
CIRAD
2003
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CIRAD, the "Centre de coopération internationale en recherche agronomique pour le développement", is the French Agricultural Research Centre for International Development. Its mission is to contribute to the economic development of the tropical and subtropical regions through research on agriculture, training, and dissemination of its results.

It employs 1 850 people, including 950 senior staff, working in the French overseas regions and some fifty other countries. Its budget amounts to approximately 180 million euros.

CIRAD has seven research departments: annual crops; perennial crops; fruit and horticultural crops; animal production and veterinary medicine; forestry; land, environment and people; and advanced methods for innovation in science. CIRAD operates through its own research centres, collaborating national agricultural research systems, universities and international centres, and development projects.

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Message from the President

The 2003 Annual Report, like last year, highlights the main results obtained in terms of research and of the partnerships established by CIRAD teams. This perhaps does not entirely do justice to the full extent of the work accomplished within CIRAD to ensure the maximum effectiveness of its operations.

The year 2003 was marked by the launch of an operation aimed at reorganizing CIRAD into research units and, more generally, of reforming how the establishment is managed. The principles of this were approved by the Board of Trustees on 28 April 2004. This decision, which is the fruit of substantial internal preparation and debate, is clear proof of CIRAD's ability to react to a fast-changing scientific and geopolitical situation.

The establishment of research units is in accord with the current changes in the European research landscape, which now centres on networks of excellence, major programmes and stronger links between research and teaching. The move was prompted by CIRAD's desire to open up to national and European research and higher education establishments.

Similarly, CIRAD will also work with research organizations, higher education establishments and professional sectors in developing countries. Research units, and particularly the joint research units we are setting up with developing-country organizations, will make an even more effective contribution to agricultural development in tropical regions and countries. In fact, in both the industrialized and the developing worlds, the linear idea of a "chain of progress" has been superseded by that of an "innovation network", which more closely reflects the complexity of the relations between the various stakeholders. In CIRAD's overall strategy, each and every research unit will have a place in those innovation networks, in line with its specific fields of expertise and skills.

CIRAD is now deeply committed to sustainable development. Under the national strategy adopted by the government on 3 June 2003, the organization is involved to various degrees in seven of the ten chosen operations. The projects in question generally have equivalents in, and are funded by, Europe and other countries. For instance, in the field of risks, pollution and health, the European EDEN project on emerging diseases is coordinated by CIRAD. Likewise, CIRAD is heading a joint project on forest ecosystems in the Congo Basin, which was approved at the Johannesburg Summit and involves partners in developing countries.

This report highlights the wide range of CIRAD's operations in metropolitan France, French overseas regions, and abroad. It gives substantial coverage to training, which is a major element in CIRAD's remit and operations.

Lastly, to ensure transparency, indicators are gradually being established for CIRAD: in addition to those laid down in the Agreement on Objectives endorsed by the French government and CIRAD, this year's report also includes indicators of scientific and technical production.

Jeanne-Marie Parly
President, CIRAD Board of Trustees

Contents

Research results

Cropping systems that stand the test of time

Tropical plant genomics

Land and resource stakeholders and managers

From international agreements to local markets

Some perspectives

Indicators

CIRAD at a glance

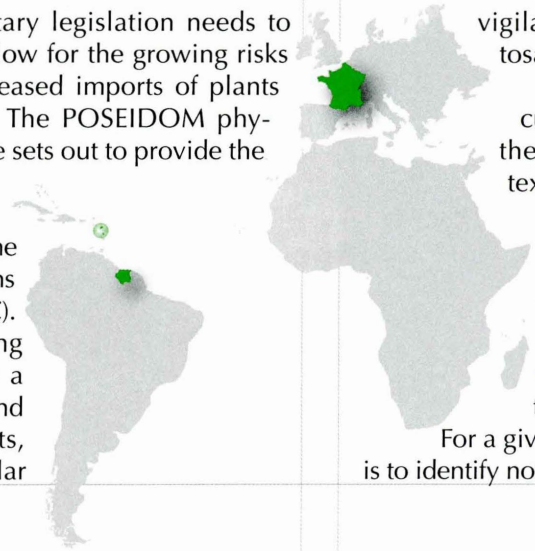
Research results

Cropping systems that stand the test of time

The climatic conditions in hot regions are particularly favourable to insect pest development and disease epidemics. The recent increase in global trade has accelerated their spread. Control strategies against some insect populations currently centre on a limited range of chemical treatments, which has resulted in the appearance of resistant populations. An integrated approach to cropping systems is required if sustainable strategies are to be developed. Under such an approach, the methods used in agriculture, animal production and forestry are pooled to optimize their effect. However, it is crucial to be able to establish hypotheses and then test them. Fundamental studies and modelling are valuable tools in this type of undertaking.

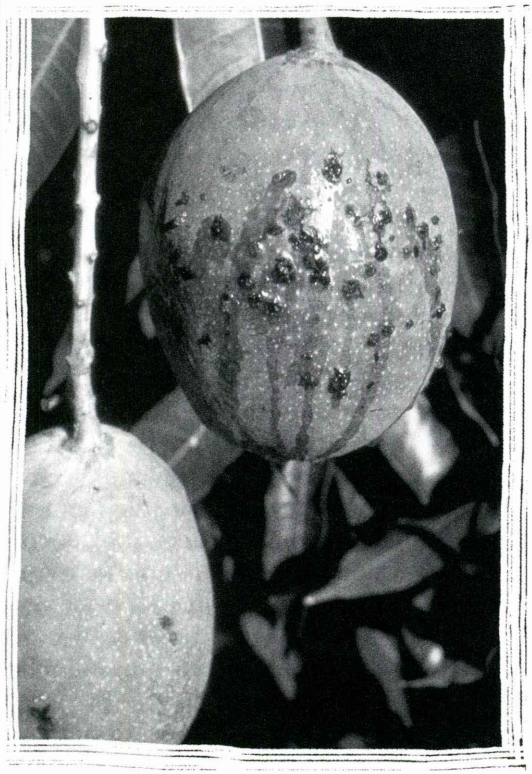
Analysing phytosanitary risk with a view to European legislation

European phytosanitary legislation needs to evolve in order to allow for the growing risks that result from increased imports of plants and plant products. The POSEIDOM phytosanitary programme sets out to provide the necessary justifications for revisions to the texts concerning the French overseas regions (Directive 2000/29/EC). It involves identifying organisms that pose a threat to agriculture and natural environments, necessitating particular vigilance in terms of border phytosanitary controls.



The French Ministry of Agriculture has entrusted CIRAD with the task of revising the current texts, through pest risk analyses (PRA). These analyses are based on an international standard adopted by the International Plant Protection Convention and the FAO and validated by the European Plant Protection Organization (EPPO). For a given geographical zone, the aim is to identify noxious organisms (pests, invasive

Partners
MAAPAR, ministère de l'Agriculture, de l'alimentation, de la pêche et des affaires rurales, France • POSEIDOM, European Community Programme of Options Specific to the Remote and Insular Nature of the French Overseas Departments



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Xanthomonas sp. pv. *mangiferaeindicae*, symptoms on mango.

plants and pathogens), describe the channels through which they may be introduced (trade, tourism, etc), assess their ability to become established and spread, and judge whether it would be appropriate to class them as "quarantine pests". The importance of sugarcane, banana, pineapple, citrus fruit, mango, and fruit and horticultural crop production chains in the agricultural economy of the French overseas regions was a determining factor in choosing the PRA to be carried out. Eighty-two PRA, covering nine production chains, were conducted in 2003. Under the agreement, a further 43 are to be conducted in 2004.

Experts from the Crop Protection Programme, AMIS Department, and the Fruit Trees Programme, FLHOR Department, and Sugarcane Programme, CA Department

Crop Protection Centre, Réunion

BGPI (Biology and Genetics of Plant-Parasite Interactions for Integrated Control) Joint Research Unit (Agro.M, CIRAD, INRA), Montpellier, France

PVBMT (Plant Stands and Biothreats in Tropical Environments) Joint Research Unit (CIRAD, University of Réunion), Réunion

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Applications

Eighty-two pest risk analyses: sugarcane, banana and other Musaceae, pineapple and other Bromeliaceae, citrus fruit, mango, market garden crops (Solanaceae and Alliaceae), Araceae (anthurium), horticultural crops (some species only).

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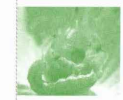
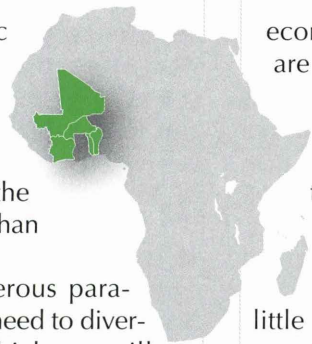
Control of a pesticide-resistant cotton pest





The political and economic importance of cotton growing in West Africa was recognized at the World Trade Organization's Cancun Summit in 2003. It is the leading cash crop in the region, and is grown by more than two million smallholders.

Cotton suffers from numerous parasites in the tropics, hence the need to diversify protection strategies, which are still largely based on chemical treatments. The most economical, easiest-to-implement strategies are now practised on a wide scale.

Severe attacks by the cotton bollworm *Helicoverpa armigera* have been observed throughout West Africa since the start of the 1990s. Year by year, the outbreaks have occurred increasingly early in the crop cycle and become more difficult to control, as treatments have had little effect, despite applying ever higher and more frequent doses of pyrethroids, which are recommended against this pest. Suspicions that

Partners

CNRA, Centre national de recherche agronomique, Côte d'Ivoire • URCF, Unité de recherche coton et fibres, Benin • INERA, Institut de l'environnement et des recherches agricoles, Burkina Faso • IER, Institut d'économie rurale, Mali

H. armigera had become resistant to pyrethroids were rapidly confirmed.

To deal with this problem, cotton sector stakeholders opted to set up a regional network with a view to preventing or at least managing *H. armigera* resistance to pyrethroids. Within the network, CIRAD researchers have been involved in both field and laboratory studies, and in drawing up a new *H. armigera* control strategy. This work was facilitated by close collaboration between national agricultural research organizations, cotton and agrochemicals firms, and producer associations.

Helicoverpa armigera on a young cotton boll.

THE KEY ROLE OF AN OXYDASE

H. armigera resistance to pyrethroids has been detected in populations sampled in Togo and Benin as well as in the production area that comprises Mali, Burkina Faso and Côte d'Ivoire.

Studies have shown that the degree of pyrethroid resistance can be very high: in laboratory tests, resistant bollworms sometimes required 100 times more insecticide than susceptible ones to achieve a given mortality rate.

Research on resistance mechanisms has prompted several conclusions. Firstly, resistant bollworms show greater enzymatic activity than susceptible ones. Oxidases in the body of resistant insects apparently break down pyrethroids. Secondly, some organophosphorus insecticides are targeted by these same oxidases and thus indirectly improve the effect of pyrethroids on resistant insects. Lastly, these studies also explained why an organophosphorus insecticide, triazophos, is more toxic to pyrethroid-resistant bollworms than to susceptible ones: triazophos is ineffective unless triggered by an oxidase.

A WIDELY ADOPTED STRATEGY

A series of practical recommendations has now been adopted, setting out new principles for chemical control. Pyrethroids are no longer used in the first instance. They have been replaced by endosulfan, an organochlorine that has proved effective on both susceptible and resistant bollworms. Formulas combining a pyrethroid and an organophosphorus compound are then sprayed, preferably using triazophos, since it can eliminate resistant bollworms. Pyrethroids are used once the trees bear fruit, as they are the only insecticides effective against other bollworms. The combined use of several chemical families also helps to control sucking insects.

H. armigera resistance to pyrethroids has meant a 25% increase in phytosanitary protection costs. The recommendations have been adjusted to ensure that farmers do not apply treatments until a certain infestation threshold has been reached. Moreover, to reduce the health and environmental risks, two additional measures have been adopted: using insecticide microcapsules, which considerably reduces toxicity through contact with the active ingredient, and approval of another two, more specific, molecules, indoxacarb (an oxadiazine) and spinosad, a substance obtained through natural fermentation of a microorganism *(Saccharopolyspora spinosa)*.

FIVE YEARS OF SUCCESS

The new strategy has now been adopted by all the farmers in the cotton-growing countries of West Africa, thanks to the sterling efforts of the cotton firms involved in collecting cottonseed and in distributing inputs. The fact that there have not been any uncontrolled outbreaks since its introduction in 1999 is proof of its success.

However, the scarcity of new insecticide molecules and the risk of pests developing resistance to several chemical families warrant further research. The ease with which resistance genes can be transferred over large geographical areas

highlights the merits of implementing regional crop protection strategies.

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Conducting a bioassay to obtain a lethal dose 50 and calculate the degree of resistance.

