichum coffeanum Noack. IRCC Bulletin No. 6. Paris: IRCC. 38 pp.

**Muller, R.A.** 1980 Contribution à la connaissance de la phytomycocénose constituée par *Coffea arabica* 

L., Colletotrichum coffeanum Noack (sensu Hindorf), Hemileia vastatrix B. et Br., Hemileia coffeicola Maublanc et Roger. IRCC Bulletin No. 15. Paris: IRCC. 175 pp.

**Saccas, A.M.** 1975. Les pourritures des caféiers en Afrique tropicale. IRCC Bulletin No. 13. Paris: IRCC. 172 pp.

**Saccas, A.M.** 1981. Etude de la flore cryptogamique des caféiers en Afrique centrale. IRCC Bulletin No. 16. Paris: IRCC. 522 pp.

The complete list of publications is supplied on request.

IRCC also publishes an annual report of its activites.

IRCC has produced two 16 mm films in French, English, and Spanish:

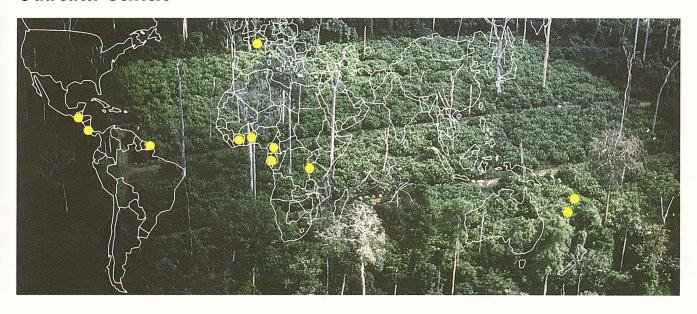
Coffee cultivation in Africa (duration 45 min).

Cocoa cultivation in Africa (duration 38 min).

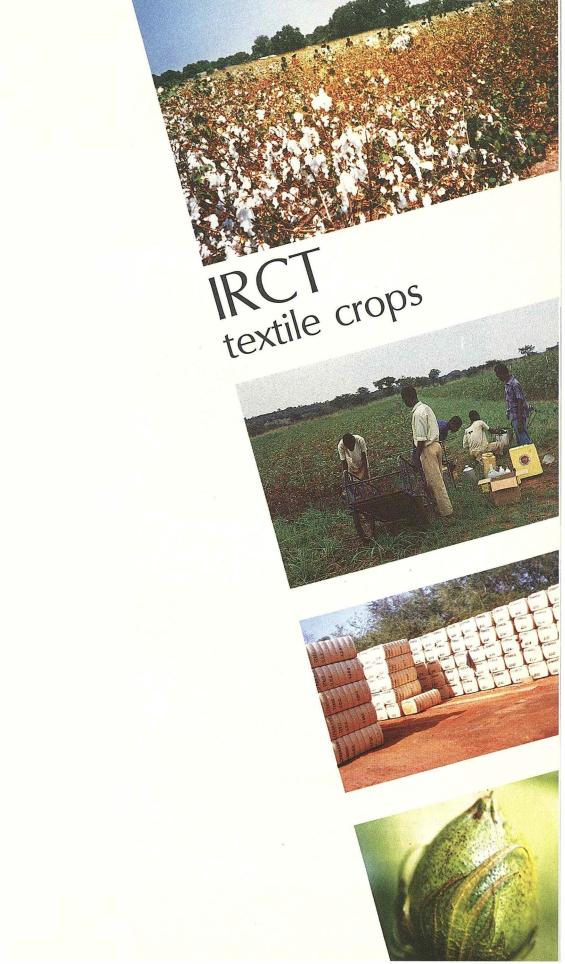
These films are also available on video cassettes (1/2 in VHS, SECAM).

# RCC AROUND THE WORLD

# **Outreach Centers**



COSTA RICA FRENCH GUIANA GUATEMALA BURUNDI CAMEROON COTE D'IVOIRE GABON TOGO NEW CALEDONIA VANUATU



# **IRCT**

The Institut de Recherches du Coton et des Textiles Exotiques, for cotton and exotic textile crops research, was founded in 1946, when it took over from other French institutes working on cotton in Africa. In 1985, IRCT became a department of Cl-RAD. The Institute has close links with other organizations for developing cotton production, including the Compagnie Française pour le Développement des Textiles (CFDT) and its counterparts in Africa (CIDT, Côte d'Ivoire; CMDT, Mali; Sodecoton, Cameroon; Cotontchad, Chad; etc).

IRCT has 66 scientists on its staff. Its headquarters are located in Paris and the laboratories in Montpellier. IRCT also has outreach centers in 12 countries.

Although it is not officially an international institute, IRCT serves this purpose, as there is, at present, no international organization for cotton research.

The other exotic fibers (sisal, hemp, ramie, etc) are being rapidly replaced by synthetic fibers; research on these crops has now been reduced.

## COTTON

Cotton is the most important textile fiber, with about 50% of the market. Seventy-five of the 90 producing countries, are developing countries, where an estimated 180 million people—including 140 million in rural areas—earn their living from production or transformation of cotton. For these countries, cotton is a source of foreign exchange; however, the number of domestic textile industries is growing rapidly. The African cotton-producing countries—where CFDT and IRCT are present—together rank tenth for world cotton production; however, their cotton-production growth rate over the past 20 years, along with that of China, has been the highest in the world.

Although this is not well known, cotton is also a food crop. Cottonseed is rich in oil and proteins. Cottonseed oil ranks fourth among vegetable oils and is used for domestic consumption in the ducing countries. But the cottonseed proteins are not being optimized, except for animal feed in the form of cakes, that are generally exported. Cotton is the most important source of vegetable protein, following soybean; but cottonseed cake is unfit for human consumption due to the presence of a toxic substance, gossypol. Use of glandless varieties would enable their use for human consumption. This would adequately meet the protein requirements of 3 million people in the 11 African countries and Madagascar, where IRCT programs are located. Some of IRCT's research is directed towards this problem.

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Institut de Recherches du Coton
et des Textiles Exotiques
2, rue Louis David
75116 Paris
Tel.: (1) 45 05 14 07

Telex: 620871 F Director: *Michel Braud* 

# PAST ACHIEVEMENTS

IRCT's research is guided by the need to ensure maximum income to the farmer. Initially, the main objective was to increase on-farm and ginning yields and to improve fiber quality. IRCT has created and developed a new family of cotton varieties for this purpose, that are well suited to local conditions in Africa and South America. They are comparable to the best North American varieties in terms of agronomic and technological performance.

In Africa, IRCT has also designed intensive cropping systems capable of producing on-farm yields close to, and even higher than, the world average. Cotton is grown as a rotation crop; IRCT has also included related cropping and farming systems in its research.

The validity of this research is confirmed by the remarkable increase in cotton-seed yields from 200 to 1000 kg/ha and in ginning yields from less than 30 to more than 40%. Fiber quality has also been improved and can now compete with that of the best North American cottons.

Statistics reveal that production increase in Africa is due to higher yields rather than expansion of cultivated area. The farmers, who produce most of the cotton in Africa, have benefited considerably. The innovations in the production systems due to the development of cotton cultivation, have given them technical and economic security.

In Paraguay, cotton production has increased seven-fold since 1969 when IRCT started its work in this region. This demonstrates once again the quality of the French cotton research.

# RESEARCH HIGHLIGHTS

## Cotton

### **Plant Breeding**

Breeding work is directed towards the development of material with higher fiber yield without modification of the technological characters. But this is not the only objective fiber fineness and maturity as well as cottonseed oil content are also important selection criteria.

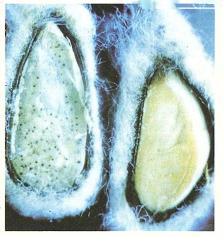
Over the past few years, IRCT has increased the number of accessions in its germplasm collection. For Gossypium hirsutum, that is widely grown in IRCT's area of concern, the number of accessions in 1984 were: 606 varieties, of which 390 were evaluated for botanical, agronomical, and technological characters and are available to breeders; 200 outstanding parent lines not used as commercial varieties; 164 lines undergoing further selection in Cameroon, Central African Republic, Chad, El Salvador; 710 weedy cotton samples; 56 wild cotton samples; and 23 hexaploid progeny. For the textile hibiscus section furcaria, accessions include 40 commercial varieties, 27 lines, and 8 wild species.

Certain varieties were released for large-scale cultivation and have substantially contributed to the general improvement of cotton production. These varieties originate from Côte d'Ivoire (L 142-9, T 120-7, L 299-10-75), Chad (SR1F4, MK73), Central African Republic (B 163, B 761), and Togo (BOU 79 and 80).



Flower of a cotton plant.





Among the varieties that are being multiplied prior to release, are:

 ISA 205 (Côte d'Ivoire) for better ginning yield (44%),

 K14 (Chad) for higher production and ginning yield,

— IRMA 96-97 and IRMA 73-76-97

(Cameroon) for fiber quality,

BOU 81-STAM (Togo) for yield,

HC-B4-75 (Mali) for earliness.

Much progress was made in the development of glandless varieties in Côte d'Ivoire (ISA BC2 and ISA BC4), Chad (J 131-253), and Cameroon (IRMA 197). As mentioned earlier, these can be used for human consumption.



Crop of cotton selections in Bebedija, Chad.

IRCT collaborated in the development of the commercial varieties Cedix and Cetex in El Salvador, H373 and F286 VR in Nicaragua, and Reba P279 in Paraguay.

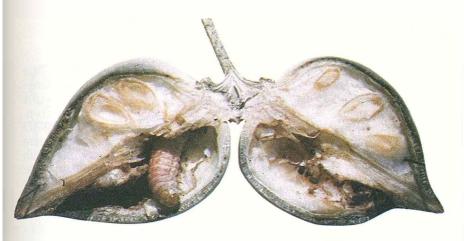
## Agronomy

Development organizations find that technology options rather than a standard package of recommendations are more useful, given the varied cropping conditions. IRCT is preparing such recommendations with alternative solutions related to

the different production factors. For example, the development of fertilization patterns for different cropping systems is of particular importance. IRCT has proposed certain evaluation methods—visual observations, soil and plant analyses, mineral balances, and others-that can be used according to the available means. Supplemental nitrogen fertilization also needs to be adjusted according to the soil type and rainfall conditions. The feasibility of various soil fertility-maintenance techniques for the different crop rotation systems can be tested through IRCT's

farming systems on-farm trial network. There is further evidence that the 1100-mm isohyet divides two distinct soil conditions; organic matter is the main limiting factor in the north and a desaturated base-exchange complex in the south. These conditions therefore require two different types of techniques for fertility maintenance.

Chemical weeding has definite advantages in terms of labor productivity. Integrated weed management requires detailed studies to define various options.



Cotton boll infested by the bollworm *Diparopsis* watersi.

## **Crop Protection**

Cotton is exposed to several pests and diseases. IRCT has recommended economical and moderate control treatments and schedules, based on the study of pest and disease development and improvements in crop protection products and treatment methods.

Cotton boll pests are the most destructive. *Heliothis armigera* occurs throughout the region and is the most difficult to control.

Cotton fibers with honeydew produced by aphids.



Other pests are distributed according to latitute. *Diparopsis watersi* is found in the north but it is becoming economically less important. Other bollworms such as *Pectinophora gossypiella* and *Cryptophlebia leucotreta* are, however, still active in the more humid southern rainy zones. There has been an outbreak of *C. leucotreta* in the Bight of Benin area following the expansion of maize cultivation.

Leaf insects have become more important as a result of the exclusive use of pyrethroids. Among the mites, Polyphagotarsonemus latus is a serious threat to crops in Côte d'Ivoire, Central African Republic, Benin, and Togo, whereas *Tetranychus urticae* is confined to Côte d'Ivoire. Among the leaf eaters, Sylepta derogata causes the most damage throughout the zone, while Cosmophila flava is restricted to northern Côte d'Ivoire and Mali. Piercing insects are often responsible for boll rot in the wooded areas. Leaf-sucking aphids and whiteflies, that produce honeydew and spoil fiber quality are being intensively studied in the affected countries.

The appearance of a new bacterial race in Chad and Burkina Faso has led to outbreaks of this disease that

was kept in control through the use of resistant varieties. Bacterial blight mainly affects the foliage and bolls.

Fusarium wilt has not spread beyond Côte d'Ivoire and Central African Republic, due to the use of resistant varieties. Control of vectors has also reduced incidence of the diseases they transmit, for example, aphids and blue disease in Central African Republic, fleahoppers and flower virescence in Mali and Côte d'Ivoire, white flies and leaf curl throughout the area.

For chemical pest control, it is not advisable to use pyrethroids exclusively. They should be combined with organophosphates selected according to the pest—mites, piercing-sucking insects or leaf worms.

Large-scale on-field experiments are being carried out on entomopathogens (Cameroon, Chad, Côte d'Ivoire), pest hyperparasites (Togo). The use of chemical traps is being studied in all the countries.

## Technology

**Fiber.** The fiber laboratory in Montpellier is studying the technological characteristics of cotton fiber and cottonseed of new varieties. The laboratory is also conducting research on analytical methods.

Technological characters of 5000-6000 fiber samples from various countries were tested at the request of breeders and private companies.

A total of 1400 minicard tests were carried out for stickiness, mainly for African cotton companies. This is known to be the most significant test for identifying sticky cottons and has been recommended by the ITMF Technical Committee following its

# 1400 minicard tests were carried out for stickiness

meeting in Brême in February 1984; however, the exact testing conditions need to be specified. A unique



Minicard test for sticky cotton.

experiment was established in Africa with the objective of developing a practical method for detecting the stickiness potential of cotton bales in a ginnery. This test will be very useful for marketing divisions.

A spinning study (1009 tests) was undertaken to determine the tensile strength of a 27-tex fiber on the basis of certain technological characteristics (50% S.L., stelometric strength, and fineness).

Standard fineness is a very variable characteristic and depends on the production environment. There is a need for further research on this characteristic.

The collection at the fiber bank is useful for studying cotton mixes.

**Cottonseed.** The laboratory continued routine chemical analyses of cottonseed for quality control of

food products after industrial processing. It is also carrying out research on cottonseed as a source of high-value protein for human consumption, in collaboration with seven French and foreign (Côte d'Ivoire, UK) organizations. Recent results obtained by the USTL nutrition laboratory in Montpellier indicated the superiority of glandless cottonseed cake over soybean cake.

## studies indicate the superiority of glandless cake over soybean cake

Standard methods for detoxicating cottonseed for use in flour production were also studied. It is now possible to eliminate 90% of the gossypol by simple physicochemical processes without affecting protein quality.

A flour with more than 68% protein was prepared in a pilot plant, using standard processing techniques. The process is ready to be used by industry.

#### **Economics of Textile Fibers**

From the producer to the world market. Research activities are closely linked to development, since they must not only meet the immediate, but also the future requirements of producers and development organizations.

IRCT has adopted a systems approach to cotton production, extending from the crop, through the rural community (village) to the international (political, economic) system.

The areas of concern are the Sudano-Sahelian and Sudano-Guinean Zones where cotton is the dominant commercial crop. Research is carried out by CIRAD scientists and coordinated by a team leader, in close collaboration with the research and development organizations of the host countries, including Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, and Togo.

#### **Remote Sensing**

The remote-sensing program for cotton crops is at its initial stage. Current activities include:

 study of spectral properties of cotton leaves with nitrogen and potassium deficiencies;

 launching of a CIRAD unit for digital processing of satellite images, and development of appropriate software.

An important achievement of this young unit is the identification of plots; this is important for monitoring the development of cotton cultivation in space (use of village lands) and in time.

# **Other Textile Fibers**

The importance of other textile fibers has been diminishing following competition from synthetic fibers. However, research on these fibers is still being continued at IRCT, particularly, plant improvement through *in vitro* culture of sisal, textile hibiscus, and agave.

The possibility of obtaining paper pulp from denser parts of hemp plants is also being studied.

