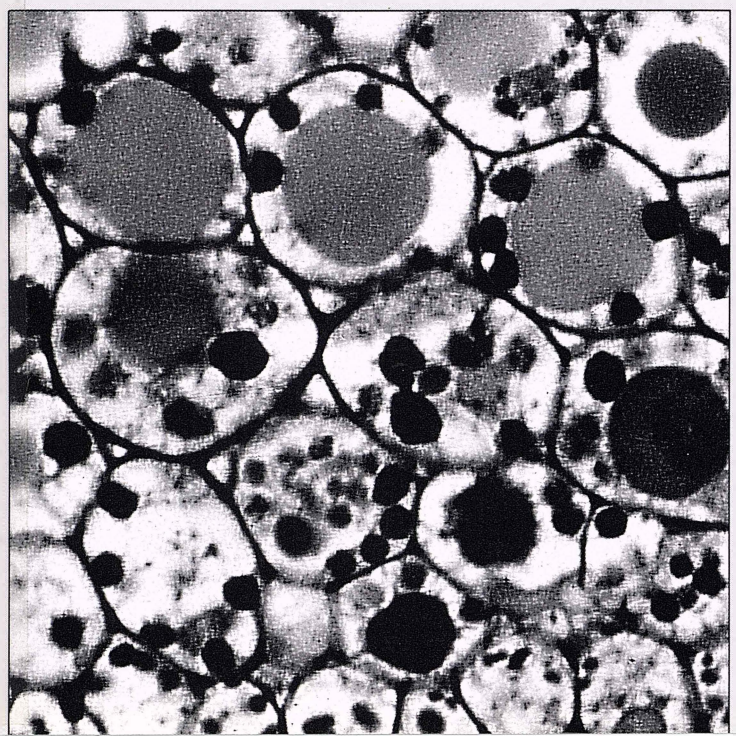
CIRAD 1989



CIRAD
1989

ISBN 2-87614-042-X

Contents

Tropical Agricultural Research: A Crucial Need Today, an Ambitious Plan for the Future

Most tropical and subtropical countries, particularly in Africa, are essentially agricultural economies with slow industrial growth. Population explosion has led to rapid urbanization. The only solution for economic development is to boost agricultural production without jeopardizing the future through wasteful exploitation of precious natural resources.

Without a real agricultural revolution, it will be difficult for the countries to achieve food self-sufficiency, to stabilize the rural population, and to establish or develop income-earning export crops.

Such development should be based on certain priorities with the general consensus of decision makers. They include: formulation of agriculture-oriented policies, organization and expansion of agribusinesses, establishment of realistic development projects supported by dynamic and productive research. Farmers are the main agents of this transformation; they need to be motivated so that they can confidently assume their responsibilities. Assistance provided through North-South cooperation should be aligned to these priorities.

In difficult economic situations short-term considerations often take precedence. Although research is a prime mover it tends to be neglected, largely because its results cannot be perceived immediately. Research is not a luxury, but a crucial necessity. Its importance for agricultural development is being increasingly recognized by those concerned with the future of the southern countries. The World Bank, for example, has based its economic recovery program for Africa on a complete reorganization of the national and regional agricultural research systems.

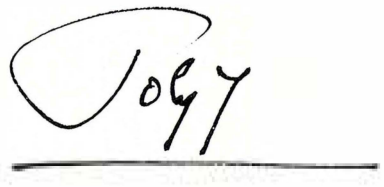
Science has no frontiers, nevertheless the knowledge gap between North and South continues to widen. There is a pressing need to bridge it by using the know-how and resources of the North to address the problems of the South. Such research involves high costs, a long-term commitment,

and efficient management. Only a new spirit of cooperation can provide these. Discoveries, innovations, and know-how should be optimized at application stage. Research can no longer be isolated from development. Many instances demonstrate that northern countries can also benefit from research results obtained in the South. Research is an ideal school for discipline and rigor.

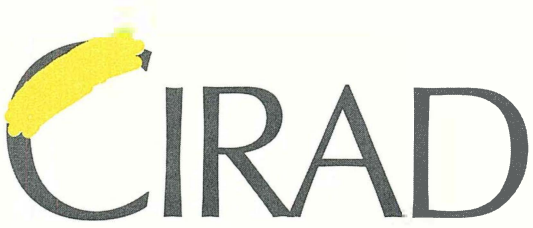
These are sound reasons for establishing cooperative networks in key areas of agricultural research. They link national organizations, international centers, and a large number of laboratories and research stations worldwide, particularly in the EEC countries.

CIRAD has adopted this cooperation policy, particularly with its African partners. Its well-conceived and assiduous efforts have enabled it to acquire a valuable knowledge base in a large number of work areas.

CIRAD is strongly determined to intensify these efforts through new collaborations and resources, to achieve greater progress.



Jacques Poly
Chairman



The Centre de coopération internationale en recherche agronomique pour le développement, CIRAD, is a scientific organization with a mandate for international cooperation in development-oriented tropical and subtropical agricultural research. It is sponsored by the French Ministry of Research and Technology and Ministry of Cooperation and Development.

CIRAD is a state-owned industrial and commercial body (EPIC). It was created in 1984 following the consolidation of agricultural, veterinary, forestry, and food technology research institutes that specialize on tropical and subtropical zones.

Mission. CIRAD has a mission to contribute to the development of the tropical and subtropical regions through research, experiments, training, and information.

Staff. In 1989, staff strength was 2000 persons, including 1025 senior scientists and administrators, who work in about 50 countries. In addition, more than 1000 French and foreign scientists are involved in its research programs.

Finance. In 1989, the budget amounted to Fr 850 million, 61% of which is subsidized by the French government. This figure does not include specific project funds for activities entrusted to CIRAD by its partners through program contracts.

Physical infrastructure. In France, CIRAD has its own research centers at the following locations: Paris (headquarters), Maisons-Alfort, Nogent-sur-Marne, and Montpellier (main research center).

CIRAD's research centers in the French overseas departments and territories are located in: French Guiana, Guadeloupe, Martinique, New Caledonia, and Réunion.

In other countries, CIRAD teams operate within national agricultural research centers in host countries, or work on site for development operations.

Organizational structure. Most of CIRAD's 11 departments were formed from the institutes that were consolidated to create the Center. They have retained the acronyms of the former institutes.

Eight departments conduct commodity-based research:

- **IRAT**, Institut de recherches agronomiques tropicales et des cultures vivrières, for food crops;
- **IRFA**, Institut de recherches sur les fruits et agrumes, for fruit;
- **IRHO**, Institut de recherches pour les huiles et oléagineux, for oil crops;
- **IRCC**, Institut de recherches du café, du cacao et autres plantes stimulantes, for stimulant crops;
- **IRCT**, Institut de recherches du coton et des textiles exotiques, for fiber crops;
- **IRCA**, Institut de recherches sur le caoutchouc, for rubber crops;
- **CTFT**, Centre technique forestier tropical, for wood and forestry;
- **IEMVT**, Institut d'élevage et de médecine vétérinaire des pays tropicaux, for livestock production and veterinary medicine.

Two departments conduct theme-based research:

- **DSA**, Département systèmes agraires, for agrarian and farming systems;
- **CEEMAT**, Centre d'études et d'expérimentation en mécanisation agricole et technologie alimentaire, for agricultural engineering and food technology.

One department is responsible for horizontal programs and general services:

- **GERDAT**, Gestion, recherche, documentation et appui technique, for management, research, documentation and technical support.

Board of Trustees (1989)[1]

Chairman

Jacques Poly

Government Representatives

***Jean Forestier**, representing the Minister for Research and Technology*

***Pierre Bobillo**, representing the Minister for Cooperation and Development*

***Rémi Bouchez**, representing the Minister for Economic Affairs, Finance, and Budget*

***Daniel Dumont**, representing the Minister for Agriculture*

***Gérard Plouchard**, representing the Secretary of State for Overseas Departments and Territories*

President of the Institut national de la recherche agronomique (INRA)

Pierre Douzou

External Personalities Selected for their Expertise

***Jean-Paul Bastian**, Agriculturalist and Member of the Steering Committee of the Fédération nationale des syndicats d'exploitants agricoles*

***Menotti Bottazzi**, Coordinator, Consortium européen de développement*

***Jacques de Chateauvieux**, President and Chairman of the Board, Industrielle sucrière de Bourbon*

***Roger Chaufournier**, Former Vice-President of the World Bank*

***Michel Levallois**, Chairman, Institut français de recherche scientifique pour le développement en coopération (ORSTOM)*

Elected Staff Representatives

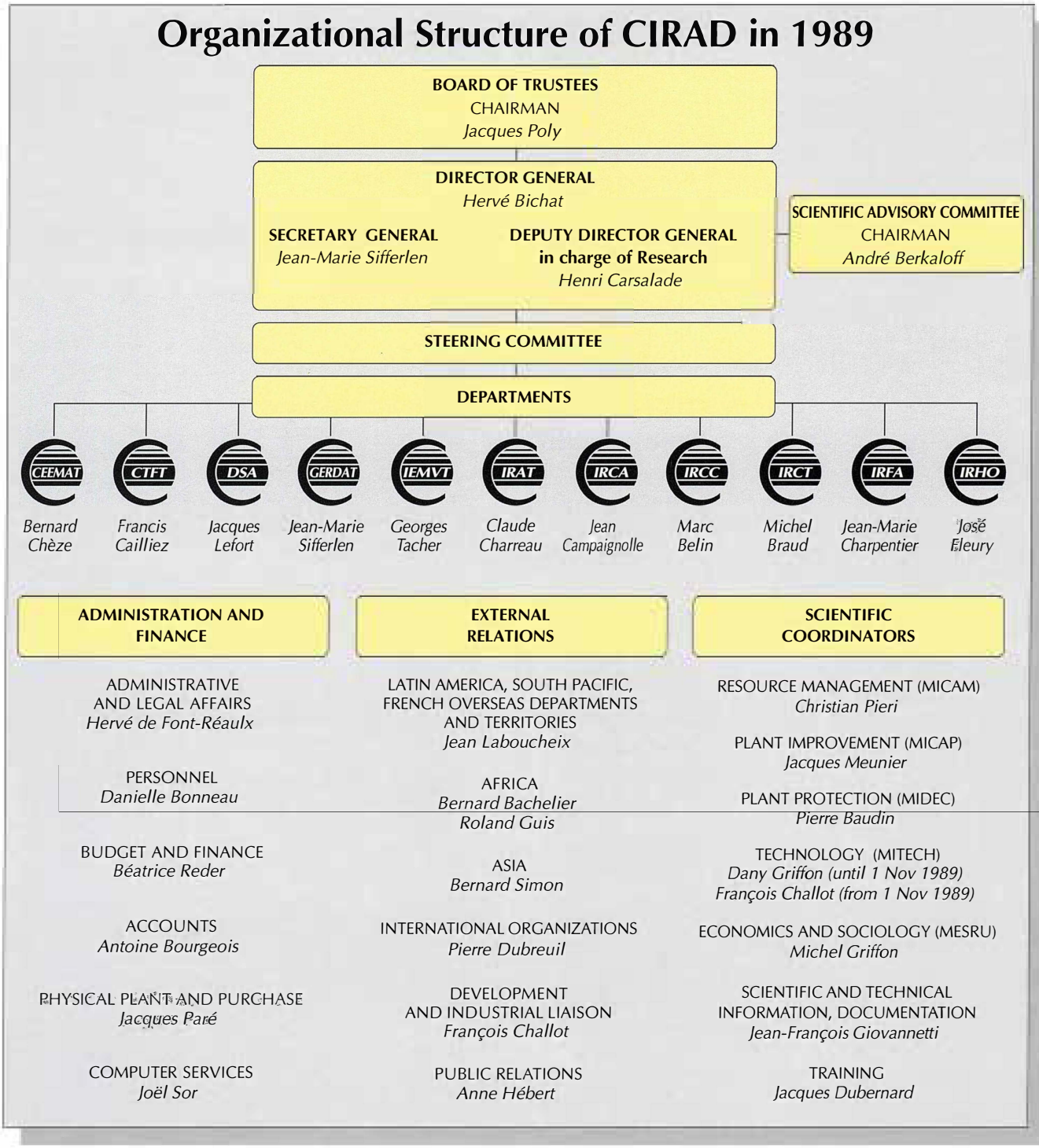
Jean-Pierre Gaillard
André Garrigues
René Kaiser
Jean-Claude Monnet
Jean Pichot
Alix Rassaby

In 1989, the Board of Trustees met on 29 June, 17 November, and 12 December (final meeting before end of term).

CIRAD's first Board of Trustees was appointed in 1984 for a 5-year term which ended in 1989. The outgoing Board successfully supervised the consol-idation of the tropical research institutes into a single state-owned industrial and commercial body (EPIC), with common staff regulations, budget, and general policy.

1. Membership on 1 December 1989.

Organizational Structure of CIRAD in 1989



Directors, Overseas Representatives and Correspondents (1989)

Overseas Representatives and Correspondents

Benin
Christian Gaborel

Brazil
Jean-Claude Leprun

Burkina Faso
Robert Nicou

Cameroon
Jean-Louis Messager

Central African Republic
Louis Richard

Chad
Yves Maurice

Congo
Jean-Claude Delwaulle

Costa Rica
Philippe Cujo

Côte d'Ivoire
François Pointereau

Ethiopia
Maurice Vigier

Gabon
Jean Meunier

Indonesia
François Rognon

Madagascar
Jean-Louis Reboul

Mali
Huu Haï Vuong

Mauritania
Renaud Lancelot

Morocco
François Bertin

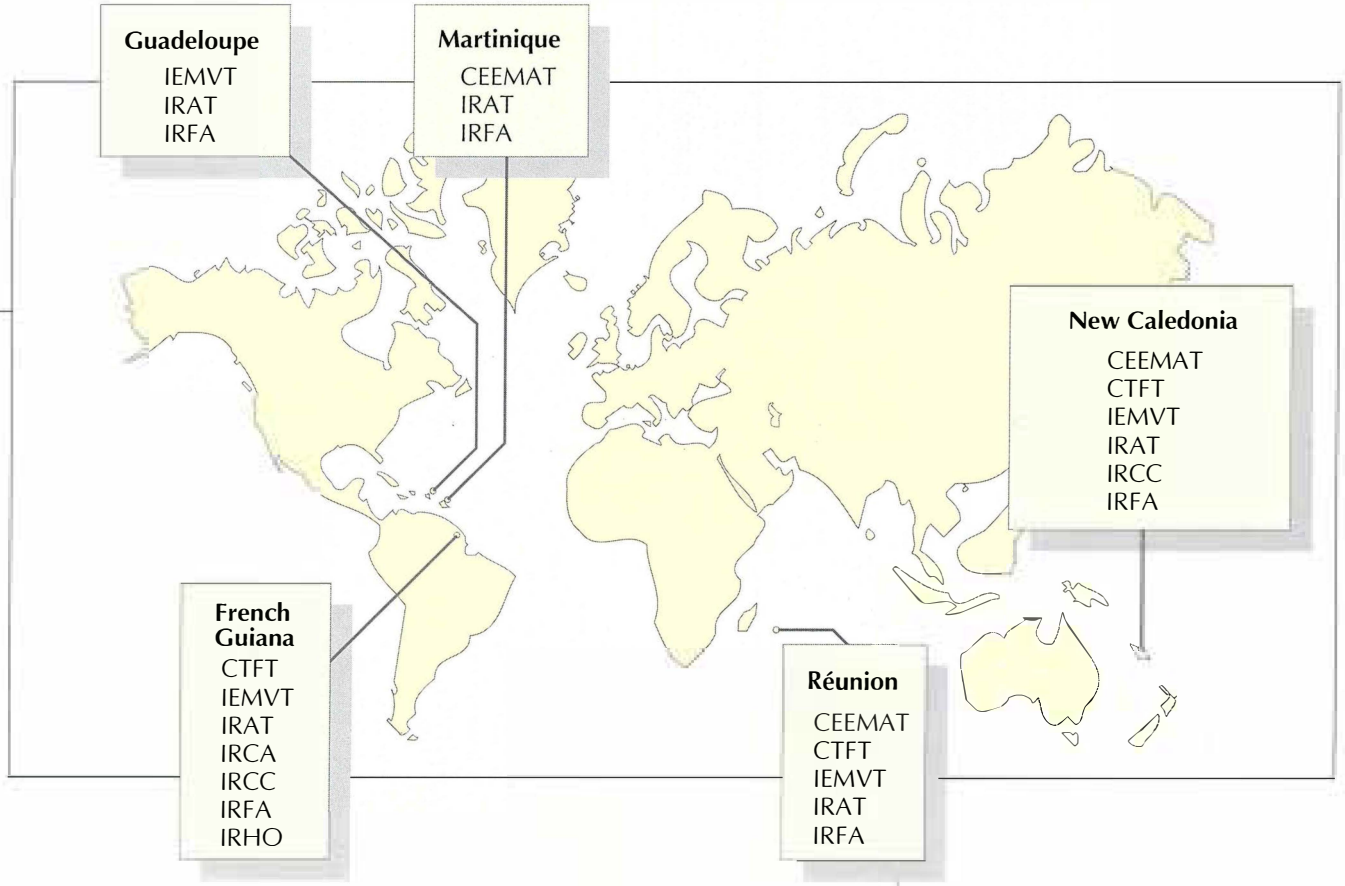
Niger
Claude Lenormand

Philippines
Michel Arraudeau

Senegal
Guy Pocthier

Thailand
Guy Machet

Vanuatu
Claude Calvez



Directors of CIRAD centers in the French overseas departments and territories

French Guiana
Olivier Hamel

French Polynesia[1]
Jacques Larcher

Guadeloupe
Philippe Melin

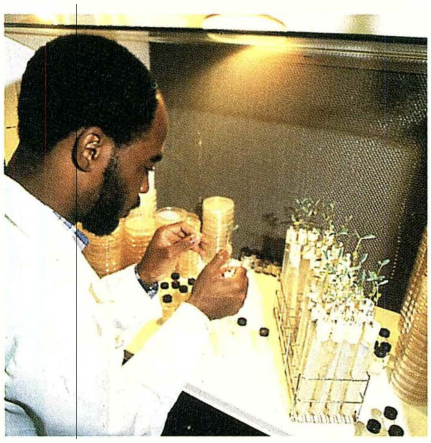
Martinique
Patrick Daly

New Caledonia
Pierre Bourdin

Réunion
Jean Servant

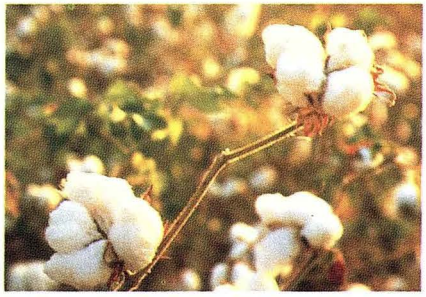
1. Center closed on 1 July 1989.

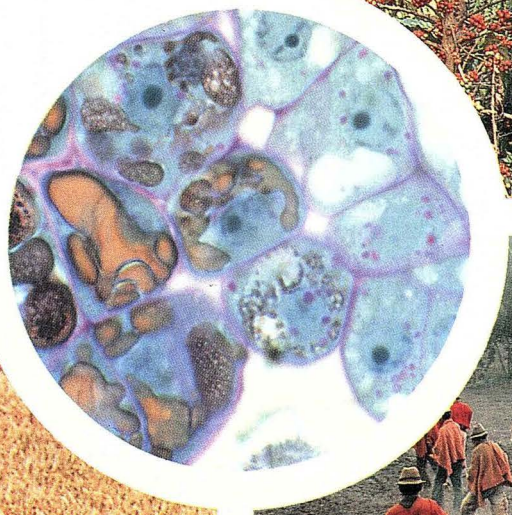
AGRICULTURAL RESEARCH

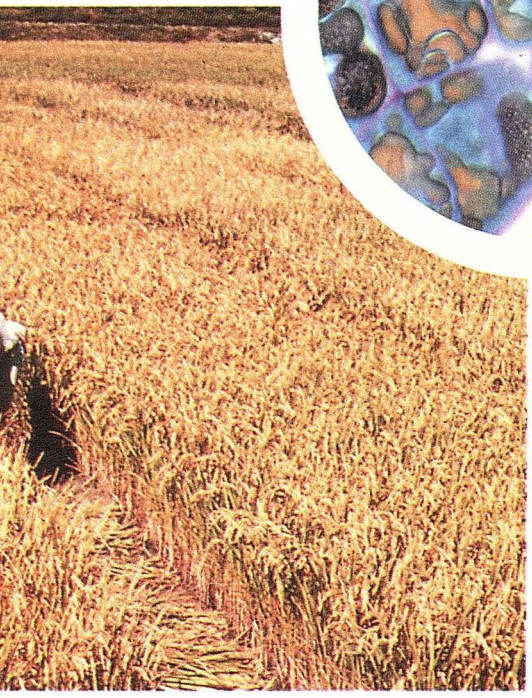


Research Policy

CIRAD's policy in 1989 reflected a desire for continuity in its activities and a determination to evolve with its environment. In a rapidly changing world, it is vital for the Center to anticipate future scenarios and adapt itself to them. In keeping with this intention, CIRAD has decided to accelerate the process of scientific and geographic consolidation of its efforts and to strengthen its links with major French and European research organizations. CIRAD has streamlined its operations by focusing on selected priorities, rigorously programming its research activities, initiating and supporting







innovative work, and establishing common criteria for evaluating its research programs.

Future Strategy

At the request of the French Ministry of Research and Technology, CIRAD started a process of consultation to plan its strategy for the future. For this it mainly drew on the conclusions of the workshop on "Changing Imbalances in the World" organized by the Center for Long-term Forecasting and Evaluation of the Ministry of Research and Technology, Groupe de recherche et d'échanges technologiques (GRET), Institut français de recherche scientifique pour le développement en coopération (ORSTOM), and CIRAD. A working group was formed in mid-1989 to prepare a draft, which will soon be put before the Center's staff.

The working group first analyzed CIRAD's environment and its future: changes in the sciences themselves and fluctuations in the scientific employment market; function of national, regional, and international agricultural research systems; status of the food and agroindustrial sectors; cooperation strategies; economic, social, and political situation in the developing countries. It then focused on CIRAD's role, to identify its financial, administrative, and scientific strengths and limitations.

A thorough appraisal within the Center and discussions with its partners will enable CIRAD to establish—by late 1990—its strategy and internal organization to meet the challenges of the decade.

Evaluation and Planning of Research Programs

Soon after its formation, CIRAD developed the framework and procedure for evaluating and planning its research programs.

The first Scientific Advisory Committee completed its term in December 1988. During its 3 years in office, it endeavored to organize the research structure of the Center, and to develop a common scientific culture. It prepared the guidelines for external reviews of the departments, which were accepted by all the departments, by determining the main themes for future work and by endorsing the scientific value of CIRAD's work in France and in other countries.

The second Scientific Advisory Committee is being constituted. The five staff representatives who were elected on 14 September 1989 are: Michel Benoit-Cattin, Vincent Dollé, Jacky Ganry, Philippe de Reffye, and Marcel Tissot. Nomination of the other members of the Committee is under way.

Several external reviews of the departments were conducted in 1989. IRAT, IRFA, CTFT, and IEMVT have submitted their 5-year plans followed by CEEMAT and DSA. The IRCC review is almost completed and drafting of the 5-year plan has begun; the IRHO

The Scientific Advisory Committee

The Scientific Advisory Committee provides guidance on the orientation, scope, and procedure for the research programs. It also organizes periodic external reviews. The Committee is made up of ten scientists (at least eight are external experts nominated by the relevant ministries) and five elected staff representatives. It is supported by an internal Scientific Programming and Coordinating Committee (CPCS).

The review process combines an external appraisal, discussions with the main CIRAD partners, and detailed internal planning. Such external reviews are useful for assessing achievements, examining the relevance of research programs to priorities set by the Center and its partners, and integrating its work in the international context.

review is under way. The IRCT and IRCA reviews are scheduled for 1990 and preparations have begun.

As a follow-up of the reviews, 32 research programs were retained or created, 5 are being considered, and 2 have still to be evaluated.

The methods and results of the first series of external reviews are also being examined. The analysis should help improve the system for the second series that is planned for 1991.

Five Scientific Coordinators were appointed in 1985 to stimulate exchange between scientists from different programs. They

Status of external reviews of departments on 31 December 1989.

Department	Submission of review report	Observations by department	Approval by Scientific Advisory Committee	Submission of medium-term plan	Approval by Scientific Advisory Committee	Examination by Board of Trustees
IRAT						
IRFA						
CTFT						
IEMVT						
CEEMAT					April 1990	mid-1990
DSA[1]					April 1990	mid-1990
IRCC			April 1990	end 1990		
IRHO	April 1990	mid-1990	end 1990			
IRCT	end 1990					
IRCA	end 1990					

Completed by 31.12.1989 — Planned for 1990

1. As DSA was created recently, it has not undergone a review.

CIRAD's 39 research programs.

IRAT

Food crops
- Rice
- Maize
- Sorghum
- Market crops
- Sugarcane
- Other crops

Natural resources
- Physical environment studies

IRFA
- Banana and plantain
- Citrus
- Pineapple
- Fruits for diversification

IRHO
- Annual oil crops
- Oil palm
- Coconut

IRCC
- Coffee
- Cocoa

IRCT
- Cotton and fiber crops

IRCA
- Latex-bearing crops

CTFT
- Environment and land-use management
- Forest conservation, management, establishment, and use
- Genetic improvement, physiology, biotechnology
- Wood technology
- Aquaculture and fishing

IEMVT

Animal production
- Feed resources
- Animal resources
- Livestock production systems

Animal health
- Infectious diseases
- Animal pests
- Ecopathology

DSA
- Agricultural systems in arid zones (Sahel)
- Agricultural systems in savanna zones (Savane)
- Agricultural systems in forest and high-altitude zones (Silvit)

CEEMAT
- Mechanization and crop production
- Food technology and engineering
- Technological research, energy

GERDAT
- Operational ecology and locust and grasshopper studies (PRIFAS)
- Plant architecture modeling (AMAP)
- Tropical species genome analysis (AGETROP)
- Agricultural policies and long-term forecasting

Status on 31 December 1989

Programs established or being established after review

Programs under consideration

Programs not yet examined by review

initiate and coordinate the scientific activities of the departments in the following research work areas:

- ❑ Resource management (MICAM),
- ❑ Plant improvement (MICAP),
- ❑ Plant protection (MIDEC),
- ❑ Economics and sociology (MESRU),
- ❑ Technology (MITECH).