Applications

Workshops

The regional project is funded by cotton firms in each country. Its conclusions are presented to the firms at annual workshops. It is the firms or national extension services that are responsible for implementing the chosen protocols.

Protocols

The studies conducted by researchers result in the establishment of joint protocols, which are then managed by the relevant NARS.

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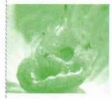
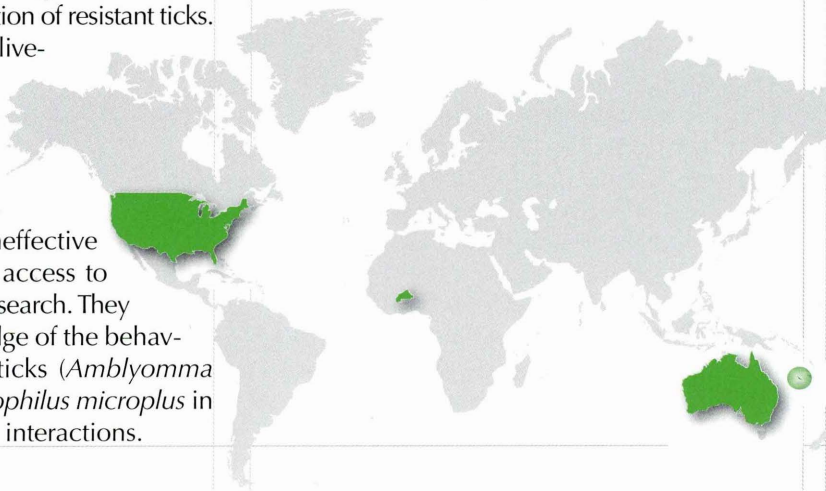
Tick control: more targeted treatments



The main tick control methods involve using chemicals: dipping animals in an acaricide formulation or spraying them with a portable sprayer, or dorsal applications of oily acaricides. On commercial cattle farms, frequent and prolonged use of acaricides has resulted in the selection of resistant ticks. On the other hand, traditional livestock farmers in West Africa find these methods too costly, which leads them to misuse the acaricides, or to replace them with inadequate or dangerous chemicals, or with ineffective practices. Farmers now have access to methods developed through research. They are based on a better knowledge of the behaviour of the most dangerous ticks (*Amblyomma variegatum* in West Africa, *Boophilus microplus* in Oceania) and of host-parasite interactions.

For instance, it was observed that, in the pastures, *A. variegatum* ticks attach to the feet, just above the hooves, where they stay until the animals lie down; then the ticks move to their preferred sites, udders and chests. The use



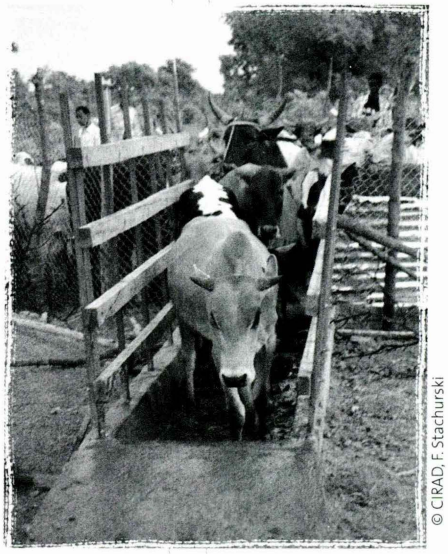
Partners

CIRDES, Centre international de recherche-développement sur l'élevage, Burkina Faso • CSIRO, Commonwealth Science and Industry Research Organisation, Australia • IAC, Institut agronomique néo-calédonien, New Caledonia • Saphyto S.A., Burkina Faso • UPLB, Union des producteurs laitiers du Burkina, Burkina Faso • USDA, United States Department of Agriculture

of an acaricide footbath kills the ticks before they attach to those sites.

An aerosol spray developed in conjunction with a firm in Burkina Faso can be used to treat only the attachment sites, thus cutting treatment costs.

On commercial farms in Oceania, breeding animals with low infestation levels of *B. microplus* could help to reduce the number of treatments. However, this would be less feasible in Africa, since it has been established that the low attraction of some cattle for *A. variegatum* is due to the animal's behaviour and seems to be not very transmissible from parent to offspring.



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Walking animals through an acaricide footbath on their return from grazing.

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Applications

Technical advice note

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Slide show (in French)

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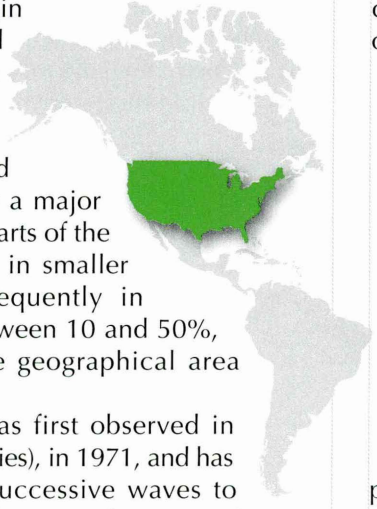
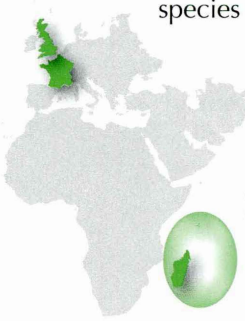
An emerging bacterial disease on onion

Bacterial blight is one of the main limitations on Alliaceae cultivation. The symptoms begin on the leaves and flower stems, in the form of small, watery patches that spread and eventually destroy a major part of the aerial parts of the plant. This results in smaller bulbs, and consequently in yield losses of between 10 and 50%, depending on the geographical area concerned.



The disease was first observed in Barbados (West Indies), in 1971, and has since spread in successive waves to almost every continent. In the 1980s, it reached Mauritius and then Réunion. Its simultaneous appearance on several continents prompted questions as to the nature of the associated bacterial clones worldwide and the degree of similarity between them.

Might a single pathogenic species have been responsible, and if so, what were the factors that led to the emergence of the disease on a global scale?



Might the causal agent in fact be a range of species causing similar symptoms, as with species of the genus *Xanthomonas*, which are pathogenic for tomato plants?

CIRAD's work initially involved characterizing an international collection of the pathogen

Partners

ARMEFLHOR, Réunion • Chambre d'agriculture, Réunion • IOC, Indian Ocean Commission (Comoros, Réunion, Madagascar, Mauritius, Seychelles) • INRA, Institut national de la recherche agronomique, France • INA-PG, Institut national agronomique Paris-Grignon, France • SEMOI (seed farm), Réunion • SPV, Service de la protection des végétaux, Réunion • SUAD, Service d'utilité agricole et de développement, Réunion • University of Edinburgh, United Kingdom • University of Florida, United States

strains responsible for the disease, followed by an epidemiological study aimed at determining whether the disease could be spread by seed.

Pathogen taxonomy and genetic diversity

Research on bacterial taxonomy was conducted jointly with INRA Angers and the University of Florida, United States.

The bacterium was characterized using various methods: DNA-DNA hybridization, 16S ribosomal DNA sequencing, analyses of carbon substrate assimilation and fatty acid composition, and genotype studies using AFLP *(amplified fragment length polymorphism)*. All the clones isolated on onion plants suffering from bacterial blight proved to belong to the same species, *Xanthomonas axonopodis*, and more precisely to genomic group 2 of the species. The bacterium is pathogenic for several Alliaceae (onion, garlic, leek, chive and shallot), but not for beans or hyacinth. It was designated *Xanthomonas axonopodis* pv. *allii*.

A genetic diversity study using various molecular techniques showed that strain polymorphism varied according to their geographical origin. There are zones with considerable diversity (United States, South Africa) and others with very little (Venezuela, Hawaii, Barbados).

There appear to be at least two clearly differentiated groups of strains in the Indian Ocean region. The diversity of a large collection from this area is currently being assessed. The collection is due to be enriched still further under a regional plant protection programme launched at the end of 2003.

A disease spread by seed

For the first time on an international level, *X. axonopodis* pv. *allii* strains have been detected in onion seed, under pioneering work at the Réunion Plant Protection Centre's laboratories. This major result has boosted collaboration between the centre and the University of Edinburgh, United Kingdom, and ARMEFLHOR, a horticultural testing organization in Réunion. The studies showed that planting plots with naturally contaminated seed batches—four contaminated seeds per 10 000—could trigger epidemics, which were initially centred on plants resulting from contaminated seeds. The studies also helped to pinpoint the climatic factors likely to affect disease distribution and development, which had never previously been identified in the case of bacterial blight on onion. For instance, daily mean temperatures of more than 20°C are apparently likely to trigger epidemics; and the bacterium seems to be spread by irrigation or rain (in the event of strong winds at the same time, secondary infection foci may occur up to 25 metres from the primary foci).

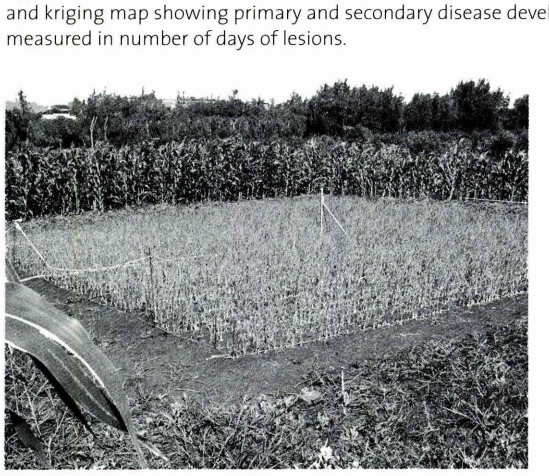
Disease transmission by onion seed is one factor that could account for the simultaneous

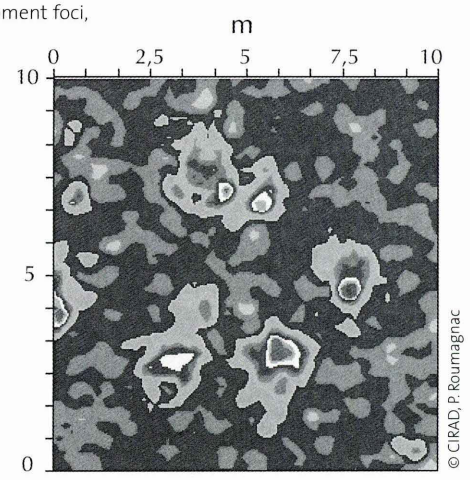
Applications

Molecular test to detect *Xanthomonas axonopodis* pv. *allii* by PCR on seed (development under way at the Réunion Plant Protection Centre).

Technical advice on irrigating onion plots.

Agronomic test of disease transmission by seed: plot sown with onion, and kriging map showing primary and secondary disease development foci, measured in number of days of lesions.





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appearance of epidemics on several continents, as a result of commercial seed batch exchanges.

What remains to be done is to elucidate disease epidemiology during the second part of the onion's biennial cycle. To this end, experimental plots were planted with onion bulbs in 2003. Some of the bulbs were inoculated with a known, identifiable bacterial strain.

▸▸ There are still some major questions, particularly concerning how seed comes to be contaminated. Might the bacterium be airborne? Might the problem be systemic transfer of the bacterium from disease tissue to the seed? Might healthy plants produce contaminated seed? A molecular test aimed at detecting *X. axonopodis* pv. *allii* by PCR *(polymerase chain reaction)* is currently being developed at the Réunion Plant Protection Centre, in the hope of providing answers to these questions.

Réunion Plant Protection Centre, AMIS, CA and FLHOR Departments

BGPI (Biology and Genetics of Plant-Parasite Interactions for Integrated Control) Joint Research Unit (Agro.M, CIRAD, INRA)

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FOR FURTHER INFORMATION

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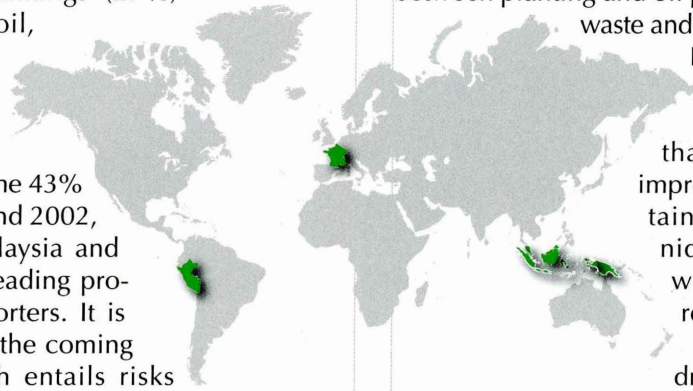
Oil palm: good agricultural practices

Palm oil, which is second in the world consumption rankings (27%) after soybean oil, is in increasing demand. The area planted with oil palm expanded by some 43% between 1990 and 2002, primarily in Malaysia and Indonesia, the leading producers and exporters. It is set to double in the coming 20 years, which entails risks resulting from the deforestation of "high conservation value" areas in these two countries, soil erosion, reduced biodiversity, and waste emissions.