# CONTRIBUTION TO DEVELOPMENT

IRCT maintains an excellent and close working relationship with cotton development organizations (CFDT and African development enterprises, Cámara Algodonera, Philcotton, etc). Excellent coordination between scientists and development agents for the transfer of research results, makes research programs cost-effective, as can be seen from the above examples.

IRCT scientists are keenly aware of the realities of the cotton-producing environment. Their programs are often executed under a wide range of soil, climate, and socioeconomic conditions in the cotton-growing areas. The aim is not only to increase the fund of knowledge, but to also accelerate the technical and economic progress of cotton cultivation and all the associated sectors.

Improvement in farmers' welfare, their assimilation of modern techniques with better on-farm results, are equally important achievements as the economic success of producers, related industrial and commercial sectors and, finally, the nations themselves.

When cotton research is associated with development activities, it becomes a dynamic factor in the economic and agricultural policies of the producing countries.

IRCT collaborates with national research institutes in the African countries and assists their development.

# TRAINING

There has been a marked increase in IRCT's training activities for national scientists, through the organization of training programs for foreign scientists and specialists and the integration of national scientists in IRCT's teams in other countries.

National scientists are assigned to IRCT by local authorities and participate to the same degree as the IRCT scientists in implementing different research programs. Some of them also carry out individual research. This provides an excellent opportunity for on-the-job training in research work. The following table gives an idea of the training activities in various host countries in Africa and Madagascar.

Country	1970	1975	1980	1984
BENIN BURKINA FASO CAMEROON	1	2	3 2	4 4 2
CENTRAL AFRICAN REPUBLIC		1	3	4
COTE D'IVOIRE MADAGASCAR			1	2
MALI SENEGAL		1	6	9
TOGO ZAMBIA	1	1	2	3 4
TOTAL	2	5	17	38

# PUBLICATIONS

IRCT publishes a bilingual quarterly Coton et Fibres Tropicales, in French and English with abstracts in Spanish, that is sent to specialists in 73 countries. One of the four issues contains IRCT's annual report of research in France and other countries. Each issue also carries a computerized bibliography in annex.

In addition to the quarterly, a new series of country reports on various subjects *Documents, études et synthèses* is also published.

## Documents, études et synthèses

No. 1. Cauquil, J., and Vincens, P. 1982. Maladies et ravageurs du cotonnier en Centrafrique. Expression des dégâts et moyens de lutte. Paris: IRCT. 32 pp.

Data collected during 1971-83 were used to assess damage and adapt control methods to local conditions. This has led to the judicious use of chemical treatments with application of insecticides only when necessary.

A list of microorganisms, diseases, and major pests is given in annex. 50 bibliographical references.

No. 2. **Crétenet, M.** 1983. Contribution à l'étude des systèmes de production au Mali. Mise au point d'une méthodologie applicable au suivi de cas en motorisation intermédiaire. Paris: IRCT. 41 pp.

Proposal of a methodology for collection and interpretation of data on three cotton farms using interme-

diate technology. Data analysis should provide solutions for individual cases.

No. 3. **Hau, B., Koto, E., and Angelini, A.** 1983. Le cotonnier « glandless » en Côte d'Ivoire. Paris: IRCT. 19 pp.

This booklet deals with breeding of glandless varieties, their pest susceptibility, and market estimates for glandless cake.

No. 4. **Sément, G.** 1983. La fertilité des systèmes culturaux à base de cotonnier en Côte-d'Ivoire. Neuf années d'expérimentation et d'observation multilocales (1973-1982). Paris: IRCT. 40 pp.

Current farming practices lead to heavy desaturation of soils in Ca and Mg and reduce organic matter content. Available data were used to develop an appropriate fertilization policy that considers fertility factors other than conventional fertilizers and is suited to different types of conditions.

No. 5. **Boulanger**, J., Follin, J.C., and Bourely, J. 1984. Les hibiscus textiles en Afrique tropicale. Part I. Les conditions particulières de la production du kénaf et de la roselle. Paris: IRCT. 81 pp.

Part I is devoted to the specific conditions for growing hemp (*Hibiscus cannabinus* L.) and roselle (*H. sabdariffa* var. *altissima* Wester) in Africa, to provide fiber for making sacks and, possibly, paper pulp. The

report presents results of about 40 years of observations and trials by IRCT.

Part II will deal with cultural techniques, fiber extraction, crop options in development programs, and new uses.

No. 6. **Richard, L., and Djoulet, B.** 1986. La fertilité des sols et son évolution : zone cotonnière du Tchad. Paris: IRCT. 20 pp.

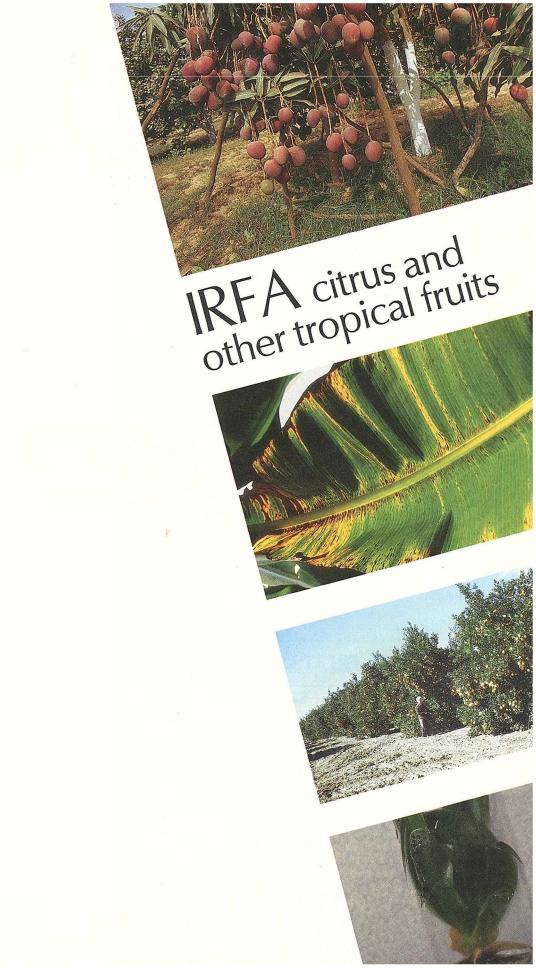
Importance of organic matter and the effect of exchangeable potassium on yield. Cropping systems are developed and tested; resulting yields were high enough to incite the use of these systems that apparently preserve soil fertility.

# RCT AROUND THE WORLD

# **Outreach Centers**



GUADELOUPE PARAGUAY BENIN BURKINA FASO CAMEROON CENTRAL AFRICAN REP. CHAD COTE D'IVOIRE MADAGASCAR MALI SENEGAL TOGO ZAMBIA **PHILIPPINES** 



# **IRFA**

The Institut de Recherches sur les Fruits et Agrumes—the French research institute for citrus and other tropical fruits—was established in 1942, with the objective of preparing a scientific, technical, and economic base for the development of tropical fruit crops and associated industries. Initially, the work was focused on citrus fruits, pineapple, banana, and plantain; but since several years, research is also conducted on other tropical fruits (mango, avocado, litchi, etc).

The IRFA headquarters are located in Paris and its main laboratories, in Montpellier. The Institute has outreach stations in Corsica (INRA-CIRAD), the French overseas departments and territories, and other countries. There are 126 scientists on its staff.

# TROPICAL FRUITS

World production of fruit has increased by more than 45% over the past 15 years. Tropical fruits with a production of 150 million t, account for more than half the total fruit production. Of these, citrus fruits rank first, followed by banana, plantain, mango, and pineapple.

Since several years, fruit consumption has remained relatively stable in the industrialized countries, but has risen in the developing countries due to population increase. Domes-

tic consumption is difficult to estimate, but fruits such as mango, banana, and especially plantain are important nutritive factors for a large part of the population.

There is a need for sustained research not only to increase and diversify production of tropical fruits, but also to improve crop protection, processing, and the infrastructure for transport.

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Telex: 610992 F
Director: Jean-Marie Charpentier

# PAST ACHIEVEMENTS

In most tropical countries, production has never been organized on a large scale; the fruit was either picked or grown in mixed plantations. IRFA's work is therefore concerned with the development, improvement and, sometimes, establishment of modern fruit crops. This effort has produced some remarkable results.

#### Citrus Fruits

IRFA was the first to determine the influence of climatic conditions on fruit characteristics. Performance trials were conducted using varieties and preselected accessions from the collection, in order to identify suitable material. Varieties were also screened for resistance to major diseases. Integrated-control methods were developed for infectious diseases. Studies were also undertaken on postharvest processing, including extraction of juice and essential oils for the perfume industry.

#### **Bananas**

In the French West Indies and Cameroon, yields have more than doubled in the past 30 years. The Institute distributed improved varieties and optimized fertilization. A treatment against sigatoka disease had been developed in 1955; but other forms of *Cercospora* have appeared since 1980. This disease also affects plantains (for cooking) that are included in IRFA's mandate. The Institute was one of the promoters of the International Network for Improvement of Bananas and Plantains (INIBAP), that has gained considerable recognition in this field.

## **Pineapple**

In Africa, average yields on pineapple plantations have doubled over the past 30 years. After selection of superior varieties from the existing heterogeneous material, further research was concentrated on fundamental studies for plant improvement (a long-term hybridization program is under way), rapid multiplication (in nurseries, *in vitro* culture), soil management, bioclimatology.

Plant physiology can now be examined through leaf analysis. Production can be regulated more closely by floral induction. In food technology, new processes such as those for frozen concentrates are being studied. Suitable packaging was designed and it has already facilitated marketing.

# Research Highlights

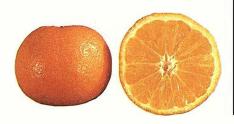
IRFA's research is divided into individual fruit programs (citrus fruits, pineapple, bananas, etc) with a tendency towards diversification of fruit crops. The research work is determined by current requirements of users, but, in general, varietal improvement, fertilization, and disease control remain the major objectives.

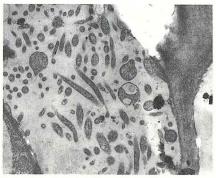
## Citrus Fruits

Plant improvement is still an important thrust of this program. Multilocation trials were conducted for different varieties and stocks. New techniques for micrografting were developed to obtain disease-free plants (virus and virus-like diseases). The basic processes that influence yield and quality are also being examined.

Crop-protection studies focus on the early detection of infectious diseases (e.g. stubborn disease) and led to the development of a biological-control model for the greening disease vector. This model was successfully applied in Réunion. Pre- or postharvest diseases can now be controlled effectively.

SRA 85 clementine from Corsica.





Endocellular bacteria of the greening disease.

# **Pineapple**

Plant-improvement work has led to the development of new varieties by normal hybridization and enhancement of the pineapple collection through the introduction of exotic clones. The hybrids were characterized and the information stored in a computer-based information system. Thorough expertise has been gained in *in vitro* multiplication.

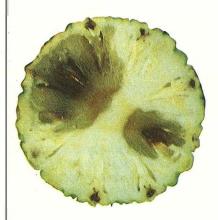
# thorough expertise has been gained in in vitro multiplication

Agronomic studies were carried out on the water balance of pineapple crops and for the development of cost-effective cropping systems (rotation, intercropping, etc).

Crop-protection studies aim to reduce harvest losses due to pests



Intercrop of pineapple and groundnut.



Pineapple showing damage by *Penicillium* funiculosum

(nematodes, symphilids) and diseases (black spot caused by *Penicillium*).

## **Bananas** and **Plantains**

Genetic research for plant improvement is of primary importance.

It involves introduction of exotic clones to enhance collections, conventional hybridization (although difficult and limited in the case of bananas), and *in vitro* culture of cells and protoplasm fusions.

An important objective is the understanding of soil-fertility factors, based on a study of the physicochemical characteristics of soils, biological factors, and cover crops.

Crop-protection efforts aim to intensify sigatoka control.

the International
Network for Improvement of Bananas
and Plantains (INIBAP)
was established
following IRFA's
initiative

In 1985, the International Network for Improvement of Bananas and Plantains (INIBAP), was established at CIRAD, Montpellier, following the initiative taken by IRFA. INIBAP is an international network that encourages and coordinates banana and plantain research worldwide.

# **Other Tropical Fruits**

#### Avocado

Enhancement of germplasm collections and performance trials are important components of this research program. Selection of stocks resistant to *Phytophthora* root disease, assessment of the physiological status of fruit before picking, control of



Nursery of banana plants grown from in vitro cultures.

ripening, increasing green-life duration, these are some of the questions that are examined.

#### Mango

Apart from maintenance and enhancement of collections, a detailed study was carried out on the morphogenesis, development, flowering mechanisms and flushes of mango. This study should help detect the

inherent causes of alternate bearing and the influence of climate.

#### Other Fruits

Occasionally, other fruits, such as, dates, papaya, guava, passion fruit, litchi, strawberry, peach, and apple, are also studied. The work is usually related to enhancement of collections and parasite problems. One study in particular was carried out on the development and flowering pattern of litchis.

# **Temperate Fruits**

Superior varieties, with minimum cold requirements were selected for high-altitude tropical areas.

Variety Fuerte of avocado.



# CONTRIBUTION TO DEVELOPMENT

The final goal of IRFA's activities is to improve the nutrition status of local populations by reducing some of the deficiencies, and to diversify national income through export or local processing of tropical fruit. The Institute's research is guided by fruit production and marketing experts; results are therefore directly applicable. IRFA offers technical support, advice, and consulting services.



Litchi tree in fruit, in Réunion.

Peach variety Culemborg grown at 800-maltitude in Réunion.



## Technical Support to Fruit Production-Development Organizations or Projects

Such assistance was provided to the Institut de l'Arboriculture Fruitière (INAF), Algeria, until 1983, and is currently being offered to several African countries. These projects are: 65-ha pilot orchard of citrus fruits and an EDF-sponsored program for banana and pineapple plantations (Senegal), banana production with the Office Camerounais de la Banane (Cameroon), 100 ha of fruit crops at village level with SONADECI (Gabon), 130 ha of fruit crops and 900 ha of cashewnut plantations under state supervision and in smallholder orchards (Burkina Faso). IRFA is participating in supervising smallholders in Réunion and New Caledonia. In the Caribbean, development of fruit production is faced with the problem of reduced profits due to the high wage levels in the French overseas departments. In Peru, a technical support program for pineapple production (PEPP) was launched. Certain projects were discontinued due to difficulties in southern and East Africa and the Middle East (Iraq).

# Technical Support and/or Advice to Agro-industrial Units

The Institute is providing support to SOSUHO, Gabon, by sending its experts to the fruit-juice production

unit. In Côte d'Ivoire, it is participating in Sogefruit, a limited liability company for pineapple plantation management through contracts. IRFA has renewed its work in Guinea-Bissau, where it is associated with French companies (Tournaire, Tecotex, Sogelerg) to strengthen agro-industrial activities: essential oils of citrus fruits and jasmine (SIPAR in Labé), canning of strawberries and tomatoes (Mamou), technical assistance for production of pineapples for canning and the establishment of production units for mango and citrus fruit bases and drinks (Salguidia, Bokasiah).

#### **Consulting Services**

The purpose of consulting services is to strengthen, expand or establish fruit projects or agro-industrial units. Recent projects included: evaluation assignments in Algeria and Tunisia (production and processing of dates), Israel (handling and packaging of bananas), Yemen (citrus fruits), Rwanda and Burundi (avocado), Comoro and Mauritius (citrus fruits), Madagascar (diagnosis of the disease status of fruit crops), China (feasibilty study for a cashewnut research center), Indonesia (pineapple), Columbia, and Venezuela. In Niger, evaluation assignments directed by the Institut National de Recherches Agronomiques du Niger (INRAN) have confirmed the importance of date palm for sedentarization of agropastoral activities to check desertification.

# TRAINING

Various types of training were provided at IRFA during 1983-1985, including supervision of thesis research (doctorate and postgraduate), technical training programs that vary in duration and level, and informal noncertified courses.