CIRAD's concern for high standards in its research work has led the management to strengthen the role of the Scientific Coordinators. They were urged to intensify their support to field work in their respective work areas. Thematic research activities are also promoted. The Coordinators were given a further incentive through a grant of Fr 5 million for innovative operations in which scientists from several departments work on a common project that is relevant to CIRAD's objectives. The projects also provide an opportunity to strengthen links with major French research organizations, mainly the Centre national de la recherche scientifique (CNRS), Institut national de la recherche agronomique (INRA), ORSTOM, and training and education institutions. Such interorganization thematic research projects, or ATPs as they are called, are similar to the US CRSP programs. In 1989 the number was reduced from 53 to 26 to concentrate support from the Scientific Coordinators and resources on a selected number of ATPs. Thematic priorities were also modified to focus on high-tech areas such as biotechnology, food technology, expert systems, and data banks. This provides an opportunity to strengthen the capacities of CIRAD's scientific services in these high-potential areas. Priority was also given to agricultural economics and sociology studies and to overviews of agricultural research achievements in each agroecological zone in the tropics.

Study and modeling of light energy circulation in a palm grove is a typical ATP project.

The 26 interorganization thematic research projects (ATP) financed in 1989.

Work area	Activities	Number	Partners
Agronomy			
Water-soil-plant	– Growth of and water uptake by roots in degenerated soils	1	INRA, Hohenheim Univ. (FRG), GERDAT, IRAT, IRHO
	– *Hevea* physiology and latex production	1	Paris VII Univ., USTL, IRCA
Remote sensing	– Survey of plant covers and analysis of surface states	3	SOCFINDO, Marihat station (Indonesia), INERA (Burkina Faso), CTFT, DSA, IRAT, IRCA, IRCT, IRHO
Modeling	– Modeling radiative transfers in palm groves	1	Orsay Univ., La Mé station (Côte d'Ivoire), GERDAT, IRHO
Soil fertility	– Improving fertility of depleted soils through introduction of *Acacia mangium* in food crop rotation systems	1	CTFT-Côte d'Ivoire, CTFT, BSSFT
Crop improvement			
Physiology	– Agroclimatology and in vitro culture (banana, *Hevea*)	1	INRA, ENSA-Toulouse, CNRS, Clermont-Ferrand Univ., GERDAT, IRCA, IRFA
Genetics	– Study of genetic diversity of tropical species and their parasites, using enzyme markers and RFLP	2	ENGREF-Nancy, INRA, CNRS, Limagrain, GERDAT, IRAT, IRCA, IRCC, IRFA
Somatic embryogenesis	– Somatic embryogenesis (cocoa, oil palm, *Hevea*)	2	CNRS, ORSTOM, Paris VI Univ., La Mé station (Côte d'Ivoire), GERDAT, IRCA, IRCC, IRHO
Data banks	– Germplasm data bank	1	INRA, INA-PG, ISIM, ORSTOM, GERDAT, IRAT, IRHO
Crop protection			
Pathology	– Disease diagnosis tools	1	INRA, GERDAT, IRAT, IRCC, IRHO, IRFA
	– Study of host-parasite relations based on sexual reproduction of fungi	1	INRA, IRAT, IRFA
Entomology	– Study of vectors that transmit tropical crop diseases	1	INRA, ORSTOM, GERDAT, IRAT, IRCC, IRFA, IRHO
Expert systems	– Expert system for disease diagnosis and decision making	1	INRA, GERDAT, IRCT

Work area	Activities	Number	Partners
Animal biology			
Aquaculture	– Genetics of *Tilapia* populations	1	INRA, IDESSA (Côte d'Ivoire), CTFT
Livestock production	– Increasing forage production on village lands	1	ORSTOM, IDESSA (Côte d'Ivoire), DSA, IEMVT, IRAT
Economics and sociology			
Micro-economics	– Socioeconomic analysis of village plantations in Africa and Asia	3	EHSS, INA-PG, CIRES, SATMACI (Côte d'Ivoire), Palmindustrie, MARDI (Malaysia), Prince of Songkhla Univ. (Thailand), DSA, IRAT, IRCA, IRCC, IRHO
	– Methodological analysis for increased productivity models	1	INRA, CNRS, ISRA (Senegal), INERA (Burkina Faso), DSA, IRAT, IRCT
Macro-economics	– Establishment of a rice economics monitoring system	1	ONIC, CCCE, INRA, IFPRI, Osiriz, IRAT
Technology			
Commodity chains	– Innovative technologies for food production (short-cycle chains)	1	ENSIAA, ORSTOM, Lyon II Univ. , Paris X Univ., ENSIAAC (Cameroon), CADEF, ISRA, ENEA (Senegal), CIEPAC-Senegal, CEEMAT, DSA, IRAT
Processes	– Osmosis-based drying process	1	INRA, ENGREF, CEMAGREF, USTL, CEEMAT

Research Activities in 1989: Main Results

CIRAD 1989 presents highlights of the Center's activities. It reports selectively on some of the achievements of the Center during 1989, and which give an idea of the diversity of its activities. The results are presented by work area. A detailed report of the research programs of the different departments is presented in another publication, *Les départements du CIRAD, rapport d'activité 1989-1990*, which will appear in French by mid-1991.

Agronomy and Resource Management for Sustainable Agricultural Development Studies

Research priorities for this work area are: to evaluate soil and water resources in tropical and subtropical rural areas, to develop cropping techniques that improve the productivity of soil-plant-climate systems, and to sustain the production potential of physical environments within farming systems that minimize economic and environmental risks and protect the environment. The Scientific Coordinator for this work area is responsible for the Mission agronomie, connaissance et amélioration du milieu (MICAM). The Coordinator has the task to promote research that aims to identify the scientific and technical basis for a sustainable use of natural resources in fixed agriculture.

From Soil and Climate Studies to Recommendations

CIRAD is examining ways of converting its knowledge on soils and climate into recommendations for agriculture. It draws on the discussions at the first Franco-African workshop on tropical soil science organized in 1989 by ORSTOM and the University of Benin, on the topic "Improving soil use through better knowledge."

Studies on the physical environment provide accurate information on its organization and mechanisms, particularly on water dynamics, soil particle distribution, mineral and organic matter balances. However, this basic information needs to be combined with other data for developing and disseminating valid technical recommendations. These data are obtained from an analysis of land-use management by farmers, trials of innovative farming systems, and climatic data series. Environment studies are useful for evaluating crop suitability as they can reveal major constraints and other problems; but they need to be supplemented by an analysis of the effect of plant growth on the environment.

For example, an important factor is the variation in the rhizosphere pH according to the crop or nutrient cation-anion balance for a given crop. Only applied research with an integrated approach to the mechanisms of soil-plant-climate systems can propose scientifically sound recommendations.

Biological factors (microorganisms, soil meso- and macrofauna) offer ways to reduce the use of commercial inputs. The importance of these factors was stressed in IRAT's and IRCT's work within the drought resistance research network, R3S, and that of IRFA in the banana plantations of more humid zones. IRAT, IRCA, IRCT, and IRHO are also conducting research on the role of plant covers and mulches for controlling weeds, and improving the physical properties of soils (porosity and strength) and their chemical characteristics (solubilization of nutrients that are not easily assimilated in their natural state).

When sufficient data are collected on the soil-plant-climate systems, they can be used to construct yield prediction models. IRHO has built a model for lower Côte d'Ivoire in which oil palm production parameters are related to climatic factors. The model explains how, under the same cropping conditions, yields in

Malaysia exceed those in Côte d'Ivoire by 35%, due to higher global radiation. Banting in Malaysia receives approximately 30% more radiation energy than the La Mé station in Côte d'Ivoire.

Development of Sustainable Farming Systems

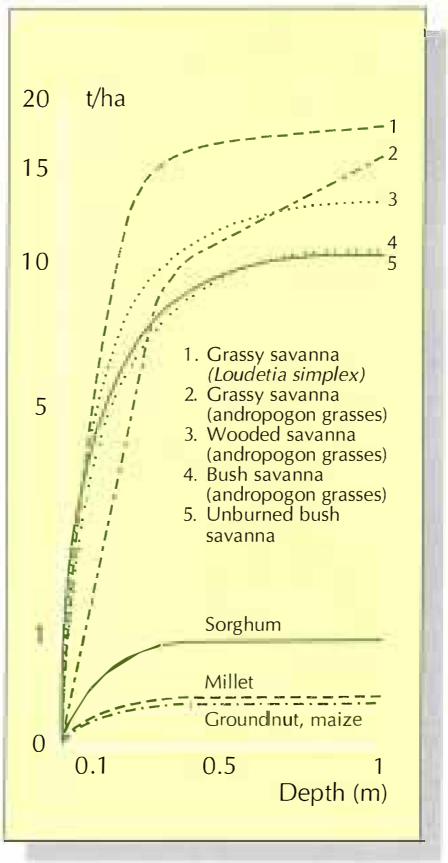
One of the abiding concerns of CIRAD, and other French agricultural research organizations, is the development of sustainable farming systems. The significance of sustainability has been endorsed by the international scientific community. The World Commission on Environment and Development (Brundtland Commission) has defined the concept in relation to agricultural development: sustainable systems are those that meet current food requirements without compromising the possibilities for fu-ture generations to satisfy their food requirements. MICAM has examined CIRAD's work in sub-Saharan Africa for sustainable agricultural development, which is likely to check the practice of shifting cultivation . The main conclusions of the study were presented at the international conference on soil quality in the semiarid tropics that was held in Canada, and at the meeting of the working group on sustainability of the Consultative Group on International Aricultural Research (CGIAR) that was held in Paris. Maintenance of physical stability, chemical characteristics,

Sustainable farming systems are proposed to check the destructive practice of shifting cultivation.

and biological activity in the soil all depend on a major factor—availability of a sufficient amount of organic matter in cultivated soils.

The departments working on perennial crops (oil palm, cocoa, coffee, *Hevea*, etc.) are studying the effects of intercrops on sustained soil productivity through experiments established in the countries of the Bight of Benin and central Africa, Asia (Indonesia, Malaysia), and Latin America (Colombia, Peru). The studies focus on intercrops of food crops such as cereals and cassava, and on legume crop covers. Very encouraging results were obtained particularly in village-level plantations.

Cumulated values of root biomass of herbaceous plants at different soil depths.



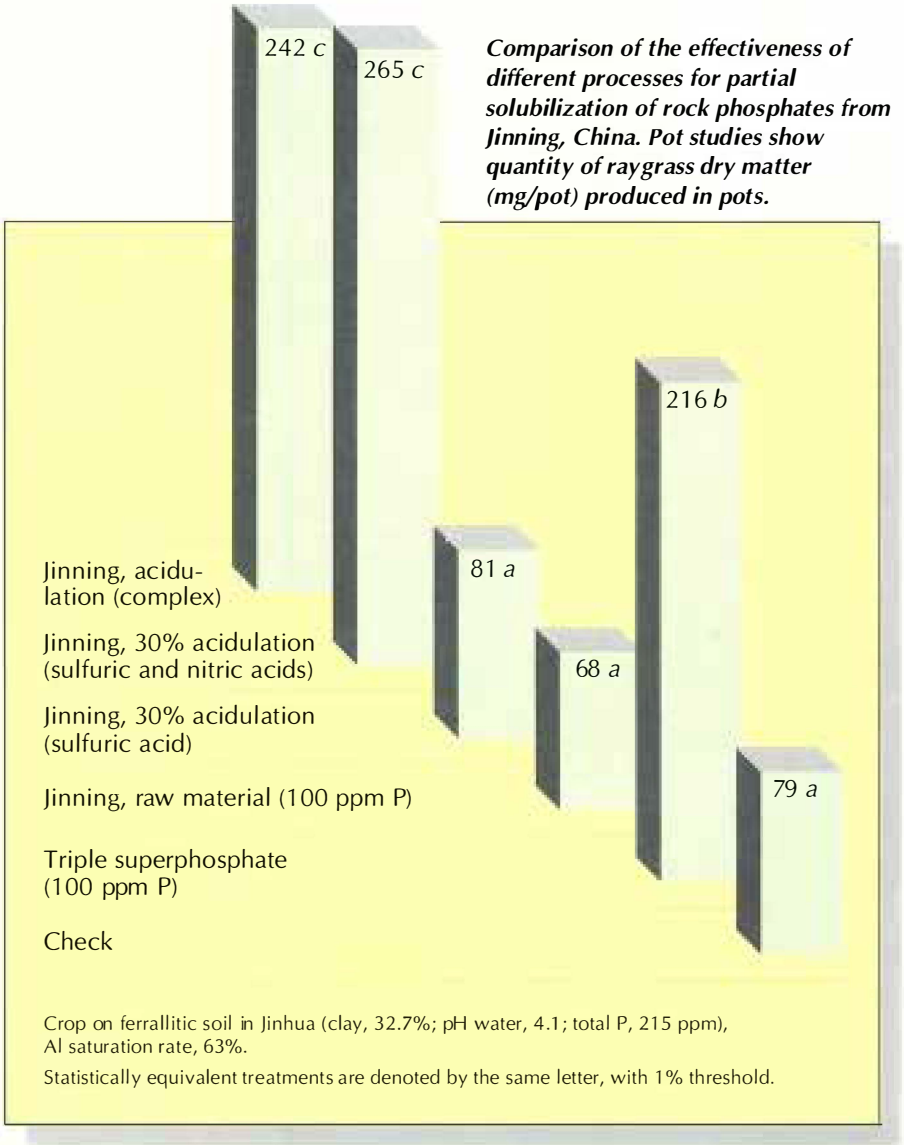
Source: C. Pieri, 1989. *Fertilité des terres de savanes.*

Sustained use of soil resources is therefore based on maintaining an adequate level of organic matter in the soil. Cropping techniques and crops should be selected according to the root residue left in the soil after harvest. This aspect is usually overlooked as agronomists and breeders concentrate mainly on the harvestable part of the plant.

The mineral balance situation in sub-Saharan Africa is causing serious concern. Each year millions of hectares of cultivated soils are being depleted of nutrients (N, P_2O_5, K_2O, CaO, Mg) at the rate of 60-100 kg/ha; the highest deficits are recorded for nitrogen, calcium, and magnesium. This applies to soils where erosion has been checked; but with the decline in such operations, organic and mineral deficits may well increase ten-fold.

Optimization of Local Fertilizer Resources

Local resources are being studied as options for satisfying the growing requirements for fertilizers in more productive and profitable farming systems. The quality of such resources, particularly the rock phosphate deposits in Africa and Asia, should, however, be suitable for agricultural use. Certain highly soluble phosphates—such as those found in Mali—can be used directly. But most rock phosphates need to be solubilized industrially. IRAT is working together



Comparison of the effectiveness of different processes for partial solubilization of rock phosphates from Jinning, China. Pot studies show quantity of raygrass dry matter (mg/pot) produced in pots.

CIRAD 1989

with industry and geological research organizations to develop partial solubilization processes that are less cost-intensive than conventional solubilization processes, but are just as effective.

Rock phosphates from the deposits in Kunyang and Jinning, China, have a P_2O_5 concentration of 26% and 20%, and formic acid solubility of 29% and 25%, respectively. Tests under controlled conditions confirm the validity of the proposed solubilization processes and effectiveness of the end product.

Crop Improvement

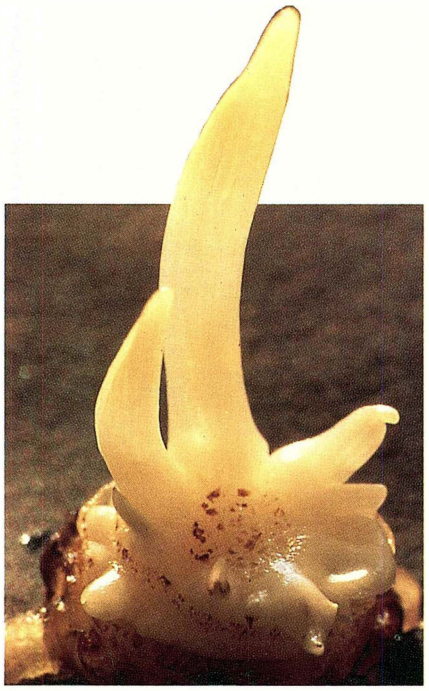
Progress in biological and genetic knowledge and techniques over the past decade has greatly influenced crop improvement potential and methods. At CIRAD, in vitro culture, cytology, and genome analysis laboratories were set up to enable the Center to play a key role in tropical crop improvement developments. The main users of these common laboratory services are the commodity research departments; their crop improvement and variety development programs benefit greatly from these modern techniques.

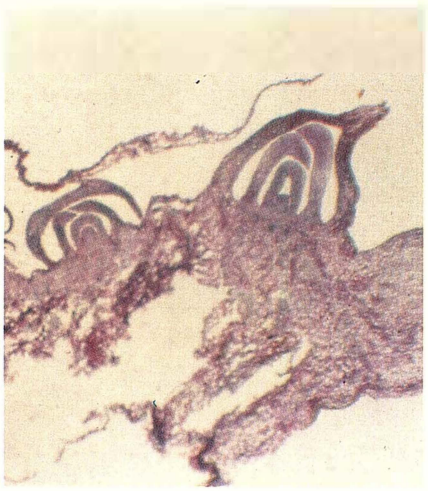
Developments in In Vitro Culture

Cellular biology and in vitro culture of tropical crops are priority research topics. The GERDAT in vitro culture laboratory has two objectives: micropropagation and genetic improvement.

Microcutting and meristem proliferation techniques are already used for large-scale operations for coffee and sugarcane and on a commercial scale for banana and pineapple. Similar techniques are being improved and developed for *Hevea*. Field experiments were undertaken with a commercial *Hevea* microcutting enterprise, Société de microbouturage de l'hévéa (SMH), and expanded to 6 ha of trials in 1989.

Significant results were obtained in the development of culture methods. Innovative techniques using liquid media for temporary immersion enable uniform growth of vitroplantlets. Environment factors (gas, light) were studied to determine optimum growth conditions. Progress in somatic embryogenesis of *Hevea*, cocoa,





Banana in vitro culture showing bud proliferation.

and coffee can be attributed to these developments.

The first whole plant of coconut (*Cocos nucifera*) obtained through somatic embryogenesis was successfully transplanted to the nursery in 1989. Conditions for somatic embryogenesis in this species are being further studied. Techniques for somatic embryogenesis of oil palm using liquid media were developed in collaboration with ORSTOM. The first clone obtained with this method was produced in 1989.

Genetic improvement increasingly depends on modern biotechnological techniques. Regeneration of *Oryza sativa* and *O. longistaminata* and the first banana somatic embryos from groups of cells in liquid media were obtained using these techniques. A genetic transformation program for developing insect-resistant cotton was established in collaboration with the Institut Pasteur and INRA; the first in vitro regenerations of certain genotypes were produced.

Cytogenetics and Histology for In Vitro Studies

Cytogenetic and histological studies are useful for understanding and controlling somatic embryogenesis processes and are therefore indispensable for in vitro culture work.

The sequence of events in oil palm and coffee in vitro cultures was established. Histological analysis is used to monitor the effect of the culture procedure on banana, cocoa, and rice regeneration. Conditions for producing *Hevea* somatic embryos were determined. Comparative histological and biochemical analyses of the development of coffee and *Hevea* zygotic and somatic embryos should help improve somatic embryogenesis.

Genome Analysis of Tropical Species

Priority is given to analysis of tropical species genomes because of the large number of applications of such studies. They are useful for variety identification, description and control of reproductive systems, germplasm evaluation, and measurement of the genetic distance between potential parents. This work is conducted by the GERDAT genome analysis laboratory, AGETROP. In 1989, isozyme electrophoresis was applied to various plants including *Hevea*, cotton, sorghum, sugarcane, date palm, groundnut, rice, and *Striga*.

Preliminary analyses of ribosomal DNA polymorphism in cocoa, sugarcane, and banana were undertaken using RFLP molecular biology techniques for genome mapping and identification of early selection markers. Substantial progress was made in sugarcane genome analysis. The results were presented at the annual meeting of the International Society of Sugar Cane Technologists (ISSCT) held in Brazil, where they generated keen interest.

Field Experiments

Food Crops

IRAT released several upland rice varieties including IRAT 351 for high altitudes and IRAT 216, which is also suited to shallow-water lowland soils. Parental formulae for developing hybrid varieties were established. Production of diplohaploid lines continues as it helps accelerate breeding programs.

Maize research conducted in Brazil in collaboration with Rhône-Poulenc Agrochimie, has provided the first series of experimental lines. Tests of recently developed cultivars (IR 30, IR 31) revealed their potential for cultivation throughout the tropics. A catalogue of recommended varieties was disseminated through the maize network of the Conférence des responsables de la recherche agronomique africains (CORAF).

In Réunion, the ancestry of scented geranium was established and higher-yielding hybrids were produced.

Fruit Crops

The pineapple breeding program undertaken in 1978 in Côte d'Ivoire was completed. Results included the multiplication of five particularly promising varieties. Progeny from interspecific crosses are being evaluated in Martinique on the basis of

segregation observed during vegetative growth. Material introduced from Venezuela is being tested in Côte d'Ivoire and Martinique.

Citrus germplasm collections were enhanced (55 entries in 1989) following a mission in Southeast Asia. Studies on the genetic and phenotypic organization of the genus *Citrus* are being carried out in Corsica and Martinique.

The banana and plantain improvement program widened its geographic scope through its integration into the International Network for the Improvement of Banana and Plantain (INIBAP). A major activity of the program is the enhancement and evaluation of germplasm collections. Another important activity is the analysis of diploid clone fertility through studies of hybrid progeny and an evaluation of their agronomic characters and pest and disease resistance in Guadeloupe and Cameroon.

Segregation of the anthocyan leaf pigmentation character in pineapple hybrids *(left).*

Genetic and morphological diversity of bananas in Indonesia *(right).*

Passionflower collections were undertaken in French Guiana. A program was established for developing varieties with resistance to the *Phytophthora-Fusarium-Pythium* complex. Twenty samples were retained for further studies.

More than 50 new varieties were added to the mango collection at the Korhogo fruit research station in Côte d'Ivoire.

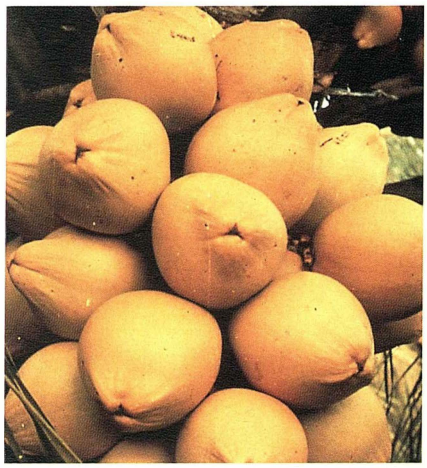
Oil Crops

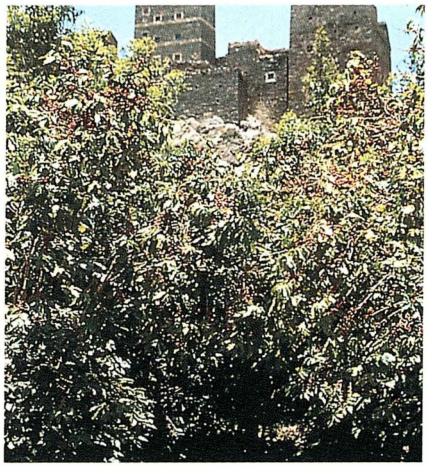
Results of field trials of early oil palm clones confirm IRHO's approach to variety improvement and development. The clones

reproduced true to type, with a higher degree of broad-sense heritability than expected. The clones also reached the average target values and variability was low compared with crosses. Germplasm trials in Indonesia showed the importance of vertical growth in competition processes.

IRHO expanded its range of coconut hybrids in 1989. Hybrids from Dwarf × Tall, Dwarf × Dwarf, and Tall × Tall crosses produce high yields and are ready for release. The Vanuatu research station has become the center of a major regional program, with support from the European Development Fund (EDF). Its objective is to evaluate material from crosses of major ecotypes from the Pacific region and to distribute improved material.

Genetic resources are enhanced through the development of hybrids *(left,* ***fruit of Red Dwarf coconut)*** ***and collection of wild material*** *(right,* **Coffea arabica *collected in South Yemen).***





Stimulant Crops

The value of hybrids obtained from crosses between Guinean and Congolese material (*Coffea canephora* var Robusta) was confirmed. This justifies the continuation of the reciprocal recurrent selection program conducted by IRCC in Côte d'Ivoire. The *C. arabica* improvement program was resumed in Cameroon in collaboration with the Institut de la recherche agronomique (IRA). Sources of resistance to *Meloidogyne* sp. were identified in the *C. arabica* collection in Cameroon. Twenty-two new strains of *C. arabica*, obtained during a joint mission with the International Board for Plant Genetic Resources (IBPGR) in Yemen, were added to collections in Brazil, Costa Rica, and Cameroon.

Cocoa hybrids evaluated in Côte d'Ivoire showed a yield potential of 3 t/ha. In Togo, orthotropic cutting proved to be a reliable clone multiplication method. Germplasm was exchanged with Cameroon, Costa Rica, Côte d'Ivoire, Togo, and Trinidad and Tobago.

Rubber Crops

Genetic and agronomic evaluations of available *Hevea* germplasm clearly show the existence of two distinct populations. One population is made up of clones developed through breeding, with every indication of domestication. The other population includes genotypes obtained from collections and which exhibit wild characteristics. Crosses between the two populations indicate that one or two generations of backcrosses are required to obtain an optimum genetic gain. In 1989, 79 new clones (IRCA 1200 to IRCA 1278) were developed, 31 of which were derived from the PB 5.51 × IR 22 family and 22 from the PB 5.51 × PR 228 family. Updated clone factsheets and recommendations help planters to select appropriate material.