A technical guide was produced in 1995, aimed at ensuring sound plantation operations through rational management of the stages between planting and oil production, including waste and effluent management. However, in recent years, three new difficulties have arisen that have prompted improvements in the sustainability of the techniques adopted, along with more stringent recommendations.

The first is how to draw up contracts laying down appropriate practices. Organic oil production is increasing, although it is still a marginal activity. Under the standards set for organic farming, chemical fertilizers are outlawed, which means that farmers have to be technically highly skilled if their operations are to be economically

Partners
INRA, Institut national de la recherche agronomique, France • Palmas del Espinos, Peru • Pontian United Plantations Berhad, Malaysia • P.T. Smart Tbk, Indonesia • P.T. Socfindo, Indonesia • WWF, Switzerland

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Palm oil mill effluent recycling: controlled spreading in the field.

viable. This raises new questions about organic matter management. In the same way, the technical specifications laid down on the basis of ecological arguments, to which new installations in particular have to conform, are imposed by investors, the agrifoods industry or buyers from large retail groups. Systematic spreading of effluent in plantations is an alternative to the current practice of discharging that effluent into the environment after ponding, which is rarely effective and constitutes a serious pollution hazard. Empty fruit bunches can be recycled as compost rather than burned. Processing by-products can also be composted, contributing to efficient mineral export management, but this raises new technical problems related to the appropriate methods for preparing and spreading this type of compost.

The second difficulty lies in the divergent interests and resources of large-scale farmers and smallholders. Moreover, in terms of management, oil palm plantation sustainability is viewed differently depending on a stakeholder's position in the commodity chain. The sustainability issue led the Malaysian Palm Oil Association to organize a round table on sustainable palm oil in August 2003, at the suggestion of Anglia Oils, Migros, Sainsburys and Unilever and in conjunction with the WWF. CIRAD researchers have a crucial contribution to make in establishing a clear terminology and drawing up standard and regulatory frameworks, with a view to shedding light on the issues that will govern future technical choices. CIRAD also signed the charter put forward at the round table in Kuala Lumpur.

The third difficulty is in evaluating recommended practices that are supposed to be sustainable. The good practices laid down in guides and specifications described the means to be employed in plantations. Internal or external reviews can be carried out to determine whether they are actually applied. However, it is more difficult to assess their relevance and efficacy in relation to the specificities of a given plantation. Such assessments call for indicators, and researchers are currently working to compile a list. This is a crucial operation, as it constitutes an objective analysis that will produce scientific results. An agronomic and environmental assessment, and more precisely the establishment of an indicator—nitrogen—was thus undertaken in Peru in 2003, with a view to analysing the terms of the equation used to determine balances under the "Indigo" method developed by INRA Colmar, under tropical conditions. This was done in conjunction with the SYSTEM Joint Research Unit (Agro.M-CIRAD-INRA), and fits into a thematic project under way at CIRAD.

Neucapalm Thematic Project, Evaluation of Nitrogen Management Practices in Perennial Agrosystems with a Legume Understorey (CIRAD)

Improvement of Agronomic Techniques for Farming System Management Team, Oil Palm Programme, CP Department

Cultivated Perennial Ecosystem Operations and Management Team, CP Department

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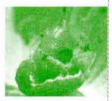


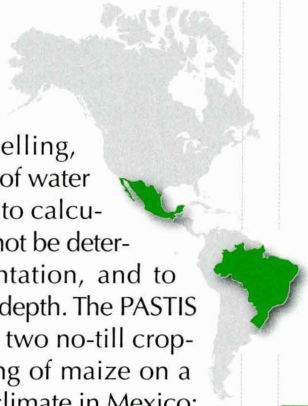
Modelling cropping systems

Partners
CIMMYT, Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico • INIFAP, Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Mexico • EMBRAPA, Empresa Brasileira de Pesquisa Agropecuária, Brazil • INRA, Institut national de la recherche agronomique, France • LTHE, Laboratoire d'étude des transferts en hydrologie et environnement, CNRS, France

How can the recommendations made by field-based agronomists be tested? Mechanistic modelling, which is based on the laws of water and energy transfer, serves to calculate balances that often cannot be determined through experimentation, and to analyse crop functioning in depth. The PASTIS model has been applied to two no-till cropping systems: direct seeding of maize on a dead mulch in a semi-arid climate in Mexico; and direct seeding of rice on a between-season plant cover in a humid climate in Brazil. It demonstrates the mechanisms underlying the positive effects that have been observed.

Under marginal water supply conditions in Mexico, maize grown in this way produces a much greater quantity of dry matter than in traditional systems. Modelling showed that even with small amounts of mulch, this method leads to a reduction in evaporation from the soil and, even more markedly, in runoff. Crusting is reduced, reconstitution of soil water reserves is facilitated, and plant transpiration is almost optimum. Moreover, variations in temperature and moisture are tempered and the soil is enriched with organic matter, favouring microorganism activity and nitrogen mineralization.

Under favourable water supply conditions in Brazil, the positive effects of no-till cropping are primarily due to nitrogen flux. The cover crop recycles the mineral nitrogen in the soil between two crop seasons, before releasing it to the following rice crop through mineralization, whereas without a cover crop nitrogen is leached after planting rice. The model thus demonstrates its ability to analyse unconventional cropping systems. It can therefore also be used to adjust certain cropping practices, and particularly to modify nitrogen fertilizer rates.



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FOR FURTHER INFORMATION

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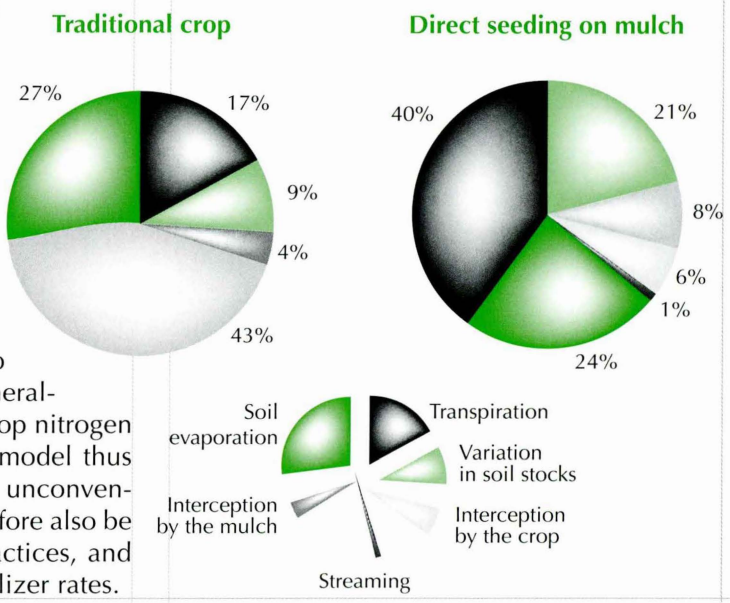
Modelling the water balance over a crop cycle in Mexico.



APPLICATIONS

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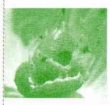
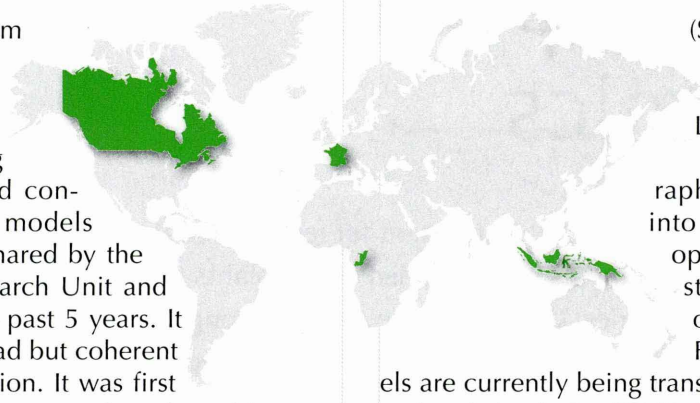
CAPSIS: a new forest management platform





The CAPSIS platform is intended to facilitate management decisions concerning forest stands, and contains some 20 models developed and shared by the AMAP Joint Research Unit and foresters over the past 5 years. It thus covers a broad but coherent range of information. It was first used in France for research and teaching purposes, was then transferred to foresters, and is now being opened up to the international community.

The platform includes forest dynamics models and silvicultural intervention tools. As required, it can handle one or more species in natural or managed forests, under temperate or tropical conditions. It can take account of forest growth and production on different scales, and can include regeneration, mortality, genetic monitoring or the risks of wind damage. Combining these models makes it possible to simulate scenarios based on an initial real or virtual situation, alternating phases of natural growth and human intervention, or exceptional events.

Three models integrated recently concern tropical forests: tree production in Indonesia (SEXI), tropical forest dynamics in French Guiana (SELVA) and eucalyptus stand growth in Congo (EUCALYPT).

A genetics bibliography was integrated into CAPSIS in 2003, opening the way for studies of diversity on a forest scale. In France, several models are currently being transferred to the Office national des forêts (ONF, the national forestry commission).

Cultivated Tropical Ecosystem Functioning and Management Team, Trees and Plantations Programme, Forestry Department

Forest Modelling and Dynamics Team, Natural Forests Programme, Forestry Department

AMAP (Botany and Bioinformatics of Plant Architecture) Joint Research Unit (CIRAD, CNRS, INRA, IRD, université Montpellier 2)

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For further information

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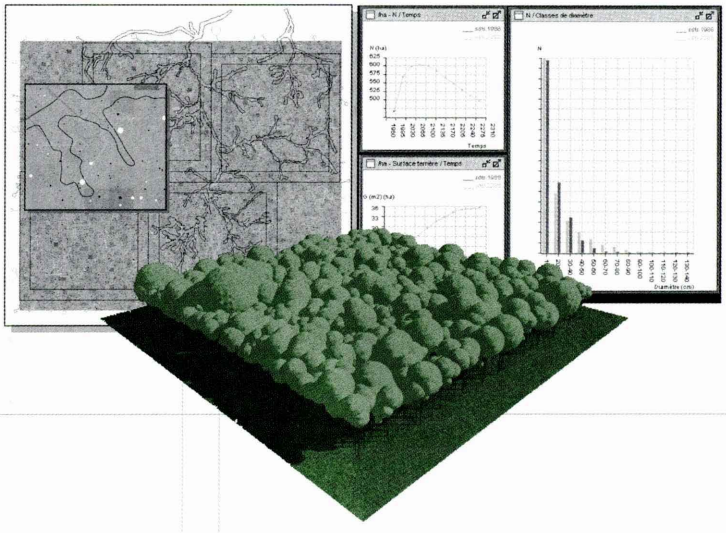

Simulation by CAPSIS (SELVA module) of dense forest stand development in French Guiana.

© Amap

Partners

France
AFOCEL, Association forêt-cellulose • CEMAGREF, Institut de recherche pour l'ingénierie de l'agriculture et de l'environnement • ENGREF, Ecole nationale du génie rural, des eaux et des forêts • IDF, Institut pour le développement forestier • IFN, Inventaire forestier national • INRA, Institut national de la recherche agronomique • MAAPAR, ministère de l'Agriculture, de l'alimentation, de la pêche et des affaires rurales • ONF, Office national des forêts

Overseas
Eco SA, Congo • ICRAF, World Agroforestry Centre, Indonesia • IEFC, European Institute for Cultivated Forest • Ministère des ressources naturelles, Quebec, Canada

Application

In meteorology

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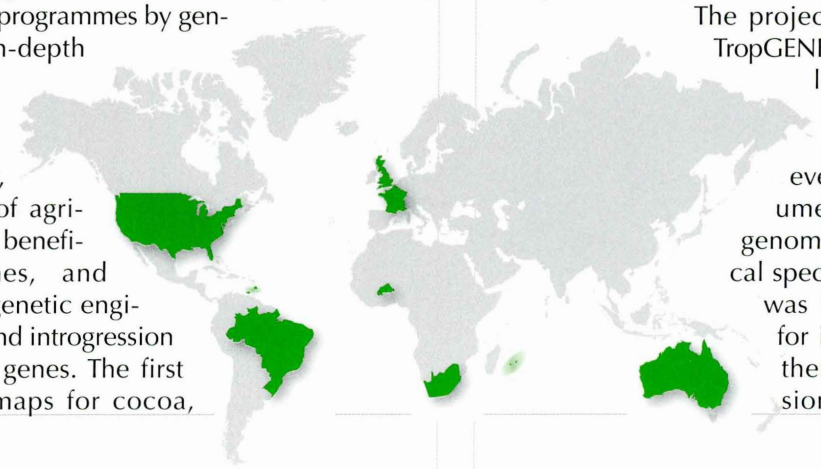
Tropical plant genomics

Genomic analysis is a powerful instrument for research on the fundamental material of living organisms. Scientists have mapped model plants and are now investigating the function of their genes. The knowledge gained through this research provides insight into the entire plant kingdom. The tools developed are subsequently tailored to different tropical plant species in order to facilitate rapid construction of their genetic maps and location of beneficial genes. Breeders systematically assess the ability of crops to adapt to different stresses with the hope of being able to provide quick answers to questions concerning epidemics, hazards and climate change put forward by producers and their agronomist, pathologist and genetic engineering partners. CIRAD is striving to enhance its capacity for collecting and sharing this knowledge.