The adjoining table shows the number of trainees and changes over the past 3 years.

During the past 2 years there has been a sharp increase in the demand for technical training programs and short-term courses.

	Level	Number of trainees			
		1983	1984	1985	TOTAL
Thesis r	esearch				
— doct	orate	3	4	5	12
— post	graduate	7	12	2	21
Technic	al training	7	23	35	65
Other c	ourses	19	25	21	65
		36	64	63	163

Out of a total of 163 trainees, about 125 came from countries having cooperation agreements with CIRAD

and the rest from France (students or IRFA staff).

# Publications

IRFA publishes a monthly in French, *Fruits*. In the 33 issues during the last 3 years, a total of 240 scientific and technical articles, 33 monthly economic reports, 9000 bibliographical references and analyses—also available on the Institute's FAIREC data base—were published. On behalf of INIBAP, the Institute publishes an abstracting journal that summarizes literature on bananas and plantains in French, English, and Spanish.

Some major publications produced or authored by IRFA are:

**Boccas, B., and Laville, E.** 1978. Les maladies à *Phytophthora* des agrumes. Paris: IRFA. 162 pp.

Bove, J.M., and Vogel, R. 1981. Description and illustration of virus

and virus-like diseases of citrus fruits. Paris: IRFA. 4 volumes, color slides.

**Champion, J.** 1973. Le bananier. Paris: Ed. Maisonneuve et Larose. 263 pp.

**Fouque, A.** 1974. Espèces fruitières d'Amérique tropicale. Paris: IRFA. 274 pp, 72 slides.

**Fouré, E.** 1985. *Mycosphaerella fi-jiensis*. Symptômes sur bananiers et plantains. Paris: IRFA. 15 pp, 30 slides.

**IRFA.** 1980. La qualité de la banane. Paris: Ministère de l'Agriculture. 77 pp, 81 slides.

**IRFA.** 1983. Les cercosporioses des bananiers et leurs traitements. Collection of articles from *Fruits*. Paris: IRFA. 770 pp.

**de Laroussilhe, F.** 1980. Le manguier. Paris: Ed. Maisonneuve et Larose. 312 pp.

Martin-Prével, M., et al (ed.). 1984. Analyse végétale dans le contrôle de l'alimentation des plantes. Paris: Ed. Lavoisier. 810 pp.

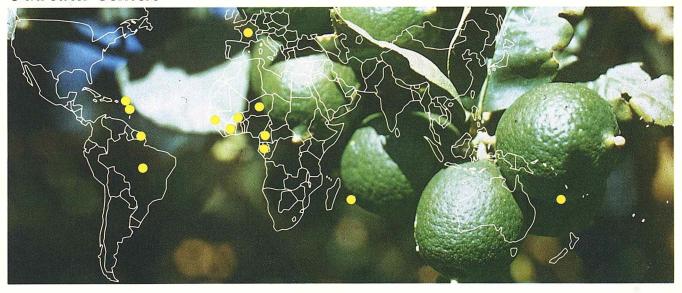
**Munier, P.** 1973. Le palmier-dattier. Paris: Ed. Maisonneuve et Larose. 222 pp.

**Praloran, J.-C.** 1971. Les agrumes. Paris: Ed. Maisonneuve et Larose. 566 pp.

Py, C., Lacoeuilhe, J.J., and Teisson, C. 1984. L'ananas, sa culture et ses produits. Paris: Ed. Maisonneuve et Larose, Agence de Coopération Culturelle et Technique (ACCT). 564 pp.

# RFA AROUND THE WORLD

# **Outreach Centers**



BRAZIL: P, B FRENCH GUIANA: O, PR GUADELOUPE: O, B, H MARTINIQUE: O, B, C, H BURKINA FASO: Ca, O, H CAMEROON: B, C, P, O, PR, H COTE D'IVOIRE: C, O, B, P, PR, H GABON: O, B GUINEA-BISSAU: P, O, PR NIGER: O, D REUNION: C, O, P, H, PR, TF NEW CALEDONIA: O

## Legend:

B: Banana

C: Citrus fruits

Ca: Cashewnut

D: Date palm

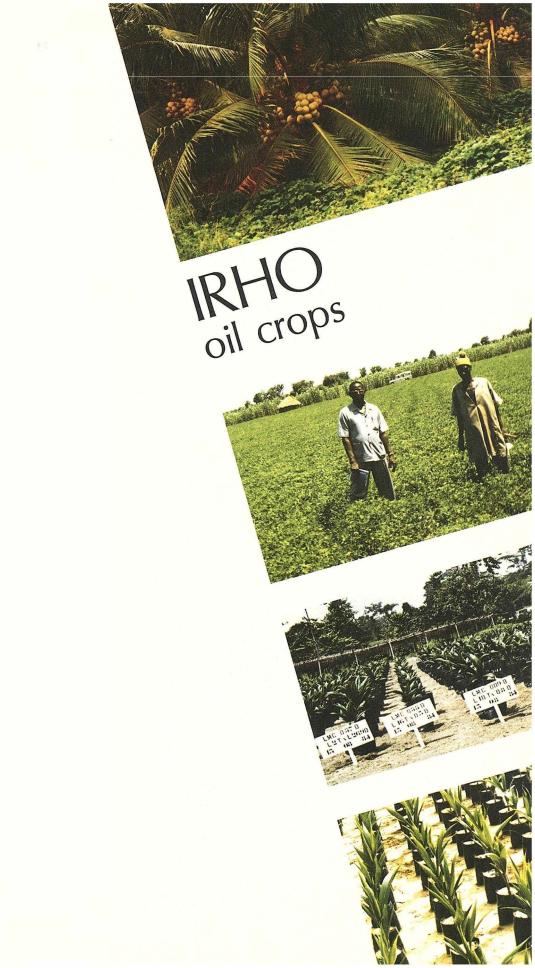
O: Other fruits

P: Pineapple

TF: Temperate fruits

H: Handling

PR: Processing



# **IRHO**

The Institut de Recherches pour les Huiles et Oléagineux, the French oil and oil crop research institute was founded in 1942 with the mandate to study oil crops including oil palm, coconut, and annual oilseeds (e.g. groundnut), from cultivation to processing. Its headquarters and documentation center are located in Paris. and the scientific divisions in Montpellier. Out of the 110 scientists working at the Institute, 80 are assigned to outreach programs in other countries and almost a third are involved more in development activities than in research. IRHO is present in 19 tropical countries and has permanent links with 26 others.

# **Tropical Oil Crops**

Tropical oil crops (oil palm, coconut, groundnut) are of major importance in the edible vegetable-oil market, representing 30% of world production and more than one-third of the exports. Their production, along with that of other vegetable fats and oils, has doubled since the 1960s to meet the increasing world demand. This was only possible through a substantial rise in soybean (x 3.5) and, mainly, palm oil (x 6) production over the past 25 years. IRHO has contributed greatly to this technical revolution in oil palm production through the successful application of its research results.

Although coconut oil production has only risen by 30% during the same period, it is expected to evolve rapidly from natural grove production to intensive cultivation following research on this crop. The new hybrids, resulting from IRHO's pioneering research, will be a key factor in this development.

During the last 15 years, groundnut production has stabilized at 15 million t after expansion in the 1960s and 1970s. Since one-third of world production (more than 50% in Africa) is used for direct consumption without further processing, only 20% enters the international market as oilseed or oil. Groundnut has a high nutritive value, three times that of cereals, due to a high content of oil (48-53%), essential fatty acids not manufactured in the body, and protein (24-34%). This oilseed is the most important source of oil in those tropical areas where perennial oil crops (coconut, oil palm) do not grow. Groundnut is normally grown as a rotation crop on family holdings. It is expected to develop, however, through large-scale extension of improved cropping techniques, better availability of the necessary inputs, and distribution of improved seed, that are essential requirements for obtaining stable yields.

Present production of food-grade fats and oils is not adequate to meet world demand; 80% of the world's population can satisfy only 25% of its requirements. Oil crops therefore have considerable prospects for development.

# PAST ACHIEVEMENTS

Since its establishment, IRHO has obtained excellent results in plant improvement, mainly for oil palm and coconut. Crosses between African and Southeast Asian material proved to be promising. Reciprocal recurrent selection has been subsequently adopted in IRHO's breeding program.

Yields of semiwild oil palm groves and the early crosses are limited—900 kg/ha and 1900 kg/ha, respectively—compared to 3900 kg/ha from the newly developed material grown in West Africa. Under more favorable conditions in Malaysia, they even rise to 5700 kg/ha. Palm growth was also reduced substantially to 51 cm/year. IRHO thus plays an important role in supplying selected oil palm seeds.

A highlight of coconut research is the development of the hybrid PB 121, a Malaysian Yellow Dwarf x West African Tall cross. The young hybrids produce 2300 kg copra/ha per year; on-station yields of 5400 kg were recorded at adult stage. Plantation yields vary between 3000 and 4500 kg/ha compared to a world average of 600 kg/ha. Moreover, its drought tolerance gives it wide adaptability to a large range of environments.

Groundnut breeding has enabled the development of drought- and rosette-resistant varieties. Current emphasis is on shorter-cycle varieties with protoplasmic resistance to prolonged water stress, and on varieties with greater resistance to other diseases (rust, leaf spot) or Aspergillus flavus to reduce aflatoxin toxicity.

In agronomy, a leaf-analysis method was developed for all three crops (oil palm, coconut, groundnut) to compare leaf contents of various nutrients with their respective critical levels. Fertilizer application is generally effective when nutrient content falls below critical level

and is therefore deficient. The main synergistic and antagonistic interactions between nutrients were also studied. Different cultural practices were examined in relation to all the crop-growth stages and modified accordingly.

In crop protection, IRHO has advanced further in integrating the most effective control methods for the different crops with their specific pest and disease problems: Coelaenomenodera, Leptopharsa, Sibine fuscafor oil palm; Pseudotheraptus, Aspidiotus, Oryctes for coconut. Experimental methods for testing appropriate treatments were developed for other diseases, such as, spear rot and bud rot of oil palm; Phytophthora and Catacauma torrendiella of coconut. Insect vectors were identified for several diseases such as blast and dry bud rot in Africa, Marchitez in Latin America, and foliar decay in Vanuatu. Oil palm and groundnut material with tolerance to certain diseases, particularly vascular wilt of oil palm, was developed through genetic improvement.

In food technology, IRHO has contributed to the improvement of the output of palm oil mills, mechanical processing of coconuts (husking, breaking, shelling), development of copra dryers, and industrial processing of edible groundnuts.

IRHO
Institut de Recherches pour les Huiles et Oléagineux 11, square Pétrarque 75116 Paris Tel.: (1) 45 53 60 25 Telex: 630491 F Director: José Fleury

# RESEARCH HIGHLIGHTS

## Oil Palm

#### Selection and Breeding

Fifty-three new *Elaeis oleifera* ecotypes from the Amazon region were added to the collections of Brazil and Côte d'Ivoire following an expedition organized jointly with the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA). Electrophoretic analysis of these populations is under way.

in Côte d'Ivoire, the first four oil palm clones obtained through *in vitro* culture are bearing

Techniques for production of plantlets through *in vitro* culture and selection of ortet adult palms for multiplication were developed in collaboration between IRHO, the Institut Français de Recherche Scien-



In vitro culture of oil palm (embryogenesis).

tifique pour le Développement en Coopération (ORSTOM), and the La Mé research station, Côte d'Ivoire. The first four clones planted at La Mé are bearing and about 200 oil palms are being cloned.

Promising results were obtained from a collaborative study on cold storage of embryoids, conducted in Paris with the Centre National de la Recherche Scientifique (CNRS).

In Côte d'Ivoire, Malaysia, and Indonesia, plantlet production laboratories are being operated in collaboration with IRHO and ORSTOM. Clones are produced for field trials to select superior material for multiplication. This is expected to increase production by 20-30% compared to the best selections developed through standard breeding methods, because of their variability.

High-yielding seed—3900 kg oil/ha in Côte d'Ivoire, 6000-7000 kg/ha under favorable ecological conditions—is being produced either under IRHO supervision (Benin, Cameroon, Côte d'Ivoire) or with its collaboration (Indonesia).

In Côte d'Ivoire, the best available tolerance to vascular wilt found in certain palms is being used in breeding programs at the R. Michaux plantation, that supplies seed to affected areas.

#### Agronomy

During the exceptionally severe 1983 drought in West Africa, differences were again observed in the performance of oil palm crosses and coconut varieties. Scientists are now examining the physiological characteristics of this material.

In a 900-ha area in Benin, production almost attained full crop potential with supplemental irrigation.

The problem of exhaustion of highly desaturated ferralitic soils was studied in Côte d'Ivoire and subsequently in Cameroon and Benin. Laboratory tests show that deflocculation caused by a potassium monovalent cation dressing, that results in the migration of evolved organic matter from the topsoil to the lower hori-



Subsoiling before trees are felled in an old oil palm plantation being prepared for replanting.

zons and loss of fertility, can be checked by a simultaneous application of calcium bivalent cation. The first practical methods such as liming and subsoiling are being tested.

The combination of reference experiments and leaf analysis is leading to an increasingly accurate determination of fertilizer requirements. It was observed that critical levels in leaves vary with climatic conditions. Critical levels for major elements were therefore specified for different conditions, as well as cost-effective fertilizer formulas. IRHO's method of establishing balanced fertilizer rates based on experimental results and modifying them each year following leaf analysis, has proved to be reliable. Correction of chlorine deficiency in oil palm and coconut has raised production in terms of number of fruit and kernels or coconut weight. Recently observed deficiencies, including that of copper in Brazil, were also studied.

Useful results were obtained from land-preparation studies on herbicide treatments for eradicating *Imperata* and on ultra-low volume spraying methods for clean weeding the circles around the palms.

The aim of palm density studies is to provide basic information for models that integrate environmental conditions and varietal vegetative characteristics. Recent results show that up to the age of 6 years, a higher density does not depress yields in spite of increased competition.

#### **Entomology**

Studies of pest-hyperparasite-host relations aim at greater efficiency of chemical control methods. A computer model based on accurate biological data was developed for a better integration of chemical treatments to control *Coelaenomenodera* in Côte d'Ivoire. Evisect, a lowtoxicity insecticide, requiring less frequent applications, was found to be more effective.

# models of pest-hyperparasite-host relations aim at greater efficiency of chemical control

In Ecuador, *Lincus* sp. (Pentatomidae: Hemiptera) was identified as the vector of Marchitez disease. A large-scale experiment was also established to identify the vector of bud rot.

Research on entomopathogens focuses on the identification, characterization, and use of such organisms to replace chemical insecticides. This work is carried out through a network that also links the Institut National de la Recherche Agronomique (INRA) and ORSTOM. Results on the picornaviruses can be used directly.

A survey on the different species of pollinating insects in Africa and Latin America was undertaken and has led to the introduction of certain species; more introductions are planned.

### Pathology, Virology

In a vascular-wilt trial, performance of hybrids inoculated at prenursery stage was studied in the field. Four tolerant hybrids were selected: D115D x L2T, (L269D x D115D) x L2T, and D5D x L5T. It was observed that clean weeding and application of calcium in the form of sulfates for soil improvement reduce wilt incidence, whereas organic matter or calcium carbonate application increases it. This research has become more important with the appearance of the disease in Brazil.

In Africa, a leaf-spot control study was conducted to determine the methods for applying fungicides that were found most effective in nurseries, e.g. weekly application of chlorothalonil.

In Latin America, the pathogen of bud rot is still not known as the symptoms following inoculation could not be attributed to any particular fungus or bacterium. The hypothesis that the causative agent is a *Pythiacae* is still retained. Scientists are concentrating on the entomology (identification of insect vectors) and virology aspects of the problem. It is hoped that *in vitro* culture studies will provide the answer.

Plant trypanosomes also cause diseases of oil palm and coconut in

## plant trypanosomes were differentiated from those of insects, animals, and man

Latin America and their characterization advanced further when scientists obtained the first laboratory culture of these organisms. Monoclonal antibodies produced in collaboration with the University of Bordeaux-II were useful in differentiating plant trypanosomes from those of insects, animals, and man.