The Scientific Coordinator for crop improvement is responsible for the Mission connaissance et amélioration des plantes (MICAP). The Coordinator's task is to assist the departments in orienting and coordinating their programs and in providing information and training to scientists. The technical committees work together with specialists from INRA, ORSTOM, and cooperating universities to review recent developments in research. CIRAD's responsibilities and priorities in biotechnology and germplasm management were examined, particularly their implications for ongoing research programs and new cooperative and training programs. Two permanent groups were created within MICAP to work on these themes. MICAP organized a crop improvement workshop in Montpellier. The participants worked in two groups. The first group focused on Hevea *improvement and vitroplantlet physiology together with INRA, Avignon, and the Ecole nationale supérieure d'agronomie, Toulouse. The second group studied genetic transformation together with the molecular biology laboratory of INRA, Versailles.*

Trees

The CTFT tree improvement program focuses on a limited number of species. These include multipurpose nitrogen-fixing species (*Acacia albida* and *A. senegal* in dry zones, *A. mangium* and *A. auriculiformis* in more humid zones); timber species (*Terminalia ivorensis, T. superba, Aucoumea klaineana*); eucalyptus; and tropical pines. Approximately 150 new families of eucalyptus hybrids were developed in Congo. Improvement and interspecific hybridization of *Eucalyptus urophylla* and *E. camaldulensis* are part of the effort to increase genetic diversity. Base populations were established for *Terminalia* breeding programs in Côte d'Ivoire and Congo. A new project for improvement and seed production of rattan and quality timber species was launched in collaboration with the Sabah Foundation in Malaysia.

Crop Protection

Crop protection research activities are integrated within the commodity-based programs. Working groups were formed by the Scientific Coordinator responsible for the Mission défense des cultures (MIDEC). The working groups design horizontal programs for the different laboratories and intercommodity thematic operations.

Insects: Identification of Pests and Parasitoids

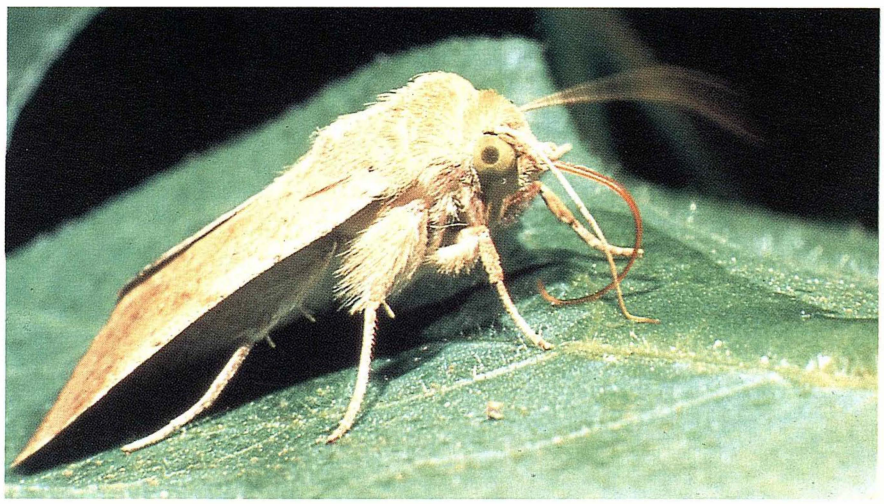
Improvement of control strategies is based on information on crop-associated insects and an understanding of the ecological balances. Exhaustive insect inventories were undertaken. The insect identification laboratory studied 1600 insect samples for identification.

More than 320 species were collected from cotton crops in Paraguay and identified.

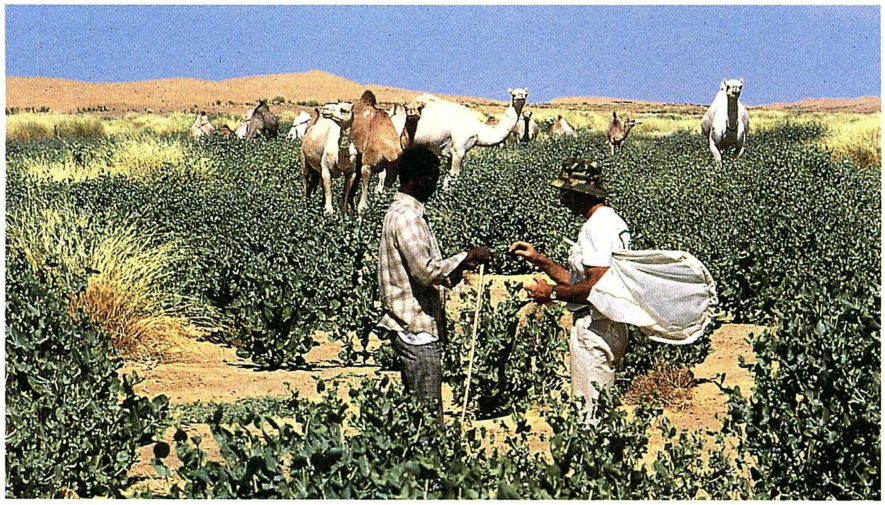
In Togo, changes in insect patterns were studied in a cotton - maize - cowpea - fallow system to determine interactions between population dynamics and crop rotation.

CIRAD scientists participated in a canopy raft[1] mission directed by Prof. Hallé of the Université des sciences et techniques du Languedoc (USTL). Exploration of the tropical forest canopy in French Guiana yielded useful information on insect life.

Heliothis armigera ***is a polyphagous pest of tropical crops. Photo shows an adult on a cotton leaf.***



1. A canopy raft is a 600-m^2 platform that is transported by a hot-air airship and deposited on the tree tops. Scientific observations and experiments on canopy biology are then conducted from the platform, while the airship returns to the base.



Grasshopper and locust survey in the Tamesna region. Spontaneous growth of the wild crucifer Schouwia thebaica *due to the rare rains offers a typical biotope for the gregarious stage of the desert locus.*

The operational locust and grasshopper studies team of PRIFAS-GERDAT undertook a 2-month survey across Niger, Algeria, Morocco, and Spain to complete the description of the desert locust biotopes in the Saharan and sub-Saharan zones. In Niger, the team also conducted a study on distribution over time and across locations of the Sahelian acrid ids in three related locations: Niamey-Arlit axis, river Niger region, and Aïr and Tamesna regions.

Multidisciplinary Research on Insect Vectors

Four teams of scientists are studying disease transmission by insects. Several disciplines are involved, including entomology, genetics, and virology. The objective is to produce resistant vari-eties and to develop techniques for detecting viruses in plants and insects. Several results were obtained in 1989.

Five species of scale insects can transmit the cocoa swollen shoot virus in Togo. Transmission rates are being measured for each species to determine their individual importance in spreading the disease.

Trap studies were conducted to observe population dynamics of bugs that transmit banana mosaic. In Côte d'Ivoire, population fluctuations are linked to climatic conditions and outbreaks usually occurduring the rainy season . In Guadeloupe, popula-tions are observed to decline during tropical depressions.

Maize cultivars with resistance to the maize streak virus (MSV)

are identified by inoculating test material. Leafhoppers were used for this purpose because of their transmission efficiency. Techniques for mass rearing of active transmitters were developed

in Réunion .

In Vanuatu, nursery plants inoculated with the coconut wilt virus by a homopteran vector, *Myndus taffini*, were found to be resis-tant in experimental fields. Trials under controlled conditions are under way to confirm this premunition phenomenon.

New Strategies for Cotton Pest Control

Pesticides should be used rationally to combine maximum efficiency with cost reduction and environment protection. New concepts are being tested for cotton crops by the IRCT crop protection division.

An integrated pest management experiment was established in farmers' fields in Togo, with assistance from the company Calliope. The baculovirus *Mamestra brassicae* was used in combination with one-tenth of the normal dose of synthetic pyrethroids to provide the same degree of control as with the normal dose.

In Cameroon, thousands of hectares of cotton crops are protected with a new method in which one-third of the normal insecticide dose is applied at twice the normal frequency.

Low-volume application of insecticides to control cotton pests.

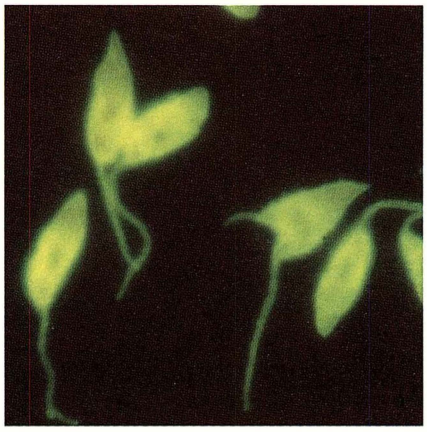
A two-level technique was proposed in 1988 and is being tested in several countries, mainly Cameroon and Chad. Only half the normal dose is applied according to the treatment schedule; the full dose is applied only if pest infestation reaches a predetermined incidence level. Very low volume application, in which the emulsion concentrate is diluted with water at the rate of 10 liters/ha, is a new application method that is gradually replacing ultra-low volume (ULV) application using 1-3 liters/ha of a prepared solution.

New Tools for Disease Diagnosis and Detection

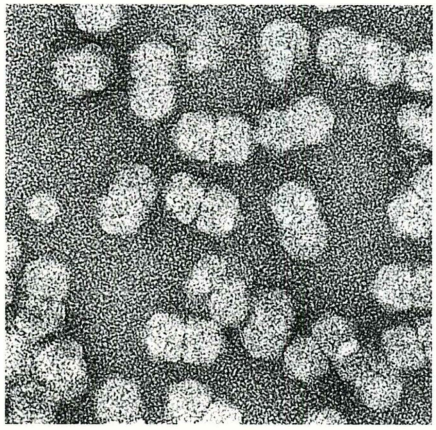
Electron microscopy is commonly used to monitor virus purification. It is also used to observe virus particles and trypanosomes in plant tissue. A new seed-transmitted virus disease was detected in Senegal on groundnuts of a variety introduced from China. Electron microscope studies by IRHO revealed the presence of a filament-shaped virus belonging to the potyvirus group. The virus was mechanically transmitted to *Chenopodium amaranticolor.*

Black leaf streak disease of banana.

*Trypanosomes (*Phytomonas *sp.) revealed by immunofluorescence tests.*



An electron micrograph (× 300 000) of purified digitaria streak viruses (geminivirus).



Immunodiagnosis is also widely used for disease detection. Immunofluorescence techniques are used to detect trypanosomes in Palmaceae and bacteria in sugarcane, millet, rice, sorghum, and wild Gramineae. Immunoenzyme assays (ELISA), using either polystyrene plates or nitrocellulose membranes, can detect viruses of groundnut, banana, cocoa, sugarcane, maize, and rice in field tests. Immunoassays are used for studying the relationship between different strains and for observing pathogen variability through characterization of virus or bacterial serotypes. They are also used for detecting pathogens in quarantine material, selecting contamination-free cuttings and seed, and developing disease-resistant varieties.

But these assays can only detect proteins, the antigens produced by microorganisms. Biochemical methods based on the recognition of specific nucleic acids or enzymes of the parasite genome can detect fungi, bacteria, viruses, and viroids without proteins. *Mycosphaerella* species that cause banana *Cercospora* diseases can be differentiated by electrophoresis based on three enzyme systems. In Cameroon, this method was effective in diagnosing the disease in plantains showing atypical symptoms. Etiology studies on bud rot of oil palm in Ecuador compared DNA of healthy and diseased oil palms. The acids were hybridized with antiviroid molecular probes and analyzed by the western blot technique. Results revealed certain similarities between the sequences observed in the oil palms and those of certain known viroids.

Studies of Plant Trypanosomes

IRHO virologists produced the first in vitro cultures of coconut Hart rot phloem-restricted trypanosomes in 1988. They have now succeeded in obtaining in vitro cultures of the Colombian oil palm marchitez trypanosomes. All types of trypanosomes—phloem-restricted and laticifer-associated—can now be cultured. Isozyme electrophoresis of 10 strains of laboratory-cultured trypanosomes revealed 22 loci and a high degree of genetic heterogeneity. Monoclonal antibodies can be used to distinguish between phloem-restricted trypanosomes and most laticifer-associated trypanosomes.

Comparative Study of Cocoa *Phytophthora*

The physiology of the two main *Phytophthora* species (*P. palmivora* and *P. megakarya*) that attack cocoa was compared in in vitro cultures. The study was conducted under darkness and alternating light-darkness conditions. Phenol compounds belonging to eight chemical groups were added to the culture medium. A factor analysis of 11 morphocultural characters revealed a high degree of uniformity in various *P. palmivora* strains and high diversity in *P. megakarya* strains. Under light conditions, benzoic acids inhibit growth of *P. palmivora* but have no effect on *P. megakarya*. These responses indicate that the two species have very different enzyme systems and therefore differ in their degeneration effect on host tissue.

Study of Host-Parasite Relations Based on Sexual Reproduction of Fungi

The studies focus on the genetic relationship between pathogens and hosts and on their physiological interactions in resistance mechanisms.

Sexual reproduction of *Mycosphaerella*, the causative agent for banana and plantain *Cercospora* diseases, was only observed under natural conditions; it has now been achieved in in vitro cultures. Ascospores obtained under artificial conditions are viable. Culture media and conditions need to be determined for replications. The risk of new pathotypes appearing due to crosses between *M. fijiensis* and *M. musicola* can be evaluated by this method. Genes controlling resistance to fungicides will also be studied.

Sexual reproduction of *Magnaporthe grisea*, the causative agent for rice blast, can now be achieved under artificial conditions. The mating type of 339 strains was determined; both types are equally prevalent. In certain countries such as Burundi, France, and Japan, only one type has been recorded. Only one rice pathogen strain is female fertile. Genetic studies of the parasite are based on the pathogen capacity of the progeny. Virulence of the rice-specific strains is either controlled by a single gene or by two independent or two complementary genes. Screening for resistance in rice varieties is facilitated by the use of strains combining different virulence genes. Genes that control host specificity were also determined. Pathogen capacity of strains specific to rice, maize, and wheat is a polygenic character. Fungal diseases in the three crops are therefore caused by genetically different populations of *M. grisea*.

Biomodels for Locust and Grasshopper Control

The biomodel for the desert locust *Schistocerca gregaria* (Forskal, 1775) is the result of a large-scale effort by the PRIFAS-GERDAT team. The range of this locust extends over 57 countries. The first phase of the project which is funded by the EEC and the French Ministry of Cooperation will be completed in July 1990. The biomodel is extremely complex and requires a powerful calculation capacity. It involves processing of 400 000 information units in routine 10-day calculations. During outbreaks, the same volume of information is processed every day. The objective is to establish charts showing outbreak risks over 10-day periods and a detailed reconstitution of local population dynamics at any location within the range, including movement of winged forms over long distances.

Training and Information at MIDEC

An international training seminar on modern methods for disease detection and prevention was organized in Madagascar by the Madagascan Ministry of Scientific and Technical Research, in cooperation with the national center for rural development research, FOFIFA; INRA; Institut Pasteur; NORAD FIFAMANOR; the universities of Antananarivo, Paris XI, and Lyons I; and CIRAD.

PANTROP, an Expert System for Tropical Crop Determinations

The PANTROP software based on expert systems was developed by the IRCT tropical weed science laboratory. It enables processing of nonnumeric data and organizes information used by a specialist to solve a problem. PANTROP offers a step-by-step procedure for determining the main botanical families of tropical species. Only vegetative characters are used for the identifications. They are usually easy to describe and show little variability within the same family. Conventional characters (flowers, fruit) can also be used, but only to confirm the identification. The scientific validity of the software was tested in the canopy raft mission conducted jointly by USTL, CNRS, and CIRAD in the French Guiana forest. It successfully determined 95% of the samples belonging to the 85 families described in the program.

Professors from Madagascar, France, and Mauritius conducted 25 hours of lectures on theory and more than 40 hours of practical and tutorial work. One session was entirely devoted to rice diseases. Three papers were presented at an open session at the Madagascan Academy.

The fourth international symposium on the epidemiology of plant virus diseases was jointly organized with the Ecole nationale supérieure agronomique de Montpellier (ENSAM), INRA, and ORSTOM. More than 180 scientists attended the symposium which was held in Montpellier from 3 to 8 September 1989.

Animal Biology

Improved Pasture Management

Methods for surveys and quantification of remote-sensing data on grass production were established on the basis of studies conducted in Mauritania. The studies demonstrate that the data are sufficiently accurate for use in planning operations.

Trials over 3 years in Djibouti for pasture management in arid zones have led to the development of large-scale applications. They will involve producer participation for replanting and measures for water conservation.

Reference Publications and Software for Development Operations

The *Atlas des ressources pastorales du Sénégal*, which was published in 1989, is an atlas on pasture resources in Senegal. The work was funded by the Centre technique de coopération agricole et rurale (CTA), and combines input from scientists at IEMVT, the Institut sénégalais de recherches agricoles (ISRA), Sheikh Anta Diop University, Dakar, and from hydrogeologists at the Bureau de recherches géologiques et minières (BRGM). Food value tables were also included; they cover fodder and industrial by-products in the Sahelian, Sudanian, and Sudano-Guinean zones. The tables were compiled by the tropical cattle feeds program (ABT) that was jointly undertaken by ISRA and CIRAD 10 years ago.

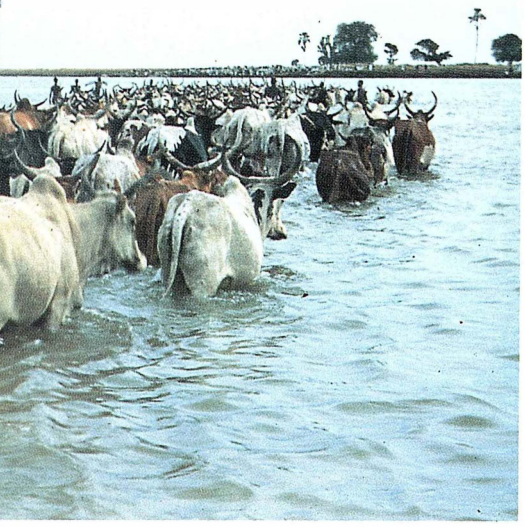
LIVMOD, a computer model for herd productivity, was designed in collaboration with specialists from FAO. The model simulates volume and value of herd output according to different parameters (reproduction, mortality, etc.). PIKBEU is a software for monitoring herds in their natural environment; field tests in Chad confirmed its reliability.

Vaccine Development: a Priority

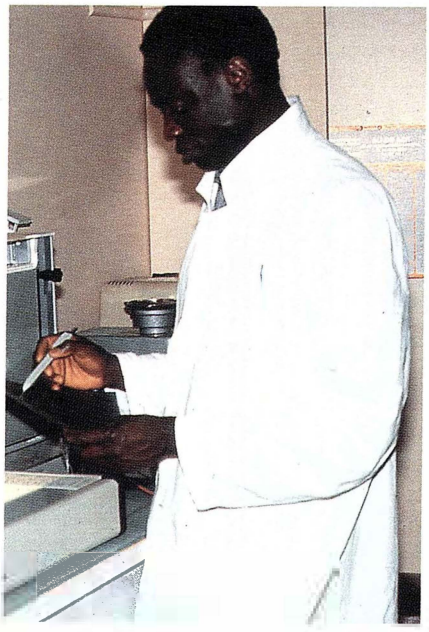
The thermostable clone of the rinderpest virus RBOK was tested on cattle at the Farcha laboratory, Chad. The clone is innocuous and its immunogenicity was found to be satisfactory. If the tests reveal stable heat resistance, the clone could be used in vaccination campaigns against rinderpest in Africa. The homologous attenuated vaccine is being tested against peste des petits ruminants in Côte d'Ivoire and Mauritania.

Improved Diagnosis of Infectious Diseases

The work on monoclonal antibodies against the rinderpest and peste des petits ruminants viruses was presented at the meeting of the European Association of Virologists in Liège. The antibodies can



Development of vaccines that retain their efficacy under tropical conditions.



distinguish between the two viruses and between vaccine and wild African strains of rinderpest. The next step is the development of specific ELISA tests. Specific fragments of the virus genomes for the two diseases were obtained and will be used for preparing cold probes.

Progress was made in the control of mycoplasma diseases. All the *Mycoplasma mycoides* strains can now be identified on the basis of biochemical and serological characteristics and behavior in culture. Several hybridomas were obtained for producing *Mycoplasma mycoides mycoides* monoclonal antibodies. They will be characterized in 1990.

Trypanosomes and Their Vectors

Studies on trypanosomes and their vectors have been carried out over several years in Bobo Dioulasso, Burkina Faso, at the Centre de recherches sur les trypanosomoses animales (CRTA).

CRTA scientists confirmed that the method for diagnosing African trypanosomiasis by hemolysis followed by double centrifugation is more sensitive than the standard single-centrifugation method. The ELISA test for detecting *Trypanosoma congolense* antibodies was improved for standardization.

Work on cattle reproduction shows that trypanosome infections in Baoulé males have a temporary effect on semen quality in adult bulls, whereas they have a permanent effect on adolescent bull calves.

Ticks and Tick-borne Diseases

A doctorate thesis reviewed current knowledge on the biology and ecology of the tick *Amblyomma variegatum* in Guadeloupe. Pheromones could possibly be used to control this tick. This aspect is being examined.

In Chad, tests of the dermatophilosis vaccine were started in collaboration with the University of London. The influence of malnutrition on the immune system will also be studied.

Heartwater research in Guadeloupe is conducted in collaboration with the University of Utrecht. Different indirect immunofluorescence tests were compared for detection of *Cowdria ruminantium* antibodies. Antigens obtained from cultures in endothelial cells are superior to those used earlier. They are more specific, easier to prepare, and cost less.

Aquacultural Research: Production of New Genotypes

CTFT's research in collaboration with the aquaculture center of the Institut des savanes (IDESSA) at Bouaké, Côte d'Ivoire, mainly concerns the genus *Oreochromis*. A characterization program based on enzyme polymorphism studies was established for major species. The characterizations were also based on production characters. Male and female steroid hormones and inhibitors were identified in *O. niloticus*. The information will be used to produce single-sex progeny for developing new genotypes.

CTFT is also studying the biology of potentially useful species for fish farming and restocking (*Lates niloticus, Labeo coubie*). It provides scientific support to development projects for optimizing *Tilapia* and *Clarias* production and for *Tilapia* tolerance to brackish waters.

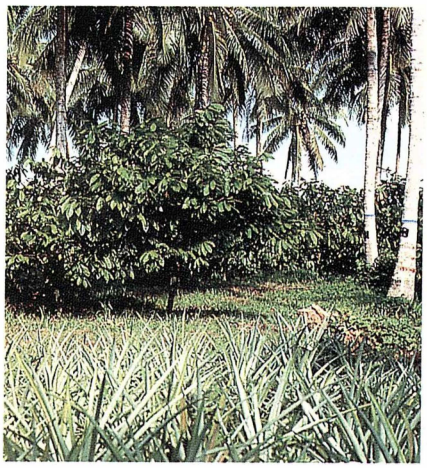
Aquacultural research at IDESSA: intraspecific genetic improvement of* Oreochromis niloticus *through hormone treatments.

Agrarian and Farming Systems

Role of Catalyst

The agrarian and farming systems department, DSA, fulfills its role as catalyst through its four research units. They were established to serve all the other departments.

The production systems unit is responsible for mobilizing ideas on the methods used by the different departments for experiments in farmers' fields. The exercise has evolved into a concrete ATP project which is scheduled for 1990. The unit gave fresh impetus to the production systems group of the R3S drought resistance network. Out of the six projects proposed at the meeting organized by the Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel (CILSS) in Ouagadougou, Burkina Faso, three were submitted to the EEC for funding in late 1989.



Complex farming system with coconut, cocoa, and pineapple intercrops.

The land-use management unit hosted a working group meeting on management of village lands. The group mainly examined livestock production, land tenure problems, and nutrient recycling. It is part of the research-development network and pools expertise in various disciplines from CNRS, ORSTOM, Société d'études pour le développement économique et social (SEDES), Caisse centrale de coopération économique (CCCE), the French Ministry of Cooperation and Development, and several universities.

The farm management unit is working together with CCCE on the crucial issue of financing of agricultural activities. A training program on this topic will be established in 1990.

The communication and farmers' organizations unit is collaborating with CCCE and the French Ministry of Cooperation and Development to prepare a field guide that will describe methods for interventions at rural community level. INRA, ORSTOM, and CIRAD are examining the question of innovation dissemination among farmers.

Overviews

An evaluation of agricultural research results used in development operations in the African savanna was presented at a symposium held in Washington in November. The study was partly financed by the World Bank. The first part of the study includes

Analysis of land-use management in villages.

theme-based findings (major commodities, soil and water resources, soil fertility, farm power and equipment). The second part describes case studies of the river Senegal basin, Volta valleys, Yatenga, southern Mali, and Senegalese groundnut basin. The relevance of innovations was analyzed on the basis of these cases. A similar study was undertaken for the Sahelian zone.

Development of Production Systems

Cropping Systems

DSA continued its efforts to develop on-farm research-development activities in cooperation with the other departments. In Brazil, the development operation for the *cerrados* was strengthened with the assignment of a DSA researcher, a researcher and a technical assistant from the Empresa Goiânia de Pesquisa Agropecuária (EMGOPA), and four extension officers from the Empresa de Assistência Técnica e Extensão Rural do Estado de Goias (EMATER-GO). The Senegal river valley program with ISRA and the Société d'aménagement et d'étude du delta et des vallées du fleuve Sénégal et de la Falémé (SAED) was enhanced with increased input from ISRA, IRAT, and DSA. New projects are being established in the oases. Scientists and development agents working in oases north and south of the Sahara are linked through the GRIDAO network for exchanging information and experience. A research project for modeling oasis crop growth and architecture is being carried out by IRFA, GERDAT, and DSA.

Livestock Production Systems

Traditional tethered cattle systems were analyzed for the IEMVT livestock production systems program. In Guadeloupe this system was found to be as productive as the modern intensive systems, but at a lower cost. Recommendations for improvement include controlled reproduction and accelerated rotation of animals.

Agroforestry Systems

The main objective of the agroforestry program conducted by CTFT is to develop methods for tree management to check degradation of the rural environment. Multiple-use species were screened in a wide range of ecological situations. The species provide many products, including lumber, firewood, fodder, fruit and leaves for consumption, wicker, ropes, ingredients for medicines, etc. The trees protect against wind, sunlight, damage by animals, erosion, and soil depletion. Methods for planting and tree management were field tested with the participation of farmers, traditional social groups, or cooperatives. The experiment confirmed the usefulness of a large number of these species. Some of the operations are: eucalyptus plantings in Burundi, tree savanna management in Niger, reintroduction of *Faidherba albida* in the cotton-growing areas of Cameroon, natural pasture management in Guinea and Kenya, establishment of wind breaks in irrigated areas in the Senegal river valley.