TropGENE DB online genetic database

All genetic and genomic research conducted at CIRAD is geared towards assisting tropical crop breeding programmes by generating in-depth knowledge on genetic diversity, markers of agriculturally beneficial genes, and through genetic engineering and introgression of useful genes. The first genetic maps for cocoa, banana and a sugarcane cultivar have already been published by CIRAD scientists.

The project to develop the TropGENE DB database was launched in 1996, with the aim of managing the ever-increasing volume of genetic and genomic data on tropical species. The database was initially designed for in-house use, but then an online version was posted on



Partners

Sugarcane

BSES, Bureau of Sugar Experiment Stations, Australia • CERF, Centre d'étude, de recherche et de formation, Réunion • COPERSUCAR, Brazil • MSIRI, Mauritius Sugar Industry Research Institute, Mauritius • SASEX, South African Sugar Association Experiment Station, South Africa • SOSUCO, Burkina Faso • WICSCBS, West Indies Central Sugar Cane Breeding Station, Barbados

the Internet in June 2003 to provide access to anyone interested.

Enhanced knowledge management

The quantity of genetic and genomic data produced by or used in CIRAD projects is increasing more and more rapidly. It was thus crucial to organize this information so that it could be used more efficiently and to combine new data with information collected previously by other research teams.

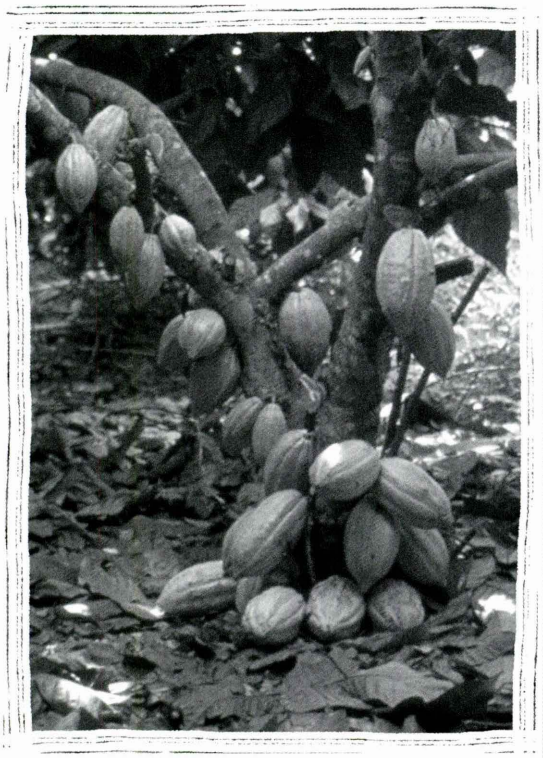
The database is organized in crop-specific modules and includes information on agromorphological data, genetic origins and allelic diversity in germplasm collections. Each module pools information on molecular markers, genetic maps, quantitative trait locus (QTL) analysis results, physical mapping data, sequences, genes, as well as bibliographical references for a specific crop. There are currently three running modules, ie sugarcane, cocoa and banana.

TropGENE DB is managed using the AceDB software system—a standard freeware program that is widely implemented by genetic scientists. It can store and search for complex biological information and provides an intuitive object-oriented view of biological data. It also includes specialized tools for viewing genetic and physical maps, in addition to a gene sequence annotation display.

CocoaGenDB—the first international extension

The cocoa module has been applauded by the international scientific community. This recognition has resulted in the development of a project, entitled CocoaGenDB, aimed at expanding the of scope this module to include other types of data, including phenotypic information associated with genome expression. This new collaborative project involves CIRAD, the University of Reading (UK) and USDA (USA). The database combines information from TropGENE DB with phenotypic data from the ICGD database developed by the University of Reading. CocoaGenDB can be consulted via the Internet using a query interface designed specifically for cocoa.

TropGENE DB is intended for scientists, breeders, genetics and genomics specialists, and even nonspecialists interested in this topic. The data are preassessed by different CIRAD teams and scientists from other institutions. Crop specialists are responsible for controlling the data quality and integrity. Application forms will soon be available to enable scientists to submit their own databases for inclusion.



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Cocoa tree abounding with fruit.

Genomics and bioinformatics research team, Genome analysis of fruit trees research team, Biotrop Programme, AMIS Department

Ligne-Paradis Research Station, Saint-Pierre, CIRAD-Réunion

Roujol Research Station, Petit-Bourg, CIRAD-Guadeloupe

Umr Pia: Polymorphisme d'intérêt agronomique (Agro.M, CIRAD, INRA)

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For further information

Ruiz M., Rouard M., Raboin L.-M., Lartaud M., Lagoda P., Courtois B., 2004. TropGENE DB, a multi-tropical crop information system. Nucleic Acids Research, 32 (1): D364-7. http://nar.oupjournals.org/cgi/content/full/32/suppl_1/D364 [28-01-2004]

Partners

Cocoa

BCCCA, the Biscuit, Cake, Chocolate and Confectionery Association, UK • Cocoa Research Unit, Trinidad and Tobago • ICGD, International Cocoa Germplasm Database, UK • University of Reading, UK • USDA, United States Department of Agriculture, USA

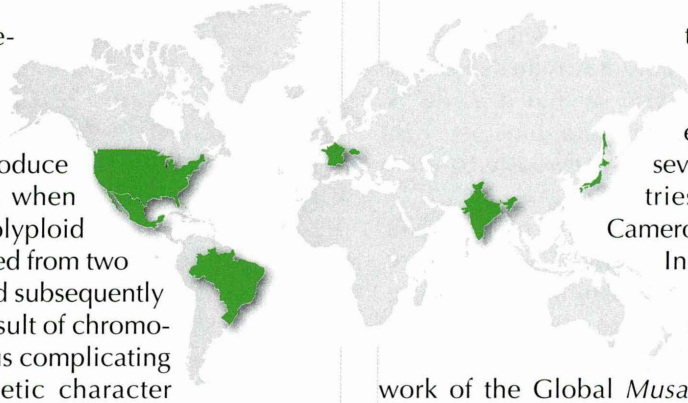
Applications

TropGENE DB User Guide. http://tropgenedb.cirad.fr/en/guide.html [29/03/2004]

CocoaGenDB, a cocoa database with phenotypic, genetic and genomic data. http://cocoagendb.cirad.fr [29-03-2004]

Banana and plantain genomics platform

Partners
CARBAP, African Centre for Research on Banana and Plantain, Cameroon • CINVESTAV, Centro de Investigación y de Estudios Avanzados, Mexico • EMBRAPA, Empresa Brasileira de Pesquisa Agropecuári, Brazil • IEB, Institute of Experimental Botany, Czech Republic • IIHR, Indian Institute of Horticultural Research, India • INIBAP, International Network for the Improvement of Banana and Plantain, France • NIAS, National Institute of Agrobiological Sciences, Japan • TIGR, The Institute for Genomic Research, USA • UCB, Universidade Católica de Brasilia, Brazil



Varietal improvement is not an easy process in banana—clones are sterile and produce seedless bananas when cropped. Their polyploid genome was formed from two main genomes and subsequently rearranged as a result of chromosome splitting, thus complicating the study of genetic character transmission. Very little funding has been allocated to banana improvement programmes worldwide, even though currently cultivated varieties have a very narrow genetic base, which means that they are highly susceptible to pests and diseases. It is thus essential to focus on developing new resistant varieties within the framework of sustainable banana cropping strategies.

With this aim, CIRAD—which is conducting a banana improvement programme—and partners at Agropolis and INIBAP decided to launch a genomic research project on the *Musa* genus in Montpellier, in collaboration with scientific teams from several concerned countries, including Brazil, Cameroon, Czech Republic, India, Japan, Mexico and USA. This project is integrated in the research network of the Global *Musa* Genomics Consortium. The research platform in Montpellier hosts scientists from all parts of the world. It benefits from the results of rice modelling studies carried out as part of the Génoplante Programme.

Molecular resources have been developed, including BAC libraries (clones of large DNA fragments spanning the genome), chromosome and cytogenic maps, genomic libraries, etc. The scientific community now has access to these resources, especially through the Consortium. The first BAC libraries representative of the two main banana genomes (genomes A and B) were sent to five Consortium members in 2003. Research work initiated 2 years ago has made inroads in four main areas: chromosome translocation, which is common in cropped varieties; comparison of the banana genome with the rice genome; mechanisms by which the banana streak virus (BSV) integrates the banana genome; and gene expression in somaclonal variants.

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Banana bunch on the plant.

Translocations

As a result of chromosome rearrangements—especially translocations—between the different banana genomes, many genetic traits are not transmitted via conventional genetic pathways. This substantially complicates the task of banana breeders. These translocations have been located using different genomic techniques. Genetic characters and molecular markers close to translocation break points will be identified in the medium term, which should ultimately facilitate the work of banana breeders.

From the rice to the banana genome

Data obtained on the genome of model plants are being tapped to gain insight into the structure and function of the banana genome. Five institutions (CIRAD, EMBRAPA, INIBAP, TIGR and UCB) are collaborating in this programme. Molecular markers mapped in rice, sorghum and banana can be used to study the structure and evolution of the genomes of these three phylogenetically distant monocot species.

Banana streak virus

The genome of banana varieties sometimes contain BSV sequences that can be reactivated—through the effects of genetic hybridization or various stresses such as in-vitro culture—to produce infectious virus particles. The Agropolis II project aims to pinpoint these sequences and unravel the molecular mechanisms involved in their activation. CIRAD, in collaboration with CINVESTAV (Mexico), has identified several BSV integration sites. Sequencing of BAC clones containing DNA from these sites is under way at CINVESTAV and at NIAS (Japan). The expression of genes involved in the activation of integrated sequences is being analysed in collaboration with IIHR (India). This approach to the analysis of genome function should ultimately give rise to breeding strategies for producing hybrids that will not develop banana streak disease, while providing insight into the factors responsible for activation of the integrated sequences.

Causes of dwarfism

Dwarfism is one of the most common modifications induced by in-vitro culture of banana. A functional genomic analysis of somaclonal variants—genetically different plants obtained by micropropagation—was launched to gain further insight into the mechanisms involved in the development of dwarfism. Gene expression variations are chiefly measured using DNA microarrays that were developed to enhance the analysis.

The platform will continue this research, along with a functional genomic study of *Mycosphaerella fijiensis,* the causal agent of black leaf streak disease and the main pathogen of banana. Many initiatives will address this issue within the framework of the Challenge Programs of the Consultative Group on International Agricultural Research (CGIAR).

Genome evolution in monocots research team, Biotrop Programme, AMIS Department

Management and optimization of banana and plantain genetic diversity research team, Banana, Plantain and Pineapple Programme, FLHOR Department

Génoplante (CIRAD, CNRS, INRA, IRD)

Umr Bepc, Biologie du développement des espèces pérennes cultivées (Agro.M, CIRAD, INRA, IRD)

Umr Bgpi, Biologie et génétique des interactions plante-parasite pour la protection intégrée (Agro.M, CIRAD, INRA)

Umr Pia, Polymorphisme d'intérêt agronomique (Agro.M, CIRAD, INRA)

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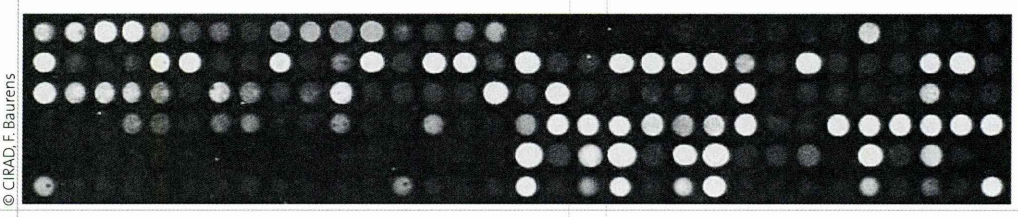
Applications

Genetic and genomic database on banana. http://tropgenedb.cirad.fr/en/banana.html [30-03-2004]

Global Programme for *Musa* Improvement http://www.promusa.org [30-03-2004]

Banana research conducted by the Umr Pia research unit. http://umr-pia.cirad.fr/ recherche/pbanane.html [30-03-2004]

Vitroplant production. http://www.vitropic.fr [30-03-2004]

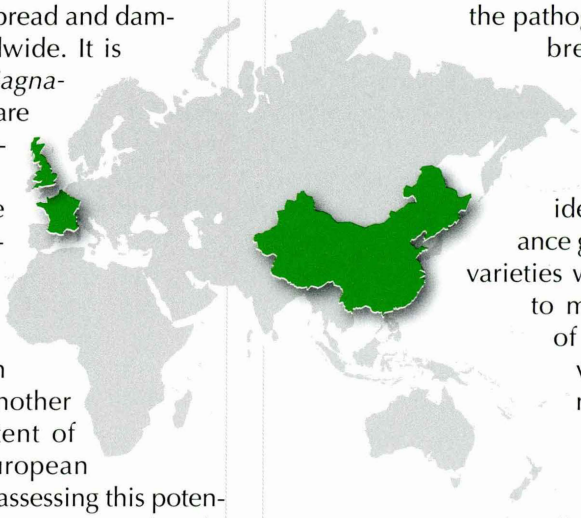


Measurement of banana gene expression in a cell suspension using the DNA microarray technique.