## **Food Technology**

Microbiological methods were used to modify fats. It was found that by-products can serve as an effective culture medium for edible yeasts. Lipases secreted by these yeasts are used for biological processing of fats. With directed interesterification it is possible, for example, to obtain from the solid fraction, oils that are more fluid at room temperature and richer in essential fatty acids. Studies on synthesis of esters by enzyme action gave interesting results.

Studies were also conducted on the use of centrifuge decanters with a screw conveyor for oil clarification and that of fluid beds for separation of cracked kernel mixtures.

## Coconut

#### Selection and Breeding

Breeders are studying the combining ability of 94 hybrids at Port Bouët, Côte d'Ivoire, and at Saraoutou, Vanuatu, where the collections have increased steadily to a current total



Bunch of hybrid PB 111 (Cameroon Red Dwarf x West African Tall).

of 43 ecotypes in Côte d'Ivoire and 23 in Vanuatu. At Port-Bouët, six ecotypes (PB 121, PB 122, PB 132, PB 111, PB 213, WAT x VIT) were found to be earlier and 2-3 times more productive than the local West African Tall (WAT) coconut. Current studies focus on the development of low-input (fertilizer) hybrids.

Successful breeding of high-yielding hybrids has led to the establishment—with IRHO collaboration—of several seed gardens in many countries of Africa, Southeast Asia, and South America.

In Vanuatu, with the discovery of the vector of the foliar decay disease, ecotypes and hybrids can now be screened for tolerance by exposing them to caged insects.

Embryoid-like structures were obtained through *in vitro* culture and techniques have also been developed to culture embryos extracted from the nut.

## Agronomy

An optimum density of 160 palms/ha for the high-yielding hybrid PB 121, was established after 11 years of observations.

## mineral requirements and plant density were determined for the high-yielding coconut hybrid, PB 121

The mineral requirements of PB 121 were determined, based on exports and critical leaf levels of different elements, under Côte d'Ivoire conditions. As fertilizer cost for achieving full potential of this hybrid is high, a practical solution is to leave the husks in the plantation so that some of the nutrients are returned to the soil.



Intercropping of maize with coconut in a village plantation in Comord

Experiments on intercropping of coconut with food crops continue.

Correction of chlorine deficiency not only increases production but also improves resistance to drought and certain diseases such as stem bleeding.

#### **Entomology**

Pseudotheraptus is a bug that attacks flowers and young fruit. In Côte d'Ivoire, biological control of this pest has priority as well as the identification of varieties and individuals more tolerant to the coconut mite.

In Vanuatu, after detection of the insect vector of the foliar decay disease, research is now being directed towards the identification of its pathogen.

In Brazil, IRHO is collaborating with EMBRAPA to study several beetles mainly *Coraliomella brunnea* and *Rhinostomus barbirostris*.

Field work on *Rhyncophorus phoe*nicis in Côte d'Ivoire and *R. palma*rum in Brazil, is combined with studies in the INRA chemical mediator laboratory and the University of Alagoas, Brazil, through a rhynchophore research network.

## **Pathology**

In Vanuatu, virology studies on foliar decay of coconut have led to the purification and characterization of a virus belonging to the new, but small, group of geminivirus. The role of this virus in the etiology of this disease is being studied.

A strategy to control *Phytophthora heveae* is being tested over 30 ha in Côte d'Ivoire. It involves the injection of Phosétyl Al in the stem every 6 months. This research is of significant importance due to the spread of this parasite across the coconutgrowing regions of the world.

Stem bleeding occurs due to a weakening of the palm and is correlated to the development of *Thielaviopsis* paradoxa. In Indonesia, chlorine deficiency and water deficit were found to be important factors in the development of the disease. In Brazil, there is increasing evidence that *Botryodiplodia theobromae* is the causative agent of the "queima des folhas" disease. Priority is given to research on *Catacauma torrendiella*, a pathogen that causes a serious leaf disease.

## chlorine deficiency agravates stem bleeding

## Food Technology

Drying parameters for copra were determined on the basis of a study on the kinetics of copra drying.

Two methods for obtaining fuel were developed in collaboration with the Ecole Nationale Supérieure de Chimie, Montpellier, and the Centre d'Etudes Atomiques (CEA), Marcoule. The first method involves catalyctic cracking of tropical oils to produce gasoline and the second uses alcoholysis for diesel. Research will now be directed towards the preparation of new industrial compounds.

# Groundnut

## Selection and Breeding

In Senegal, the drought-resistance program aims at the development of a minimum-cycle variety (80 days) by crossing Chico (75 days) with the dormant line 73-30 (95 days). Another important objective is the development of a medium-cycle (105 days) variety with high intrinsic resistance, through an 8-variety pyramid cross. Two generations are produced per year using the complementary rainy seasons in Senegal and Botswana.



Mineral fertilizer trial of groundnut to determine the effect of phosphorus application.

The disease-resistance program focuses on aflatoxins (Aspergillus flavus) in Senegal, rust and leaf spots in Senegal and Burkina Faso. Hybrid progeny with resistance to rust (Puccinia arachidis) and rosette were identified and are undergoing further selection.

Among the genotypes introduced from West Africa for varietal improvement programs in Botswana, those from Senegal and Burkina Faso performed well. A total of 200 groundnut and sunflower lines of different origin were assembled in a collection.

#### Agronomy

In Senegal, trials on plant density reveal that in spite of abundant leaf development following nematocide treatments, the highest pod yields were still obtained at high densities: 1530 kg/ha at a density of 167 000 plants/ha compared to 900 kg/ha at 68 000 plants/ha (variety 55-437). In Guinea-Bissau, the flat-bed system was slightly superior to the ridge system (1616 kg/ha compared to 1495 kg/ha) as it allows the use of animal-drawn equipment. In Burkina Faso, rotation of groundnut and maize gave excellent yields (2975 kg/ha).

## **Crop Protection**

Chemical control of nematodes with DBCP nematocides has proved to be very effective in Senegal resulting in substantial increases of 43% for pod

yield (in Bambey), 110% for haulm yield, and 18% for 100-grain weight.

## chemical treatments effectively control nematodes in groundnut crops

#### Food Technology

Three electronic sorters were tested at Sonacos-Lyndiane, Senegal, and it is now possible to obtain aflatoxinfree edible groundnuts.

Vacuum-packed groundnut seeds using the Bernhardt system were successfully tested in farmers' fields.

# CONTRIBUTION TO DEVELOPMENT

#### Oil Palm and Coconut

IRHO's work on oil palm and coconut development is carried out on four continents—Africa, Latin America, Asia, and Oceania, in response to requests from national and international organizations as well as private enterprises. It is mainly involved in the supply of improved plant material, recommendation of better cultural practices, disease monitoring of crops and control of major pests and diseases, and optimum fertilizer management based on leaf analysis. Assistance is provided through consultation, project

supervision, feasibility studies, preliminary investigations, supervision of oil mills and other facilities, training and development of staff, and technical support to development projects through visits or secondment of experts.

Africa. IRHO continues to provide technical support to the Palmindustrie group in Côte d'Ivoire for oil palm and coconut. The group with 100 000 ha of oil palm and 30 000 ha of coconut plantations, is launching an oil palm replanting program at the rate of 15 000-20 000 ha/year. In

a village-level operation in central Côte d'Ivoire, coconuts were successfully planted along the banks of bottomlands; another 800 000 ha of potentially useable land were identified through soil surveys. Socioeconomic studies revealed that farmers were interested in coconut.

IRHO also carries out its oil palm work in Ghana (5000 ha), in Cameroon for commercial plantations (Socapalm, 21 000 ha; Safacam, 3000 ha; SPFS, 2300 ha), and on Socfinco-managed plantations in Central African Republic, Congo, Gabon, Nigeria, Liberia for computerized monitoring of mineral requirements.

In Madagascar, at the request of the European Development Fund (EDF), IRHO provides technical support to the Sambavoanio coconut and Somapalm oil palm plantations.

The establishment of individual terraces to control erosion and improve water supply.



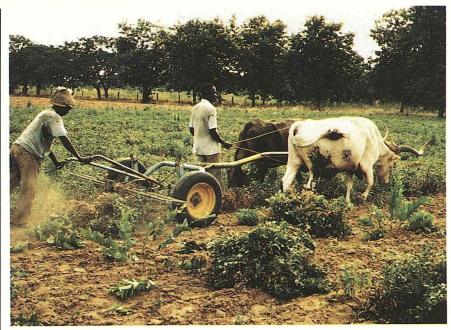
IRHO experts visited development projects in Benin, Comoro, Mozambique, Seychelles, Tanzania, and Togo for coconut, and Benin, Burundi, Liberia, Togo, and Zaire for oil palm.

Latin America. In Brazil, IRHO is participating in the establishment of a local seed-production operation to meet the requirements of developers. The Institute provides technical assistance, in particular for cultural practices, fertilizer management, and crop-protection problems to various companies such as Sococo, Maguary, Frutop for coconut, and CRAI, Agromendes, Denpasa, Codepa for oil palm.

The Indupalma group with oil palm plantations in Colombia (San Alberto, 7600 ha) and Ecuador (Shushufindi, 3000 ha; Quininde, 3200 ha) continues to cooperate with IRHO. Adult plantations have reached or exceeded the level of 25 t bunches/ha, yielding more than 5 t oil/ha.

IRHO experts undertook assignments for oil palm projects in Mexico, Peru, and Venezuela; and for coconut projects in the Dominican Republic, Mexico, Nicaragua, and Panama.

Asia. IRHO is assisting in the organization of coconut seed production and *in vitro* culture for oil palm. The Institute is offering considerable technical support to the Smallholder Coconut Development Project (SCDP 1) in Indonesia. Two experts are assigned to SCDP 1 to provide training to project staff and to assist in the establishment of the plantations (22 000 ha of hybrids in late 1984). IRHO's work also concerns public (PTP) and private (PT Astra) enterprises, and village sectors.



Harvesting of groundnut using animal traction.

In Malaysia, an oil palm plantlet production unit is operating at FELDA using IRHO-ORSTOM technology and with assistance from IRHO.

IRHO experts visited China (Hainan island), India, Malaysia, Philippines, Sri Lanka, Thailand, and Vietnam for coconut development; Burma and Thailand for oil palm development.

Oceania. The Institute is conducting work on coconut in several Pacific islands, including Fiji, French Polynesia, Papua New Guinea, Samoa, Tonga, Vanuatu, etc.

#### Groundnut

In Senegal, the recent drought has drastically reduced groundnut production. IRHO is participating in the seed-stock conservation effort by assisting Sonacos that has the responsibility for edible groundnut production (seed, commercial pro-

duction, industrial processing) in Senegal.

In Guinea-Bissau, average yields varying between 1500 and 1700 kg seed/ha, depending on the zones, were obtained by seed-producing farmers and 600 t of 69-101 seed were collected.

In Burkina Faso, foundation and certified seed of groundnut, soybean, and sesame are produced over 100 ha, with satisfactory yields on contractual farms (1520 kg/ha for groundnut, 1250 kg/ha for soybean).

In southern Africa, groundnut cultivation has received a fresh impetus. The seed stock is being reconstituted with the establishment of 96 ha of seed-multiplication plots on seed-production farms in Mozambique (including 36 ha of RMP 12 imported from Burkina Faso) and 2.5 ha of foundation-seed plots in Botswana (including 1 ha of 55-437 introduced from Senegal).

# TRAINING

Training programs offered by IRHO are tailored to the exact requirements of trainees and vary in level, location, and organization. Those in charge of cooperative research or development programs receive special training in Montpellier and other research centers.

In Côte d'Ivoire, the La Mé and Marc Delorme stations serve as training centers for oil palm and coconut, respectively. During the last 2 years, scientists from nine countries in Africa, four in Latin America and the Caribbean, and eight in Asia, received training at these two centers.

At the request of the Member States of the South Pacific Commission, the Saraoutou station in Vanuatu was instituted as a regional training center. An EDF-sponsored international workshop on coconut was orga-

nized at the center in 1984, in collaboration with other institutes from the region; participants included scientists from eight countries and several international organizations.

IRHO also provides on-site training and reorientation for extension agents at the request of development programs in Côte d'Ivoire, Ghana, Indonesia, and Vanuatu.

# **P**UBLICATIONS

IRHO publishes three periodicals.

Oléagineux. Revue internationale des corps gras

This periodical was started in 1946 with 11 issues each year. It is sent to more than 95 countries through subscriptions or inter-institute exchange. Articles are also contributed by external authors. The articles appear in both French and English (sometimes Spanish) and deal with agronomy, chemistry, technology, and economics of oil crops in the tropics as well as the temperate and Mediterranean regions.

From 1983 until the first half of 1985, 29 articles were published on oil palm, 31 on coconut, 22 on groundnut, 3 on soybean, 1 on sesame, 1 on cotton, 1 on rape, 5 on new crops (jojoba, *Jatropha curcas*, oenothera, etc.). General articles on

chemistry and technology of fats were also published. A special issue on groundnut seed was brought out in 1983, following two others in 1978 and 1981 on the pests of oil palm and coconut. A special section is devoted to economic data.

Two sections of *Oléagineux* i.e., *IRHO Advice Notes* and *Documentation analytique* are also printed separately.

IRHO Advice Notes. Agricultural Practice

This information sheet in French, English, and Spanish is meant for those involved in production and gives details of the latest techniques developed by IRHO for oil palm, coconut, and groundnut. The series was launched in 1961 and is avail-

able through annual subscription (11 issues per year). The June 1985 issue will be the 256th of the series.

Documentation analytique

This a monthly collection of 140-160 annotated references on tropical, temperate, and Mediterranean oil crops, and chemistry, technology, and economics of fats and oils. The references are selected from more than 200 periodicals from all over the world. It is also available through annual subscription (11 issues per year).

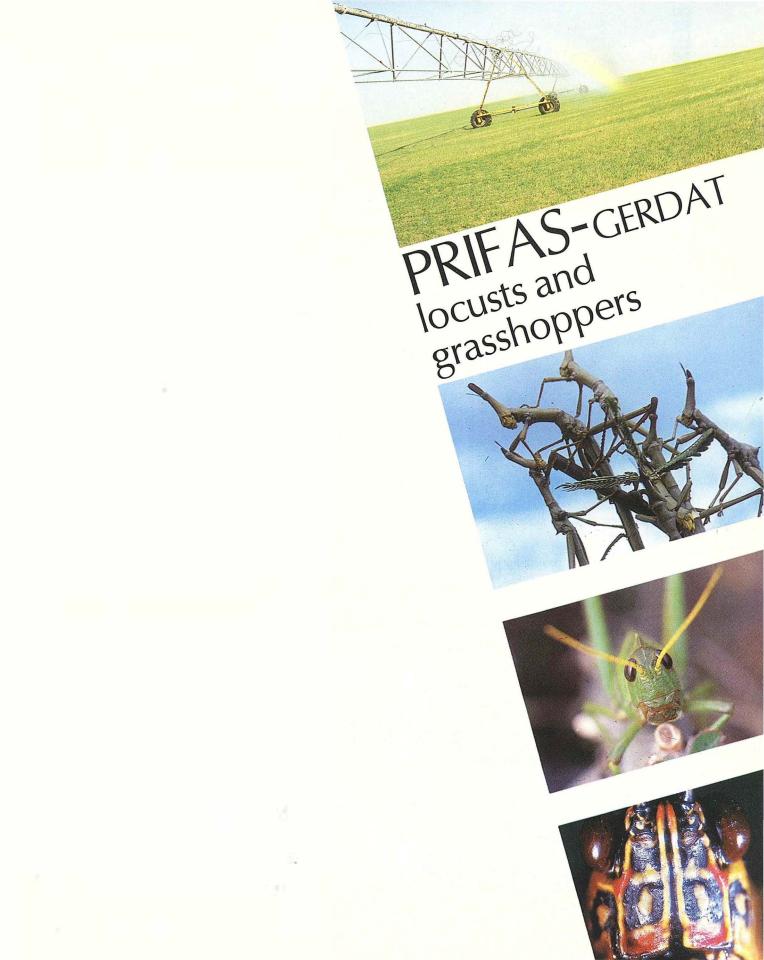
Among the other IRHO publications are: reports, bibliographies, manuals, the *General Index 1946-1980* of articles published in *Oléagineux* with annual updates. A complete list is available on request.