Transfer of Technology

A regional workshop on methods for analyzing farm management and for providing effective support to farmers was organized jointly by the Fundación Nacional de Investigación Agropecuaria (FONAIAP), Fundación para el Desarrollo de la Región Centro Occidental (FUDECO), and DSA in Venezuela. It provided an opportunity for participants from Brazil, Bolivia, Chile, Mexico, Nicaragua, and Venezuela to compare their methods and practices in a domain where the demands on research by agricultural professionals are growing.

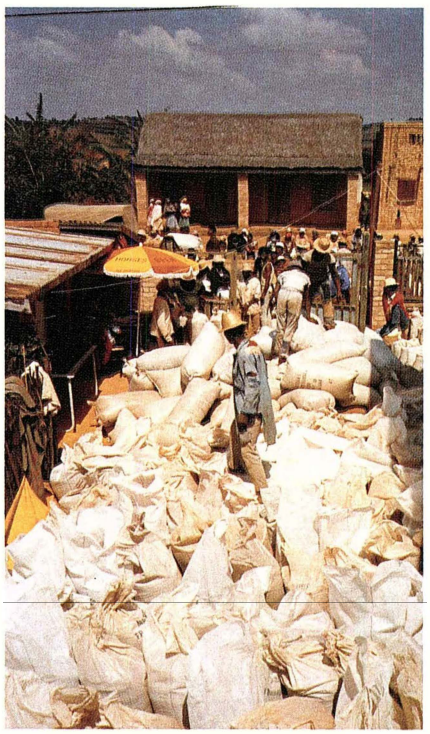
The meeting of the West African network Réseau d'étude des systèmes de production en Afrique de l'Ouest (RESPAO), was held in Accra, Ghana, in August 1989. CIRAD chaired the working group on irrigated crop systems.

The DSA workshop in September 1989 focused on reference farm networks as a support to on-farm experiments and as a means for adapting and disseminating innovations among farmers. The positive effects of changes introduced by different teams in varied environments were evaluated, with particular reference to operations in France (Ségala, Aveyron), Brazil, Mexico, Venezuela, and Madagascar.

Economics and Sociology

CIRAD's economics and sociology program is directed by the Scientific Coordinator responsible for the Mission économie et sociologie (MESRU). 1989 witnessed a reorganization of research themes of this work area. The research is organized into four subgroups: food and agroindustrial products and commodity chains (*filières*); resource economics and input industries; farm management; and agricultural policies and long-term forecasting.

Collection of barley in Madagascar. Efficient harvest collection motivates farmers to produce more.



Economics of Products and Commodity Chains

CIRAD participated in the formation of the Osiriz association that groups together CCCE, Office national interprofessionnel des céréales (ONIC), Centre français du riz, and IRAT. National rice production networks, markets, and policies were analyzed and a data bank was established for monitoring the economic status of this sector.

Cocoa economics research was undertaken following the crash in world prices. It provides information on international market mechanisms and comparative data on cocoa production in Africa, Asia, and Latin America. CIRAD also participated

in a study sponsored by the French Ministry of Cooperation and Development on the competitiveness of African cocoa.

The annual MESRU workshop was held from 11 to 15 September 1989 in Montpellier. The theme selected for the workshop was Economics of Commodity Chains in Tropical and Subtropical Countries: Price Formation and Agricultural Exchange. It was attended by a large number of teams, mainly from Europe and Africa. Seventy papers were presented; they covered most of the tropical and subtropical commodities, including rice, maize, tubers, fruits and vegetables, coffee, cocoa, oil crops, cotton, *Hevea*, livestock, and tropical woods. The practical orientation of wood economics research, mainly its stress on international wood markets, brought about a greater convergence of views between scientists and professionals.

New Unit for Agricultural Policies and Long-term Forecasting

URPA, the agricultural policies and long-term forecasting unit was created within GERDAT. It responds to the need for socioeconomic analyses concerning the countries that collaborate with CIRAD. The information is useful for planning research suited to national development philosophies and for proposing modifications to structural adjustment to French and European donors.

Economics of commodity chains involves analysis of price formation and agricultural exchange.

Structural adjustment in agriculture was undertaken in several countries of Africa (Ghana, Guinea) and Latin America (Colombia, Costa Rica, Ecuador). An international symposium was organized on structural adjustment and agricultural policies, in collaboration with the Instituto Interamericano de Cooperación para la Agricultura (IICA). It

was held in Costa Rica. Research priorities were determined, they are: redefinition of the role of government and decentralized local organizations in production processes, timely implementation of adjustment measures to reduce negative effects on low-income sectors, and analysis of economic dynamics to predict the impact of agricultural policies.

Seminars for Guiding Research

At CIRAD's invitation, Prof. Carl K. Eicher, a specialist on Africa from Michigan State University, gave a seminar on the analysis of rural development factors in African countries. The seminar was organized in Montpellier in November 1989. Prof. Eicher then participated in several meetings on cotton and groundnut economics and extension methods for Africa.

The first meeting on Africa of the European Association of Agricultural Economists was held in Montpellier. The theme selected for the meeting was Production and Consumption in Relation to Agricultural Policies in Africa.

Agricultural and Food Technology

The work area covered by the Scientific Coordinator was changed from agricultural and food technology (MITAA) to technology (MITECH). It was thus extended to include nonfood technology and farm power and equipment.

Following discussions at the CEEMAT review, the CIRAD management decided to promote research in food technology by strengthening the role of MITECH. The Scientific Coordinator is responsible for stimulating and coordinating the work of the departments and for organizing intercommodity thematic projects. Most of the departments involved in these programs—IRAT, IRCC, IRCT, IRFA, and IRHO—conduct field and laboratory research directly related to their mandate crops. The CEEMAT food technology and engineering division is mainly concerned with technological processes and their transfer.

Changes in Urban Food Habits

The ATP on technological innovations for food production in rural areas was initiated in 1988. Three reports were published on the preliminary work. *Quelle approche de la consommation alimentaire?* presents concepts and methods for analyzing urban food habits in sub-Saharan Africa. It was prepared by the unit for

economics of technological changes at the Lumière University of Lyons. The conclusion stresses the need to consider food patterns in analyses of changes in urban consumption habits in Africa. The two other reports were prepared by the Ecole nationale supérieure des industries agricoles et alimentaires (ENSIAA) through Altersyal.[1] They attempt to determine technological innovation patterns in the food system. The first report by ENSIAA proposes a method for a socioeconomic analysis of innovations. The second report presents six case studies: mechanization of *gari* production in Togo, production of maize pasta in West Africa, cereal grain mills in Senegal, oil presses in Cameroon and Casamance, and production of cassava chips in Colombia.

Postharvest Technology

Research priorities were established following an evaluation of the program on postharvest technology conducted in Garoua in northern Cameroon by the Institut de la recherche agronomique (IRA) and CIRAD. The priorities are: to intensify commodity-based studies (cereals, groundnut, cowpea, fruits, beef) for determining market demands and to propose appropriate techniques. The studies will first concentrate on maize and sorghum. Current surveys reveal the need to develop a dry hulling and milling system. The Ecole nationale supérieure des industries agricoles et alimentaires du Cameroun (ENSIAAC) located in N'Gaoundere, Cameroon, will also participate in this effort. ENSIAAC has expressed its desire to extend its collaboration with CIRAD to other themes such as yam preservation and production of sorghum beer. It is also interested in the drying techniques developed and tested by CEEMAT.

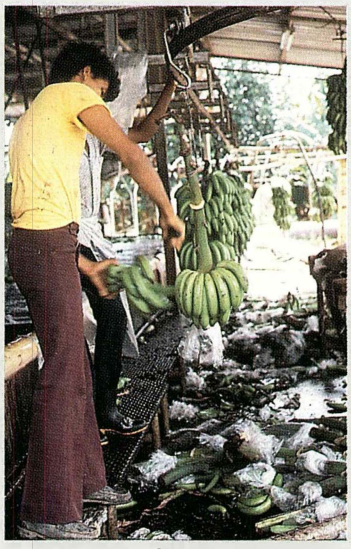
A Regional Center for Innovation and Transfer of Technology

CIRAD participated in the establishment of a regional center in France for innovation and transfer of technology. The center is called TRIAL (Transfert et innovation en agroalimentaire) and its objectives are to:

– strengthen regional expertise in specific scientific themes;

– harmonize management of the regional pilot plants at the Commissariat à l'énergie atomique (CEA, Marcoule), Centre national du machinisme agricole, du génie rural, des eaux et des forêts (CEMAGREF), CIRAD, ENSAM, INRA, University of Montpellier I, USTL;

1. Altersyal is a scientific group formed by ENSIAA, GRET, and CIRAD.



Packaging of bananas in Panama.

Food Technology Research by the Different Departments: Main Research Topics for 1989

At IRAT, laboratory research on cereal technology focused on parboiling qualities of rice; production of couscous from maize, millet, and sorghum; hulling of sorghum and its use for making tô *(thick porridge made from sorghum). The results are used in breeding programs. Couscous and* tô *are considered as reference products for characterizing cereals to facilitate selection of appropriate breeding material.*

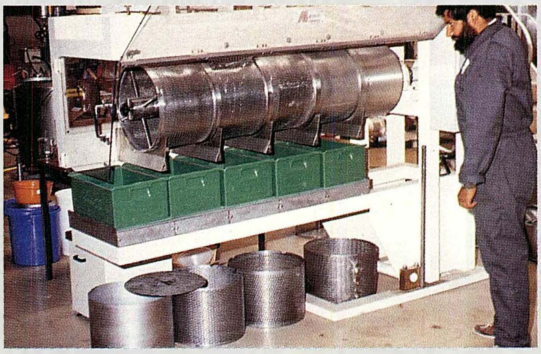
IRCC is carrying out several studies on coffee and cocoa chemistry and technology, including:

– tests of a rotary dryer fitted with steam pipes for cocoa;

– construction of a fluidized bed dryer for coffee;

– monitoring of changes during fermentation and roasting of cocoa beans by determining the pyrazine content;

The AFREM couscous mixing, rolling, and sifting machine.



– use of enzymes for pectin hydrolysis of cocoa beans;

– characterization of ground roasted coffee mixes (arabica-robusta) by determining 16-O-methylcafestol;

– studies on coffee aroma (characterization of sulphur compounds, consumption of aroma precursors during roasting).

IRCT and British scientists are working together with research teams from Burkina Faso, Côte d'Ivoire, and Togo in a large-scale project financed by the EEC. They are studying glandless cotton (without gossypol) as a highly nutritive source of proteins for human and animal (single-stomached animals) diets.

The IRFA food technology team gives priority to fruit storage, and packaging and processing methods that minimize loss of aromatic qualities. Several studies were carried out on the following topics:

– cooling kinetics for bananas packed in cartons;

– determination of avocado maturity through thermal conductivity measurements;

– development of a process for extracting mango pulp;

– application of tangential flow microfiltration for different citrus juices.

The IRHO oils and fats chemistry laboratory is testing a physico-chemical process for eliminating most of the cholesterol in milk products in a pilot unit. Encouraging results were obtained for improving fat refining techniques, particularly for deacidification of hyperacidic oils and for bleaching of palm oil. The department is also conducting research on the synthesis of new surfactants, hydroxamic acid agents, and N-substitute fatty amid agents.

– provide assistance in technology innovation and transfer to manufacturers in the region;

– conduct studies on future perspectives.

TRIAL is strategically located at Agropolis, Montpellier's agricultural research and technology complex, and is part of a national network of similar centers . It is therefore favorably placed for pro-moting the development of innovative technology.

Biometrics

The biometrics unit was established in March 1988 by bringing together biometricians with expertise in agronomy, mathematics, and computer science from the different departments. The unit provides support to agronomists, breeders, forestry experts, livestock production experts, and economists of the CIRAD departments and their partners. Well-targeted research and training operations were conducted with support from CIRAD's central computer services unit and in collaboration with INRA, USTL, Institut national agronomique Paris-Grignon (INA-PG), and Institut technique des céréales et des fourrages (ITCF) .

The unit organized training seminars on agricultural experimenta-tion methods at ISRA in Senegal; on the use of statistics software at IRA in Cameroon; on interpretation of results from multilocation trials and on genetic improvement of forest trees at CIRAD in Montpellier. It has produced and disseminated technical papers and provided training to more than 50 participants.

The unit also supervises the development of new techniques for dividing populations into subgroups using different types of criteria. In this it collaborates with USTL. The unit is working with INA- PG for determining experimental designs that are better than conventional designs for trials in heterogeneous environments.

It was also involved in the development of software and expert systems. The CSTAT and LISA programs were improved and a new program for management and use of meteorological data, METEOSOFT, was developed. An expert system for diagnosing cotton diseases and a cotton crop development model are being designed.

INTERNATIONAL COOPERATION

CIRAD is a tropical agricultural research center, but it is above all a center for international cooperation. The Center fulfills its mission to promote development of tropical and subtropical regions by operating within national systems in Africa, Latin America, Asia, and the Pacific region. It participates in on-site programs designed and conducted in collaboration with its partners. Links with the national systems form the core of CIRAD's cooperation effort. They are supported by other linkages with European centers of excellence and international organizations.

CIRAD 1989

Europe

Due to historical reasons, Europe has acquired a vast experience in tropical agricultural research. France, in particular, has maintained strong, integrated teams in the tropics and devoted substantial funds to the development of these regions. It now intends to combine its efforts with those of its European partners. The aim is to mobilize know-how and to pool resources to effectively meet the massive requirements for international development.

CIRAD 1989

Two objectives guide CIRAD's cooperation policy: to strengthen existing links with EEC institutions and to establish links with other European centers of excellence.

European Economic Community

CIRAD deals with two EEC directorates on a regular basis: Directorate-General for Development (D-G VIII) and Directorate-General for Science, Research and Development (D-G XII).

A Significant Event: Lomé IV Convention

During 1989, D-G VIII negotiated the new EEC-ACP agreement between the Community and the 66 African, Caribbean, and Pacific (ACP) countries. The fourth Lomé Convention was signed in December and marks an important stage for research activities. It enhances the role of the national research systems, which are considered a cornerstone of economic development and cultural evolution in the ACP countries. The convention envisages long-term support, including equipment supply, to national programs with a regional scope, rather than occasional assistance to specific projects.

D-G VIII also administers the European Development Fund (EDF) which finances several projects in tropical countries. CIRAD is involved in ten such projects.

Priorities of D-G XII

Forty-nine projects proposed directly or indirectly by CIRAD were approved for the second program on science and technology for development (STD II, 1987-1991) of D-G XII. They will be undertaken directly by CIRAD or in association with European, African, and Latin American teams (listed in annex). The projects correspond to the thematic expertise of different organizations. CIRAD's strength lies in the areas of crop improvement, crop protection, livestock production, and postharvest technology.

D-G XII also supports the establishment of research networks. It financed the creation of the Bureau pour le développement de la recherche sur les oléagineux tropicaux perennes (Burotrop), an office for developing research on perennial tropical oil crops.

IRHO is an active member of this association of seven European countries. Burotrop has the mandate to establish research networks in producer countries and to coordinate the efforts of donor organizations. The project for establishing a network on small ruminants, undertaken by GTZ in collaboration with IEMVT, was also approved by the EEC. The idea of a tropical forest network was mooted. The first meeting was organized in October at the initiative of the EEC; CTFT participated in the meeting.

On the occasion of the EEC presidency held by France, the Institut national de la santé et de la recherche médicale (INSERM), INRA, ORSTOM, and CIRAD organized a seminar in Paris on the future strategies of European research in the areas of health and agriculture in the tropics. It was attended by 40 participants from various European countries who discussed the priorities of the next program on science and technology for development.

European Centers of Excellence

CIRAD has long-standing and broad-based links with the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), FRG. The two organizations have jointly undertaken various field projects. The most important projects are: in Burkina Faso, at the animal trypanosomiasis center CRTA, Bobo Dioulasso; in Malawi, for small ruminants; in Niger, on herd management; in Ghana, on rice cultivation. A new cooperative project is being prepared for developing the crop protection database Iphytrop. Regular meetings are held to coordinate these joint activities.

The Chairman of the Arbeitsgruppe tropische und subtropische Agrarforschung (ATSAF), the FRG tropical and subtropical agricultural research working group, also attended the last meeting which was held in May 1989. The proposed tour of German universities by CIRAD directors in 1990 was discussed at this meeting.

In the Netherlands, CIRAD has established firm links with the Koninklijk Instituut voor de Tropen (KIT), which involve exchange of scientists and joint projects. CIRAD is also collaborating with the University of Utrecht. In 1989, contacts were made with the Tropenbos foundation for studying tropical forests and with the University of Wageningen.

In Belgium, CIRAD works together with several universities, including those of Leuven, Gand, Liège, Brussels, Gembloux, and Louvain-la-Neuve.

Several CIRAD departments work with organizations in UK. CEEMAT collaborates with the National Institute of Agricultural Engineering (NIAE), Bedford; IRFA with the Overseas Development Natural Resources Institute (ODNRI); and IEMVT with the Centre for Tropical Veterinary Medicine, Edinburgh, and ODNRI. The ODNRI Director visited CIRAD in June 1989.

United States of America

For more than 10 years now, CIRAD has been collaborating with specialized laboratories at universities (California, Florida, Michigan, New York, Pennsylvania, Texas), Agricultural Research Service centers of the United States Department of Agriculture (USDA) or private companies. The activities focus on variety improvement (genetics and molecular biology) and crop protection (virology, entomology) for groundnut, cotton, and citrus. The two scientific communities are brought closer through visits, information exchange, postdoctorate training, and joint projects. CIRAD also maintains contacts with American companies interested in its know-how on cotton breeding, maize and rice hybrids, cotton and natural rubber processing techniques, and protection of banana plantations.

International Organizations

International organizations, funding agencies, and agricultural research centers work in the same countries and often on the same themes as CIRAD. As might be expected they cooperate to coordinate their activities more effectively.

World Bank and United Nations Agencies

CIRAD is involved in 15 projects funded by the World Bank in Africa and Asia. The CIRAD liaison office for the World Bank organized a meeting during which IRCT presented the status of cotton research in France before 15 specialists from the Bank. At a World Bank workshop on agricultural technology in Africa, DSA presented an overview of activities in the arid zones, while Winrock International reviewed work in the humid zones.

CIRAD maintains long-standing links with the UN agencies, mainly FAO. Like the World Bank, FAO often calls in CIRAD specialists for consultation and long-term assignments. For example, an IRFA scientist is coordinating the FAO-funded regional program based in Fujian, China, for controlling greening disease of citrus.

International Agricultural Research Centers

CIRAD has signed cooperation agreements with six international agricultural research centers (IARCs) of the CGIAR: International Center for Agricultural Research in Dry Areas (ICARDA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), International Rice Research Institute (IRRI), Centro Internacional de Agricultura Tropical (CIAT), and Centro Internacional de la Papa (CIP).

Two new operations were added to the nine ongoing joint programs. One of the new operations is conducted with CIAT on the improvement of natural pastures in the eastern plains of Colombia. The other operation carried out with the International Livestock Center for Africa (ILCA) and CIAT concerns the formation of a West African network to evaluate the tropical forage legume germplasm from CIAT's collection in the humid zone. Fifteen CIRAD specialists are assigned to these programs. Two meetings were held to discuss coordination and planning of the collaborative programs: one with IRRI in Montpellier (June) and the other with ICRISAT in Hyderabad, India (October).

CIRAD also assigned senior scientists to two international centers. One IRAT scientist was nominated to head the upland rice program at IRRI and one IRFA scientist is responsible for the INIBAP germplasm program.

Program	Partner(s)
Maize-based farming systems	CIMMYT
Groundnut pathology	ICRISAT
Sorghum in West Africa	ICRISAT
Rice varietal improvement	IRRI
Cassava postharvest technology	CIAT
Agroforestry	ICRAF
Small ruminants	ILCA
Trypanosomiasis immunology	ILRAD
Fertilizer economics in West Africa	IFDC
Improvement of natural pastures in the eastern plains of Colombia	CIAT
Evaluation of forage legumes in the humid zone of West Africa	CIAT ILCA

CIRAD's collaborative programs with the international agricultural research centers.

Frequent contacts stimulate and strengthen cooperation between CIRAD and the IARCs. Visits and exchanges between the organizations increased. CIRAD received the visits of the Director Generals of the International Service for International Agricultural Research (ISNAR) and of CIAT and the CGIAR Executive Secretary. The Center hosted the meeting of the CGIAR working group on sustainability chaired by the Director General of ICRISAT. Specialists from the International Food Policy Research Institute (IFPRI) attended the economics and sociology workshop organized by MESRU in Montpellier. The Director General of CIRAD visited IITA in Nigeria and CIAT in Colombia. The nomination of Henri Carsalade, CIRAD's Director of Research who is also Chairman of the ISNAR Board, to chair the Committee of the CGIAR Board Chairs (CBC) for 1989-1990 will cement CIRAD's relations with the international system.

Africa: Past and Future

A major CIRAD objective is to maintain its cooperative effort through mixed teams working at the African research centers. Past ties through a common history are sufficient justification for this priority. It is also warranted by current preoccupations. Africa is a continent confronted by severe constraints to agricultural development for self-sufficiency and economic well-being.

Experience acquired in other regions can only be beneficial if it is adapted to the African situation, with the participation of the national systems. CIRAD is determined to contribute to this effort.

Research with a Regional Scope

National agricultural research systems are best placed to identify and satisfy the needs of local agriculture. However, challenging research programs that correspond to development priorities need to be based on regional cooperation. Human and financial resources can thus be pooled and concentrated on common-interest themes.

In keeping with this philosophy, agricultural research institutions from 15 African countries have formed a regional cooperation network, CORAF (Conférence des responsables de recherche agronomique africains). The ultimate objective of CORAF is to

CORAF network workshops in which CIRAD participated in 1989.

Groundnut Network

- Crop protection workshop, Ouagadougou, Burkina Faso, 19-22 September
- Workshop on groundnut cultivation in zones with two rainy seasons, Brazzaville, Congo, 13-16 December

Cotton Network

- Meeting for establishing a cotton network, Lomé, Togo, 30 January
- Meeting and tour of Mali, Burkina Faso, and Côte d'Ivoire by network scientists, 18-30 September

Maize Network

- General network meeting, Brazzaville, Congo, 24-27 January

Rice Network

- Weed control workshop, Abidjan, Côte d'Ivoire, 30 January-3 February

Drought Resistance Research Network

- Field program: Workshop on agronomic factors for drought tolerance, Bouaké, Côte d'Ivoire, 24-28 April
- Watershed program: Workshop on hydrological potential of lowlands and lowland management for agriculture, Ouagadougou, Burkina Faso, 8-14 May
- Farming systems program: Planning workshop for research priorities, Ouagadougou, Burkina Faso, 4-7 April

Livestock Production

- Feed resources
- Animal health
- Genetic improvement and reproduction in the Sahel
- Genetic improvement and reproduction in the humid zone
- Livestock production systems

Forestry

- Agroforestry
- Management of natural forests
- Germplasm improvement

Priorities adopted by CORAF for livestock production and forestry.

strengthen national organizations and build up a real African scientific community. To achieve this objective, CORAF encourages constant interaction among partners to establish priorities and respective tasks, pools expertise and facilities, and forms dynamic research networks.

Organization of Research Networks

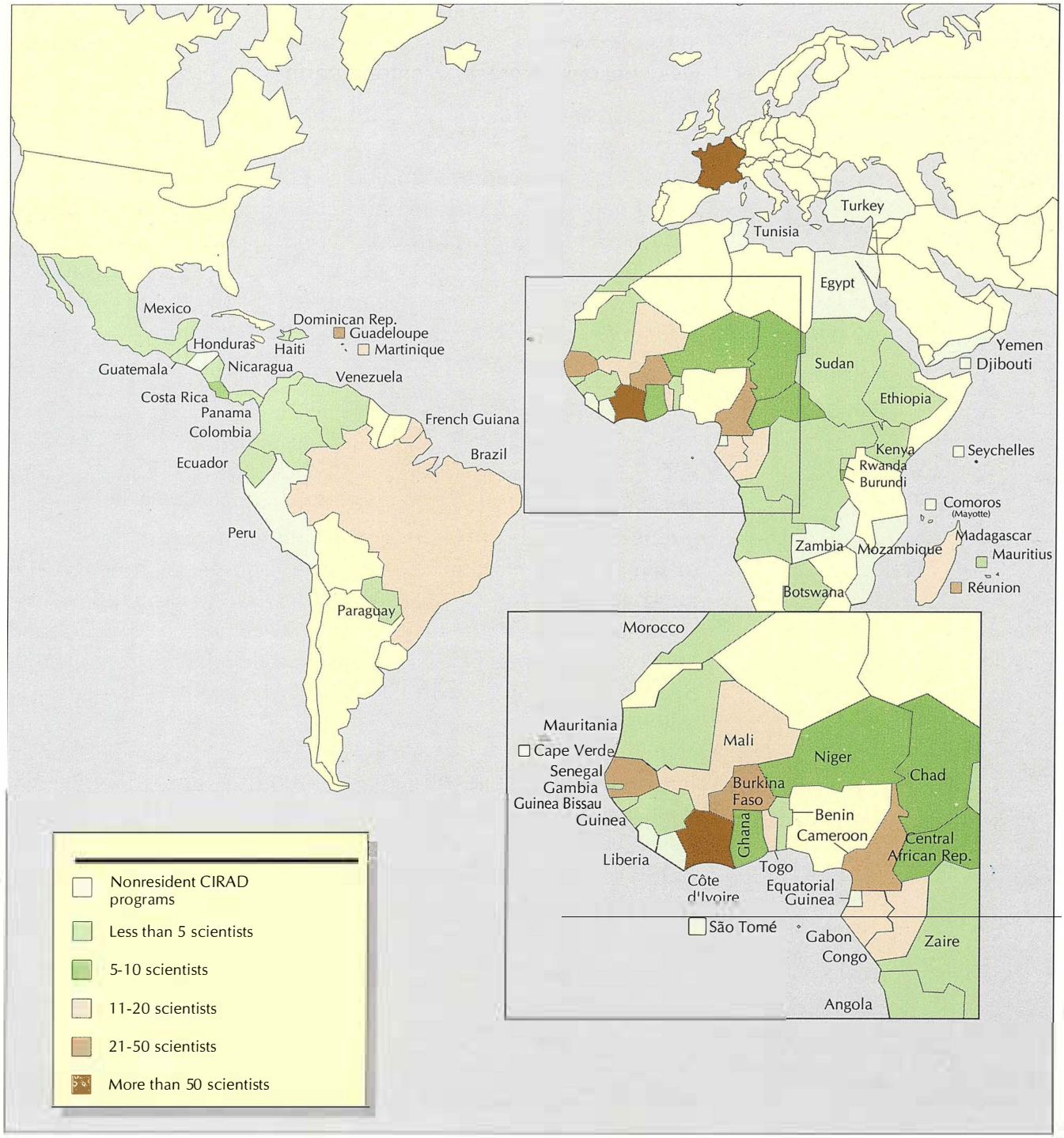
CIRAD, along with ORSTOM and INRA, participates in the CORAF activities. It assists in defining priorities and many of its scientists are involved in the networks. Six networks were set up for drought resistance research (R3S), groundnut, maize, cassava, rice, and cotton (established in 1989). CIRAD also participated in organizing the network workshops held in 1989. At the CORAF meeting held in Libreville in February, other sectors of activity were explored. Priorities for forest, livestock production, and veterinary research were defined. Three themes were adopted for forestry and five for livestock production.