Rice blast in China

Partners
CNRRI, China National Rice Research Institute, China • FRE 2579 (CNRS, INRA, Bayer Cropscience), France • Institute of Genetics, Chinese Academy of Sciences, China • University of Aberdeen, UK • EU, European Union

Rice blast is the most widespread and damaging disease of rice worldwide. It is caused by strains of the *Magnaporthe grisea* fungus, which are evolving constantly to overcome the resistance of improved rice varieties. Some genes and gene combinations do, however, seem to generate varieties with more sustainable resistance than others. The adaptation potential of *M. grisea* is another factor linked with the extent of durable resistance. The European RESIDIV project focused on assessing this potential in China, where *M. grisea* strains and traditional rice varieties form a substantial reservoir of genetic diversity. CIRAD coordinated this project between 2000 and 2003, which also involves two other European teams and two Chinese teams.



The information collected through the project will be valuable for rice breeding programmes in China. First, strategic information on the pathogen strains will help breeders in choosing the most suitable ones to be used for rice improvement. Secondly, accurate identification of resistance genes in Chinese rice varieties will enable breeders to make better choices of "resistance donor" varieties to be implemented for subsequent hybridization. Thirdly, mapping of resistance genes will pave the way for marker-assisted selection. Finally, characterization of the genetic diversity of *M. grisea* strains in terms of their efficacy in attacking resistant rice varieties will provide important information on the best way to utilize and combine rice resistance genes to create varieties with durable rice blast resistance.

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A field test comparing a rice blast resistant variety with a susceptible variety.

Genetic mapping of the pathogenic fungus

A high-resolution genetic reference map was obtained for the first time for the *M. grisea* fungus using microsatellite markers. Seven avirulence genes, which enable the plant to recognize the pathogen and trigger a resistance response, were identified. Three of them were accurately located so they can now be cloned.

Mapping resistance in Chinese rice varieties

Rice blast resistance genes were detected in a study of the progeny of two crosses between susceptible and resistant rice varieties. Screening of all of the progeny with 18 *M. grisea* strains led to the detection of 295 quantitative trait loci (QTLs) that could ultimately correspond to 98 rice resistance genes—QTLs are chromosome areas identified by linking agronomic traits to molecular markers.

Prospects for producing isogenic rice lines

The project ended at an international closing meeting held at Hangzhou, China, in September 2003. Cloning of two avirulence genes of the fungus is planned in 2004. These cloned genes will be used to determine the corresponding rice resistance genes. A long-term goal is to develop genetically close rice lines (isogenic lines), each containing one of the resistance genes identified in this project.

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Harvesting upland rice in the Yunnan province of China.

Rice research team, Food Crops Programme, CA Department

Umr Bgpi, Biologie et génétique des interactions plante-parasite (Agro.M, CIRAD, INRA)

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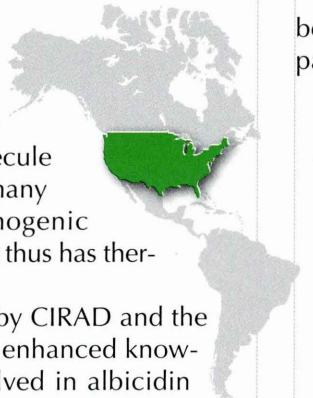
Talukder Z.I., Tharreau D., and Price A.H., 2004. Quantitative trait loci analysis suggests that partial resistance to rice blast is mostly determined by race specific interactions. New Phytologist, 162: 197-209.

Application

Site of the European RESIDIV Programme: http://residiv.cirad.fr [30/03/04]

Albicidin—an antibiotic produced by a sugarcane pathogen

Albicidin is a toxin produced by *Xanthomonas albilineans*, the bacterium that causes sugarcane leaf scald. This molecule is bactericidal against many bacteria that are pathogenic to humans and animals. It thus has therapeutic potential.



Research carried out by CIRAD and the University of Florida has enhanced knowledge on the genes involved in albicidin synthesis in *X. albilineans*—they have now been identified, cloned and sequenced. A comparison of the sequences obtained with those of genes involved in other antibiotic synthesis systems has shed light on the function of each gene. A biosynthesis model was developed and the structure of albicidin was partially simulated. A patent application was submitted for these results and their use, with CIRAD and the University of Florida as coproprietors of the patent.

Partner

University of Florida, USA

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Bioassay on albicidin toxin production by *X. albilineans* (centre of culture dish) as revealed by the inhibition of *E. coli* bacterial growth. On the left, toxin-producing strain (plaque without *E. coli*); on the right, nonproducing mutant strain.

It is still, however, hard to purify albicidin because only scant quantities are produced by *X. albilineans*. Moreover, the mode of action and structure of this compound have not yet been fully decrypted and no studies have been conducted to assess its therapeutic potential.

Now that the genes involved in albicidin biosynthesis have been cloned and sequenced, it should be possible to transfer these genes into other organisms—it will then be possible to produce the molecule in sufficient quantities to be able to purify and study it.

Crop protection research team, Sugarcane Programme, CA Department

Genetic engineering and plant molecular pathology laboratory, Crop Protection Programme, AMIS Department

Umr Bgpi, Biologie et génétique des interactions plante-parasite (Agro.M, CIRAD, INRA)

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Application

Patent

Royer M., Gabriel D.W., Frutos R., Rott P.C., 2002. Complete biosynthetic gene set for synthesis of polyketide antibiotics, including the albicidin family, resistance genes, and use thereof. Patent application number USA60/419,463 (coproprietors CIRAD/University of Florida).

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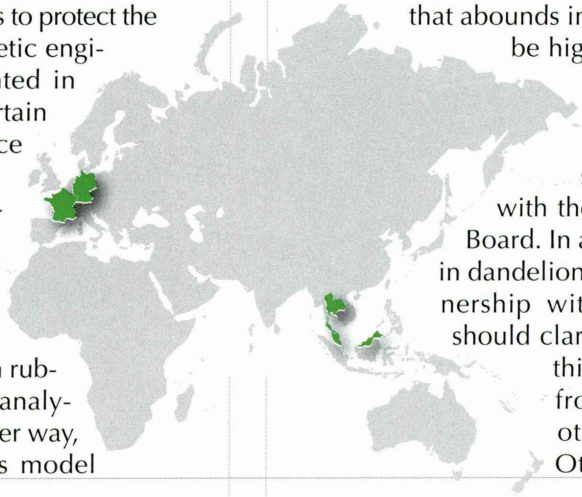
Royer, M., Costet L., Vivien E., Bes M., Cousin A., Damais A., Pieretti I., Savin A., Megessier S., Viard M., Frutos R., Gabriel D.W., Rott P.C, 2004. Albicidin pathotoxin produced by *Xanthomonas albilineans* is encoded by three large PKS and NRPS genes present in a gene cluster also containing several putative modifying, regulatory and resistance genes. Plant-Microbe Interactions, 17 (4): 414-427.

Rubber trees —promoters of a cellular factory

Latex cells in rubber trees resemble a cellular factory devoted to abundant production of rubber—a natural polymer. In addition to its industrial applications, latex seems to protect the tree against agressors. Genetic engineering can be implemented in rubber trees to improve certain agronomic traits or produce high added-value molecules in the latex, eg for therapeutic applications.

Within the framework of a joint French-Thai project, several promoters of genes naturally expressed in rubber latex were isolated. An analysis of their regulation is under way, in rubber tree and various model plants (rice, *Arabidopsis*, dandelion). In particular, the promoter of a gene encoding hevein, a small protein with antifungal properties that abounds in latex, was found to be highly active and stimulated by certain stresses. A patent application was submitted jointly with the Malaysian Rubber Board. In addition, an analysis in dandelion, carried out in partnership with IME (Germany), should clarify the behaviour of this promoter in latex from rubber plants other than hevea. Other promoters are



Partners

IME, Fraunhofer Institute for Molecular Biology and Applied Ecology, Germany • IRD, Institut de recherche pour le développement, France • MRB, Malaysian Rubber Board, Malaysia • RRIT, Rubber Research Institute of Thailand, Thailand • University of Mahidol, Thailand

also being assessed for their reactivity in response to ethylene, which is commonly used in rubber farming for its stimulatory effects on rubber yield.

Beyond rubber trees, these promoters could be used in various genetic engineering programmes when high stress-stimulated expression is required in a latex-type cell system.

Metabolic typology, productivity and ecological adaptation of rubber growing research team, Rubber Programme, CP Department

Umr Bepc, Biologie du développement des espèces pérennes cultivées (Agro.M, CIRAD, INRA, IRD).

Umr Pia, Polymorphismes d'intérêt agronomique (Agro.M, CIRAD, INRA)

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For further information

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Pujade-Renaud V., Montoro. P., Sanier C., Phuangkosol N., Konsawadworakul P., Chrestin H., 2001. Specific promoters for genetic engineering of rubber tree. IRRDB Annual Meeting: Heveaculture and Biotechnology. Montpellier, France.

Application

Patent application

Pappusamy A., Pujade-Renaud V., Jones H., 2003. Promoter sequences from *Hevea brasiliensis* hevein genes. Application PI 2003 1807 (coproprietors CIRAD/MRB) [Application submission: 16-05-2003].

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The first transgenic rubber plants.

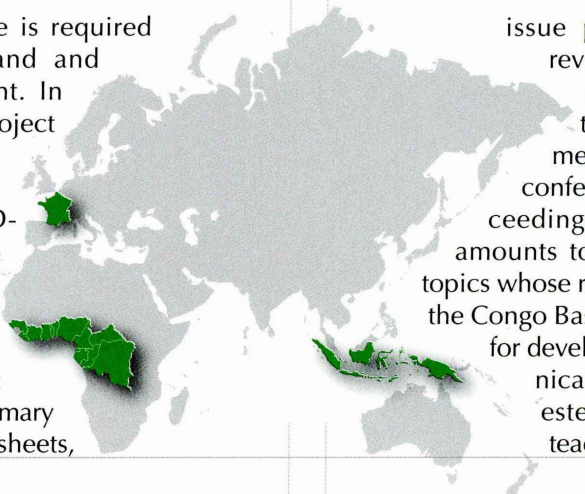
Land and resource stakeholders and managers

Natural resources and land management are closely linked, and many problems can arise as the population pressure increases. When land conflicts are triggered by different resource uses, and when the resources are not sufficiently replenished, it is essential to be able to quickly assess the impact on local communities. Sharing knowledge and methods is a prerequisite for effective discussion and negotiation. Efficient solutions can be found by bringing together economists, sociologists, agronomists, breeders and foresters, public authorities, NGOs and users. CIRAD—in line with French policy-making strategies—gives stakeholders considerable clout in decision making and promotes the development of local organization and management bodies.

FORAFRI—sharing knowledge on African tropical rainforests

Partners
CENAREST, Centre national de la recherche scientifique et technologique, Gabon • CIFOR, Center for International Forestry Research, Indonesia • CORAF, Conseil ouest et centre africain pour la recherche et le développement agricoles, Senegal • MAE, ministère des Affaires étrangères, France

Information exchange is required for efficient joint land and resource management. In 2003, the FORAFRI project compiled all of its previously published documents on a CD-ROM with a book supplement, and the package was presented at the World Forestry Congress. It includes: scientific summary documents, technical sheets, issue papers, bibliographical reviews, a toolbox of criteria and indicators for sustainable forest management, training manuals, and conference and workshop proceedings. This package, which amounts to some 5 000 pages on topics whose relevance extends beyond the Congo Basin, should be very useful for development companies, technical administrations of interested countries, as well as teachers and scientists. Deci-



sion makers, environmental NGOs, and technical support and cooperation agencies and programmes should also benefit from it.