# RHO AROUND THE WORLD

# **Outreach Centers**



BRAZIL COLOMBIA ECUADOR FRENCH GUIANA PERU BENIN BOTSWANA BURKINA FASO CAMEROUN COMORO COTE D'IVOIRE GHANA GUINEA-BISSAU MADAGASCAR MALI MOZAMBIQUE SENEGAL INDONESIA PHILIPPINES VANUATU



# **PRIFAS**

When it was established in 1975, PRIFAS was called the Programme de Recherches Interdisciplinaires Français sur les Acridiens du Sahel. Since 1984 it has expanded its research activities that focus on two approaches: locust and grasshopper studies (acridology) and operational ecology.

PRIFAS is a research unit of the GERDAT department and is very similar in structure and function to a multidisciplinary consulting service. The core team is made up of eight scientists; about 20 external scientists are involved, through cooperation agreements, in certain research programs.

The PRIFAS research programs are concerned with the bioecology of locusts and grasshoppers (acridology section) as well as analysis and forecasting methodology for ecosystems and agrosystems (operational ecology section).

The results are optimized through training programs and action-based interventions.

PRIFAS Acridologie et Ecologie Opérationnelle Centre de Recherches du CIRAD BP 5035

34032 Montpellier Cedex Tel.: (16) 67 63 91 70 Telecopy: (16) 67 41 09 58 Head: *Michel Launois* 

# PRACTICAL ACRIDOLOGY AND OPERATIONAL ECOLOGY

Practical acridology includes the bioecological study of economically important locusts in their natural habitats, development of control strategies, that are more efficient and cost-effective compared to the currently used methods. The research work is accompanied by training, information dissemination, surveillance, and locust-control activities.

Operational ecology is intended to be action-oriented, with objective evaluations. It is integrated in development projects at the initial operation planning stage. It provides at least some coverage against major risks that were not, but could have been anticipated.

# PAST ACHIEVEMENTS

The PRIFAS studies have enabled the development of unique methods for:

evaluation of insect population density expressed in the number of pests per hectare;

— interpretation of ovary examination of captured female locusts;

— early-warning systems based on the determination of the ecological optimum of the pests and their response to unfavorable conditions;

— stratified sampling systems covering various locations at different periods, to understand the ecological behavior of target animal or plant species;

— integrated multidisciplinary approach to study natural situations for analysis and forecasting;

- identification and demarcation of ecologically similar areas.

The application of these methods to actual situations, has supplied valuable information that is reported in the large number of scientific publications, technical reports, and extension material produced by PRIFAS.

Oedaleus senegalensis, grasshopper pest of millet crops.



# Research Highlights

PRIFAS has made considerable progress in the development of methodologies for analyzing and forecasting some of the unexpected consequences of the new agrosystems and for studying locust and grasshoppers.

# Methodology of Operational Ecology

- Electronic data processing of occurrence tables, e.g., ecophytogeography of Saharan desert locust biotopes.
- Group typology, e.g., small farmers in the Juazeiro and Uaua regions in Brazil.
- Biotope description of different species, e.g., lizards and reptiles of Ouricuri in the Brazilian Nordeste region.

• Écological biomodels, e.g., application to migratory organisms in the Sahel

Sahel.

• Diachronic and synchronic analyses, e.g., fauna and flora of the Cape Verde islands.

# Acridology

In the Nordeste and Mato Grosso regions of Brazil:

 preparation of five monographs on parasitic species;

— initiation of a locust and grasshopper collection in the Nordeste region. In the Sahel:

— the OSE biological model was made operational for *Oedaleus senegalensis*, a millet pest that occurs in the region extending from Senegal to Chad;

— research continues on the LMI biological model for *Locusta migratoria*, that is specific to the internal delta region in Mali and lakeshore regions of lake Chad.

In the Sahara:

— initiation of the SGR biological model for *Schistocerca gregaria*, that seeks refuge in the mountainous or peripheral regions of the Sahara.

In France:

— identification of locust and grasshopper populations in the Bas-Languedoc region and the ecological behavior of the major species.

The PRIFAS reference collection in Montpellier.



# CONTRIBUTION TO DEVELOPMENT

Dissemination of research results, through scientific and technical publications and information campaigns, is of great importance at PRIFAS. A poster on practical advice to farmers for locust and grasshopper control was prepared by PRIFAS and printed in five languages by FAO; it has been distributed in about 50 countries. Five videotapes and a 16-mm film were also produced. The film is a result of a collaborative effort between Périscoop, the Organisation Commune de Lutte Antiacridienne et de Lutte Antiaviare (OCLALAV), and FAO, and shows

methods for training locust and grasshopper control investigators.

Poster on recommendations to farmers for locust and grasshopper control.



PRIFAS provided support to several locust and grasshopper control and operational ecology projects:

— the reorganization of the locust early-warning service and a study on environmental changes in Madagascar sponsored by FAO;

- the operational ecology project in Brazil:
- national surveillance project for major crop pests in Senegal.

Experts were sent, at the request of inter-African organizations and pu-

blic or private enterprises, to northern Africa (Libya) and West Africa (Burkina Faso, Cape Verde, Côte d'Ivoire, Mali, Niger), and other African countries (Chad, Cameroon), as well as Madagascar, Indonesia, Brazil, and various European countries.

# TRAINING

The locust and grasshopper research activities at PRIFAS have expanded beyond innovative research to include training in France and other countries.

In an effort to transfer available information, PRIFAS participated in the organization of eight long- and medium-term programs in France and other countries for training and reorientation of about 100 officials and technical staff involved in locust and grasshopper control.

A course in operational acridology was held in Montpellier in 1984, in operational ecology in 1985; both were conducted in collaboration with the Centre National d'Etudes Agronomiques des Régions Chaudes (CNEARC). A total of 39 trainees from 21 countries attended the courses.

In Niger, intensive training in acridology was provided in 1983, 1984, and 1985, in collaboration with the Comité Permanent Interétats de Lutte contre la Sécheresse

dans le Sahel (CILSS), Institut du Sahel (INSAH), and the Netherlands.

During the past 3 years, training was also provided on locust and grass-hopper surveys in Senegal, Burkina Faso, and Niger, in collaboration with OCLALAV and FAO.

This training is supplemented by reports and manuals published by PRIFAS on its research results and applications.

# Publications

During the past 3 years about 20 scientific reports were published by PRIFAS; they mainly deal with the bioecology of locusts, bioecological models, evaluation of natural resources, and the theoretical fundamentals of operational ecology. In addition, about 20 technical reports were also published on project organization, evaluation assignments, functional development of bioecological models, application of the principles of operational ecology to weed problems, and management.

A list of 85 publications is available on request.

Some of the major publications are:

**Duranton, J.F., et al.** 1982. Manuel de prospection acridienne en zone tropicale sèche. Montpellier: PRIFAS. 1500 pp, 2 vol.

**Launois, M.** 1977. Modélisation écologique et simulation opérationnelle en acridologie. Application à *Oedaleus senegalensis* (Krauss, 1877). Montpellier: PRIFAS. 212 pp.

**Launois, M.** 1978. Manuel pratique d'identification des principaux acridiens du Sahel. Montpellier: PRIFAS. 303 pp.

The following publications are being prepared:

- a new practical guide for identification of Sahelian locusts and grasshoppers;
- a guide for locust control in Brazil;
- a guide for identification of locusts and grasshoppers of the Nordeste region in Brazil;
- an ecophytogeographical inventory of biotopes of *Schistocerca gregaria* in the Sahara and outlying regions;
- a report on the *Zonocerus variegatus* in West Africa.

# Prifas around the world

## Long- and Short-term Projects

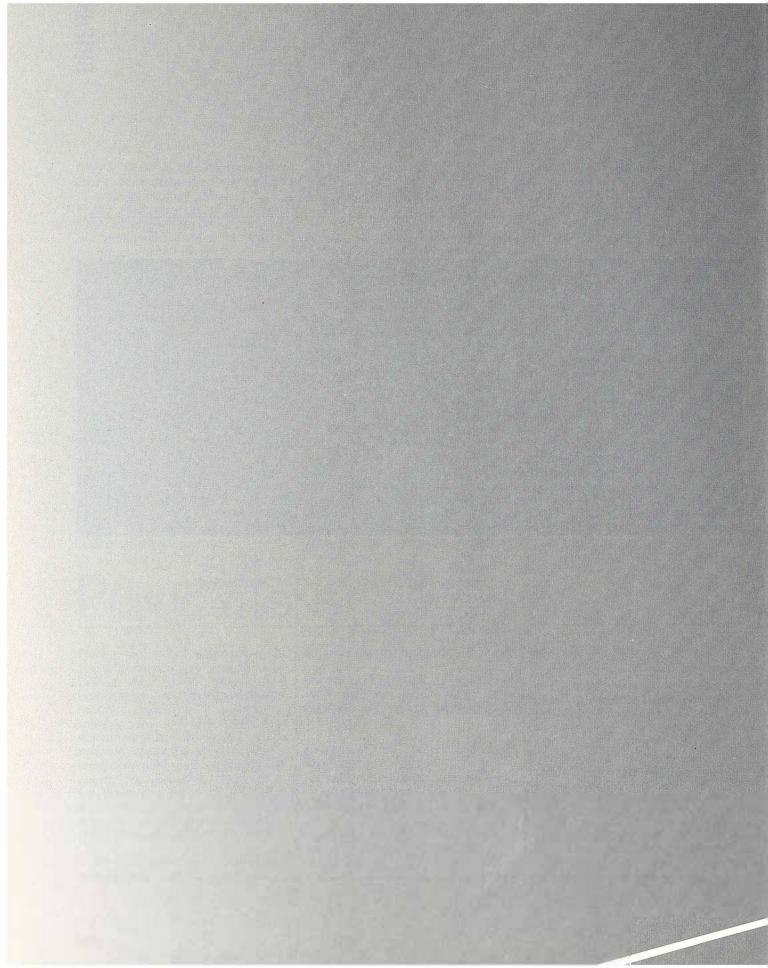


BRAZIL\*\*

ALGERIA\*
BURKINA FASO\*
CAPE VERDE\*
MALI\*
NIGER\*
SENEGAL\*\*

AUSTRALIA\* INDONESIA\*

<sup>\*</sup> short-term projects \*\* long-term projects



Scientific Coordination, Craining, Training, Support Services

The GERDAT institutes that have now become CIRAD departments have retained their autonomy and specialization in one or several tropical commodities within the restructured public establishment.

However, scientists from the same discipline working in the different CIRAD departments, should be given the opportunity to share their experiences, methods, and findings, through the establishment of joint programs. This has led to the formation of discipline-based scientific coordination groups. The organization and primary activities of these groups and of the support services are presented in this section.

The groups complement the commodity-based research by strengthening their discipline-based work in the following areas: improvement-oriented physical environment studies (MICAM), improvement-oriented plant studies (MICAP), crop protection (MIDEC), rural economics and sociology (MESRU), food technology (MITA'A). The coordination groups work closely with the French scientific organizations and are supported by the general and specialized laboratories.

The support services are common to all the CIRAD departments, coordination groups, and services. They include the Centre International de Documentation en Agronomie des Régions Chaudes (CIDARC), industrial liaison and development service, training service, and scientific and technical support laboratories.

# SCIENTIFIC COORDINATION GROUPS

### Mission Connaissance et Amélioration du Milieu (MICAM)

#### **Scientific Coordination**

MICAM has the responsibility to coordinate research on the physical environment and agronomy, conducted by more than 200 specialists in the CIRAD departments.

This coordination involves the research administration services of CIRAD and its departments.

MICAM is mainly concerned with:

- the coordination of scientific approaches and methods within Cl-RAD, mainly through training and reorientation;
- maintenance of an appropriate balance between applied and basic research;
- linkages between CIRAD and other French, European, and international organizations, through research networks;
- development of CIRAD's research findings.

MICAM also participates in setting long-term regional research priorities in its area of concern.

MICAM has an independent budget to fulfil its task.

#### **Three Priority Programs**

In addition to the application of remote sensing to the characterization of landforms and their dynamics, MICAM is involved in two priority domains—land productivity assessment and drought resistance.

# Restoration and Maintenance of Land Productivity—Physical, Chemical, and Biological Fertility

- Evolution of cropped soils and acidification related to evolution of organic matter, cations and aluminum dynamics.
- Crop residue management.
- Improvement of symbiont-plantenvironment relationships (e.g., nitrogen fixation, mycorrhiza). A CTFT-CNRS laboratory is being established for root symbionts of tropical trees.
- Rock phosphate benificiation (IRAT, IRCT, IRHO, industry).

## **Drought Resistance and Desertification Control**

- Agroclimatology and biophysics of soil-plant-atmosphere interactions.
- Study of resistance mechanisms for application of these data in plant breeding activities.
- Soil and crop management for greater water-use efficiency.
- Efficient irrigation systems (possibly supplemental irrigation).
- Farm and land management to control runoff and to collect water in

reservoirs; identification of favorable regions.

#### **Some MICAM Projects**

#### **Research and Research Networks**

- Organization of two interorganization thematic research projects (ATP) on cation dynamics and aluminum in tropical soils in collaboration with foreign organizations in West Africa, Brazil, and Madagascar; CNRS; and ORSTOM.
- Launching of the drought resistance research network, R<sup>3</sup>S, following the colloquium on "Integrated Drought Control in the Tropics" organized by CIRAD and the Institut Sénégalais de Recherches Agricoles (ISRA), Senegal, in December 1984.
- Preparatory work prior to participation with the Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM), Paris, in the network on "Agricultural Use of Acid Soils," initiated by the International Board for Soil Research and Management (IBSRAM), in May 1985.

#### Training and Development

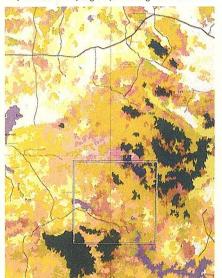
• Organization, in collaboration with the Ecole Nationale Supérieure d'Agriculture et des Industries Agroalimentaires (ENSAIA), Nancy, of the annual training program at the Centre National d'Etudes Agronomiques des Régions Chaudes (CNEARC), Montpellier, on "Fertility and Fertilization in Tropical Regions."

- Training workshops on research methodology, experimental designs for on-farm research, including initiation to microeconomic mathematics, e.g., the CIRAD-CIMMYT workshop organized in September 1985 in Montpellier; a similar workshop will also be held in West Africa.
- Funding and distribution of an IRAT bibliography (476 references) on crop residue management in the tropics.

#### **Future Research**

- To intensify research on the effects of new techniques on the characters and properties of environments, and physiological mechanisms of yield components at field level (cultivated plot, natural pasture, forest plot).
- •To encourage on-farm themebased research through the determination of appropriate methods to establish working relations between

Map established by digital processing of Landsat data.



agronomists, microeconomists, physical environment and crop specialists.

•To establish specialized laboratories (nitrogen and organic matter, nutrient availability) to encourage

### Remote Sensing at CIRAD

The remote sensing program in CIRAD aims to bring together specialists in a research operation or project within an organization having the necessary equipment and methodology.

This program is conducted by a technical committee attached to the Office of the Director of Research (CIRAD). Its task is to establish and manage the budget, to define and coordinate research guidelines in liaison with the CIRAD department directors, and to apply research findings through contract projects.

Research is focused on rural development. It concerns remote sensing methodology (development of image-interpretation software), and environmental studies (cartography of landforms and agroecological units, agrometeorology, crop protection studies, biomass assessment, etc).

CIRAD has acquired the equipment to process satellite-transmitted data including a Numélec Pericolor 1000 workstation, a color ink jet printer, a black and white printer, and a digitalization table.