CORAF has been studying its future strategy. It plans to strengthen its political mandate and to extend its scope to organizations in nonfrancophone countries of West and central Africa and to other European research centers.

Research Bases at Network Nodes

Innovative technologies need to be developed in the environments where they will be applied. The use of identical methods throughout the network enables a comparison of the results. Network activities also need to be supported by transnational research bases with multidisciplinary teams, guaranteed funding, and the necessary infrastructure.

Substantial progress was made in the establishment of such bases. In early 1989, the CIRAD-ICRISAT team was established in Mali for conducting a joint sorghum research program. The team is made up of eight scientists, four of whom come from IRAT. It is connected to the West African sorghum network coordinated by ICRISAT. In Cameroon, a general agreement was signed by the Cameroon Minister for Higher Education, Information Science, and Scientific Research on 25 October 1989 for establishing a


Mexico
Dominican Rep.
Guadeloupe
Martinique
Haiti
Honduras
Guatemala
Nicaragua
Venezuela
Costa Rica
Panama
Colombia
French Guiana
Brazil
Ecuador
Peru
Paraguay
Turkey
Tunisia
Egypt
Yemen
Djibouti
Sudan
Ethiopia
Kenya
Seychelles
Rwanda
Burundi
Comoros
(Mayotte)
Madagascar
Mauritius
Zambia
Mozambique
Botswana
Réunion
Morocco
Mauritania
Cape Verde
Mali
Niger
Chad
Senegal
Gambia
Guinea Bissau
Guinea
Burkina Faso
Benin
Cameroon
Ghana
Central African Rep.
Liberia
Togo
Côte d'Ivoire
Equatorial Guinea
São Tomé
Gabon
Congo
Zaire
Angola
Nonresident CIRAD programs
Less than 5 scientists
5-10 scientists
11-20 scientists
21-50 scientists
More than 50 scientists

CIRAD 1989

regional banana and plantain research center. It will be located at the Nyombé station of the Institut de la recherche agronomique (IRA) and will be linked to INIBAP.

CIRAD assigned scientists to the Senegalese agricultural research organization, ISRA, as part of its cooperation with CORAF. The scientists will support the multidisciplinary teams in Senegal, at the irrigated maize base in Saint-Louis and the vegetable crops base in Cambérène-Dakar. Funds for equipment and operations were granted by the French Ministries of Cooperation and Development and of Research and Technology to the groundnut team at the ISRA Bambey station and the rice team at the IDESSA Bouaké station in Côte d'Ivoire.

Integrated Research-Development Projects

CIRAD's cooperative activities are not limited to commodity- or theme-based networks. The Center offers technical assistance to development projects in regions with similar ecologies and production systems. Such projects combine expertise in various disciplines and on different agricultural products. They provide an opportunity for CIRAD to study development methods. Two such projects are under way: in Garoua, Cameroon, with IRA and Sodecoton for cotton-based systems in the Sudanian zone; and in Saint-Louis, Senegal, with ISRA and SAED for irrigated crops in arid regions.

Bilateral Links for Regional Cooperation

Interaction with CORAF enables CIRAD to visualize the regional context and thus define the main priorities and guiding principles for transnational cooperation. Concrete operations to attain the objectives, however, require bilateral negotiations with each partner. The negotiations also provide an opportunity to review ongoing collaborative programs and to effectively direct the course of cooperation. In 1989, 13 agreements were signed between CIRAD and national research organizations or their sponsors. More than 300 CIRAD scientists are working for research operations or development projects within bilateral programs.

Research organizations meet regularly, in Africa and France, to coordinate their activities. Their conclusions are communicated

to the sponsoring bodies in host countries and ratified by inter-State commissions. Three meetings were held in France in 1989: from 16 to 21 June with ISRA; on 5 and 6 October with the Madagascan rural development research center, FOFIFA; and from 24 to 26 October with the Cameroon Ministry of Higher Education, Information Science, and Scientific Research. In Côte d'Ivoire, the follow-up commission, appointed through the

Agreements between African governments or national agricultural research organizations and CIRAD.[1]

Country	Type of agreement	Date when signed
Burkina Faso	Draft agreement between the Centre national de recherche scientifique et technologique (CNRST) and CIRAD	4 July 1989
Cameroon	Special arrangement between the Délégation générale à la recherche scientifique et technique (DGRST) and GERDAT	6 June 1980
Congo	Agreement between the government of the Republic of Congo and GERDAT	27 October 1984
Côte d'Ivoire	Draft agreement between the Institut des savanes (IDESSA) and CIRAD	26 February 1988
	Executive agreement between the government of the Republic of Côte d'Ivoire and CIRAD	4 May 1988
Gabon	Draft agreement between the Centre national de la recherche scientifique et technologique (CENAREST) and GERDAT	3 January 1985
Guinea	Draft agreement between the government of the Republic of Guinea and CIRAD	23 April 1987
Madagascar	Draft agreement between the Ministry of Scientific and Technological Research for Development and CIRAD	12 June 1989
Mali	Draft agreements between the Ministry of Rural Development and GERDAT, concerning: – Institut d'économie rurale (IER) – Institut national de la recherche zootechnique, forestière et hydrobiologique (INRZFH)	 9 May 1977 10 January 1983
Niger	Draft agreement between the Institut national de la recherche agronomique du Niger (INRAN) and CIRAD	17 December 1987
Rwanda	Draft agreement between the Institut des sciences agronomiques du Rwanda (ISAR) and CIRAD	16 December 1987
Senegal	Executive protocol to the general cooperation agreement between the Institut sénégalais de recherches agricoles (ISRA) and GERDAT	20 February 1979

1. Or with GERDAT, before 1985.

executive agreement between the Ministry of Scientific Research and CIRAD, met on 24 and 25 January in Abidjan.

New Cooperation Programs

The geographic groups formed through cooperation between CIRAD and its traditional African partners are not intended to be closed structures. The existing networks will be extended to new partners and thus benefit from fresh input. Consequently, CIRAD organized a workshop in Lagos on mechanized farming systems. It was attended by a large number of Nigerian scientists and agroindustrialists. A large-scale cooperative effort is planned for *Hevea* cultivation.

Several personalities from African institutions visited CIRAD during the year. Prominent among them were the Angolan Vice-Minister for Cooperation; the Director General of the Institut des sciences agronomiques du Burundi (ISABU); the Chairman of the Board and Director of Research of the Institut national pour l'étude et la recherche agronomiques (INERA), Zaire.

Mediterranean Countries

CIRAD's activities in the Mediterranean region are limited to a cooperative program with Morocco for production of vaccines and greenhouse-grown bananas. In Turkey, contacts made through IRCT and IRFA are currently beset by funding problems. However, the Groupe de recherche pour le développement de l'agronomie oasienne (GRIDAO), coordinated by DSA, is often called upon by the northern African countries to carry out expert missions and provide training to national scientists.

Latin America: Evolving Cooperation

CIRAD's activities in Latin America have not progressed very far. Many new operations had to be postponed or cancelled following a significant decrease in specific funding.

During the past 10 years, collaborative research programs were successfully developed with various organizations, particularly with the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), Brazil. They dealt with upland rice improvement, oil palm and coconut improvement and breeding, tropical wood technology and forest management, and farm mechanization for smallholders in semi-arid zones. These collaborative programs with Brazil are being scaled down. Only research on smallholder farming systems (DSA) is being enhanced in the cerrados and the Nordeste region.

In other countries of the southern cone, the situation remains unchanged. The most significant program is that between IRCT and Paraguay, which has acquired a high degree of efficiency over the years. The development potential of the subtropical regions in Argentina and Paraguay is being considered; climatic conditions in these regions are similar to those in southern Europe.

Contacts were established with countries of the Andean zone. In Bolivia, development of tropical crops, mainly upland rice and soybean, is progressing rapidly. In Ecuador, CIRAD scientists are assisting in the development of oil palm, banana, and cotton crops. Plans are under way to extend the Center's activities to cocoa, coffee, and upland rice sectors. In Colombia, CIRAD continues to work with the Federación Nacional de Cafeteros de Colombia (FNCC), and the private sector, particularly the oil palm plantations. New operations were initiated for *Hevea* and fruit crops. In Venezuela, DSA maintains links with research and development organizations for dual-purpose livestock production (milk and meat).

In Central America, the networks, mainly those for cotton and banana, were extended to most regions of the isthmus. This is the result of collaboration with IICA (Promecafé program) and the Centro Agronómico Tropical de Investigación y Enseñanza, CATIE (agroclimatology, cocoa and banana cultivation). Funding for the Promecafé program and CATIE is due for renewal in 1990 and 1991. Therefore, apart from an expansion of the IRCC

team for the Promecafé program, there have been no significant changes, despite an in-depth analysis of the strategy for the 1990s. In Nicaragua, France has offered emergency aid to rehabilitate areas affected by cyclone Joan. IRHO was thus entrusted a large-scale coconut replantation program on the Atlantic coast.

In the Caribbean, CIRAD increased its contacts with Trinidad and Tobago, Barbados, and the Dominican Republic. Discussions are under way with the Caribbean Agricultural Research and Development Institute (CARDI). CIRAD teams are also playing an increasingly important role in the French West Indies and French Guiana.

Pacific Region: Increased Cooperation

In the South Pacific, the Saraoutou coconut station in Vanuatu now serves as a regional base from which IRHO provides support to 19 countries of the region. Expansion of the Valetururu station, with support from IRCC, is expected to lead to the gradual emergence of regional coffee and cocoa networks linking Vanuatu, New Caledonia, Papua New Guinea, Samoa, etc.

CIRAD resumed its activities in the Cook Islands (reforestation), Papua New Guinea (coffee, oil palm), and Fiji (coconut).

Asia: Increased Presence

CIRAD strengthened its presence in Asia through new cooperative projects by CTFT in Malaysia, Indonesia, and Vietnam, and by IRHO in the Philippines.

The Center's research work in Asia comprises a strong socioeconomic component; it is aimed at smallholders and stresses their participation. CIRAD's activities in the region are marked by a long-term approach. In 1988, CTFT appointed a regional officer

who is based in Singapore. The department can thus plan a consistent cooperation strategy for Southeast Asia. It focuses on four areas: monitoring changes in the vegetation canopy through remote sensing (Thailand, Malaysia), forest inventories (Malaysia), silviculture (Indonesia), and wood technology (Vietnam).

Indonesia is poised to become Southeast Asia's leading producer due to its size and potential, dynamic agricultural sector, enterpris-

CIRAD 1989

ing farmers, and rigorous economic policy. Agriculture and agribusiness are important aspects of the country's development efforts. CIRAD's assistance concerns soybean, oil palm, coconut, *Hevea*, and forestry. DSA, in collaboration with the Regional Coordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops (CGPRT), is conducting a study to identify socioeconomic constraints to intensive soybean cultivation. This study was recently extended to include Thailand.

Agriculture in Thailand is mainly based on smallholdings. Priorities include improved productivity and agroindustrial development. In the research program on cattle reproduction physiology by the Chulalongkorn University and IEMVT, herd surveys were completed and the data are being analyzed. The second phase of the program will be designed according to the results. IRCA's collaboration with the Rubber Research Institute of Thailand (RRIT) and the Mahidol and Prince of Songkhla Universities received official recognition by the Thai authorities. A resident researcher and a French government-sponsored research fellow were assigned to the projects.

Cooperation with the Economic and Social Commission for Asia and the Pacific (ESCAP) progressed further with the expansion of the Iphytrop crop protection database. It is being extended to include human and animal health sectors, in collaboration with the International Health Development Foundation, the Netherlands, and the Ecole nationale vétérinaire de Lyon, France.

CIRAD signed an agreement with the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) in 1987. Cooperation has now progressed beyond preliminary exchange to the assignment of an IRHO researcher to PCARRD, Los Baños, to participate in the coconut-based farming systems program.

In Vietnam, various projects were launched as private enterprise was revived in the country. In October, a seminar was organized

in Hanoi to discuss the current status and future of scientific and technical cooperation between France and Vietnam. The seminar gave fresh impetus to Franco-Vietnamese relations which had been at a standstill during the past 2 years. A mixed commission was subsequently formed; it defined the objectives and content of ongoing programs (*Hevea*, coconut, agrarian and farming systems in the Red river delta). It also identified new projects which will be launched in 1990. They concern upland rice improvement and cropping systems, processing of local rock phosphates to produce phosphorus fertilizers, integrated development of the Pointe de Camau region, and creation of a forestry research center for pine and eucalyptus.

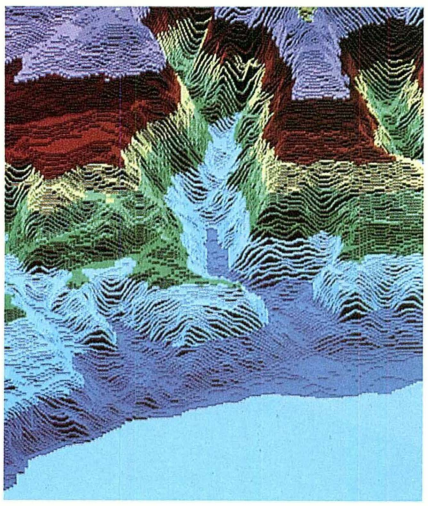
DSA is participating in a project for developing the Mekong delta, and CTFT in a private Franco-Vietnamese project for logging and transforming the eucalyptus forests in the south.

In Laos, work on the cotton research project continues. The possibility of resuming coffee research as part of the Bolovens plateau development project is being examined.

Lastly, in China, due to internal difficulties, CIRAD's projects with the Chinese Academy of the South were shelved. They concerned tropical crops in Hainan (*Hevea*, coconut, coffee, banana). The citrus project with the Agricultural Institute of the Southwest, Chonging, was also put aside. But CIRAD still maintains contacts in the expectation that cooperation will be resumed in 1990.

IRAT, however, was able to continue work on the operation for processing Yunnan rock phosphates to produce phosphorus fertilizers, in cooperation with the Institute of Soil Sciences (Academia Sinica), Nanjing. The eucalyptus and poplar wood technology research program, jointly conducted by the Chinese Research Institute for Wood Industry (CRIWI), CTFT, and the Centre technique du bois et de l'ameublement, was completed according to plan.

CIRAD has successfully accomplished the pioneer phase in Asia. Its task now is to structure and strengthen its presence and to coordinate its efforts with its partners on the continent.

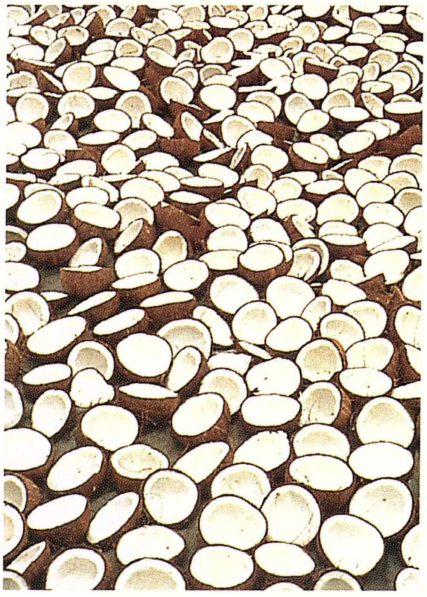


PRODUCTS AND SERVICES FOR DEVELOPMENT

Scientific and technical information through publications and training are among the main output of CIRAD's research. CIRAD has a commitment to develop these products. For certain departments such as DSA, they represent the key domains that lend significance to their work. The next chapter describes some of these products and services in detail.

One of CIRAD's primary objectives is to promote and improve the use of its scientific research. This knowledge is converted into products that will benefit tropical countries. Their use by farmers creates a fresh demand for know-how, which in turn stimulates further research. Experience gained over the past 40 years shows that it is paradoxically easier to start from grass-roots level to set up research programs than to work in the opposite direction.

With 11 departments that cover most of the sectors and ecological situations for the tropics, CIRAD is in a position to offer a vast range of products to its target group. Its products include plant



a nd animal material, crop and livestock production systems, consulting services, methods, tools, biotechnological and industrial processes, etc . Only a few significant examples of the Center's output in 1989 a represented in this chapter.

Plant Material Production

Seed and Young Plants

CIRAD's departments establish and manage nurseries, seed plots, budwood gardens, and seed orchards for large-scale supply of plant material and multiplication of new clones.

Successful Released Varieties

This is only one example of the large number of successful releases of selected varieties at CIRAD. In Senegal, production of the Virginia-Jumbo type edible groundnut developed by IRHO increased to 26000 t in 1989, compared with 19500 t in 1988. Export value of the end product also increased because of the high prices on the international market.

❑ IRAT produces seed and cuttings of various annual food crops for farmers in the French overseas departments. In Guadeloupe, the Roujol station supplies contamination-free sugarcane setts obtained through in vitro culture. In French Guiana, 70 t of foundation seed of the cultivar Mana were produced for multiplication by rice farmers.

❑ In Côte d'Ivoire, IRCA delivered 5000 m of budwood to large commercial *Hevea* producers, 23000 m to small private nurseries, and 7000 m to the company HEVEGO to start its experimental plantations.

❑ IRFA produced 20500 young plants of woody fruit trees—mostly tropical and a few temperate—in Réunion, and 10000 each at the Neufchâteau station, Guadeloupe; Rivière Lézarde station, Martinique; and in New Caledonia. The San Giuliano station in Corsica, which is jointly managed with INRA, produced 650 young plants, 39000 scions, and 39 kg of seed.

❑ IRHO has established coconut seed gardens in Vietnam (52 ha for the PB 121 hybrid), Fiji, New Caledonia, French Polynesia, and Nicaragua. The Seme-Podji seed garden in Benin exports pollen to Asia through IRHO. It also supplies

Seed germination plot and nursery of coconut hybrids.

oil palm germplasm, seed, and clones to plantations in Benin, Cameroon, Côte d'Ivoire, Indonesia, and Malaysia. Shelled and coated groundnut seed that can be planted directly is supplied to farmers in Senegal.

❑ CTFT has established seed orchards of selected fast-growing species in Côte d'Ivoire. They include one plot of *Eucalyptus camaldulensis* in the north and two plots of *Acacia mangium* in the south. Ten new tested clones of eucalyptus hybrids were offered to the Unité d'afforestation industrielle du Congo (UAIC). In Burundi, more than 3 million seedlings of forest species are produced each year with support from CTFT and distributed to farmers for establishing small private forest plantations. This success is perhaps unique in Africa.

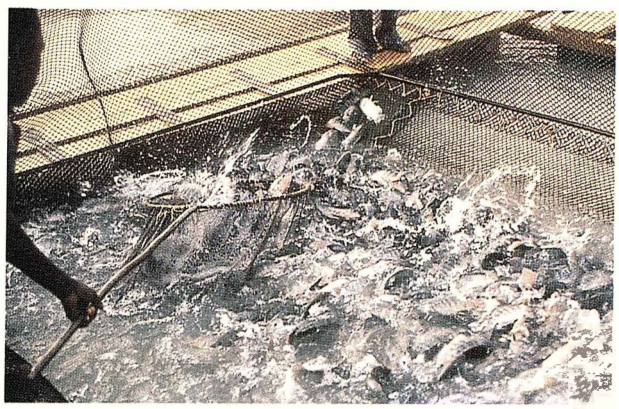
Inoculum

The Laboratoire de biotechnologie des sytèmes symbiotiques forestiers tropicaux (BSSFT) ensures intensive production of inoculum of new symbiotic strains of *Casuarina* and *Acacia*.

Production of Animal Material

Young Fish for Fish Farming

In Côte d'Ivoire, a stock of *Tilapia aurea* parents was established at the Mopoyen station in 1989. The species was selected for its survival and growth rates in lakes. It is expected to replace *T. nilotica* and two local species for production in brackish water.



Catch of commercial value from floating cages on the river Niger.

CIRAD 1989

A total of 80 000 young fish of *T. aurea* were produced. They are used for growth rate trials in pilot fish farms of the lake aquaculture project supported by IDESSA and CTFT. About 10 water pens and 40 floating cages were stocked and produced 20 t of fish, each weighing between 250 g and 500 g.

In Niger, the Sona stocking station of the aquaculture development project produced 3 million young fish of 1 g.

Limousin Breeding Stock for the Pacific Region

In New Caledonia IEMVT, in collaboration with the Unité néo-calédonienne de sélection et de promotion des races bovines (UPRA), has been distributing locally selected breeding animals for many years. The Limousin breeding program includes semen production for supplying the countries of the region. New embryo production techniques should help meet the demand for high-yielding, locally adapted, pedigree breeding stock in Australia and New Zealand.

The First Baoulé Bull Semen Bank

After several years of efforts, a Baoulé bull semen bank was established at CRTA, Bobo Dioulasso, in Burkina Faso. Baoulé is a trypanosomiasis-resistant race. This is the only semen bank for the West African shorthorn on the market. CRTA can now meet the large demand for this semen. Moreover, sperm of zebu bulls was collected from artificial vagina, which is rare.

Limousin bulls in the Pacific region.

Barley crops grown in the Madagascar highlands during the off-season for optimum land use.

Agrarian and Farming Systems

Innovative and Productive Cropping Systems

The cropping system developed for the *cerrados* in Brazil by the French and Brazilian research teams (Centro Nacional de Pesquisa em Arroz e Feijão, CNPAF, and IRAT) has proved to be extremely profitable. It is based on deep tillage, rice - maize - soybean rotation, and modern varieties. The system was adopted over tens of thousands of hectares in the west central region of the country.

Research on brewer's barley production in the mid-season on *tanety* or alluvial soils and in the off-season in rice fields, has led to an expansion of this crop in the high plateaux of Madagascar. As a result, the Star brewery acquired its first malting unit in 1989.

Silvicultural Systems for Environment Protection

CTFT develops silvicultural systems for erosion control, soil regeneration, and more rational use of forests. In the plateaux of Burundi, the practice of planting forage trees in pastures is spreading. Other measures were also undertaken: extensive afforestation for logging and erosion control and establishment of hill-top forests, which prevent erosion on the upper slopes of watersheds. These measures have rapidly improved the country's landscape and its economy.

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In northern Cameroon, several development projects in the cotton-growing area seek assistance from CTFT for the establishment of erosion check systems (strips of uncultivated soils planted with trees), reintroduction of Faidherba albida for fertility maintenance, simple methods for fallow with establishment of trees to regenerate crop soils, and forest plantations. In Fouta-Djalon, Guinea, watershed management methods were developed based on experiments conducted in the pilot watersheds of Bafing and Balé. In Niger, the silvicultural system proposed by CTFT is aimed at firewood production. It involves management of village forests (coupe rotation, controlled areas, etc.); organization of loggers, livestock producers, and other users of savanna lands; modification of laws and tax systems to make properly managed forests a profitable enterprise; energy saving (improvement of house structure, use of alternative resources).

Consulting Services and Methods

Dissemination of Nonpolluting Methods for Tsetse Fly Control

Nonpolluting methods developed by CRTA for tsetse fly control are disseminated in the Central African Republic through the national livestock development project. Producers learn to set the screens and traps through public awareness campaigns on this new method.

Forest Management

Conservation and economic use of tropical forest ecosystems can be combined. This involves the use of appropriate thinning methods that do not affect stand reconstitution and stimulate growth of useful species. In Côte d'Ivoire, these methods were used by the Société pour le développement des plantations forestières (SODEFOR) to manage 10 000 ha of natural forests in Yapo. In Oyane, to the south of the Gabon estuary, natural stands of logged-over okoumé forest that used to be exploited selectively are now thinned by removing up to 20-50% of the basal area[1] of dominant, damaged, and nonproductive trees. The logging age of the stands is thus lowered from 60 to 40 years.

1. Area of tree girth at 1.30 m above ground level.

Technology Package for Sugarcane Cultivation

Fertilization of sugarcane crops was optimized for each ecological microzone and a specific technology package was established for irrigation according to soil characteristics and altitude. These results were obtained in Réunion and can be transposed to other situations through the development of diagnosis and recommendation systems.

Latex Diagnosis: a Tool for *Hevea* Planters

Latex diagnosis is similar to biological analyses that indicate the health status of an individual. It indicates the physiological status of the latex production system (cell, laticiferous system, tree, plantation). Latex microdiagnosis is a simplified version in which only the four main parameters are measured; it can therefore be used on a large scale. The four parameters are: total solids content, sucrose content, inorganic phosphorus content, and thiol content. A small sample of seven drops of latex extracted with a syringe from each tree is adequate for this analysis.

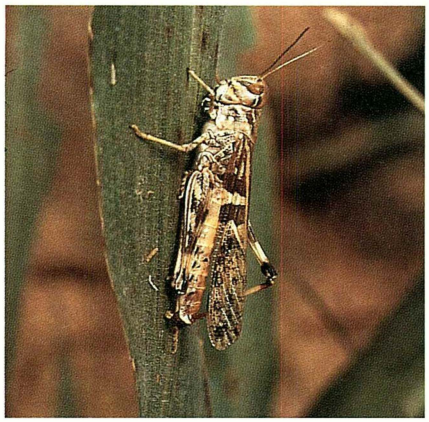
In 1989, such diagnoses were carried out for major plantation companies in Cameroon and Côte d'Ivoire.

Data Banks, Biomodels, Software

Iphytrop, a Crop Protection Data Bank

The crop protection data bank, Iphytrop, is jointly managed by ESCAP and CIRAD. It became operational in 1989 for Southeast Asia and was extended to cover 12 countries in Asia and 16 in the Pacific region. It includes all the available pesticides and official recommendations for use. A similar project was undertaken for northern, western, and central Africa, with support from the EEC. This bank will come into operation in 1991 when it will be accessed by users through the Transpac telecommunications network. CIRAD will serve as the host center for the EEC countries. CIRAD published three pesticide indexes for Asia, Africa, and the South Pacific using data from the bank.