FORAFRI—a project that was launched by CIRAD and the Center for International Forestry Research in 1996—aims to contribute to the sustainable management of tropical rainforests in central and western Africa by providing stakeholders of the forestry sector with access to specialized knowledge and techniques. The project makes effective use of data from research studies, some of which have been under way for more than 20 years in the Congo Basin. This information is tailored to users' needs.

Striking a balance between forestry management and users' interests

Tropical rainforests of central and western Africa cover an area of almost 2 million km^2, the second largest stand of forest in the world after that in the Amazon. The first explorers, forest users and inhabitants thought that these forests were eternal because of their tremendous size and seemingly exuberant growth. This initial impression turned out to be unfounded. The increase in the human population and activities in the vicinity has led to degradation and fragmentation of this stand. It is now time to change forest usage methods to avoid further depletion of this natural resource—by stopping harvesting of the "standing capital" (timber) in order to be able to glean the interest from this capital, ie only the volume of wood or non-wood products that is restored by forest regeneration.

Sustainable forestry management must begin by understanding the physical and biological environment of a forest stand, its logging potential, and how trees will react to logging or silvicultural treatments. Ecological traits, growth, mortality, current uses of logged species and stands are key parameters on which managers require information in order to understand the dynamics of forests, predict their productivity, and draw up management plans adapted to each specific situation.

Tropical forests offer rural communities and urban populations a broad range of goods and services. All forest development projects should reconcile sustainable forestry management and users' interests. Pilot projects carried out by scientists have shown that conflicts can be avoided or easily solved when stakeholders are involved in forest resource management. All ecological, social, economic and political factors that can have an impact on forestry management should be taken into account. This requires developing and disseminating socioeconomic survey methods, and tools to foster discussion, negotiation and joint decision making.

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Eucalyptus stand in the Congo.

A learning process

Forestry development stakeholders should have access to digital technology. Remote sensing, satellite positioning systems and geographical information systems can be implemented to outline the boundaries of forests and village land, to highlight land used by rural inhabitants, to supplement standard terrestrial inventories, to analyse forest dynamics or to draw up resource maps. In addition, forest users require technical information, such as the minimum felling diameter and

Applications

The FORAFRI website. http://www.forafri.org [30-03-2004]

A few technical documents from the FORAFRI CD-ROM 2003.

Durrieu de Madron L., Forni E., Mekok M., 1998. Les techniques d'exploitation à faible impact en forêt dense humide camerounaise. CIRAD, Montpellier, France. FORAFRI Document, 17, 30 p. [CD-ROM, 17].

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Pain-Orcet M., Lo-Seen D., Fauvet N., Trébuchon J.-F., Dipapoundji B., 1998. Les cartes, la télédétection et les Sig, des outils pour la gestion et l'aménagement des forêts tropicales d'Afrique centrale. CIRAD, Montpellier, France. FORAFRI Document, 12, 27 p. [CD-ROM, 35].

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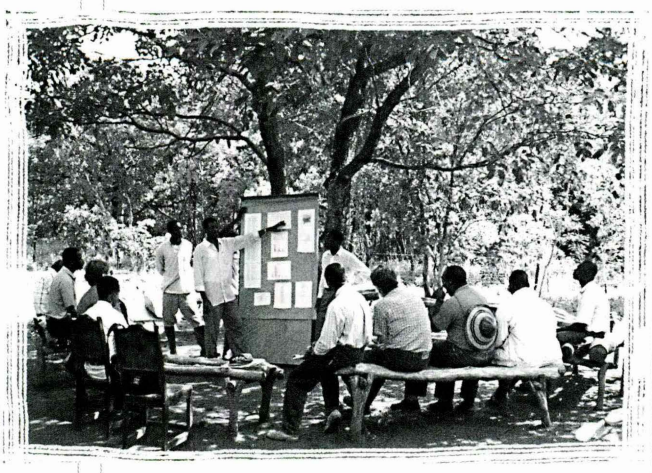
Reid C.P.P., 2002. Manuel pour la préparation et la rédaction de propositions de recherche. Doumenge C. (Ed.), IUFRO-SPDC, Vienna, Austria; FORAFRI, Libreville, Gabon, 160 p. [CD-ROM, 38].



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Forestry training session in Côte d'Ivoire.

between-felling turnaround time, which are key factors for implementing low-impact development or silvicultural strategies geared towards increasing the logging volume in managed forests. Finally, administrations, political decision makers and donors should have access to monitoring and assessment criteria and indicators for sustainable forestry management.

The FORAFRI project is striving to supply targeted information tailored to specific stakeholder needs. This effective use of scientific knowledge is accompanied by efforts to train and strengthen the human potential of the region in terms of research and the entire forestry sector.

FORAFRI, which is funded by the French Ministry of Foreign Affairs, has established partnerships with many national research institutions and regional and international organizations, including educational, research and communications organizations, scientific networks and research institutions, professional organizations in the forestry sector (associations, unions, consultancy offices), NGOs and conservation organizations, etc.

▸▸ Now that the initial goals of this project have been reached, CIRAD, CIFOR and CORAF research teams have launched a new project that is funded by the French Ministry of Foreign Affairs. It is focused on training of scientists and providing support for forestry and environmental research in the Congo Basin.

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FOR FURTHER INFORMATION

Doumenge C., Gami N., Louppe D. (Eds), 2003. La gestion durable des forêts denses en Afrique centrale et occidentale. Un panorama du projet Forafri. FORAFRI, Libreville, Gabon; CIRAD, Montpellier, France [CD-ROM, 39 documents, more than 5 000 p, booklet 30 p] .

Protected areas: the French position

Partners
IFB, Institut français de la biodiversité, France • IUCN, The World Conservation Union

One of CIRAD's missions is to help formulate public sustainable development policies on the basis of its expertise. It is thus actively involved in drawing up French policies in this area. At the request of the French Ministry of Foreign Affairs, a CIRAD-coordinated working group was created to lay the foundations for a new French cooperation strategy for the management of protected areas. The document generated by this work was disseminated in 2003 to coincide with the World Parks Congress and a meeting within the framework of the Convention on Biological Diversity. In order to strike a balance between economic growth, environmental protection, poverty control and social justice concerns, the French standpoint is to give concerned people an active role in ecosystem management by inviting public and civil society stakeholders to participate in negotiations and arbitration under conditions that are acceptable to all parties. In this way, the entire community is involved in the long-term management of protected areas.

Seven recommendations are put forward in the document: to focus interventions and enter into

sustainable partnerships; to approach protected areas from a landuse management perspective; to strengthen coordination between cooperation partners; to support organizational, institutional, economic and technical innovations; to promote project assessment and funding and draw up a cooperation memorandum for the management of protected areas; to strengthen and make effective use of local and national stakeholders' skills and experience; and to improve operations by implementing tailored procedures.

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Common resource management research team, Green, Renewable Resources and Viability Programme, TERA Department

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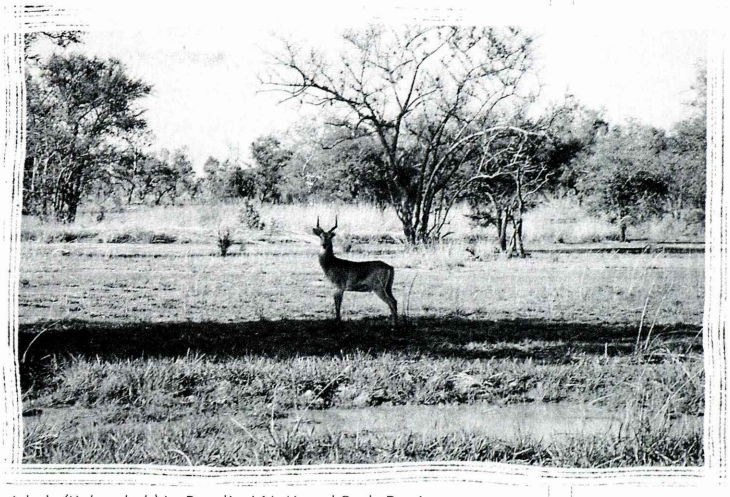

© CIRAD, D. Babin

A kob *(Kobus kob)* in Pendjari National Park, Benin. UNESCO-MAB/UNEP-MAB project on game reserves in the West African biosphere.

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APPLICATION

IFB website. http://www.gis-ifb.org [30-03-2004]

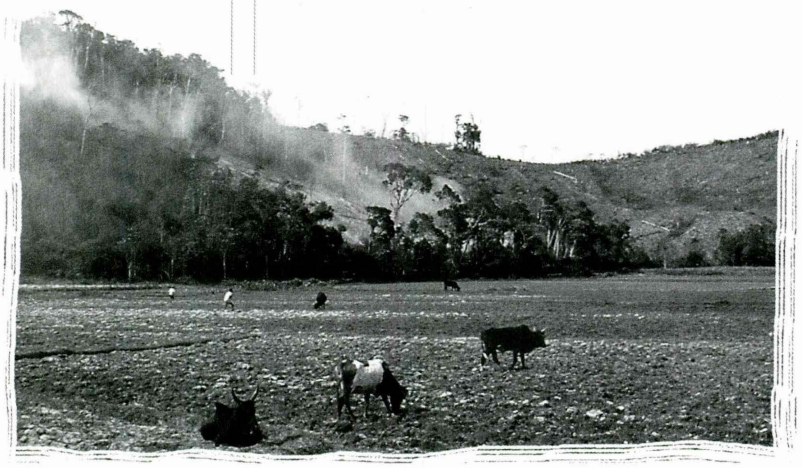
Fires and deforestation in Madagascar

In Madagascar, it is commonly claimed that traditional *tavy* slash-and-burn agriculture is responsible for deforestation on the island. CIRAD and FOFIFA, the Malagasy agricultural research institute, carried out a historical, agronomic and socioeconomic study of this practice, which is still implemented by rural communities in the eastern coastal region. The results of this study revealed that beyond the over-simplified discussion on the staggering population growth, which is the prime cause of deforestation, *tavy* cultivation involves agrarian farming system dynamics. Depending on the socioeconomic status of the farmer, *tavy* can thus be limited to slash-and-burn cultivation—clearing and burning of a wooded area followed by a temporary cropping phase—or lead the way to the planting of a series of crops after bush fires. *Tavy* cropping also changes and diversifies according to social constructions and representations of the forest as sacred, protective or nourishing, but also as an arable land reserve. These concurrent representations can result in conflicts over the appropriation of wooded areas. Sustainable management of forest resources is now crucial, and this could be achieved by creating a framework for discussion to promote coordinated convergence of the different forest representations. The findings of these studies, which highlight

Partners

FOFIFA, Centre national de recherche appliquée au développement rural, Madagascar • Université d'Antananarivo, Madagascar

the tight cooperation between CIRAD and FOFIFA, were copublished in CIRAD's Repères collection. In 2004, a research unit will be set up in Madagascar, in partnership with the University of Antananarivo, to further explore this theme.



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Gradual hillside clearing by *tavy* slash-and-burn methods along the edges of permanent rice fields. This hillside cropping is temporary.

Territorial governance and restructuring research team, Renewable Resources and Viability Programme, TERA Department

Forestry policy: instruments, institutions and governance research team, Natural Forests Programme, Forestry Department

Pcp Fand B, Gestion durable des forêts et protection de la biodiversité (CIRAD, CNRE, FOFIFA, University of Antananarivo), Madagascar

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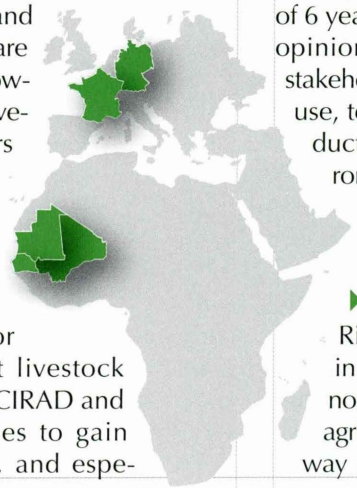
Babin D., Andriantsilavo F., Aubert S., Pechard G., Bourgeois C., Bechaux E., Ramamonjisoa Ranaivoson L., Joly H., 2001. Methods of rapid appraisal for in situ management of genetic resources: a Malagasy set of tools. Genetics Selection Evolution, 33, suppl. 1: 513-535.

Livestock production—a driving force for development in the Senegal River valley

Competition between agriculture and livestock production can lead to serious clashes for access to land and resources since these issues are vital to local inhabitants. However, the joint presence of livestock producers and farmers can also be beneficial.