#### **Ongoing or Completed Operations**

- Cartographic assessment of the biomass based on SPOT simulations in drought-affected areas in Senegal and Niger, in collaboration with ISRA, INRAN, and ORSTOM.
- Water balance estimates based on NOAA and Météostat data in Senegal, in collaboration with ISRA, INRA, and the Centre National des Etudes Spatiales (CNES).
- Cartography of landforms and agroecological units based on Landsat data in Thailand, in collaboration with CEGET-CNRS and IGN. Changes in the environment (water resources, agricultural units, forests) between 1972 and 1982 were studied.
- Study of the changes in the forest canopy in Guinea, in collaboration with Intégro-Imatel.
- Cartography of landforms, bare and degraded soils in Burkina Faso, in collaboration with IBRAZ and IBM-France.
- Identification of *Fomes* incidence in *Hevea* plantations in Côte d'Ivoire, in collaboration with ORSTOM.
- Identification of white grub infestation in sugarcane crops in Réunion, in collaboration with INRA.

A list of reports and publications on these projects is supplied on request.

exchanges between the Montpellier laboratories and on-farm research in other countries.

- To support the establishment of international research networks (R<sup>3</sup>S, acid soils).
- To conduct training programs, particularly workshops in cooperating countries.

### Mission Connaissance et Amélioration des Plantes (MICAP)

#### **Structure**

Each of the commodity-based departments has a plant improvement division that is supported by general and specialized laboratories, and thematic working groups. MICAP is assisted by a technical committee and working groups, for the coordination of these discipline-based activities.

About 100 CIRAD scientists are involved in the plant improvement effort, and collaborate with colleagues in Africa, the Americas, and Asia. Greater interaction with French and European organizations is sought to strengthen this coordination program.

Training in new techniques and their application to tropical crops is provided at Montpellier, in order to integrate these techniques and recently collected ecotypes in the breeding programs. This is the re-

sponsibility of the general laboratories and thematic working groups.

The 1984 research priorities for these laboratories include study of *in vitro* culture, biochemical and cytogenetic analyses and their contribution to plant improvement research. This has led to the establishment of three general laboratories.

Thematic working groups were also formed for interactive studies on germplasm resources and drought tolerance.

#### **Research Activities**

The CIRAD Scientific Advisory Committee has set two research priorities—in vitro culture and germplasm resources. The work of the CIRAD departments and the CIRAD Research Center has gained international recognition. Research on biotic and abiotic constraints will be intensified.

Research work is accompanied by training, information, and development activities.

#### In Vitro Culture and Its Applications

The *in vitro* culture laboratory was established at the CIRAD Research Center in 1977 and develops methods for:

- true-to-type multiplication of superior individuals from populations and heterogeneous crosses (*Hevea*, bananas, pineapple, sugarcane, coffee, forest trees).
- variety development based on generative multiplication (bananas, sugarcane) and haploidydiplodization (rice, cotton).

These methods are made available to cooperating countries through training of national scientists and establishment of laboratories. Two types of laboratories, experimental and industrial, have been designed since it is difficult to associate varietal and clonal development with industrial production:

— the experimental laboratory is designed to produce varieties and clones and to adapt the methods to industrial plantlet production. One unit was established in Guadeloupe for sugarcane, rice, and *Hevea* and another in Réunion for sugarcane and geranium. A third unit is being designed for Cameroon; two others are planned for Côte d'Ivoire where an *in vitro* laboratory has been in operation since 1981 for oil palm;

— the industrial unit is designed for large-scale production of plantlets. Two units have produced their first batch of oil palm plantlets in Indonesia (300 m²) and Malaysia (1300 m²) using technology developed by IRHO and ORSTOM. A third unit is being built in Indonesia (1300 m²).

An independent unit is planned in addition to the present laboratory in Montpellier, in order to support in vitro culture and germplasm-related activities. It will later serve as a bank.

This new unit will enable the production of disease-free plantlets that will be supplied to the different participants following collection expeditions and to research stations for exchange of material. It will also undertake the conservation of fragile plants and production of plantlets required for research.

When phytosanitary problems prevent the export of disease- and pest-free material, the plantlet production unit can, if required, serve as an intermediary between countries.

The conservation of clones in the bank for user countries will help avoid accidental loss of useful material.

Detailed studies are planned to improve techniques for somatic embryogenesis and cryopreservation of embryos and embryoids. These studies will be part of an interorganization thematic research project (ATP) in collaboration with other French research organizations (CNRS, INRA, universities).

The cytogenetics laboratory in Montpellier also monitors *in vitro* cultures and studies somatic embryogenesis.

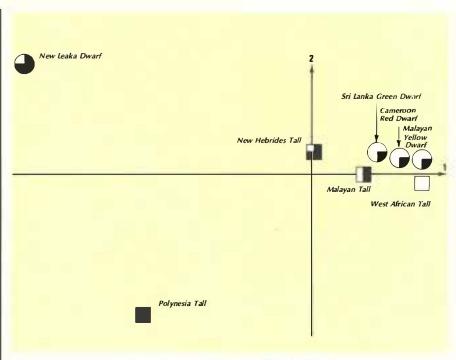
#### Germplasm and Data Banks

The CIRAD departments and general laboratories increasingly support tropical research stations for collection expeditions, quarantine, collection management and evaluation, and data banks.

Collection expeditions. The CIRAD departments and ORSTOM have participated in several collection expeditions, often in collaboration with international organizations such as the International Board for Plant Genetic Resources (IBPGR), International Rubber Research and Development Board (IRRDB), and the International Network for Improvement of Bananas and Plantains (INIBAP).

**Quarantine.** The Montpellier and Guadeloupe centers serve as quarantine units for sugarcane, bananas, *Hevea*, coffee, cocoa, and pineapple. This service also justifies the need for an additional plantlet production unit.

Collection management. Conservation and enhancement of existing collections are a major concern due to phytosanitary, political, and financial risks. One solution is to duplicate them by establishing dormant seed and clone collections.



An example of enzyme variability in certain coconut ecotypes, determined by electrophoresis.

**Evaluation.** Data from isozyme electrophoresis developed by CIRAD eand ORSTOM, can be used to supplement field observations. The biochemical analysis laboratory in Montpellier has examined nine crops (maize, rice, sugarcane, *Hevea*, oil palm, coconut, cotton, terminalia, sorghum) for genetic variability, population structure, and relationships.

These results are used for the determination of better breeding strategies and the identification of lines and clones.

**Data bank.** Data accumulated from these studies should be easily accessible for subsequent use. Limited data banks are already in operation, others are being established.

Tolerance to biotic and abiotic constraints. For drought, the objective is to assemble various physiological adaptation mechanisms in the same genetic background. During the 1984 workshop on drought tolerance in Dakar, the approach proposed on the basis of results obtained for rice, sorghum, groundnut, and oil palm, includes physiological tests; detailed studies on plant phenology, particularly the root system; breeding for earliness; and use of reciprocal recurrent selection methods.

For disease resistance, selection criteria for *in vitro* culture and development of field and laboratory resistance tests, are useful for breeding programs.

# Training and Information

Scientists from the general laboratories are involved in training French and foreign junior scientists, and organizing meetings to keep them informed about the latest developments. For example, a training seminar was held in July 1984 on mathematical techniques used in breeding.

Information is disseminated through the formation of informal groups, organization of round table meetings, distribution of publications, establishment of links with breeders in other countries, and participation in important meetings.

### Mission Défense des Cultures (MIDEC)

# Structure and Program of Activities

The Mission Défense des Cultures, CIRAD's scientific coordination group for crop protection is concerned with the development of pest and disease-control methods for the hot-climate regions. MIDEC coordinates the work of about 100 CIRAD crop scientists; in addition, 13 entomologists work on the transmission of domestic animal diseases.

Certain scientists are attached to the CIRAD general laboratories. In 1983-1984, most of the scientists

were integrated in multidisciplinary or commodity-based teams in one of the CIRAD departments. Their work is centered on the following disciplines: entomology, pathology, plant pharmacology, and weed control.

#### Activities of the General Crop Protection Laboratories

The general laboratories in Montpellier support field operations by determining the methodology and providing documentation on a common theme that concerns several CIRAD commodities.

#### **Fauna Studies**

**Insect identification.** The fauna laboratory receives hundreds of sam-

ples for identification. In 1983-1984, two-thirds of the requests concerned hymenoptera hyperparasites and coleoptera. Two-thirds of the samples could be identified, most of them at Montpellier; for the rest MIDEC consulted the Muséum d'Histoire Naturelle and ORSTOM, Paris; the Commonwealth Institute of Entomology and British Museum, UK; and the National Museum of Washington.

**Research activities.** Two studies were undertaken on hymenoptera:

— revision of the genus *Eurytoma* (Eurytomidae) from West Africa, that parasitizes fruit pests or causes gall disease;

— revision of the genus *Spilochalcis* (Chalcididae) using material from Colombia; this genus includes several hundreds of species that are mostly hyperparasites of lepidoptera.

Mass rearing of Heliothis armigera.



#### Rearing and Feeding of Insects

The laboratory rears insects required for the CIRAD specialized laboratories (entomophagous insects, entomopathogens) and the INRA chemical mediator laboratory. Twelve species (lepidoptera, coleoptera, heteroptera) are produced continuously. The techniques and nutritive medium were modified following the rearing of four new species:

— Brazilian cotton borer (*Eutinobothrus brasiliensis*);

— Amorphoïdea lata from Philippines;

— yam moth from Africa;

— pink bollworm (*Pectinophora gossypiella*) from Côte d'Ivoire.

#### **Plant Bacteriology**

The laboratory conducts bacterial diagnosis for different departments (IRHO, IRAT, IRFA). The causative agent (*Erwinia* sp.) of the papaya bacterial blight in the French West Indies was characterized. Different strains of *Pseudomonas solanacearum* from Réunion were compared for pathogenicity and immunity.

Blackrot of crucifers (*Xanthomonas campestris*) and citrus canker (*Xanthomonas citri*) were studied for the introductory training programs on bacteriology.

#### Interorganization Thematic Research Projects (ATP) and Multiple-commodity Theme-based Research

Practical Application of the ATP on Biological Control Using Hymenoptera (*Trichogramma* sp.) and Pheromones against Lepidoptera in the Sahel

This 2-year study was concluded in December 1983. Multilocation ex-

periments were conducted in several other countries.

Trichogramma sp. are hymenoptera hyperparasites that feed on insect eggs. Of the strains examined by the laboratory, two parasitized eggs of Heliothis armigera—polyphagous pest in the tropics—and three parasitized eggs of Chilo partellus.

Experimental releases of hyperparasites in Togo, Cameroon, and Comoro encountered difficulties. This should be integrated with other control methods.

Certain pheromones were synthesized in the INRA chemical mediators laboratory. Experiments were conducted in Senegal, Togo, Côte d'Ivoire, and Cameroon to determine insect population dynamics. Further research is required on the correlation between the number of captured individuals and crop damage.

#### Study of *Fomes*

Research was undertaken on *Fomes lignosus* that causes root disease in *Hevea* and forest trees, for an ATP sponsored by the Ministry of Education; it has the following program:

— study of lignin biodegradation (Nancy-1 and Paul Sabatier de Toulouse Universities, CNRS-IBMC, IRCA);

biology of Fomes lignosus (ORSTOM);

— biochemical study of the fungus rhizomorphous formation factors (University of Nancy-1);

— biochemistry of host plant reactions (University of Toulouse);

study of enzymes excreted in vitro by Fomes (ORSTOM);

— harvest loss estimates using satellite imagery by IRCA and ORSTOM were: 40-60% on 20-year trees, 20% after 10 years, 4% after 3 years;



Parasitization of a *Diparopsis watersi*egg by an adult *Trichogramma* for biological control.

genetic-control studies using resistant stocks (IRCA);

— biological-control studies using lignivorous organisms to destroy the fungus strains (IRCA);

 chemical-control studies by IRCA demonstrated the effectiveness of calixin.

## Specificity of a Pathogen Complex to Perennial Hosts

This research was carried out in a CNRS-CIRAD collaborative program for a Ph. D. thesis. *Phytophtora* sp., pests of citrus fruits in the east coast region of Corsica, is a complex of several species, comprising one major species *P. citrophthora* (Smith and Smith) Leonian and two minor species *P. nicotianae* B. de Haan f. sp. *parasitica* (Dastur) Waterhouse and *P. citricola* Sawada. A study of their protein spectrum suggests the possibility of gene exchange between these species.

The pathogenicity of 18 isolates, obtained from clementine grafts and

stocks of sour orange and Troyer citrange, was evaluated on a series of young citrus trees. Symptoms were monitored regularly and then compared. It was observed that the host ranges of these isolates vary.

Host specificity of the stock isolates was verified on adult trees. Apparently, vertical resistance can be quantified. Increase in pathogenicity of one of the clones of the sour orange isolate indicates a gradual adaptation of the pest.

This type of host-pest relationship was demonstrated earlier but only in a few, very different pathogen complexes. The results obtained in the experiment with perennial crops and a soil pathogen prove that it is a general phenomenon.

#### **Future Research**

#### **Fauna Studies**

In 1983, discussions with different organizations, mainly ORSTOM, were initiated for the establishment of a common identification center in Paris.

#### Virology

A CIRAD-INRA-ORSTOM hotclimate plant virology laboratory will pool scientific talent, investments, and research work. A group of scientists from the three institutes has established its program, organization, and equipment requirements. It will be located at the CIRAD Research Center in Montpellier.

Several virology programs are conducted by the different CIRAD departments. In 1984, IRAT started work on a new maize virus immunity diagnosis program with funding from the European Economic Com-

munity (EEC) and the Ministry of Research and Technology.

#### New ATPs

In 1984, several possibilities of joint ATP programs between CIRAD and other French research organizations were examined. Eight ATPs were proposed for virology, two for weed control, five for fungal diseases, and eight for entomology. These proposals were presented to CIRAD, CNRS, and the Ministry of Research and Technology.

#### **Training**

The scientists of the crop protection laboratories at the CIRAD Research Center, Montpellier, are also involved in training activities: courses, practical assignments, and teaching assignments at CNEARC. Linkages were established with other institutes for information exchange:

 ACTA, for meetings and collaboration with the CIRAD weed control and plant pharmacology laboratories;

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), FRG, collaborates with CIRAD for various crop protection operations of common interest to the two institutes;

— Crop Protection Directorate of the Ministry of Agriculture, particularly the cooperation program responsible for liaison with foreign counterparts and for plant quarantine regulations. Since 1984, annual meetings are held between the Crop Protection Directorate, scientists in the French Overseas Departments, and CIRAD scientists.

#### **Development**

MIDEC's research results are presented in its publications; the list is available on request.

### Mission Technologie Agro-alimentaire (MITAA)

#### **A CIRAD Priority**

The development of food technology research was established as a priority for CIRAD in the second plan for research orientation and programming.

There was a need to coordinate food technology by the different CIRAD departments and to conceive new research programs to meet the needs and expectations of the related professions.

#### **Two Objectives**

MITAA was established in 1985 to fulfill these requirements, and during the first year of its operation, it set itself two objectives.

•To provide scientists and professionals the means to realize their ideas and to coordinate their work.

For this purpose, the food technology workshop at the CIRAD Research Center was constructed to meet three types of requirements:

- research and predevelopment (until the pilot operation stage) of appropriate food technology for tropical crops adapted to the technology level of the developing countries; this ranges from the improvement of traditional techniques to the development of industrial methods:
- support to research centers in developing countries through bi-

and multilateral cooperation programs, training of national scientists; — support to industries in the Languedoc-Roussillon region in southern France; these industries plan to diversify their products by including produce from the hot-climate regions. They will serve as a demonstration of French technology that is relevant to and applicable in the developing countries.

• To undertake research on two main concerns—processing and food self-sufficiency. Much progress has been made since the formation of a new type of working group of the Languedoc scientific institutes, called Gridamet.