*Two examples of modeling for timely intervention: biomodel of desert locust (*Oedaleus senegalensis*) population dynamics (left) and plant growth model of the Japanese elm (right).*



Data Bank on Secondary Tree Species

The data bank was designed and established by CTFT. It provides information on the technological characteristics of secondary tree species. Little information is otherwise available on these species. Woods can now be selected according to 21 criteria. The data bank is sponsored by the International Trade Timber Organization (ITTO) and developed in collaboration with foreign research organizations. Data are available in English and French.

Transfer of the OSE Biomodel to the Sahel

The OSE biomodel for the Senegalese grasshopper *Oedaleus senegalensis* (Krauss, 1877) was designed and developed by PRIFAS, the locusts and grasshoppers studies unit of GERDAT. It was judged to be operational and the French Ministry of Cooperation and Development has approved funding for computer equipment and staff training. These will be provided to the Centre régional de formation et d'application en agrométéorologie et hydrologie opérationnelle (AGRHYMET) and national crop protection departments in Burkina Faso, Chad, Mali, Mauritania, Niger, and Senegal. The model will be run on PCs for establishing 10-day charts for zones with high outbreak risks in the six countries where the pest is a serious threat.

Plant Architecture Models for Diverse Applications

The plant architecture modeling laboratory of GERDAT started work with French and foreign research organizations, local bodies, and private companies in 1989. This work is governed by agreements with the different partners. The models have several applications in agricultural research, for example: tree architecture, cassava mosaic disease epidemiology, radiative transfer in palm groves, flax plant density, etc. They are also useful for medical research (e.g. simulation

of tympanic membrane vibration in the inner ear). Such models are developed in all domains where simulations are used. Landscapists from Urba-Paysage requested the laboratory to prepare a simulation of changes in a park. The City of Rochefort has ordered a set of begonia models to optimize horticultural production in Poitou-Charente. An audiovisual on the growth of the Japanese elm was requested by the company Links, Tokyo, for the Osaka flower show.

LOGENTO Software for Entomologists

LOGENTO has a collection of 1400 records representing about 1600 trials conducted since 1975. The trials were conducted in 12 countries: Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Madagascar, Mali, Paraguay, Senegal, Togo, Zambia. The software is used for managing results of entomological trials in cotton crops. The records can be retrieved selectively using different criteria such as active ingredients, pests, and mixes of active ingredients and their effect on a given pest.

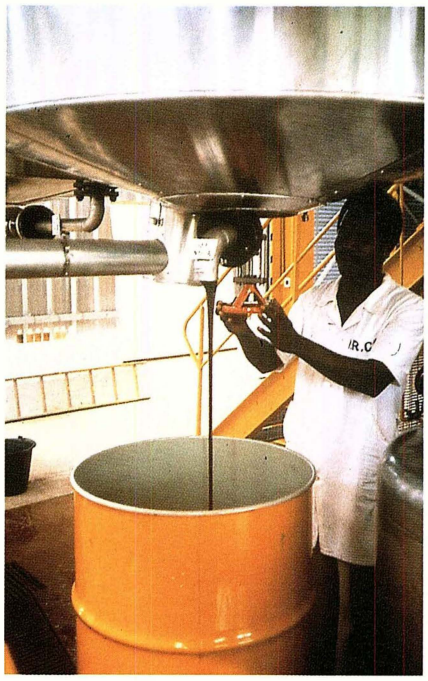
Several programs were designed and developed by the CIRAD departments. IRAT, for example, has marketed the BIPODE software for calculating water balance and daily actual evapotranspiration of a crop. It has also developed four programs to rationalize crop irrigation: FIRST, for processing climatic data and frequential analyses; RAIE, for evaluating furrow irrigation efficiency; BIRIZ, for flood irrigation management for rice crops; SOURCE, for designing irrigation networks in small watersheds.

Remote Sensing Data for Cartography

CIRAD's remote sensing research unit uses satellite image data (SPOT, NOAA, METEOSAT) to map crop, forest, and pasture environments. The following maps were published in 1989:

- *Malaysia: maps of surface states of the forest canopy on a 1:50 000 scale (Sabah Foundation, IGN, CTFT, IRAT);*
- *Burkina Faso: maps for assessing crop area in the Houndé and Satiri regions on a 1:100 000 scale (INERA, IRAT, IRCT);*
- *Mali: land-use and vegetation maps on a 1:200 000 scale to inventory wood resources (BDPA, DNEF, SCET-AGRI, CTFT);*
- *Mauritania: experimental maps to assess forage resources in the Lekseiba and Rosso regions on a 1:100 000 scale (IEMVT).*

Biotechnological and Industrial Processes



Liquid natural rubber offers new possibilities for using natural rubber.

Epoxydized Liquid Natural Rubber

The process for epoxidization of liquid natural rubber (LNR) was developed by IRCA in its laboratory and successfully used in Côte d'Ivoire for field latex. The pilot unit in Côte d'Ivoire was modified to produce epoxidized LNR. Samples from the IRCA laboratory and the Côte d'Ivoire pilot unit were sent to likely users to demonstrate the potential of epoxydized LNR for producing adhesives and as an additive for the rubber industry.

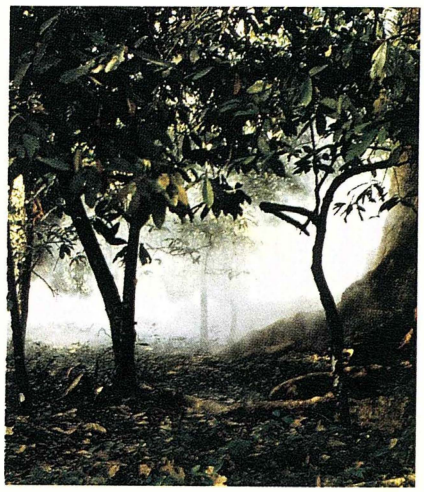
Cocoa Quality Improvement

Excess acidity is a defect that depreciates the market value of cocoa. IRCC developed a process for using cocoa with high acid content to make chocolate without increasing the duration of conching.

Biotechnology and Trypanotolerance

CRTA, Burkina Faso, now has a complete set of 105 reagents for characterizing BoLA class 1 antigens, which form an important histocompatibility system in cattle. This is the largest collection in the world and it was established in collaboration with ILRAD, Kenya, Agricultural and Food Research Council (AFRC), Scotland; and INRA.

Farm Equipment



Timely treatment of cocoa plantations with the new pyrotechnical foggers (6 units/ha).

"Pyrotechnical" Foggers for Insecticide Treatments for Cocoa Crops

The use of foggers for insecticide treatments is a promising technique for controlling cocoa mirids. The foggers were developed in collaboration with the company Ruggieri and will soon be marketed by Rhône-Poulenc. They can effectively replace conventional methods, such as the traditional thermal foggers. The pyrotechnical foggers are light, easy to use and maintain, less cost-intensive, and very safe. The system has many possibilities and it can be used for various active ingredients and crops (e.g. banana).

From Design to Marketing of the Sticky Cotton Thermodetector

❑ 1986: IRCT developed a new method for detecting sticky cottons. A prototype was built in collaboration with the workshop SERCOM, Montpellier, and tested in a spinning factory.

❑ 1987: IRCT designed a chamber for preparing samples. In August, the first thermodetector was sold to a spinning company. It proved to be reliable. Four thermodetectors were then delivered to the stations of the IRCT network and five were sold to the Compagnie française pour le développement des fibres textiles (CFDT). In late 1987, the Swiss company Graf purchased the licence to manufacture the thermodetectors.

❑ 1988: In June, the first sample preparation chamber was sold to a manufacturer.

❑ Status in end 1989: 12 IRCT RF13 thermodetectors and 12 FG sample preparation chambers are in operation; 20 IRCT-Graf thermodetectors were produced and sold.

Transpaille and Pollution Control

Agriforce has developed a system for tropical zones using the Transpaille process patented by IRAT in 1983. It produces organic o matter and energy from crop residue and food industry wastes. The system thus helps reduce environment pollution . The first unit for processing abattoir wastes was established in Thiès, Senegal . A larger project is under way in Dakar to install similar systems in abattoirs.

UPIL, an Inoculum Production Unit

UPIL is a unit for producing inoculum for legumes. This sturdy, reliable, and simple digester is designed for use in developing countries and it received an award at SIMA 1988, Paris. In 1989, 37 units are in operation in 22 countries.

Support to Agricultural Professionals

CIRAD's departments provide technical assistance to all types of agriculturalists in tropical countries, ranging from smallholders to large agroindustrial corporations. Support is offered in the form of assistance in establishment and management of plantations or industrial units, and quality control of products . Evaluations are also undertaken at the request of funding agencies and professional or development organizations. The French Agence nationale de valorisation de la recherche (ANVAR) often calls in CIRAD specialists to carry out technical assignments in French companies.

❑ IRFA is providing technical assis-tance to several banana produc-ers, mainly the Unión de Países Exportadores de Banano, Panama, and to Fruitière des Lagunes, Côte d'Ivoire. The recommendations mainly concern control of *Cer-cospora* diseases and fruit pack-aging.

IRFA undertakes quality

Improvement of Arabica Quality in Burundi: Positive Results

Since 1986, IRCC has been working with the Office des cafés du Burundi (OCIBU) to improve the quality of arabica coffee produced in the country. The French funding agency, CCCE, has financed the construction of 13 depulping and washing plants, each with a processing capacity of 120-150 t of parchment coffee. Extension services were reorganized and about 400 agents received training. IRCC also supervises more than 300 coffee nurseries and maintains and manages village depulping units. It also participated in the expansion of the Gitega parchment-removing plant and the establishment of a central workshop for repairing farm equipment. These positive results were presented at the meeting of the European Association of Agricultural Economists, which was held in Montpellier in 1989.

control of bananas arriving at Marseilles from two regional cooperatives in Côte d'Ivoire. More than 14000 cartons were checked.

❑ One of the main development activities of IRHO is technical support to industrial and village plantations. It monitors more than 120 000 ha of coconut plantations (Brazil, Côte d'Ivoire, Indonesia, Vanuatu) and 230 000 ha of oil palm plantations (Cameroon, Central African Republic, Congo, Côte d'Ivoire, Gabon, Ghana, Liberia, Madagascar, Nigeria, Brazil, Colombia, Ecuador, Honduras, Peru, Indonesia).

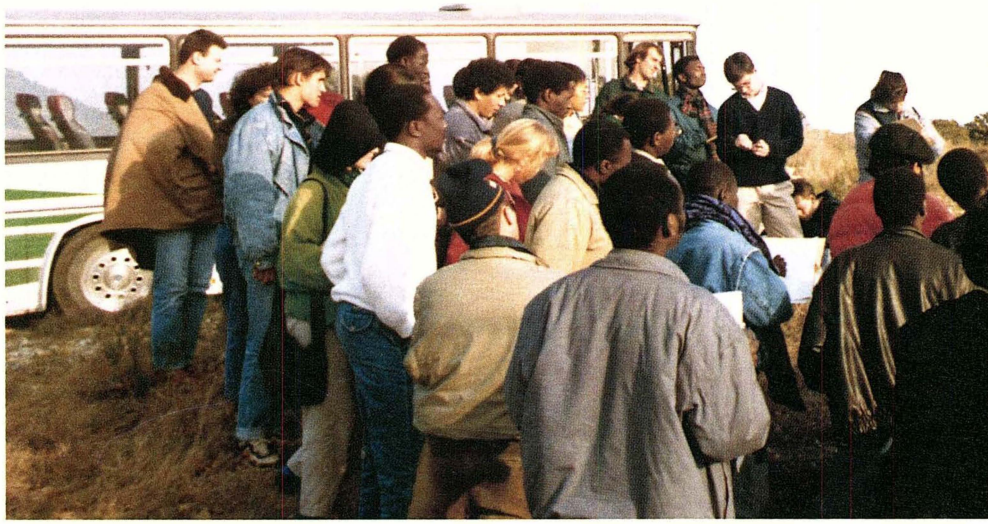
❑ IRCA is responsible for quality control and technical specifications for all the natural rubber produced in Côte d'Ivoire and Cameroon. More than 16000 samples were analyzed in 1989. It also offers technical support to *Hevea* plantation companies in northern Sumatra and to *Hevea* cultivation development projects in Guinea (SOGUIPAH), Gabon (AGROGABON), and Côte d'Ivoire (HEVEGO).

CIRAD's subsidiaries and stakes in companies.

Name of enterprise	Activity	CIRAD's stake (%)	Partners
VITROPIC (SA)	Production of banana, plantain, and pineapple plantlets	51%	SCB/SODECI, nurseries
TROPICLONE (SA)	Production of oil palm plantlets	54%	SOCFINCO
COPAR (SARL)	Production of coconut seed	30%	SOCOCO
SMH (SA)	Production of *Hevea* microcuttings	14%	Michelin, SODECI-SOFFO, Terres Rouges, IFC, Delbard
SOCA 2	Coffee and cocoa R&D	5%	BDPA, SOCFINCO

CIRAD is also a member of two economic-interest bodies: Technisucre (sugar plantation R&D) and Agriforce (rural biogas production systems).

TRAINING AND INFORMATION

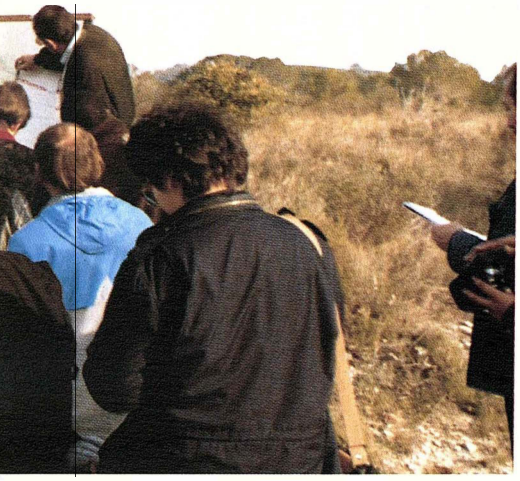


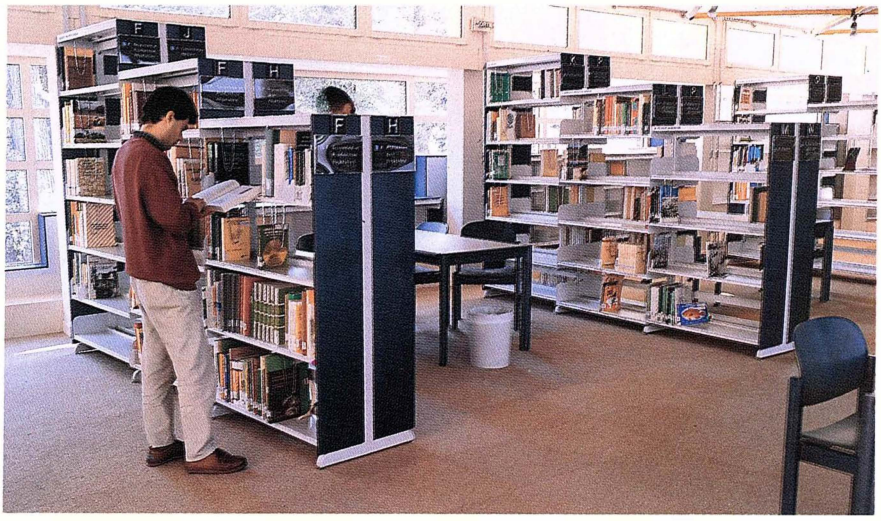
Training

Training national scientists from tropical countries is one of the missions of CIRAD, which it adopted from the former institutes.

CIRAD believes that by enhancing the knowledge and skills of national scientists, it can help create efficient, homogeneous teams that are more easily integrated into the international scientific community.

CIRAD's training policy was established through discussions with its partners. It involves all the departments; DSA and IEMVT are particularly active in this domain. In 1985, a training unit,





CIRAD-Formation, was created to organize and coordinate training activities.

Two types of training are offered by CIRAD. Long-term training combines preparation for a doctorate degree and research skill development (student training programs). Shorter programs enable scientists to acquire additional professional skills.

Student Training Programs

Student training programs are long-term programs of at least 1-year duration. The schedule is established jointly with the training institution that awards the degree and the CIRAD department identified for research training. The programs are intended for junior

A Unit for Organizing and Coordinating Training Activities

CIRAD-Formation does not directly deliver training; it organizes, coordinates, and manages programs conducted by the departments or external organizations. The unit first identifies training needs in host countries, in keeping with national or regional priorities. It sets forth the program content according to the needs of ongoing research programs or projects. It then proposes a detailed program, including funding and identification of a suitable training organization. The unit provides logistic and administrative support to participants and follows their scientific and academic progress. Even after the program is completed, the unit continues to provide information support in collaboration with CIRAD's scientific and technical information service.

scientists having the equivalent of a French graduate degree. Long-term scholarships are needed for such programs. They are granted by the government of the trainee's country, the French government (e.g. Ministry of Cooperation and Development, Ministry of Foreign Affairs), international organizations (e.g. EEC, FAO, World Bank), or donors for development projects (e.g. EDF, FAC, KIT).

For countries that have cooperation agreements with CIRAD, the student training programs are covered by special contracts (*contrats formation-insertion professionnelle*). The training is funded through French-government scholarships and by the Ministry of Research and Technology. In this case, research training following university studies is carried out both in the country of origin and France.

Such contracts were signed between CIRAD and national research organizations in Cameroon and Madagascar. In 1989, four additional contracts were signed with IRA, Cameroon. Others are being discussed with Burkina Faso and Côte d'Ivoire.

Thirteen trainees participated in such programs in 1989. Five IRA scientists have already obtained doctorate degrees.

Apart from the special contract arrangements, several trainees participate in long-term programs organized by the departments themselves. In 1989, 72 students and junior scientists—including 29 who were preparing research theses—from 26 countries worked with CIRAD scientists.

Short-term In-service Training

CIRAD regularly organizes or participates in the organization of several courses for groups of foreign scientists who wish to acquire additional professional skills. The departments also offer individualized programs, including postdoctoral internships and specialized training.

In-service Training Course on Research and Rural Development

This 12-week in-service training course on research and rural development (FPR), which is organized and conducted by CIRAD-Formation, is intended for research specialists. It enables them to

A major concern of the training unit, CIRAD-Formation, is to maintain high standards of quality.

adapt their work to the actual needs of rural communities. The course is also attended by students from the Ecole supérieure d'agronomie tropicale (ESAT), Montpellier. It introduces participants to a multidisciplinary approach and gives them the necessary tools for such an approach: survey methods, data processing, experiment planning, and extension methods. Input for the course is provided by specialists from CIRAD as well as CNRS, INRA, ORSTOM, and universities in Montpellier.

In 1989, 35 participants attended the course : 6 researchers from Africa and Latin America and 29 students (including 13 foreign students).

Training Seminar on Agricultural Research Center Management

The international training seminar on agricultural research center management (FGCR) is jointly organized by DSA and FAO. The fourth semina r was held in Marseilles from 13 November to 22 December 1989. The program is funded by CTA, the Netherlands; EEC; FAO; and the French Ministry of Cooperation and Development. The objective is to improve the efficiency of national agricultural research organizations and thus accelerate the rural development process. The seminar attempts to achieve this by applying business administration and management techniques to agricultural research organizations. It also involves input from the other CIRAD departments, INRA, and ISNAR. In 1989, 24 research managers from 16 African countries attended the seminar; one participant came from the regional organization Union douanière des Etats d'Afrique centrale (U DEAC). To date,

a total of 110 scientists with managerial responsibilities from 27 countries have participated.

Since 1988, former FGCR participants have been organizing similar seminars in their own countries, using training materials developed by FAO and CIRAD. FOFIFA, Madagascar, was the first to conduct an FGCR seminar; sessions were organized in 1988 and 1989. A similar seminar will soon be undertaken in the Central African Republic.

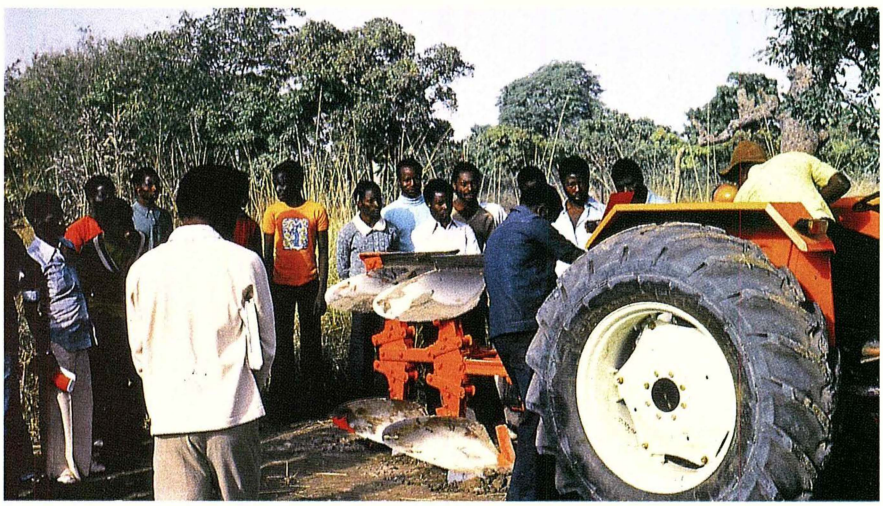
International Training Program on Development Strategies

The international training program on agrarian and farming systems and development strategies (SASD), organized by DSA, is mainly addressed to rural development managers.

Funds for participation are offered by the Banque centrale des Etats de l'Afrique de l'Ouest (BCEAO), EDF, GTZ, the Swiss cooperation authority, World Bank, and the French funding agencies CCCE and FAC.

An original and practical approach is used for this program. It is conducted in a developing region, Ségala, a highland area with few resources in southwestern France. Participants study a concrete problem that is put before them by the local development organization. They work with the local community to identify strategies for overcoming the problem. Such an exercise offers an opportunity to learn and use the systems and research-development concepts and methods. However, the relevance of the conceptual and methodological aspects to developing countries is not neglected.

Field training.



In 1989, 15 participants from 8 countries attended the SASD program. A similar program was organized and conducted by DSA in Brazil, at the request of the national organizations,

EMBRAPA, Centro de Pesquisa Agropecuária do Trópico Semi-Arido (CPATSA), and Empresa Brasileira de Assistência Técnica e Extensão (EMBRATER).

Other Training Programs

CEEMAT regularly organizes training programs for groups. The course on rational use of farm equipment in the arid intertropical zones is organized every 2 years. It is intended for francophone agricultural scientists and technicians who manage mechanized operations. It includes lectures in theory and practical work in the workshop (maintenance techniques) and field (use of equipment and adjustments). The course was held from 10 April to 24 June 1989 in the Mediterranean region and was attended by 10 participants.

Certain departments hold training programs in other countries. In Venezuela, DSA collaborated with the national funding agency FONAIAP and the Lisandro Alvarado University (UCLA) to organize a

In 1989 more than 350 participants received training at CIRAD.[1] Number of participants by CIRAD department and training category.

Department	Long-term training (> 1 year)	Short-term training (< 1 year)	Total
CEEMAT	6	19	**25**
CTFT	8	26	**34**
DSA	2	39	**41**
GERDAT	1	35	**36**
IEMVT[1]	27	83	**110**
IRAT	16	30	**46**
IRCA	1	3	**4**
IRCC	10	15	**25**
IRCT	5	9	**14**
IRFA	3	9	**12**
IRHO	6	4	**10**
Total	**85**	**272**	**357**

1. Excluding formal training.

1. Excluding participants of CNEARC-CIRAD courses.

seminar on methods for advising smallholders on management techniques. In Mauritius, a 1-month agricultural engineering program conducted by CEEMAT was attended by 46 agricultural scientists and technicians from the sugar industry. In Ethiopia, cadres from agricultural departments were trained in the use of farm equipment.

Regions of origin of trainees at CIRAD in 1989.

Region	Number
Africa	222
Mediterranean region	47
Indian Ocean region	33
Latin America	24
Asia, Pacific region	24
Europe, North America	7
Total	**357**

The departments also provide input for about 20 professional training courses managed and organized by the Centre national d'études agronomiques des régions chaudes (CNEARC). The courses are aimed at agricultural research and development professionals. Lectures for these courses are given by specialists from research organizations (CNRS, INRA, ORSTOM, CIRAD) and training institutes (ENSAM, IAM, universities).

Some of the courses are listed below:

❑ Recognition of economically significant insect families in tropical and subtropical regions,

❑ Grain storage and preliminary postharvest technology,

❑ Training for sector heads of rural development projects,

❑ Analysis and improvement of agricultural production systems,

❑ Seed production for vegetable crops in the tropics,

❑ Soil management and erosion,

❑ Crop protection in tropical and subtropical regions,

❑ Epidemic diseases of tropical crops,

- ❑ Pests of tropical crops,
- ❑ Crop water management,
- ❑ Design and use of irrigation systems.

Individualized Training Programs

Various types of training programs are organized by the departments at the request of their partners. Participants usually work at CIRAD or in other organizations, in which case the program is jointly developed by CIRAD and the training organization. In 1989, 200 participants received this type of training.

Formal Education

CIRAD scientists also teach courses at postgraduate training institutions in France (including overseas departments and territories). In other countries, training through teaching is a form of cooperation and CIRAD's expatriate scientists are sometimes requested to assist in this domain.

Formal training at CIRAD is mainly offered at IEMVT. Regular courses are conducted for a diploma in tropical animal pathology and a DESS[1] in livestock production in tropical and subtropical regions. The department also organizes specialized short-term training courses.

The diploma in tropical animal pathology is a specialization offered to French and foreign veterinarians. It is a 3-month program with 160 hours of courses and practical work. In 1989, 21 students, 14 of whom came from France and 7 from other countries (including 6 from Africa), successfully completed the course.

The DESS in livestock production for tropical and subtropical regions is organized jointly by IEMVT and the Ecole nationale vétérinaire d'Alfort, INA-PG, and Muséum national d'histoire naturelle. The 1-year (October-September) course is open to veterinarians, agricultural scientists, and postgraduate students. In addition to theoretical and practical work, students do an apprenticeship in France or a tropical country. At the end of the course they are expected to prepare and defend a dissertation. In 1989, 22 students undertook the DESS course; 11 of them came from Africa.