This is the situation in the Senegal River valley where irrigated crops have been grown on former floodplain rangelands for more than 60 years—but livestock farming is still carried out. CIRAD and partners conducted studies to gain insight into this situation, and especially to boost public awareness through an intentionally global participatory approach. The results of 6 years of applied research helped to sway the opinion of decision makers and professional stakeholders on the positive aspects (social, land-use, technical and economic) of livestock production. The research also created an environment that promoted partnerships between many stakeholders, ie scientists, livestock producers and decision makers.



Partners
CNERV, Centre national d'élevage et de recherche vétérinaire, Mauritania • COVAPE, Compagnie ouest-africaine pour la valorisation et l'amélioration des produits d'élevage, Senegal • GTZ, Deutsche Gesellschaft für Technische Zusammenarbeit, Germany • IER, Institut d'économie rurale, Mali • INA-PG, Institut national agronomique de Paris-Grignon, France

LOCAL DYNAMICS

Rice growing was the main farming activity in this region until quite recently. As the economic and environmental situation worsened, agricultural diversification seemed to be a good way to stall outmigration of rural inhabitants

from the Senegal River valley region and substantiate the huge investment that has been allocated to irrigation since the 1960s. Livestock farming thus seemed to be a good activity to support.

A research project was launched in the area where irrigated systems prevail, which is the focal point for regional collaborative research involving national research centres. It was based on two options: the scientists took development issues into account from the baseline, ie with respect to the concerns expressed by farmers and local decision makers; and the research was carried out on a village-land scale rather than a farm scale.

In the Sahelian region, there are actually no "farms" in the Western sense. Moreover, the standard combination of forage crops, animal draught and animal manure application is only occasionally practised.

In terms of land-use and social parameters, the studies are carried out in a decentralized management setting, which has prevailed in Senegal since the late 1990s. A new strategy—"upward territorial support"—was tested and assessed. It aims to quickly promote collective autonomous discussion dynamics and the emergence of new endogeneous political spaces at all decision-making levels. The land around the rural community of Ross Bethio, which accounts for almost 80% of the Senegal River delta area, was selected for this pilot operation, called the *Plan d'occupation et d'affectation des sols* (POAS), a land-use and allocation plan. In drawing up this plan, local inhabitants and leaders acknowledged that the joint presence of livestock production and agricultural activities was a priority.

An activity recognized by public authorities

Based on geographical tools (geographical information systems) and on animation-type tools (role playing, etc.), elected representatives and local inhabitants joined forces to draw up maps of their area, which were then gradually refined. This resulted—2 years after the beginning of this process—in a thematic map delineating three general area types, ie rangeland areas, mainly agricultural areas, and mainly livestock production areas. Regulations were drawn up for each of these area types and a monitoring system—to control water access, rice straw burning and rangeland use— is now operational or being developed.

These regulations are still hard to apply, often due to a lack of human and financial resources, but the process is under way. The most significant advance is that public authorities have now recognised that livestock production is a beneficial activity that should be taken into account.

In technical and economic terms, this initiative is useful for determining new range management projects to be set up. It highlights the reciprocal implications of livestock production and crop farming with respect to food supplies and mobility. The results of system studies have revealed the diversity and relevance of crop-livestock farmers' strategies.

A new income-generating activity

Livestock production is thus clearly recovering its status within irrigated cropping systems, in line with food security strategies implemented in Sahelian countries. Milk production is a new promising source of income. Targeted studies on key factors concerning milk marketing have improved the organization of milk collection operations. Several mini-dairies were set up in the late 1990s as a result of joint initiatives of milk producers and merchants. The focus is now on setting up an industrial-scale dairy in Senegal.

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Mini-dairy in the Senegal River valley—a promising initiative.

Partners
INRA, Institut national de la recherche agronomique, France • ISRA, Institut sénégalais de recherches agricoles, Senegal • PSI, Pôle systèmes irrigués, Senegal • SAED, Société d'aménagement et d'exploitation des terres du delta et de la vallée du fleuve Sénégal, Senegal • Université Gaston Berger, Senegal • Université Paris X, France

© CIRAD, G. Magrin

Rangeland management project in the Saint-Louis region in Senegal.

Birth of a network

The action research dynamics around POAS gave rise to the GIRARDEL network—an interdisciplinary research group to support regional planning and local development. It is based at the Université de Saint-Louis, and involves several institutions: Université Gaston Berger, SAED, ISRA and CIRAD. Livestock production is one of the main focuses of this network. GIRARDEL organized a mobile workshop for POAS monitoring, accompanied by the first range management experiment that was set up at Débi Tiguette in 2003. Finally, the extent of interest in livestock production in the "GIRARDEL Wednesdays" seminar, which involves university stakeholders, technicians and local elected representatives, is evidence that this is a recognized key issue in discussions concerning the development of the Senegal River valley.

It seems likely that POAS and the new milk collection operators will be successful, and also that this experience could be matched in targeted areas in Mali, ie the central Niger River delta region.

Domestic livestock feed research team, Animal Production Programme, EMVT Department

Common resource management research team, Territorial governance and restructuring research team, Renewable Resources and Viability Programme, TERA Department

GIRARDEL, Groupe interdisciplinaire de recherche pour l'appui à la planification régionale et au développement local (Université Gaston Berger, SAED, ISRA, CIRAD).

Umr Errc, Elevage des ruminants en régions chaudes (Agro.M, CIRAD, INRA)

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For further information

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Applications

Workshops

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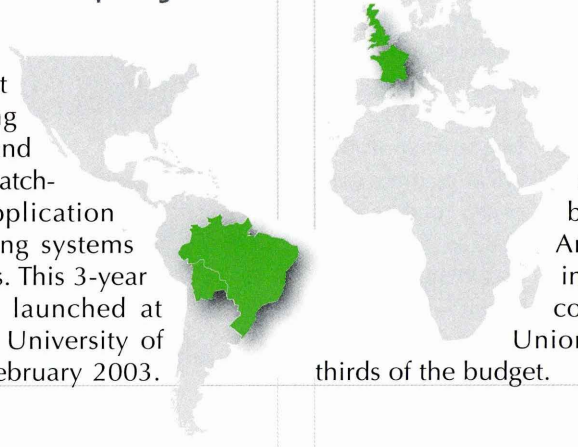
Periurban catchment management —the NEGOWAT project

The NEGOWAT project is aimed at facilitating negotiations on land and water use in periurban catchments through the application of multiagent modelling systems and role-playing games. This 3-year project was officially launched at a seminar held at the University of São Paulo, Brazil, in February 2003.



The research will be conducted at two sites, ie Cochabamba, Bolivia, and São Paulo, Brazil, by a consortium of South American and European institutions. CIRAD is the coordinator and European Union funding covers two-thirds of the budget.

Partners

APTA, Agência Paulista de Tecnologia dos Agronegócios, Brazil • CERES, Centro de Estudios de la Realidad Económica y Social, Bolivia • Instituto Internacional de Ecologia, Brazil • Instituto Polis, Brazil

Conflicts over land and water resources

In periurban catchments of Latin America, rapid urbanization—often involving highly disadvantaged populations—places stress on environmental legislation. Many conflicts arise over access to land and water resources, urban nuisance and water resource conservation (in terms of quantity and quality).

In the Brazilian São Paulo catchment region, the human population has grown to 18 million inhabitants. Domestic water demand is constantly increasing but supplies are limited. It is also crucial to protect the spring catchment area from pollution. These general problems include more localized issues: competition in wetland areas among crop farming, raw material for construction and urbanization; organization (centralized or not) of water and sanitation treatment; complex discussions between regional management bodies and often marginalized local bodies.

At the Cochabamba site in Bolivia, water supplies have to be able to meet the increasing urban demand for drinking water as well as agricultural irrigation needs. What is the status of agriculture in periurban areas? How can water supply—especially drinking water—be organized?

© CIRAD, R. Ducrot

Periurban agriculture in fringe areas of São Paulo, Brazil.

A negotiation support tool

In urbanized catchments, where land resources are just as limiting as water resources, the NEGOWAT project provides support for drawing up—in a participatory way—new water and land use regulations. It is testing simulation tools such as multiagent models, role-playing games and scenario building, which facilitate assessment of the potential effects of different options.

In 2003, the main focus was on organizing the project teams and setting up research activities. Nine partners are involved in markedly different research themes and methods: hydrology, farming and rural dynamics, urban dynamics, land markets and social conditions for water management. Negotiations were organized with stakeholders—catchment committees, local communities, mayors, irrigators' associations, and drinking water managers—to develop operational strategies. A conceptual framework for the functional dynamics of the two catchments was developed on the basis of different scientists' representations. The research results supplemented the already available agronomic and economic information.

Demonstration tools were presented to the partners. Two role-playing games were developed to boost stakeholder awareness on the types of tools that could be implemented. One very simple card game is designed to encourage illiterate members of Bolivian communities to contemplate interactions between the land market and irrigated agriculture. The other computer-based game is more complex and representative of the functional dynamics of the São Paulo catchment in Brazil. This game, called Jogoman, focuses on three municipal areas, a water supply company and several landowners. These role-playing games are helpful for designing models of catchment dynamics and stakeholder interactions at different levels.

▸▸ In 2004, the focus will be on the building of different discussion tools in collaboration with all stakeholders. Thus a representation of the functioning dynamics of one of the subcatchments in fringe areas of São Paulo is being developed. It is based on a multiagent model that combines quantitative (water sup-

Partners
NRI, Natural Resources Institute, UK • UMSS, Universidade Mayor de San Simon, Bolivia • University of Campina, Brazil • University of São Paulo, Brazil • EU, European Union

ply), qualitative (pollution, water quality patterns in reservoirs) and social (land-use, land markets) features.

Territorial management of water resources research team, Renewable Resources and Viability Programme, TERA Department

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Applications

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© João Andrades, APTA-IEA

Horticulture: washing produce.

Land-use management in Central America —the SHERPA project

The SHERPA project was launched in August 2002 by IGN France International and CIRAD with the aim of tailoring the European land-use database, CORINE Land Cover, to conditions that prevail in Central America. A pilot project was set up in the Rio Lempa catchment, one of the largest catchment areas in Central America, which has a "footprint" that covers Guatemala, Honduras and El Salvador.

The georeferenced database developed by the European Union includes satellite imaging, computer-assisted photointerpretation and standardized land-use nomenclature data. It provides uniform information on the environment in European countries.

In 2003, CIRAD and the ministries of environment of Guatemala, Honduras and El Salvador jointly developed baseline applications for the Rio Lempa catchment. These applications are being implemented for mapping patterns of forests (in conjunction with the regional Mesoamerican Biological Corridor conservation initiative), agriculture (land-use patterns and planning atlas on CD-ROM) and urban areas (very high resolution satellite mapping with Spot 5 imaging). Three PhD theses devoted to this topic were defended at the National University of El Salvador. The overall project results were presented at an international workshop, organized by CIRAD, that was held in San Salvador in November 2003, and

Partners

CATIE, Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica • CCAD, Comisión Centroamericana de Ambiente y Desarrollo, El Salvador • IGN, Institut géographique national, France: IGN France International, IGN Guatemala, IGN Honduras, IGN El Salvador • IPGH, Instituto Panamericano de Geografia e Historia, Mexico • Ministries of Environment, Guatemala, Honduras, El Salvador • National University of El Salvador • EU, European Union

also at different events organized by the French Embassy in El Salvador and Honduras.

▸▸ The SHERPA project has now, at the request of the El Salvador Ministry of the Environment, been extended to cover the entire territory of this country. Similar projects—funded by international donors—are being prepared in Ecuador, Colombia and Venezuela.

Spatial analysis, information systems and appropriation research team, Renewable Resources and Viability Programme, TERA Department

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For further information

CORINE Land Cover Programme: nomenclature, regions, products.
http://www.ifen.fr/pages/2corin.htmc [31-03-2004]

Applications

SHERPA website and information on the CORINE Land Cover database.
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El Salvador Ministry of the Environment website
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Mangrove areas along the El Salvador coastline.

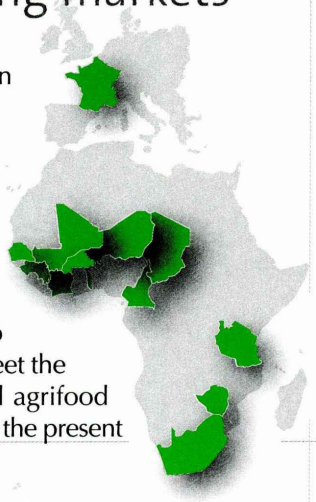
From international agreements to local markets

CIRAD conducts research in an ever-changing global economic setting, overshadowed by large trade groups and regulated by international agreements. Its mandate—research oriented towards assisting developing countries—should be clearly reflected in its partnerships and development activities. Developing applications with industrial partners who are able to cover the expenditures, promoting access to finished products and creating innovative companies in developing countries, while striving to achieve fair and balanced sharing of benefits generated by tapping the biological resources of these countries—these are the main thrusts of CIRAD's Intellectual Property Charter, which was drawn up in 2003 in collaboration with other French public research organizations. The results presented here illustrate the broad scope of this code of conduct.