Industry-oriented research work has already been started in the local laboratories.

Research for these two sectors is funded through regional and state subsidies.

#### **Industry-oriented Research**

In the immediate future, MITAA will strive towards greater interaction between research and industry. For this purpose, it aims:

- to train junior scientists in food technology at the Montpellier food

technology workshop;

— to encourage inter-commodity research and develop multidisciplinary programs;

— to promote collaborative research between European organizations:

to increase information on ongoing programs and projects both in France and developing countries;
 to create posts for food technologists in producing countries;

— to promote similar activities in new geographical areas.

### Mission Economie et Sociologie Rurales (MESRU)

The commodity-based programs of the CIRAD departments include economic and sociological studies on commodity production and marketing. The studies usually occupy a limited part of the agronomists' work.

In 1973, a group was established at GERDAT to direct and orient sectoral research on rural economics and sociology; in 1983, it became the Mission Economie et Sociologie Rurales. MESRU's technical committee is made up of a representative from each department and external experts from INRA, ORSTOM, and IAM. MESRU monitors the scientific work, determines methodologies, provides information support, and contributes to the application of CIRAD's socioeconomics findings.

#### **Objectives**

MESRU seeks to understand the mechanisms and evolution of different situations related to agricultural production, commodity economics, rural areas, development projects, technical innovations, etc.

Four sectors of research were determined based on several years of research on agricultural production and commodity economics:

pricing, marketing and agricultural devlopment (commodity program);

— technical and economic management of agricultural production (management program);

animal traction and mechanization;

— forests, perennial crops, rural communities and development strategies (forestry program).

#### Ongoing programs

MESRU is involved in regional research programs in addition to the socioeconomics studies conducted by the CIRAD departments on farming systems, commodity economics, and development projects.

Since 1982, CIRAD is participating—with funding from the Ministry of Research and Technology—in the IFRI-ICRISAT-CIRAD-CIRES-CEDRES-ISRA multiorganization project in Africa on the substitution of imported cereals by local cereals. The research is organized in a network that was formed following a meeting in Ouagadougou. Several documents were published, including a bibliography on cereal economics in West Africa (1984).

The commission on the dynamics of agrarian systems of the Ministry of Research and Technology has sponsored a research project on the comparative analysis of changes brought about by animal traction and intermediate mechanization in the agrarian systems of the cottongrowing areas in Burkina Faso, Mali, and northern Côte d'Ivoire. The studies were started in 1984 in collaboration with CIRES, IAM, IBRAZ, and IER. The project has now been completed and the results established.

Since 1984, a MESRU scientist has been assigned to the World Bank research program on farm mechanization and changes in agrarian systems in Sub-Saharan Africa. A report will be published on completion of the program.

Other projects are planned based on the application of research results, and will mainly concern the three forestry, management, and commodity programs.

#### **Future Research**

CIRAD's work in rural sociology and economics focuses on:

 agricultural economics, to provide socioeconomic information required for recommendations;

— commodity economics (relationships between commodity; local, regional, national markets; international trade), to provide information for sectoral policy decisions).

There still remains a need to study agro-industrial development and its impact on farming systems and agricultural development.

#### **Training**

Four Ph. D. theses on economics are being prepared on wood production in Cameroon, tropical wood utilization in France, socioeconomic changes in agrarian systems due to mechanization in the cotton-growing area of western Burkina Faso, fertilization economics in village coconut plantations in Indonesia.

CIRAD's agricultural economists are increasingly involved in training students and trainees mainly from developing countries.

Training is becoming an increasingly important activity at MESRU.

#### **Publications**

Since October 1984, MESRU has started regular publication of its newsletter.

The rural economics group has published research reports, collective publications, theme-based reports (e. g. farming in Africa south of the Sahara).

A list of publications is supplied on request.

# SUPPORT SERVICES

#### **Documentation**

#### Vast Store of Information

The library collections of the 10 institutes that were grouped under CIRAD were inventoried in 1982. They represent an important knowledge base constituted through the French cooperative activities for rural development in the Third World countries, mainly in Africa. Details of the GERDAT/CIRAD data base (number of references) are presented in the adjoining table.

Manual management made it difficult to have easy access to this information for cooperative work. It was imperative to computerize the system in order to place it on the international information networks and make this scientific information available for application through cooperation.

# Compatibility with International Networks

The computer system and programs installed in the documentation centers are compatible with the national and international systems.

The RESAGRI-AGRIS format used for entry of cataloging data, is that used by INRA, the French Ministry of Agriculture, Crédit Agricole, and farmers' mutuals. CIRAD documentation can now be integrated in the national agricultural information

CENTERS	INTERNATIONAL COLLECTION INCLUDING PROCESSED REFERENCES (number of references)		PUBLICATIONS AND REPORTS (number of references)	
	Retrospective	Current (per year)	Retrospective	Current (per year)
CEEMAT	15 000	550	328	16
CTFT	65 000	500	2 585	50
IEMVT	25 000	3 500	3 092	500
IRAT	160 000	4 300	6 815	500
IRCA	90 000	650	5 371	30
IRCC	25 000	1 300	1 493	60
IRCT	25 000	1 300	942	15
IRFA	50 000	3 000	3 717	320
IRHO	26 000	950	1 110	40
CIRAD	2 500	500		
Research Center				2.5
TOTAL	483 500	16 550	25 453	1 531

circuit. Bibliogaphical data on CIRAD publications can also be supplied to INRA—the AGRIS center in France—directly on magnetic tapes using the ISO 2709 format. In 1984, 112 test references were sent to INRA.

The RESAGRI cataloging rules were integrated in a program for interactive controlled data entry. This program is in operation since December 1984 and is integrated at the nodes of CIRAD's computer-based network.

#### **Instrument for Cooperation**

CIRAD recognizes the importance of scientific and technical information

for cooperation with developing countries. For this purpose, not only should bibliographical references be supplied for rural research and development activities, but also the means (hardware, software) to process them.

CIRAD has therefore developed certain practical software for managing a document center:

• Program for preparing bulletins or catalogs based on 2-level sorting including the author and subject indexes. An interface was developed for direct photocomposition. This program was used to prepare the 1984 list of publications by IEMVT scientists. It is also used by IRFA and IRCT for the bibliography section of their periodicals.

• Other interfaces were developed for the ISO 2709 format, S/75 format to connect to the French host computer Télésystèmes, and word processing of library cards and microfiche headings.

Other software was developed as part of the cooperation agreement between EMBRAPA, Brazil, and GERDAT/CIRAD. Several visits were undertaken to study and analyze the functional organization of the EMBRAPA Technology Dissemination Department. The documentation software needed for GERDAT/CIRAD was specified following this study, the most important being the development of an SDI software with AGRIS.

In 1984, the GERDAT/CIRAD team working on TITUS, a multilingual data base processing system, was reorganized and merged with the publication of AGRITROP. The second 1984 issue of this multilingual abstracting journal was produced by processing data on disks corresponding to the different language versions. The AGRITROP classification scheme was revised completely to make it compatible with that of AGRIS.

#### CIDARC: an International Center for Documentation on Agriculture in Hot-climate Regions

During 1983 and 1984, the documentation team in Montpellier worked with the planners and architects to finalize the blueprint for the physical facilities of the Centre International de Documentation en

Agronomie des Régions Chaudes (CIDARC), the CIRAD documentation center. Construction work was started in 1985 following this preparatory work. Funds for the 2800-m² facilities were provided by the Ministry of Research and Technology (91 %) and regional subsidies (9 %).

CIDARC is located on the CIRAD campus. Documents from the different departments in Paris and Montpellier can now be assembled together at one location. The center will provide:

— a bibliographical data base for agriculture and rural development in

the hot-climate regions;

— a specialized library with a direct access system, that is open to students, teachers, scientists, and development workers from developing countries or hot-climate regions;

— a question-answer service with direct access to national and international bibliographical data bases;

— computer-based support to field and laboratory workers to regularly supply selective theme-based individualized information.

## International Scientific Publications

All the CIRAD departments publish an international-level scientific periodical:

- Machinisme agricole tropical (CEEMAT);
- Bois et forêts des tropiques (CTFT);
- Revue d'élevage et de médecine vétérinaire des pays tropicaux (IEMVT);
- Café, cacao, thé (IRCC);
- L'Agronomie tropicale (IRAT);
- Coton et fibres tropicales (IRCT);

- Fruits (IRFA);
- Oléagineux (IRHO);
- part of the *Revue générale des caoutchoucs et plastiques* (IRCA).

These publications represent, over a 1-year period:

- 4280 pages of scientific reports,
- 9200 subscribers,
- 18 000 copies for distribution.

The periodicals carry abstracts in English and Spanish; some are also bilingual (French and English). Articles contributed by external authors in other languages are also accepted.

About 30 staff members are involved in the publication services of the different departments.

The periodicals are distributed worldwide and are processed by all the major international abstracting systems.

A working group similar to that for documentation, was formed in 1984 for all the CIRAD publications. The group participated in two workshops that provided an opportunity to exchange and develop ideas concerning the CIRAD services:

 Workshop on French-language Publications, organized by CILF-ACCT in Montpellier, 16-18 October

1984.

— Workshop on Scientific and Technical Information for Agricultural and Rural Development, organized by CTA-GRET-GERDAT in Montpellier, 17-21 December 1984.

### **Training**

The objective of the training service is to coordinate the training activities that have been conducted since a long time by the CIRAD departments. It also endeavors, if possible, to constantly improve training given to scientists from France and other countries. Three main working programs were formulated, in consultation with the Office of the Director of Research:

- in-service training;
- support to trainees who have completed their programs and follow-up;
- training programs for CIRAD scientists.

#### **In-service Training**

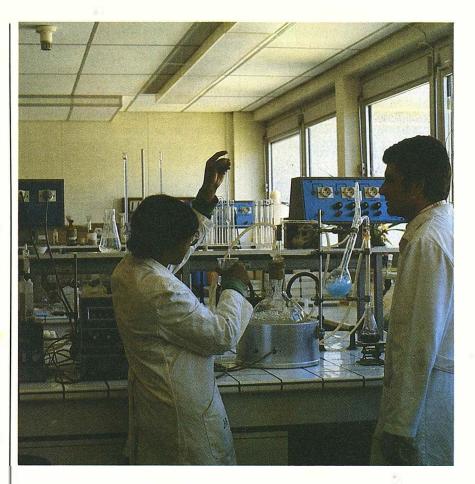
The objectives and target group of this program were modified since its establishment in 1977.

In 1984, 32 trainees participated in the program; 8 were and are still working in the national research institues; 15 were in their second year of study at the Ecole Supérieure d'Agronomie Tropciale (ESAT), prior to the preparation of a thesis. Since 1981, at the end of their studies, the students are expected to present a thesis on a research topic related to their work, based on the methods learned during the course of their studies.

The objectives of this program are:

— to recognize this training as an important factor to obtain the Diplôme d'Ingénieur d'Agronomie Tropicale awarded by the Centre d'Etudes Agronomiques des Régions Chaudes (CNEARC).

— to design in-service training programs in collaboration with the scientific coordinators for each discipline.



# Support to Former Trainees and Follow-up

This aspect mainly concerns foreign trainees and it aims:

- to update the list of trainees and to follow their careers;
- to determine the impact of the training received at CIRAD on the trainees' professional capacities and career;
- to identify the trainees' requirements in terms of information and exchange of scientific and technical ideas.

This information serves to better understand the issues related to technology transfer and information dissemination.

It also represents the end result of CIRAD's contribution to French technical cooperation in the area of agricultural training. It is not simply a review of past activities but an opportunity to adapt CIRAD's training program to actual needs. Training programs should be geared to the requirements of different countries, national research and development organizations, and to the aspirations of the trainees who wish to enhance their prospects through university studies that give them the scientific

qualifications and improve their social well being.

The training service has contacts with six countries: Burkina Faso, Côte d'Ivoire, Madagascar, Mali, Togo, and Venezuela.

#### **Training of Scientists**

This program concerns all the French and foreign scientists at or associated with CIRAD. The training service provides logistic support and participates in programs offered by the CIRAD departments.

The training service attaches great importance to contracts with African cooperating countries for training/integration scientists who work or will work in the programs developed jointly by the national research organizations and CIRAD.

The implementation of this policy of long-term (e.g. 10 years) contracts, requires from the cooperating country:

— the need and willingness to participate in such an operation;

— a general definition of priority programs and areas of research where competent scientists are needed;

— the possibility for CIRAD scientists to express their judgement of the trainees' abilities;

— scientist status in the host country.

For CIRAD, this signifies:

— a willingness to participate or collaborate in fundamental training for the degree program;

research training through research work;

— close collaboration between the teams working in France and those in the cooperating country;

- the possibility to provide

long-term scholarships for studies in France and abroad.

Through this new form of cooperation, CIRAD aims to create more coherent mixed teams, with the same level of knowledge and proficiency. It intends to offer junior French scientists the opportunity to train at the national agricultural research centers, and also to receive national scientists in the French organizations. It hopes to enable French scientists to expand their activities and initiate new research programs.

# Industrial Liaison and Development

Research results can be applied through three approaches in order to maximize the social benefit of the financial support offered by the national organizations:

— opening towards the French and international scientific community, to place CIRAD on a high-level exchange network through the recognition of its work;

— extension of research results to a maximum number of farmers in the Third World:

 acquisition of self-generated resources to maintain and increase the existing scientific and technical potential.

The economic aspects were separated from the two others and are the responsibility of a cell established in early 1985 that is attached to the Office of the Director General. Its function is:

— to ensure logistic support to the departments to carry out their projects (awareness of the prospects

and means of industrial liaison; identification of applicable results; advice for implementation strategies; partner search; legal, commercial and financial support; etc);

— to define and implement a CIRAD-level industrial liaison policy; this includes: industrial property, establishment of branches, relations with industry and technical planning departments, uniform and synergistic action by the different departments, integration of the optimization logic in the other horizontal functions of CIRAD.

These examples serve to illustrate the range of actions undertaken or supported by the industrial liaison cell.

#### **Assignment of Scientists**

Two qualified scientists were assigned to major crop protection industrial groups to assist them in determining their strategies.

# BRGM-GERSAR-CIRAD Agreement

On 2 October 1985, the Bureau de Recherches Géologiques et Minières (BRGM), Groupement d'Etudes et de Réalisations des Sociétés d'Aménagement Rural (GERSAR), and CIRAD signed an agreement to pool their experience for the promotion and development of small-scale irrigation in the African Sudano-Sahelian countries.

The experience of these three organizations will enable the national authorities to launch rural development projects.

# Computer Simulation of Plant Growth

CIRAD scientists associated with the botanists from the Université des Sciences et Techniques du Languedoc (USTL), Montpellier, in collaboration with computer scientists from the Universities of Strasbourg and Paris-Orsay, and the Ecole Normale Supérieure de Sèvres, have developed a software package to simulate plant growth.

Certain characteristic parameters of the different species (trees, grasses, creepers, etc) are entered in the computer to obtain realistic images of the plants at different ages. Discussions with industrial partners will enable the application of this work in different areas: films and advertising, image banks (flight simulators), computer-aided design (architects, urban and landscape planners), computer-aided teaching (motion pictures of plant growth), etc.

# Development of Maize Varieties in Brazil

CIRAD and Rhône-Poulenc have signed an agreement to develop and market new maize varieties in Brazil. The products will be jointly owned by the two partners.

#### Licensing of Patents and Prototypes

Technological processes or equipment developed by CIRAD departments were patented.

Several patents will soon be licensed to industry, for example, frozen fruit

juice concentrate processes, prototype of a cereal stripper. A biogas digester will be utilized in association with SOMDIAA.

#### Licensing of Varieties

Sorghum lines developed by CIRAD scientists for the arid zones can be used in the Mediterranean region, either directly as varieties or as parent material for new varieties. Performance trials are under way and the varieties should be ready for marketing in a few years.