1. *Diplôme d'études supérieures spécialisées.* Final degree for advanced applied studies; equivalent to an MS.

CIDARC facilities at Montpellier.

Scientific and Technical Information

CIRAD's central scientific and technical information service is responsible for all functions related to the centralization of scientific and technical information within CIRAD and its subsequent dissemination.

It is located at the Montpellier research center within a special structure—CIDARC, Centre d'information et de documentation en agronomie des régions chaudes. CIDARC houses the documentation and publication services of all the departments except CTFT and IEMVT. The two departments are however linked to CIDARC through regular meetings of working groups and the computer network that connects all the CIRAD centers in France.

CIDARC has four main functions: management of a specialized library, administration of a central database which is common to all the departments, documentation support to scientists from CIRAD and partner organizations, dissemination of the Center's research work and results.

CIDARC Central Library

The CIDARC central library is open to students, teachers, scientists, and development workers specializing on agriculture in the tropical and subtropical regions. It has the responsibility of acquiring and processing all types of documents required by users.

The Library's 1989 Activities in Figures

- *Acquisitions: 923 monographs, 387 periodicals*
- *Documents from past collections: 350 publications*

The library has 2117 collections of periodicals and 5784 documents.

- *Visits to the library: 2665 readers, 3418 documents consulted, 354 documents on loan*
- *Bibliographic bulletin: 4 issues containing 848 references*
- *Supply of documents: photocopies of 12 531 pages of 1591 articles*

The library collections of the former institutes represent a valuable knowledge base and CIRAD intends to make them available to the international scientific community. CIDARC therefore undertook a computerization program and in 1989 it processed retrospective records mainly from DSA, IRCT, and IRFA. Demand for documents increased with the growth of the selective dissemination of information (SDI) service and integration of the CIDARC journal collections into the collective French catalogue of serials (CCN).

New Orientations

- ***The library opens to the public***

In 1989, CIDARC was opened to a wider public thanks to financial support from the District of Montpellier. A multimedia library and a sales counter for CIRAD publications were established. A guide to library services, Guide du lecteur, *was prepared on the occasion of Visitors' Day and widely distributed among the public.*

CIDARC also participated in the meetings organized by the Languedoc-Rousillon administration, for scientific, technical, and industrial organizations in the region.

- ***CIDARC becomes an AGLINET library***

AGLINET is a cooperative network within FAO, which links all the major national agricultural libraries.

The CIDARC library was thus officially designated as a depository library for publications of the IARCs. They will be made available according to the AGLINET rules and procedures for photocopies and interlibrary loans. It is also a depository for publications of the Club du Sahel (OECD) that are available for consultation and loan. References of these documents will be listed in the next update of the CD-ROM Sésame. To date, about 400 documents have been received; they represent the entire Club du Sahel collection.

Consultation of documents increased by more than 50% compared with 1988. A computerized loan system was developed during the second half of the year and will be operational in early 1990.

The library publishes a bibliographic bulletin of current acquisitions. From 1989 it will appear on a quarterly basis. The last issue is combined with a cumulative index.

A serials catalogue was also compiled with an update on existing collections. Two separate lists were published for periodicals available at CIDARC and the departments.

The library continues to develop its press cuttings collection. Press files can be consulted in the reading room and are a useful source of current information on CIRAD's activities and other relevant current topics. The files were reorganized and outdated cuttings were eliminated. Articles for the files are supplied by the CIRAD press service. General interest articles that are not indexed elsewhere are also included in the files.

CIRAD's Central Database

The central service coordinates the internal documentation network that links all the CIRAD departments. It controls bibliographic records supplied by the departments and integrates them into the central database. As of December 1989, the database contains 35 000 references. It can be accessed from all the CIRAD centers in France, and from certain countries such as Cameroon, Côte d'Ivoire, and Senegal through a Transpac-type network. As the bibliographic format is compatible with that of FAO, CIRAD publications are referenced in AGRIS, FAO's international database.

Proposals were considered for enhancing FAO's trilingual thesaurus, Agrovoc, according to the topics studied at CIRAD.

CIDARC is linked to international databases through its computer network.

Sésame, the Tropical Agriculture Database

Sésame is a tropical agriculture database on CD-ROM. Its release in 1989 marks a major investment in new information-transfer technology.

Sésame is a collection of all the original bibliographic data from CIRAD, INRA, ORSTOM, BDPA, France; Faculty of Gembloux, Belgium; and ISRA, Senegal. The software is designed to make it as user-friendly as possible. The first version which was released in 1989 contained 50 000 references of French-language publications on agricultural research and rural development, with indexes in French and English. It is a relatively low-cost, easy-to-use database that provides access to information from documentation centers in tropical countries.

Sésame was produced with technical assistance from the company Jouve. Funds were provided by the French Ministry of Research and Technology, and through subsidies from the AUPELF-UREF network (Association des universités partiellement ou entièrement de langue française–Université des réseaux d'expression française) and the French Ministry of Cooperation and Development. An updated version is scheduled for release in 1990.

The methodological know-how on CD-ROM acquired by CIDARC through the production of Sésame will be useful for other applications (information systems using text and graphic data, expert systems).

Agreements were signed with several organizations for supply of bibliographic references in exchange for access to the database. They include ORSTOM, CNEARC, GRET, Bureau pour le développement de la production agricole (BDPA), Section industries alimentaires des régions chaudes (SIARC) of ENSIAA, Ecole nationale du génie rural, des eaux et des forêts (ENGREF-Montpellier), USTL tropical botany library, and ISRA (Senegal). Five hundred references were thus added to the central database in 1989.

Over the past 13 years, the CIRAD documentation service has been publishing a bibliographic bulletin, *Agritrop*. It reviews all publications by francophone scientists on tropical agriculture. The bulletin is published in French and English and distributed in both francophone and anglophone countries. It was made a quarterly in 1989 and the four issues published during the year contained 1889 references. *Agritrop* now serves as a bulletin for the francophone tropical agriculture network that was established through the agreements mentioned earlier.

Documentation Support

CIDARC offers an SDI service to CIRAD scientists according to their specialization. Information is obtained from the CIRAD database and from international agricultural databases that can be accessed by CIDARC. The efficiency of this service depends on the computerized network established at CIRAD and its connection to international telecommunications networks.

Transfer of Know-how on Documentation Engineering

CIDARC offers its know-how on documentation network engineering to developing countries through training seminars on documentation methodology.[1] Expert missions for computerized documentation are also undertaken.

Since 1988, CIDARC is participating with the Centre d'information et de documentation scientifique et technique (CIDIST), Madagascar, in the establishment of a national research documentation network. The French funding agency, FAC, offered funds to supply the necessary computer equipment (6 PCs and 1 mainframe). CIDARC organized a training seminar on computerized documentation in Madagascar, and two Madagascan network managers received training, in France, in information and computer sciences.

The Madagascan project was completed in November 1989. Its success prompted CIDST and CIRAD to extend it for another 2 years. CIDARC was also requested to assist in the establishment of a desk-top publishing system.

1. At the request of FAO, the AGRIS-CARIS seminar was organized in collaboration with INRA from 13 to 17 March 1989 in Montpellier.

The SDI service is also extended to scientists in Benin, Burundi, Cameroon, Ethiopia, and Madagascar, through an agreement with CTA, the Netherlands.

In 1989, 300 scientists benefited from the SDI service; they received approximately 30 000 references and 6000 photocopies of articles.

The question-answer service was originally intended for CIRAD scientists. It has now been extended to several countries in Africa, following an agreement with CTA. Apart from bibliographic support, the service also offers suggestions and various types of information (catalogues, addresses, brochures, documents).

CIDARC prepared an agricultural bibliography for CTA. It contains 22 485 references for the nine member-states of the South African Development Coordination Conference (SADCC). Six databases were interrogated to compile the references. A separate bibliography was prepared for each country, combined with a subject index.

Publications

A central publications service was established within CIDARC in 1989. It has the responsibility of implementing CIRAD's communication policy.

Four types of publications were developed with the production of *Images de la recherche*, *Le CIRAD en 1988*, *Les départements du CIRAD, rapport d'activité 1988*, and *Notes et documents du CIRAD*.

Images de la recherche is intended for nonscientists who have responsibilities related to tropical agriculture. It aims to present CIRAD's research activities and output as well as their applications

in a more accessible form. It is available in French and English (*Images of Research*). Its wide distribution has largely contributed to greater public awareness about CIRAD's work.

The two other publications, *Le CIRAD en 1988* and the annual report *Les départements du CIRAD, rapport d'activité 1988*, form a set. The annual report compiles information on the departments' activities during 1988. *Le CIRAD en 1988* was conceived as a general introduction to the annual report. It is based on information from the CIRAD management, external relations services, and administration and finance services. The two documents are primarily intended for CIRAD's sponsors, financiers and donors, and provide more detailed information than in *Images de la recherche*.

Notes et documents du CIRAD is an internal collection that aims to inform CIRAD scientists on major matters under discussion. The first five issues were published in 1989.

One of the main responsibilities of the central publications service is to achieve consistency in publications produced by CIRAD. It assists the departments in creating different types of information material (brochures, newsletters, posters, etc.). The service offers various types of support ranging from design and preparation of information material to advice and production supervision.

The service also directs a working group of all the departmental publications services. Several common issues were taken up in 1989, including mailing lists and desk-top publishing (DTP) systems for the periodicals.

Publications of the CIRAD Departments

❑ *Most of the departments have been publishing specialized periodicals over the past several years.*

❑ Bois et forêts des tropiques, *CTFT (2 issues in 1989)*

❑ Café, cacao, thé, *IRCC (4 issues, 1 special issue)*

❑ Cahiers de la recherche-développement, *DSA (4 issues)*

❑ Coton et fibres tropicales, *IRCT (4 issues)*

❑ Fruits, *IRFA (11 issues)*

❑ L'Agronomie tropicale, *IRAT (4 issues)*

❑ Oléagineux, *IRHO (9 issues, including 1 special issue)*

❑ Revue de l'élevage et de médecine vétérinaire, *IEMVT (5 issues, including 1 special issue)*

❑ MAT (Mécanisation agricole et technologie alimentaire des régions tropicales), *CEEMAT (4 issues)*

IRCA regularly publishes articles in Revue générale des caoutchoucs et plastiques.

PERSONNEL

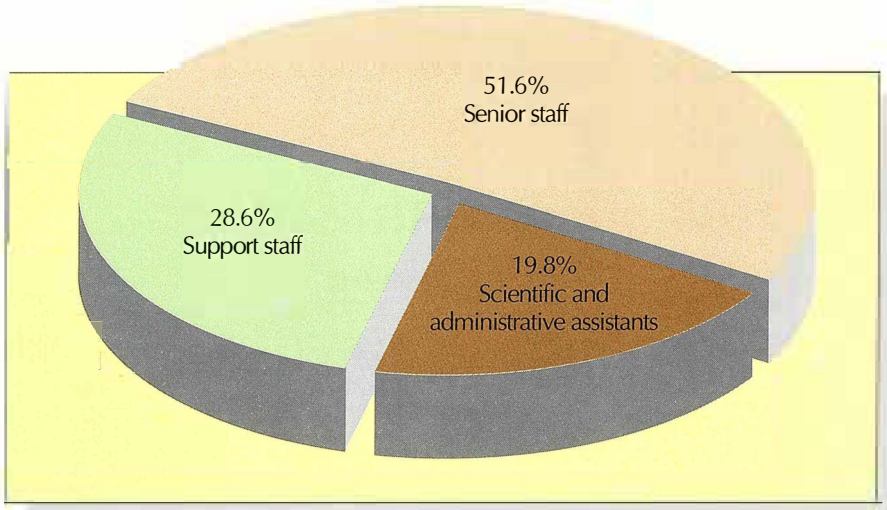
During the past 5 years CIRAD has witnessed the emergence of a common personnel policy, with a harmonization of the staff rules of the former institutes.

The agreements signed in 1988 between the staff and management serve as a basis for strengthening CIRAD's contractual policy. The Center simultaneously established the means and procedures for harmonizing management of human resources.

Strengthening the Contractual Policy

The staff-management agreements of 1988 provide for further negotiations between staff representatives and the management.

A new agreement was thus signed on 13 October for integrating staff from CIRAD centers in the French overseas departments. As from 1 January 1990, medical benefits and retirement schemes for monthly-wage staff will be aligned with those of staff recruited in metropolitan France.



Staff categories at CIRAD.

The issue of conditions for overseas assignments is a major concern at CIRAD. The discussions focus on incentives for encouraging young scientists to undertake such assignments. The study undertaken jointly by the general management and staff representatives led to the preparation of a discussion paper (*Livre blanc de l'expatriation*), which was circulated among CIRAD staff for further discussions.

CIRAD Staff

As of December 1989, CIRAD has a staff strength of 1992[1] persons. Of the 1027 senior staff, 559 (54%) are stationed overseas.

Location of CIRAD staff.

France (metropolis)	45.5%
French overseas departments and territories	8.6%
Other countries	45.9%

Staff strength by department, end 1989.

Department	Senior staff	Assistants	Support staff	Total
CEEMAT	35	15	12	**62**
CTFT	110	65	62	**237**
DSA	47	13	3	**63**
GERDAT	99	72	88	**259**
IEMVT	104	43	46	**193**
IRAT	195	71	170	**436**
IRCA	61	18	9	**88**
IRCC	81	13	10	**104**
IRCT	76	14	16	**106**
IRFA	104	42	125	**271**
IRHO	115	29	29	**173**
Total	**1 027**	**395**	**570**	**1 992**

1. Including seconded staff and national service volunteers for technical assistance and cooperation.

Seventy-one national service volunteers (VAT and VSN)[1] were assigned to CIRAD for on-site work.

1. The *volontaires à l'aide technique* (VAT) are posted to the French overseas departments and territories for technical assistance; the *volontaires du service national* (VSN) are posted to other countries for cooperation activities.

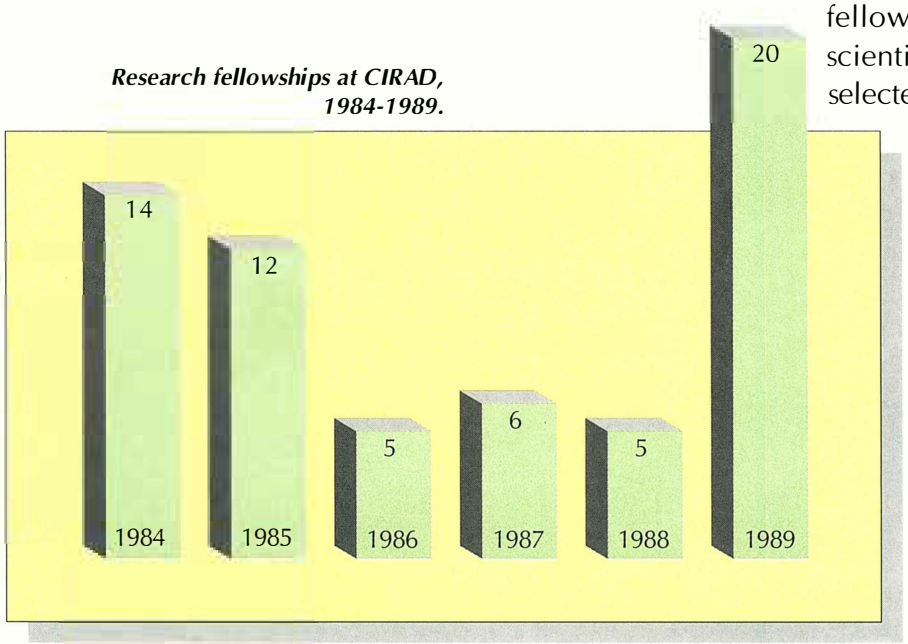
Towards a Harmonization of Human Resources Management

Harmonization of the different staff rules of the former institutes is complete. CIRAD will consolidate its human resources management by focusing on recruitment, career planning, and systematized appraisal.

Recruitment

CIRAD intends to acquire the means for efficient and homogeneous training and development, particularly for young scientists. Doctoral studies offer valuable training and recruitment opportunities. A decisive step was taken in this direction when the French Ministry of Research and Technology granted—for the first time—research fellowships for tropical agriculture scientists. Twenty research fellows were selected to work at CIRAD or with partner organizations, in France and other countries. The Ministry's decision is one of the outcomes of future planning by the research management, in relation to the Center's manpower needs in different disciplines.

Research fellowships at CIRAD, 1984-1989.



An analysis of the research programs shows a shift in focus towards cellular and molecular biology, crop improvement, economics, and agricultural and food technology.

In addition to the Ministry's fellowships, CIRAD announced the establishment of fellowships in strategic research areas. Four research fellowships for thesis work and one postdoctoral fellowship are offered from CIRAD's self-generated funds.

Career Planning and In-service Training

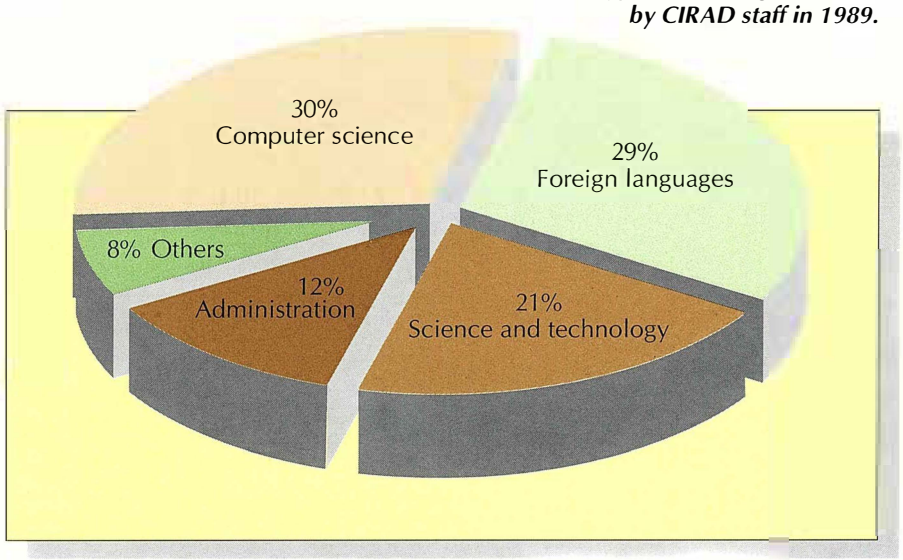
In 1989, 360 staff members (senior staff, 38%; administrative and scientific assistants, 30%; support staff, 32%) received in-service training. Computer training accounted for more than one-third of the training expenses.

Staff members usually attended courses conducted by specialized external organizations. Recognizing the need for programs with greater relevance to the Center's environment, CIRAD decided to provide in-house training through the training unit. The program will be operational in 1990.

After joint discussions, the department directors and the training unit decided on the following priorities:

– computer training, particularly for word processing (a common program will be recommended for the entire Center), spreadsheet applications, database management;

Types of training requested by CIRAD staff in 1989.



– biometrics, mainly methodologies for agricultural experiments and computerized data processing.

Training in foreign languages and oral and written communication techniques will also be encouraged.

Staff Representation Structures

The Joint Staff-Management Committee, which is chaired by the Director General, is made up of 16 members (8 full members and 8 alternates) who are elected by the staff.

The Committee was regularly informed and consulted on financial, administrative, and professional matters, particularly general management and organization issues and decisions on staff management. These issues concern working and employment conditions, overseas assignments, integration of staff from the French overseas departments, staff-management agreements, training plan, staff profiles, decentralization of activities and staff transfer to the Montpellier center.

CIRAD's Joint Staff-Management Committee (1989)

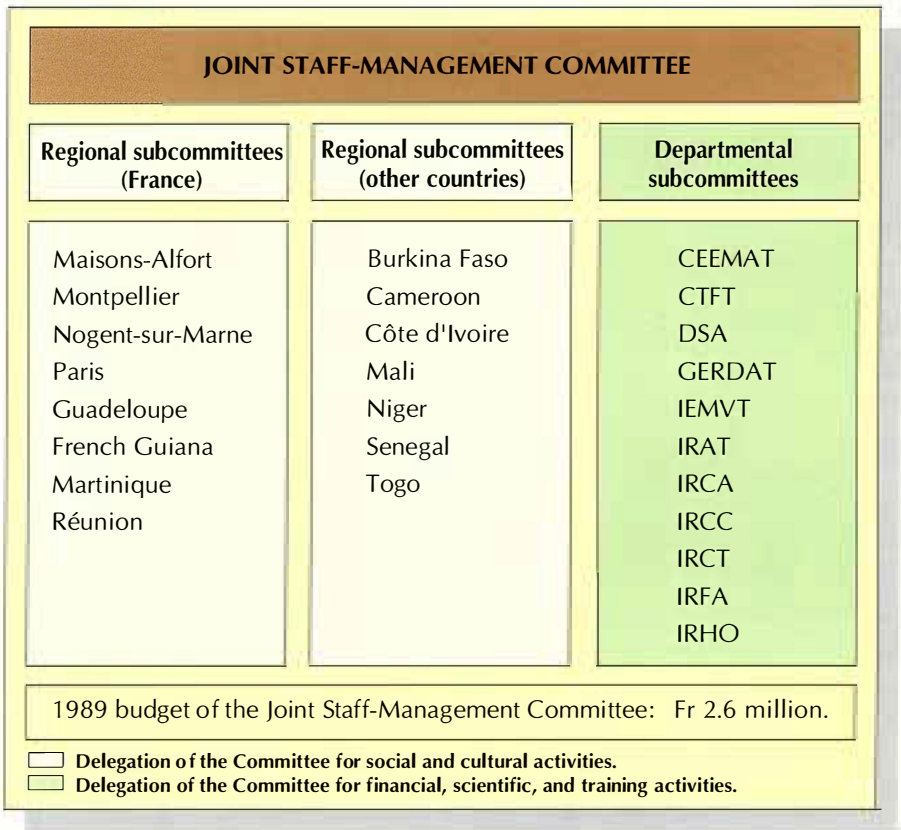
Chairman
Hervé Bichat

Full members
Alain Bertrand, Secretary (metropolitan France)
Alexis Bienaimé (Réunion)
Jeanine Chaumont, Treasurer (metropolitan France)
Cécilia Demant (Guadeloupe)
Jean-Pierre Denis (Senegal)
Michel Falais (French Guiana)
Raymond Lauret (Réunion)
Bernard Mallet (Côte d'Ivoire)

Alternates
Guy Bénard
Jacques Deuse
Charles Egouménides
Renée Graulière
Sylvi Lakhia
Dominique Laurent
Jacqueline Martin
Anne Thibaut

In 1989, the Joint Staff-Management Committee met eight times; four of these meetings were general-body sessions.

The CIRAD Joint Staff-Management Committee and its subcommittees.



The Committee delegates part of its functions to departmental and regional subcommittees.

The departmental subcommittees were established in 1988 for a dialogue between department managements and their staff. They deliberate on scientific, financial, and administrative matters as well as training.

The regional subcommittees administer social and cultural activities. In 1989, such subcommittees were established in Niger and Togo.

A relief fund is provided for exceptional subsidies or emergency loans to staff. In 1989, due to the Firinga cyclone in Réunion and the Hugo cyclone in Guadeloupe, the Committee granted assistance to staff at the two locations.

FINANCE

Note to the reader

Two points need to be specified for the budget analysis.

The budget does not cover projects managed by CIRAD as an executing agency on behalf of host governments. In 1989, these activities were valued at Fr 113 million.

Activities financed through self-generated income did not increase as planned. Although figures for fiscal year 1989 are not available, the volume of these activities is expected to be 5-10% lower than the estimated figure.

The 1989 budget reflects renewed growth based on additional funds from the French government for 1989 (*décret d'avance* 88-754 of 10 June 1988).

This growth marks the efforts made since the formation of CIRAD to reorganize administrative, financial, and staff structures; to rationalize and clarify the research organization; and to promote high standards of quality for research.

The Center's research organization is being structured into programs which are established according to disciplines or groups of disciplines. Human and financial resources are being concentrated—particularly in Africa—at locations that offer the most favorable conditions for scientific output. Bilateral activities are thus given a wider and more regional scope.

The 1989 budget is aligned to the following mid-term priorities: to structure the departments, to strengthen and clarify research programs, to give fresh impetus to its overseas activities, and to keep pace with progress in CIRAD's work areas.

The 1989 budget presents the following features:

– An overall increase of 10.2% compared with the 1988 budget,[1] mainly due to an increase (+24.3%) in self-generated income.

– Moderate increase (+2.8%) in operating subsidies, due to funds pledged in advance through the 1988 decree;

1. Modified to include additional funds for 1989 (*décret d'avance* 88-754 of 10 June 1988).

Expenditure			Income		
	1988	**1989**		**1988**	**1989**
Operating expenses	204.1	235.4	Operating subsidies	107.0	110.0
Personnel expenses	488.3	565.8	Personnel expense subsidies	369.5	388.1
Depreciation and contingencies	53.4	31.7	Self-generated income	269.3	334.8
Investments	27.5	19.4	Investment subsidies	27.5	19.4
Total	**773.3**	**852.3**	**Total**	**773.3**	**852.3**

Income and expenditure for fiscal years 1988 and 1989 (Fr millions).

– Second and penultimate phase for integrating staff on monthly wages from the French overseas departments into the regular CIRAD staff system;

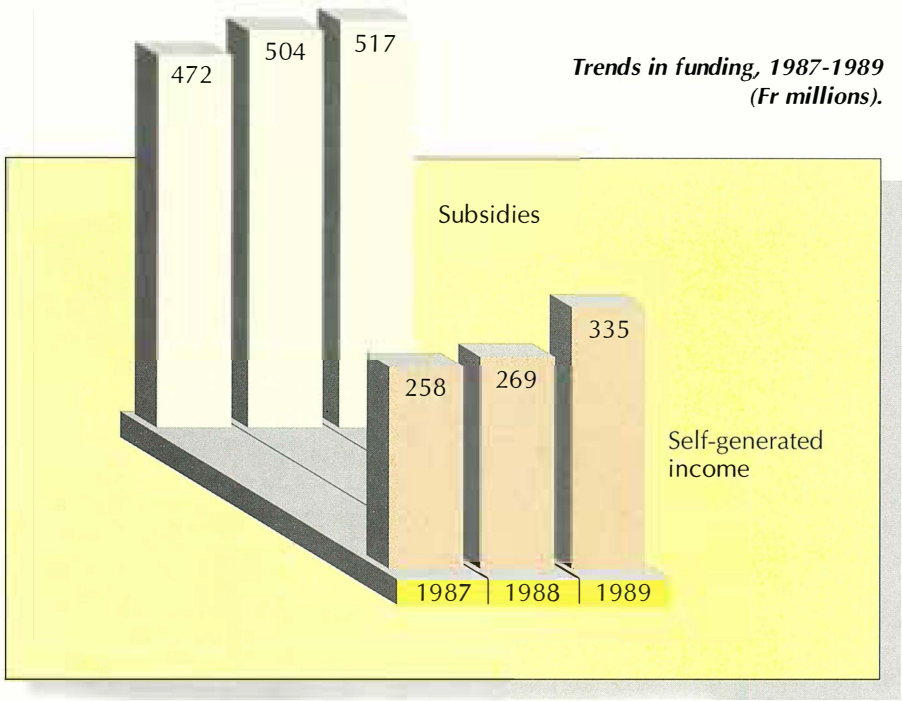
– Temporary suspension of physical plant operations.