## Industrial *In Vitro* Culture Units

Plantlet production has passed the laboratory stage for many crops including oil palm (collaborative progam with ORSTOM), sugarcane, coffee, banana, pineapple, etc. CIRAD has already undertaken major technology transfers to Southeast Asia. It now plans to establish an industrial *in vitro* unit in France in partnership with private companies.

# **Support Laboratories**

Several laboratories at the CIRAD Research Center (listed on page 20) provide scientific and technical support to work done in other countries through detailed analyses of soil, water, plant samples; identification of organisms useful or harmful to crops; development of new methods for genetic improvement of crops. These laboratories serve as

bases for interorganization thematic research programs (ATP) that bring together scientific talent from French or foreign institutions. They also provide training to junior scientists. All these activities are carried out in close collaboration with the specialized laboratories and divisions of the CIRAD departments.

Acronyms

# LIST OF ACRONYMS

AARD, Agency for Agricultural Research and Development (Indonesia)

ABO, Animal Breeding Organisation (Scotland)

ACCT, Agence de Coopération Culturelle et Technique

AFME, Agence Française pour la Maîtrise de l'Energie

ATP, Action Thématique Programmée

BETPA, Bureau d'Etudes Techniques des Projets Agricoles (Côte d'Ivoire)

BRCD, Budget Civil de Recherche et de Développement

BRGM, Bureau de Recherches Géologiques et Minières

CARDER, Centre d'Action Régionale pour le Développement Rural (Benin)

CCCE, Caisse Centrale de Coopération Economique

CEA, Centre d'Etudes Atomiques

CEAT, Cycle d'Enseignement d'Agriculture Tropicale

CEEMAT, Centre d'Etudes et d'Expérimentation du Machinisme Agricole Tropical

CEGET, Centre d'Etudes de Géographie Tropicale

CEMAG, Ceara Maquinas Agricolas (Brazil)

CEMAGREF, Centre National du Machinisme Agricole, du Génie Rural, des Eaux et des Forêts

CENADEFOR, Centre National de Développement Forestier (Cameroon)

CFDT, Compagnie Française pour le Développement des Textiles

CIDARC, Centre International de Documentation en Agronomie des Régions Chaudes

CIDT, Compagnie lvoirienne de Développement des Textiles (Côte d'Ivoire) CILF, Conseil International de la Langue Française

CILSS, Comité Permanent Interétats de Lutte contre la Sécheresse dans le Sahel (Mali)

CIMA, Centre Ivoirien du Machinisme Agricole (Côte d'Ivoire)

CIMMYT, Centro Internacional de Mejoramiento de Maíz y Trigo (Mexico)

CIRAD, Centre de Coopération Internationale en Recherche Agronomique pour le Développement

CMDT, Compagnie Malienne de Développement des Textiles (Mali)

CNEARC, Centre National d'Etudes Agronomiques des Régions Chaudes

CNES, Centre National des Etudes Spatiales

CNPq, Centro Nacional de Pesquisa e Tecnologia (Brazil)

CNRS, Centre National de Recherche Scientifique

CORDET, Commission de Coordination de la Recherche dans les Départements et Territoires d'Outre-Mer

CPATSA, Centro de Pesquisa Agropecuária do Tropico Semi-Arido (Brazil) CRGPT, Regional Coordination Center for Research and Development of Coarse Grain Pulses, Root and Tuber Crops in the Humid Tropics of Asia and the Pacific (Indonesia)

CRTA, Centre de Recherches sur les Trypanosomes Animales (Burkina Faso)

CSTC, Comité Scientifique et Technique du Caoutchouc (IRCA)

CTBA, Centre Technique du Bois et de l'Ameublement

CTFT, Centre Technique Forestier Tropical

DPARC, Formation au Développement des Productions Animales des Régions Chaudes (IEMVT training course)

DSA, Département Systèmes Agraires

EDF, European Development Fund

EMBRAPA, Empresa Brasileira de Pesquisa Agropecuária (Brazil)

EMBRATER, Empresa Brasileira de Assisténcia Técnica e Extensão Rural (Brazil)

ENSAIA, Ecole Nationale Supérieure d'Agriculture et des Industries Agroalimentaires

ENSAM, Ecole Nationale Supérieure d'Agronomie de Montpellier

ESAT, Ecole Supérieure d'Agriculture Tropicale

ESCAP, United Nations Economic and Social Commission for Asia and the Pacific

ESEM, Ecole Supérieure d'Energie et des Matériaux

ESICA, Ecole Supérieure des Industries du Caoutchouc

FAO, Food and Agriculture Organization of the United Nations

FFCAC, Fédération Française des Coopératives Agricoles de Céréales

FOFIFA, Centre National de Recherche Appliquée du Développement Rural (Madagascar)

FUDECO, Fundacion para el Desarrollo de la Region Centro Occidental (Venezuela)

GERDAT, Groupement d'Etudes et de Recherches pour le Développement de l'Agronomie Tropicale (until December 1984); Département de Gestion, Recherche, Documentation et Appui Technique (CIRAD Department)

GERSAR, Groupement d'Etudes et de Réalisations des Sociétés d'Aménagement Régional

GRET, Groupe de Recherche et d'Echanges Techniques

GTA, Programme Génie et Technologie Alimentaire (CEEMAT)

GTZ, Gesellschaft für Technische Zusammenarbeit (Federal Republic of Germany)

HASYMA, Société de Développement de la Production Cotonnière (Madagascar)

IBMC, Institut de Biologie Moléculaire et Cellulaire de Strasbourg IBPGR, International Board for Plant Genetic Resources (Italy)

IBRAZ, Institut Burkinabé de Recherche Agronomique et Zootechnique (Burkina Faso)

IBSRAM, International Board of Soil Research and Management

ICRISAT, International Crops Research Institute for the Semi-Arid Tropics (India)

IDESSA, Institut des Savannes (Côte d'Ivoire)

IEMVT, Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux IFARC, Institut pour la Formation Agronomique et Rurale des Régions Chaudes

IFOCA, Institut de Formation et d'Enseignement Professionnelle du Caoutchouc

IFPRI, International Food Policy Research Institute (USA)

IGN, Institut Géographique National

ILRAD, International Laboratory for Research on Animal Diseases (Kenya) INAF, Institut d'Arboriculture Fruitière (Algeria)

INIBAP, International Network for Improvement of Bananas and Plantains INPA, Instituto Nacional de Pesquisas d'Amazonia (Brazil)

INRA, Institut National de la Recherche Agronomique

INRAN, Institut National de la Recherche Agronomique du Niger (Niger) INSAH, Institut du Sahel (Mali)

IPA, Empresa Pernambucana de Pesquisa Agropecuária (Brazil)

IRAP, Institut de Recherche Appliquée sur les Polymères

IRAT, Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières

IRCA, Institut de Recherches sur le Caoutchouc

IRCC, Institut de Recherches du Café, du Cacao et Autres Plantes Stimulantes

IRCT, Institut de Recherches du Coton et des Textiles Exotiques

IRFA, Institut de Recherches sur les Fruits et Agrumes

IRHO, Institut de Recherches pour les Huiles et Oléagineux

IRRDB, International Rubber Research and Development Board (UK)

IRRI, International Rice Research Institute (Philippines)

ISP, Institut Supérieur Polytechnique (Burkina Faso)

ISRA, Institut Sénégalais de Recherches Agricoles (Senegal)

ISTOM, Institut Supérieur des Techniques d'Outre-Mer

ITCF, Institut Technique des Céréales et des Fourrages

ITMF, International Textile Manufacturers' Federation (Switzerland)

LECSA, Laboratoire d'Etudes Comparées des Systèmes Agraires

LIDER, Laboratorio de Investigacion y Desarrollo Regional (Mexico)

LNERV, Laboratoire National de l'Elevage et des Recherches Vétérinaires

MASEC, Machinisme Agricole et Sciences Economiques Connexes

MESRU, Mission Economie et Sociologie Rurales

MICAM, Mission Connaissance et Amélioration du Milieu

MICAP, Mission Connaissance et Amélioration des Plantes

MIDEC, Mission Défense des Cultures

MITAA, Mission Technologie Agro-alimentaire

NIAE, National Institute of Agricultural Engineering (UK)

OCLALAV, Organisation Commune de Lutte Antiacridienne et de Lutte Antiaviaire (Senegal)

ORSTOM, Institut Français de Recherche Scientifique pour le Développement en Coopération

PRIFAS, Acridologie et Ecologie Opérationnelle

SAED, Société d'Aménagement et d'Etude du Delta (Sénégal)

SCDP, Smallholder Coconut Development Project (Indonesia)

SEDES, Société d'Etudes pour le Développement Economique et Social

SEMRY, Société Expérimentale de Modernisation Rizicole de Yagoua (Cameroon)

SOMALAC, Société Malgache d'Aménagement du Lac Alaotra (Madagascar) SOMDIAA, Société d'Organisation et de Management Départemental Industriel Agro-alimentaire

SRCC, Société Nationale pour la Rénovation et le Développement de la Cacaoyère et de la Caféière (Togo)

TDRI, Tropical Development and Research Institute (UK)

UAIC, Unité d'Afforestation Industrielle du Congo (Congo)

UNDP, United Nations Development Program

USTL, Université des Sciences et Techniques du Languedoc

WARDA, West African Rice Development Association (Liberia)

# For Further Information

## **CEEMAT**

### Centre d'Etudes et d'Expérimentation du Machinisme Agricole Tropical

For more information check the corresponding box and return the form to the address given below.	
• Aide-mémoire du moniteur de culture attelée. 1974. 2 vol, 178 pp	
• Aide-mémoire pour l'utilisation des motoculteurs dans la zone intertropicale. 1976. 116 pp	
• General index of the periodical <i>Machinisme agricole tropical</i> . 1956-1983	
• Quarterly Machinisme agricole tropical,  1986 rates — France and FF zone: 124 FF per year  Other countries: 142 FF per year  (extra charge for airmail)	
Quarterly information bulletin. Issued free.      List of publications. Issued free.	
Your name and address:	
	4
	3

Return to:

#### **CEEMAT**

Parc de Tourvoie 92160 Antony France

## **CTFT**

## Centre Technique Forestier Tropical

For more information check the corresponding box and return the form to the address given below.	
• Annual report	]
• Sample copy of the periodical <i>Bois et forêts des tropiques</i>	
• Index of articles published in <i>Bois et forêts des tropiques</i>	
• List of publications	
• General information leaflet on CTFT	
• Information on CTFT training programs	
	7
Your name and address:	

#### Return to:

### **CTFT**

Division des Publications 45 bis, avenue de la Belle Gabrielle 94736 Nogent-sur-Marne France

## **DSA**

## Département Systèmes Agraires

For more information check the corresponding box and return the form to the address given below.	
• 1984 annual report	
• Sample copy of the periodical Les Cahiers de la recherche-développement	
• Sample copy of the Gazette des sytèmes	
• 1984 list of publications	
• General information leaflet on DSA	
• Information on DSA training programs	
Your name and address:	
***************************************	***

Return to:

**DSA** 

Avenue du Val de Montferrand B.P. 5035 34032 Montpellier Cedex France

## **IEMVT**

### Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux

For more information check the corresponding box and return the form to the address given below.	
Annual report (specify year)	
• 1983 list of publications	
• 1984 list of publications	
• Etudes et synthèses series (indicate title)	
• Sample copy of the periodical Revue d'élevage et de médecine vétérinaire des pays tropicaux	
General information leaflet on IEMVT	
• Information on IEMVT training programs	
Your name and address:	
***************************************	

**Return to:** 

**IEMVT** 

10, rue Pierre Curie 94704 Maisons-Alfort Cedex France

## **IRAT**

### Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières

For more information check the corresponding box and return the form to the address given below.
• 1984 Annual report
• Sample copy of the quarterly L'Agronomie tropicale
• List of publications
• General information leaflet on IRAT
Your name and address:

**Return to:** 

#### **IRAT**

Service des Editions et de l'Information 45 bis, avenue de la Belle Gabrielle 94736 Nogent-sur-Marne Cedex France

# **IRCA**

### Institut de Recherches sur le Caoutchouc

r more information check the corresponding box and return	the form to the address given below.
Sample copy of the periodical Revue générale des caoutche	oucs et plastiques
List of publications	
General information leaflet on IRCA	[
Annual report. 150 pp	[
Your name and address:	
	······································

Return to:

**IRCA** 

42, rue Scheffer 75116 Paris France

## **IRCC**

### Institut de Recherches du Café, du Cacao et Autres Plantes Stimulantes

General information leaflet on IRCC		
	France	Other countries
Café, cacao, thé Single issue	80 FF 🗌	90 FF 🗌
Subscription for 4 issues	235 FF 🗌	275 FF 🗌
Subscription for 4 issues and 1 special publication	365 FF	425 FF 🗌
Annual report: 1983 or 1984	158 FF 🗌	188 FF 🗌
1985	170 FF 🗌	200 FF
IRCC 25th anniversary (1958-1982) brochure. Issued free		
Dixième colloque scientifique international sur le café. 450 FF		
IRCC Bulletin No. 17. Contribution à la connaissance de la résistance incor à la rouille orangée. 200 FF + tax.	•	
0		
Programmes de recherche de l'IRCC dans les domaines de l'amélioration et de l'agronomie du cacaoyer.		
Programmes de recherche de l'IRCC dans les domaines de l'amélioration		
Programmes de recherche de l'IRCC dans les domaines de l'amélioration et de l'agronomie du cacaoyer.		
Programmes de recherche de l'IRCC dans les domaines de l'amélioration et de l'agronomie du cacaoyer		
Programmes de recherche de l'IRCC dans les domaines de l'amélioration et de l'agronomie du cacaoyer.  Video cassette, 1/2 in. VHS, Secam system  Coffee cultivation in Africa. 45 min. 500 FF + tax		
Programmes de recherche de l'IRCC dans les domaines de l'amélioration et de l'agronomie du cacaoyer.  Video cassette, 1/2 in. VHS, Secam system  Coffee cultivation in Africa. 45 min. 500 FF + tax  Cocoa cultivation in Africa. 38 min. 500 FF + tax		
Programmes de recherche de l'IRCC dans les domaines de l'amélioration et de l'agronomie du cacaoyer.  Video cassette, 1/2 in. VHS, Secam system  Coffee cultivation in Africa. 45 min. 500 FF + tax		

Return to: IRCC 42, rue Scheffer, 75116 Paris, France

## **IRCT**

#### Institut de Recherches du Coton et des Textiles Exotiques

For more information check the corresponding box and return the form to the address given below. France Other countries • Periodical Coton et fibres tropicales 76 FF 70 FF Single issue (specify) 278 FF 270 FF Subscription for 4 issues ..... 355 FF 367 FF Subscription for 4 issues + supplements ..... (Seamail, additional charges for airmail) • Documents, études et synthèses 40 FF No. 1 40 FF No. 2 40 FF No. 3 40 FF No. 4 60 FF No. 5 40 FF No. 6 Your name and address: .....

Return to:

**IRCT** 

2, rue Louis David 75116 Paris France

## **IRFA**

### Institut de Recherches sur les Fruits et Agrumes

For more information check the corresponding box and return the form to the address given below.	
• Periodical <i>Fruits</i> . Table of contents for 1983-1984-1985	
• List of publications	
• Annual reports per station: Côte d'Ivoire, Cameroon, Réunion (specify)	
• Programmation recherche, développement, formation à l'IRFA, 1984.	
Proceedings of annual meetings:     1983 - Diversification of fruit crops     1984 - Citrus fruits     1985 - Bananas and plantains	
Your name and address:	

Return to:

**IRFA** 

6, rue du Général Clergerie 75116 Paris France

## **IRHO**

### Institut de Recherches pour les Huiles et Oléagineux

For more information check the corresp	onding box and return the form to the	address given below.
• Sample copy of the periodical <i>Oléag</i>	rineux or special issues	
• Oléagineux General Index (1946-198	0). With annual updates	
• List of <i>IRHO Advice Notes. Agricultus</i> In English, French, Spanish.	ral Practice	
Oil palm	Coconut	Groundnut
• General information leaflet on IRHO		
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