Financial Resources

Between 1988 and 1989, state subsidies were increased by Fr 13.5 million (2.6%), compared with Fr 32 million (6.7%) between 1987 and 1988. Subsidies for 1989 account for 61% of the budget, compared with 65% in 1988.

The increase in operating subsidies is 2.8%; they cover 46.7% of operating expenses compared with 52.4% in 1988.

The 5-percent growth in subsidies for personnel expenses covers 3% through an adjustment of the 1988 contribution and 2% for creating 27 positions and for integrating French overseas

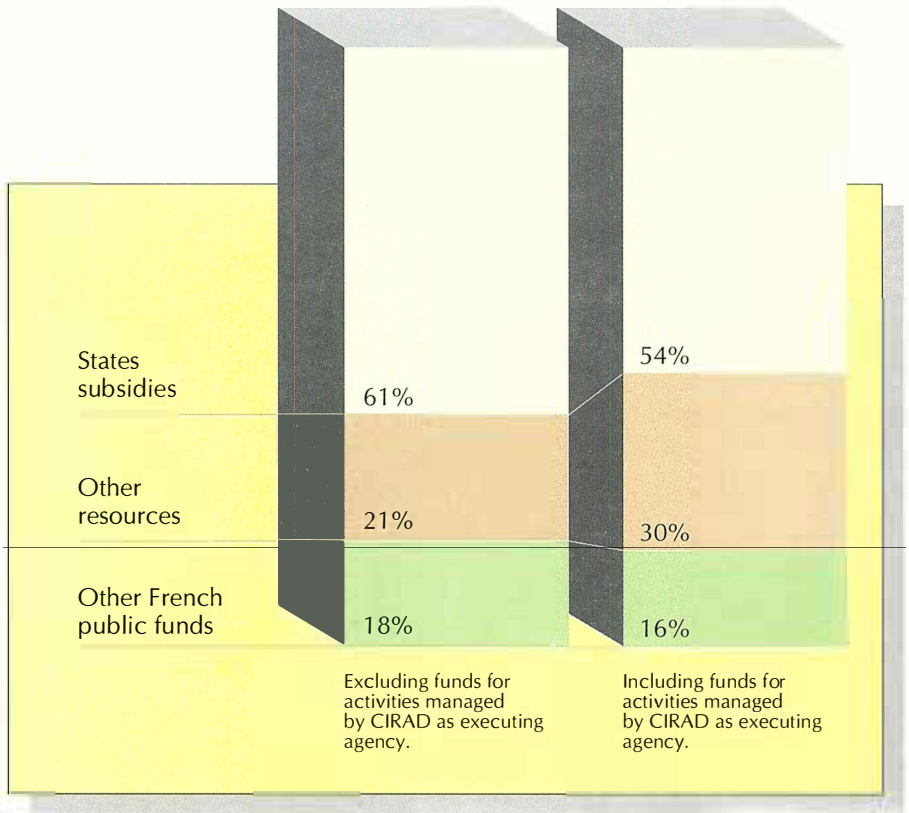


Trends in funding, 1987-1989 (Fr millions).

department staff on monthly wages into the regular CIRAD staff system. The subsidy for 1989 accounts for 68.6% of total salaries.

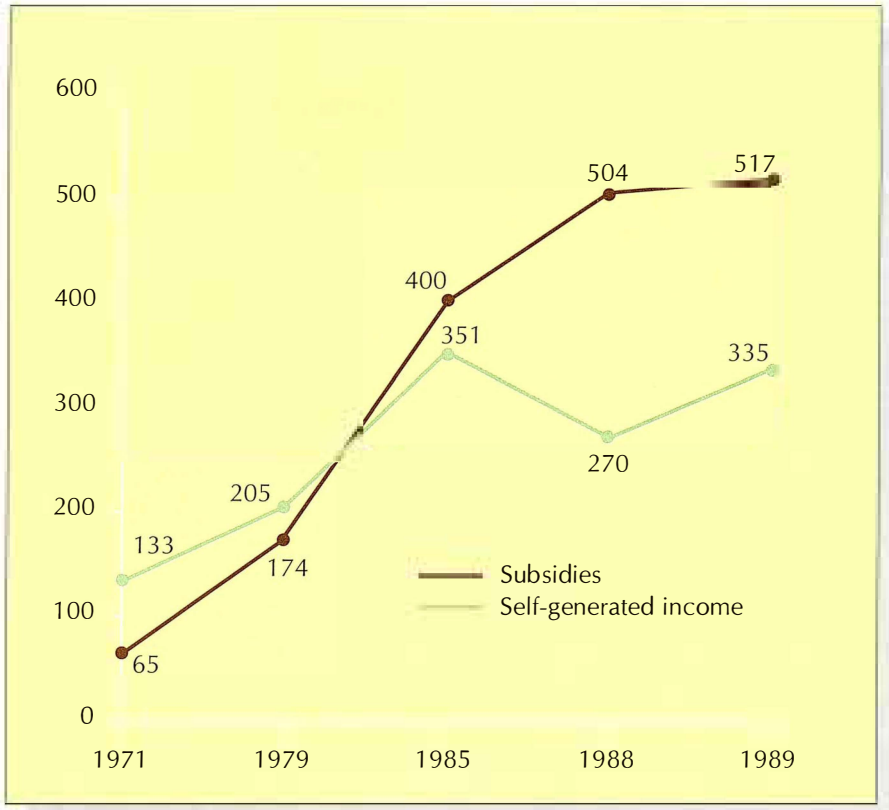
The 29.4-percent decrease in investment subsidies corresponds to the temporary suspension of physical plant, mainly in Montpellier.

The share of activities financed through self-generated income is increased substantially by 24.3% (Fr 65.5 million). It



Sources of funding, 1989.

Trends in funding, 1971-1989 (Fr millions).



The graph shows three phases:

– Between 1979 and 1985, the year when CIRAD's first budget was planned, the percentage of BCRD funds increased and exceeded self-generated income;

– In 1988, the proportion of BCRD funds gained more importance as research and development activities managed by CIRAD on behalf of Côte d'Ivoire were discounted from the budget.

– 1989 shows an upswing in the volume of activities financed through self-generated income.

represents 39% of the budget for all activities. This explains the overall budgetary growth in 1989 compared with 1988.

Of the operations financed through self-generated income, 18% are supported through public funds other than the state R&D budget (BCRD) and 21% through other sources.

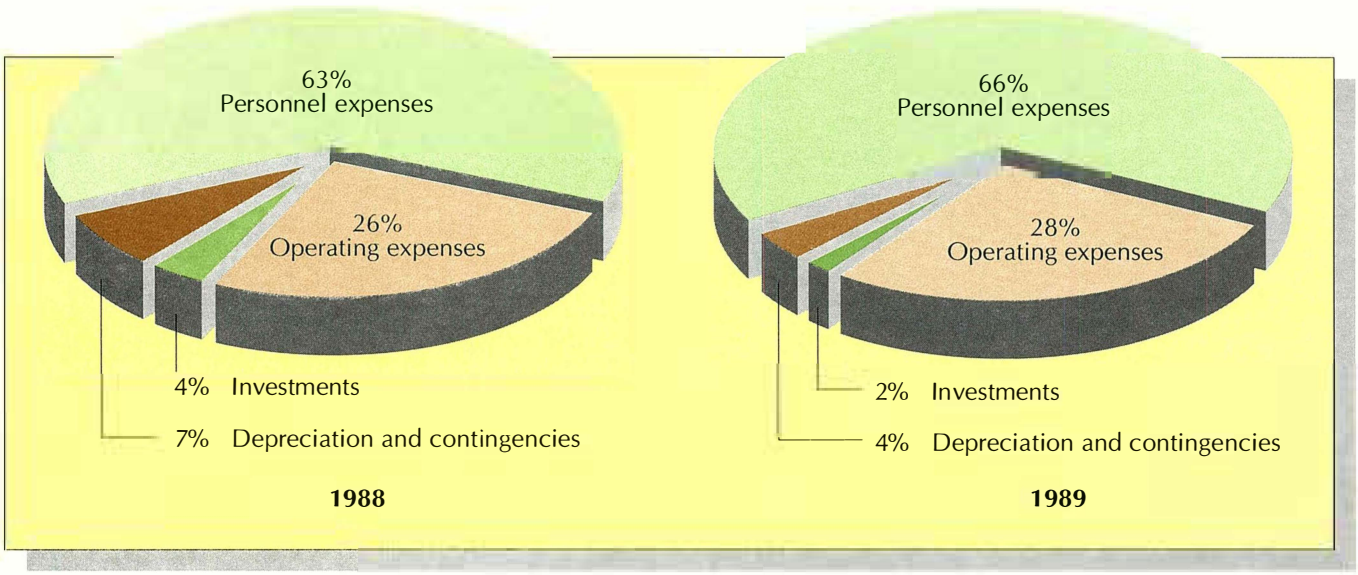
The non-BCRD public funds are obtained through contracts given by the Ministry of Cooperation (mainly Fonds d'aide et de coopération), Ministry of Foreign Affairs, and Ministry of Research and Technology (mainly Fonds de la recherche et de la technologie); program contracts with the French overseas departments; and an export duty on fruit from the French West Indies and French Guiana.

Income is also generated through contracts from international organizations (EEC, FAO, World Bank, etc.) and the private sector, sale of agricultural products, and subsidies from host countries (although such funding is decreasing).

Expenditure

Personnel expenses account for 66% of the total expenditure. The 3-percent increase compared with 1988 is mainly due to staff classification costs and integration of monthly-wage staff from the French overseas departments.

There is a 3.5-percent increase in total salaries for 1989 (for the same staff strength). As subsidies for this item only allow an adjustment of 3%, the difference is covered by the Center's own funds.



Expenditure in fiscal years 1988 and 1989.

The 27 new positions are financed through subsidies. They include 23 senior positions, 6 of which are based in France and 17 overseas (including 10 in Africa).

Operating expenses of mixed teams of national and CIRAD scientists are increasingly supported by CIRAD, due to the economic situation in the host countries. French state subsidies for this budget item only partially offset this significant reduction.

	GERDAT	CEEMAT	DSA	CTFT	IEMVT	IRAT	IRCA	IRCC	IRCT	IRFA	IRHO	Total
Personnel expense subsidies	75.886[1]	10.164	12.571	38.983	39.192	74.683	18.075	25.052	29.773	35.888	27.873	**388.140**
Operating subsidies	29.866[1]	3.555	3.151	11.149	11.076	19.004	5.449	3.823	7.070	9.711	6.146	**110.000**
Self-generated income	34.685	9.095	16.827	32.622	25.829	61.747	19.358	22.368	22.277	35.905	54.106	**334.819**
Investment subsidy	17.239[1]	0.450	0.100	0.180	0.140	0.395	0.100	0.100	0.425	0.100	0.205	**19.434**
Total	**157.676**	**23.264**	**32.649**	**82.934**	**76.237**	**155.829**	**42.982**	**51.343**	**59.545**	**81.604**	**88.330**	**852.393**

1. Including funds for core activities.

Distribution of income by department for fiscal year 1989 (Fr millions).

Income and Expenditure at Department Level

The individual share of the 11 departments in the total budget varies from 2.7% to 18.5%. GERDAT is a special case as it comprises some research programs and laboratories, central services, offices of the Scientific Coordinators, and special budget items that are allocated by the CIRAD management for core activities.

Distribution of expenditure by department for fiscal year 1989 (Fr millions).

	GERDAT	CEEMAT	DSA	CTFT	IEMVT	IRAT	IRCA	IRCC	IRCT	IRFA	IRHO	Total
Personnel expenses	73.099	14.797	20.294	65.910	52.725	103.307	29.314	39.040	41.250	61.099	64.982	**565.817**
Operating expenses	48.892	7.917	10.952	15.510	22.519	49.730	13.170	11.094	16.845	17.389	21.375	**235.393**
Depreciation and contingencies	18.446	0.100	1.303	1.334	0.853	2.397	0.398	1.109	1.025	3.016	1.768	**31.749**
Investments	17.239	0.450	0.100	0.180	0.140	0.395	0.100	0.100	0.425	0.100	0.205	**19.434**
Total	**157.676**	**23.264**	**32.649**	**82.934**	**76.237**	**155.829**	**42.982**	**51.343**	**59.545**	**81.604**	**88.330**	**852.393**

ANNEXES

List of Projects Financed by EEC (D-G XII) in which CIRAD Participates

CIRAD department	Title	Main executing agency
CEEMAT	Quality improvement of fermented cassava products	CIRAD
	Increasing the efficiency of draft animal-powered crop production through the development of novel implements	AFRC, UK
	Studies on performance of various tillage implements on different soil types	Univ. of Giessen, FRG
	Drying and rural agroindustries in central America	Univ. of Valencia, Spain
CTFT	Natural forest and graminaceous formations in Africa	CIRAD
	Wood shortage: from on-farm consumption to rural or urban marketing of firewood in Benin	CIRAD
	Controlled mycorrhization to improve production of commercial plantations	CIRAD
	Agroforestry in the West African dense forests	CIRAD
	Conservation and increase of local leafy timber resources using improved material and vegetative multiplication (*Terminalia*) in the wet zones of West and central Africa	Univ. of Gembloux, Belgium
DSA	SYGAP II: Soybean yield gap analysis project. Phase II	CIRAD
GERDAT	Agricultural price policy in Cameroon. A farming systems-based analysis	Univ. of Hohenheim, FRG
IEMVT	Use of attractants and pheromones for integrated tsetse fly management	CIRAD

CIRAD department	Title	Main executing agency
	Nutritive value of tropical woody forage plants for ruminants	CIRAD
	Peste des petits ruminants: tests of the homologous vaccine, virus biochemistry, test development	CIRAD
	Integrated control of cowdriosis and dermatophilis of ruminants	Univ. of Utrecht, Netherlands
	Semi-intensive forage production through restoration of fallows and ranges in the Senegal river valley	ISRA, Senegal
	Mixed animal species in range grazing and preservation	AFT, Ireland
	Studies on trypanotolerance of cattle, sheep, and goats in Africa	IMT, Belgium
	Small ruminant adaptive research in Malawi	GTZ, FRG
	Herd size and management in range grazing systems in Niger	Univ. of Hohenheim, FRG
	Transmission and virulence of rinderpest	Univ. of Liège, Belgium
IRAT	Improving water supply through cultural techniques (R3S)	CIRAD
	Improving water supply through cultural techniques in the Sudano-Sahelian zone (R3S)	Institut du Sahel, Mali
	Identification of drought-prone areas, characterization of the effects of drought on production systems (R3S)	CIRAD
	Lowland development: type, water resources, agricultural potential (R3S)	CIRAD
	Oryza sativa-Magnaporthe grisea relations and resistance breeding strategies	CIRAD
	Particle aggregation mechanisms in tropical soils with low content of swelling clays	CIRAD
	Optimum use of tropical cereals through industrial pasta production	CIRAD
	Study of constraints to high-altitude rice crops and development of suitable varieties	Univ. catholique de Louvain, Belgium
	Sorghum improvement through genetic manipulation	Univ. libre de Bruxelles, Belgium
	Resistance in maize to the parasitic weed *Striga* and the relationship between infestation and farming practices	KIT, Netherlands

CIRAD department	Title	Main executing agency
	Research for soil, water and crop management at farm scale on acid sulphate soils in the Mekong delta, Vietnam	Univ. of Wageningen, Netherlands
IRCA	Evaluation, characterization, and use of new genotypes for *Hevea* improvement	CIRAD
	Intercropping with *Hevea*	CATH, Gabon
IRCC	Integrated management of the coffee berry borer, using parasitoids	IICA, Costa Rica
IRCT	Glandless cottonseed as a source of protein for human and animal diets	CIRAD
IRFA	Banana improvement for local consumption and export	CIRAD
	Pineapple improvement	CIRAD
	Control strategy for banana and plantain black leaf streak disease	CATIE, Costa Rica
IRHO	Trypanosome diseases of coconut and oil palm in South America	CIRAD
	Breeding for drought tolerance in groundnut	ISRA, Senegal
	Groundnut leaf disease control in Africa	INERA, Burkina Faso
	Physiology of drought resistance in annual crops (R3S)	Univ. Paris VII, France
	Development of methods for controlling the weed *Chromolaena odorata* in Africa and South America	IRHO, Côte d'Ivoire
	Physiology of drought tolerance in coconut and oil palm and development of suitable material	DRA, Benin
	Establishment of an office for developing tropical oil crops (Burotrop)	CIRAD
	Defense reactions of oil palm to *Fusarium oxysporum*	CIRAD
	Study of *Phytophthora* diseases of coconut: characterization of species, epidemiology, control strategies	CIRAD
	Development of cropping techniques for irrigated groundnut	ISRA, Senegal

List of Acronyms

ACP, African, Caribbean, and Pacific countries

AFRC, Agricultural and Food Research Council, UK

AFT, An Foras Taluntais (Agricultural Institute), Ireland

AGRHYMET, Centre régional de formation et d'application en agrométéorologie et hydrologie opérationnelle, Niger

ANVAR, Agence nationale de valorisation de la recherche, France

ATP, Action thématique programmée (interorganization thematic research project)

ATSAF, Arbeitsgruppe tropische und subtropische Agrarforschung, FRG

AUPELF-UREF, Association des universités partiellement ou entièrement de langue française—Université des réseaux d'expression française, France

BCEAO, Banque centrale des Etats de l'Afrique de l'Ouest, Senegal

BDPA, Bureau pour le développement de la production agricole, France

BRGM, Bureau de recherches géologiques et minières, France

BSSFT, Laboratoire de biotechnologie des systèmes symbiotiques forestiers tropicaux, France

CADEF, Comité d'action pour le développement du Fogny, Senegal

CARDI, Caribbean Agricultural Research and Development Institute, Trinidad and Tobago

CATH, Centre d'appui technique à l'hévéaculture, Gabon

CATIE, Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica

CCCE, Caisse centrale de coopération économique, France

CEA, Commissariat à l'énergie atomique, France

CEMAGREF, Centre national du machinisme agricole, du génie rural, des eaux et des forêts, France

CENAREST, Centre national de la recherche scientifique et technologique, Gabon

CFDT, Compagnie française pour le développement des fibres textiles, France

CGIAR, Consultative Group on International Agricultural Research, USA

CGPRT, Regional Coordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops, Indonesia

CIAT, Centro Internacional de Agricultura Tropical, Colombia

CIDST, Centre d'information et de documentation scientifique et technique, Madagascar

CIEPAC, Centre international pour l'éducation permanente et l'aménagement concerté, France

CILSS, Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel, Burkina Faso

CIMMYT, Centro Internacional de Mejoramiento de Maíz y Trigo, Mexico

CIP, Centro Internacional de la Papa, Peru

CIRES, Centre ivoirien de recherches économiques et sociales, Côte d'Ivoire

CNEARC, Centre national d'études agronomiques des régions chaudes, France

CNPAF, Centro Nacional de Pesquisa em Arroz e Fejão, Brazil

CNRS, Centre national de la recherche scientifique, France

CNRST, Centre national de la recherche scientifique et technologique, Burkina Faso

CORAF, Conférence des responsables de la recherche agronomique africains, Congo

CPATSA, Centro de Pesquisa Agropecuária do Trópico Semi-Arido, Brazil

CRIWI, Chinese Research Institute for Wood Industry, PRC

CRTA, Centre de recherches sur les trypanosomoses animales, Burkina Faso

CTA, Centre technique de coopération agricole et rurale, Netherlands

D-G VIII, Directorate-General for Development (EEC), Belgium

D-G XII, Directorate-General for Science, Research and Development (EEC), Belgium

DGRST, Délégation générale à la recherche scientifique et technique, Cameroon

DNEF, Direction nationale des eaux et des forêts, Mali

DRA, Direction de la recherche agronomique, Morocco

EDF, European Development Fund, Belgium

EEC, European Economic Community, Belgium

EMATER-GO, Empresa de Assistência Técnica e Extensão Rural do Estado de Goias, Brazil

EMBRAPA, Empresa Brasileira de Pesquisa Agropecuária, Brazil

EMBRATER, Empresa Brasileira de Assistência Técnica e Extensão Rural, Brazil

EMGOPA, Empresa Goiânia de Pesquisa Agropecuária, Brazil

ENEA, Ecole nationale d'économie appliquée, Senegal

ENGREF, Ecole nationale du génie rural, des eaux et des forêts, France

ENSAM, Ecole nationale supérieure agronomique de Montpellier, France

ENSIAA, Ecole nationale supérieure des industries agricoles et alimentaires, France

ENSIAAC, Ecole nationale supérieure des industries agricoles et alimentaires du Cameroun, Cameroon

ESAT, Ecole supérieure d'agriculture tropicale (CNEARC), France

ESCAP, Economic and Social Commission for Asia and the Pacific, Thailand

FAC, Fonds d'aide et de coopération, France
FAO, Food and Agriculture Organization of the United Nations, Italy
FNCC, Federación Nacional de Cafeteros de Colombia, Colombia
FOFIFA, Centre national de la recherche appliquée au développement rural, Madagascar
FONAIAP, Fundación Nacional de Investigación Agropecuaria, Venezuela
FUDECO, Fundación para el Desarrollo de la Región Centro Occidental, Venezuela
GERDAT, Groupement d'études et de recherches pour le développement de l'agronomie tropicale, France (until December 1984)
GRET, Groupe de recherche et d'échanges technologiques, France
GRIDAO, Groupe de recherche pour le développement de l'agronomie oasienne, France
GTZ, Deutsche Gesellschaft für Technische Zusammenarbeit, FRG
IAM, Institut agronomique méditerranéen, France
IARCs, International Agricultural Research Centers
IBPGR, International Board for Plant Genetic Resources, Italy
ICARDA, International Center for Agricultural Research in Dry Areas, Syria
ICRAF, International Council for Research in Agroforestry, Kenya
ICRISAT, International Crops Research Institute for the Semi-Arid Tropics, India
IDESSA, Institut des savanes, Côte d'Ivoire
IER, Institut d'économie rurale, Mali
IFC, Institut français du caoutchouc, France
IFDC, International Fertilizer Development Center, USA
IFPRI, International Food Policy Research Center, USA
IGN, Institut géographique national, France
IICA, Instituto Interamericano de Cooperación para la Agricultura, Costa Rica
IITA, International Institute of Tropical Agriculture, Nigeria
ILCA, International Livestock Center for Africa, Ethiopia
ILRAD, International Laboratory for Research on Animal Diseases, Kenya
IMT, Institut de médecine tropicale, Belgium
INA-PG, Institut national agronomique Paris-Grignon, France
INERA, Institut national d'études et de recherches agricoles, Burkina Faso
INERA, Institut national pour l'étude et la recherche agronomiques, Zaire
INIBAP, International Network for the Improvement of Banana and Plantain, France
INRA, Institut national de la recherche agronomique, France
INRAN, Institut national de la recherche agronomique du Niger, Niger
INRZFH, Institut national de la recherche zootechnique, forestière et hydrobiologique, Mali
INSERM, Institut national de la santé et de la recherche médicale, France
IRA, Institut de la recherche agronomique, Cameroon
IRRI, International Rice Research Institute, Philippines
ISABU, Institut des sciences agronomiques du Burundi, Burundi
ISAR, Institut des sciences agronomiques du Rwanda, Rwanda
ISIM, Institut des sciences de l'ingénieur de Montpellier, France
ISNAR, International Service for National Agricultural Research, Netherlands
ISRA, Institut sénégalais de recherches agricoles, Senegal
ISSCT, International Society of Sugar Cane Technologists, USA
ITCF, Institut technique des céréales et des fourrages, France
ITTO, International Trade Timber Organization, Japan
KIT, Koninklijk Instituut voor de Tropen, Netherlands
MARDI, Malaysian Agricultural Research and Development Institute, Malaysia
NIAE, National Institute of Agricultural Engineering, UK
OCIBU, Office des cafés du Burundi, Burundi
ODNRI, Overseas Development Natural Resources Institute, UK
OECD, Organization for Economic Cooperation and Development, France
ONIC, Office national interprofessionnel des céréales, France
ORSTOM, Institut français de recherche scientifique pour le développement en coopération, France
PCARRD, Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, Philippines
RESPAO, Réseau d'étude des systèmes de production en Afrique de l'Ouest, Burkina Faso
RRIT, Rubber Research Institute of Thailand, Thailand
SADCC, South African Development Coordination Conference, Botswana
SAED, Société d'aménagement et d'étude du delta et des vallées du fleuve Sénégal et de la Falémé, Senegal
SEDES, Société d'études pour le développement économique et social, France
SIARC, Section industries alimentaires des régions chaudes (ENSIAA), France
SMH, Société de microbouturage de l'hévéa, France
SODEFOR, Société pour le développement des plantations forestières, Côte d'Ivoire
UAIC, Unité d'afforestation industrielle du Congo, Congo
UDEAC, Union douanière et économique de l'Afrique centrale, Central African Republic
UPRA, Unité néo-calédonienne de sélection et de promotion des races bovines, New Caledonia
USDA, United States Department of Agriculture, USA
USTL, Université des sciences et techniques du Languedoc, France

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Production
Service central d'information scientifique et technique (GERDAT-CIRAD)

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Editing and Coordination
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Layout and Production Manager
Bernard Favre

Graphics
Crayons & Cie, Montpellier

Platemaking and Printing
Imprimerie Déhan, Montpellier

Translated from the French Le CIRAD en 1989. *Also available in Spanish.*

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en recherche agronomique pour le développement
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