CIRAD's Intellectual Property Charter (in French)

http://www.cirad.fr/fr/le_cirad/pdf/charte_prop_int.pdf [30-04-2004]

African family agriculture and changing markets



Family agriculture in Africa is currently affected by a process of population and agricultural transition—a first in the history of this continent. Productivity will actually have to increase further to meet the high agricultural and agrifood demand. However, in the present economic setting, the prospect is dim for active people who are forced out of farming because they are unable to adjust to technical progress. A change of paradigm is thus at issue—simply striving to increase productivity will not enhance agricultural and rural employment opportunities, crucial factors in the war on poverty. Technical models that have accompanied sectoral changes in industrialized countries, or the green revolution that has come about in many developing countries, fall short in meeting this dual challenge of boosting production and employment.

Partners

CIEPAC, Centre international pour l'éducation permanente et l'aménagement concerté, France • FPH, Charles Léopold Mayer Foundation for the Progress of Humankind, Switzerland • MAE, ministère des Affaires étrangères, France • UPAFA, Université paysanne africaine, Senegal

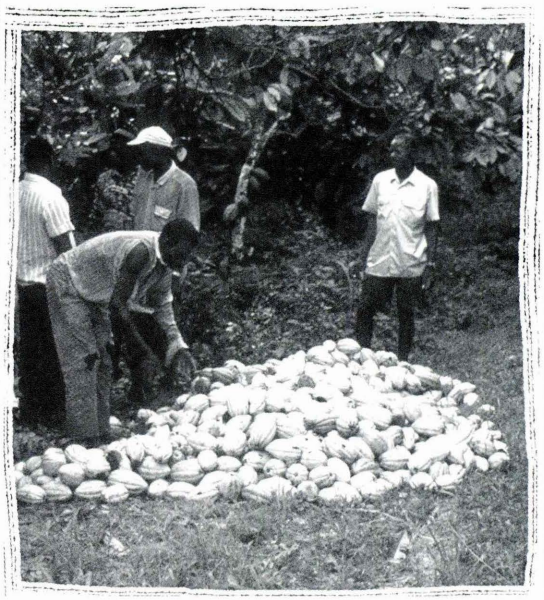
Markets controlled by transnational companies

The employment issue is aggravated by the fact that African agriculture must now enter the global economy—farmers are hampered by the fact that this global market is volatile, very competitive (with new conditions), in a highly asymmetrical environment. African agricultural sectors are badly structured—suffering from sudden governmental disengagement, weak economic stakeholders—whereas world markets are dominated by oligopolistic structures due to 15 years of increasing mergers. Many tropical farm commodity markets are controlled by a few large, omnipotent, transnational companies. Studies conducted in Côte d'Ivoire, which is the top-ranking world producer of cocoa, revealed that the national supply concept and the world market concept generally do not apply. After liberalization of the market, which occurred when the Caisse de stabilisation halted its activities, the global cocoa-processing "giants" have taken control of most of the Ivorian cocoa supply. This process, which is under way in most cocoa-producing countries, is profoundly upsetting market and world trade patterns.

Essential organization of producers

African agricultural producers are aware of the risks that come with this new trend and are thus trying to organize themselves at national and sub-regional levels. The goal is to gain bargaining power with public authorities and donors as well as with companies, and especially to be present during important international meetings such as the recent World Trade Organization Summit in Cancun.

Strengthening of the strategic thinking, bargaining and proposal capacities of African professional organizations has become a major challenge. CIRAD is contributing to gaining insight into and analysing local situations, opportunities and constraints, while training agricultural leaders, eg in collaboration with the Université paysanne africaine (UPAFA—African farmers' university). In February 2003, CIRAD and CIEPAC jointly coordinated the fifth module of an international training course held over a 2-week period in Dar Es Salam, Tanzania, which focused on developing a strategic plan for rural and farmers' organizations. Twenty-three leading farmers from 13 French- and English-speaking countries participated in UPAFA's international training course.



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Harvesting cocoa in Côte d'Ivoire.

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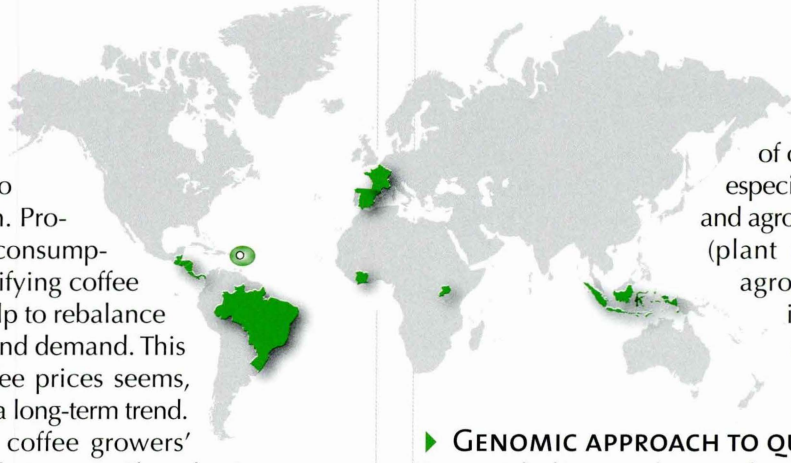
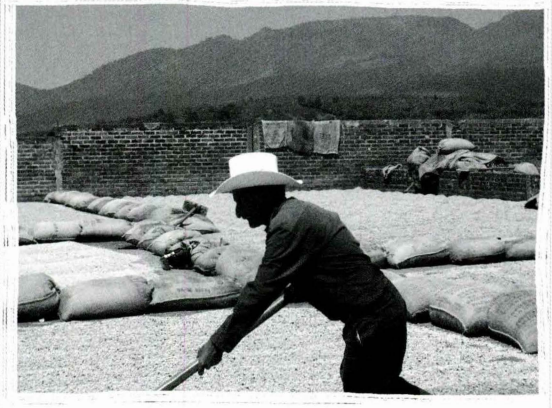
Coffee quality: an integrated approach, a public good

Partners
CATIE, Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica • CNRA, Centre national de recherche agronomique, Côte d'Ivoire • COPCAF, Coopérative des producteurs de café de la Guadeloupe, Guadeloupe • CORI, Coffee Research Institute, Uganda • IAPAR, Instituto Agronomico do Paraná, Brazil • ICAFE, Instituto del Café de Costa Rica, Costa Rica • ICCRI, Indonesian Coffee and Cocoa Research Institute, Indonesia • IHCAFE, Instituto Hondureño del Café, Honduras • IRD, Institut de recherche pour le développement, France • PROMECAFE, Programa Cooperativo Regional para la Protección y Modernización de la Caficultura, Guatemela • UNICAMP, Universidade de Campinas, Brazil • University of Seville, Spain

The slump in market prices for coffee in recent years is partly due to overproduction. Promoting coffee consumption and diversifying coffee crops could help to rebalance coffee supply and demand. This decline in coffee prices seems, however, to be a long-term trend. Consequently, coffee growers' income will only improve if production costs are reduced or if the quality of the coffee produced warrants a higher than standard price.



The quality of coffee is understood to be determined by its overall chemical, physical and organoleptic features—it is not just limited to cup quality. The first step is thus to identify the quality traits that actually generate profits for coffee growers—bean size, caffeine content, acidity, flavour, etc. The cost of producing coffee with these traits should then be compared with the extra price that consumers are willing to pay for them. The next step involves identifying the key factors controlling each specific trait, ie genetic, physiological and environmental factors, which often have overlapping effects. Quality is now systematically considered in all aspects of coffee research, especially in genomic and agronomic research (plant physiology to agroforestry) and in the "terroir" approach.



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Drying coffee beans in El Salvador.

Genomic approach to quality

Key metabolisms and genes that determine coffee quality can be identified through integrative genomics, with the ultimate aim of enhancing genetic improvement strategies. Recently, major progress has been achieved through analyses using molecular markers, which highlighted a relationship between disease resistance and coffee quality in varieties obtained by introgressing *Coffea canephora* traits in *C. arabica* varieties. In *C. canephora*, a progeny study was carried out and the genetic map for this species was completed, which prompted a study that is currently under way to pinpoint key quantitative trait loci (QTLs). Moreover, an investigation on the molecular physiology of sugar metabolism in coffee highlighted the importance of the sucrose synthase enzyme in quality development. A detailed analysis of the gene coding for this enzyme will be conducted using the genomic DNA library constructed by CIRAD.

Plant physiology and agroforestry

A large-scale project is under way to investigate the physiological development—in quantitative and qualitative terms—of coffee trees in agroforestry systems. The results of these studies were used to design plant function models that correlate the chemical composition and size of coffee beans with the quantity of sunlight captured by coffee trees and their fruit load. The findings also showed that coffee tree branches are not

as autonomous or autotrophic as previously claimed, ie each branch does not solely nourish the fruit it bears, in fact there are substantial exchanges between the different fruit-bearing tiers of the tree.

The "terroir" approach

The aim of studies on the "terroir" effects is to identify and describe the relationships between the specific features of produced coffees and the general characteristics of the geographical area from which they come. Recent advances in bioinformatics and the greater statistical strength of organoleptic tests have helped to confirm the importance of elevation and shading, while also identifying important new factors such as catchments. Many coffee-producing countries are issuing requests for this type of study, which associates coffee quality with geographical origin.

Among other results, areas in Honduras were identified where typical high quality coffees are produced, while the specific "lemon" taste of an Indonesian coffee was recognized, and a strategy for promoting a renowned coffee from Guadeloupe—"Bonifieur" coffee—was proposed.

These coffee quality studies were designed not only to provide coffee growers with technical innovations that will enable them to produce different quality traits, but also to boost their overall understanding of the coffee they grow. This will enhance bargaining with buyers and enable coffee growers to get a fairer deal. In this setting, farmers' organizations should also be supported because a top quality reputation is a public good that can only be built with cooperatives or producers' organizations.

© CIRAD, C. Pelletier

Family harvesting of coffee beans in Brazil.

Quantitative and qualitative development of coffee production research team, coffee analysis, traceability and processing research team, integrated coffee pest management research team, Coffee Programme, CP Department.

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Application

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Economic assessment of CBPP control programmes

New regulations set out by the World Trade Organization require better certification of the health status of marketed animal products, especially by monitoring the economically important diseases noted on OIE's List A. This includes contagious bovine pleuropneumonia (CBPP), the second most serious disease of cattle after rinderpest. National animal health services are thus striving to create disease-free livestock production areas. Livestock farmers must also have access to markets and domestic services, so health status monitoring is necessary.

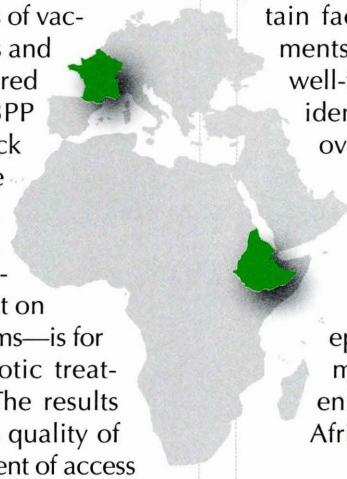
CIRAD and partners conducted a field research study in Ethiopia to assess certain disease management methods using economic, geographical and epidemiological simulations.

Partners
EARO, Ethiopian Agricultural Research Organization, Ethiopia • ILRI, International Livestock Research Institute, Ethiopia • NAHRC, National Animal Health Research Center, Ethiopia • NARS, National Agricultural Research System, Ethiopia • OIE, World Organisation for Animal Health, France • PACE, Pan African Programme for the Control of Epizootics, Kenya • AU/IBAR, African Union/Interafrican Bureau for Animal Resources, Kenya

The aim was to optimize individual and collective operations.

At the herd level, the effects of vaccinations, antibiotic treatments and mixed strategies were compared by investigating different CBPP outbreak scenarios. In livestock farming systems, in which the disease is endemic but with a low mortality rate, the most economically efficient solution—only a short-term impact on the herd and local livestock farms—is for the farmer to manage antibiotic treatments of the farm animals. The results also depend, however, on the quality of these treatments and on the extent of access the farmer has to services.

At a collective level, disease control must combine vaccinations and monitoring specifically focused on areas with a high CBPP risk. In countries with very limited resources, it would be impossible to schedule countrywide disease screening or preventive vaccination programmes.



Geographical models show that a disease risk gradient can be determined on the basis of certain factors, in this instance animal movements. Expenditures are minimized when well-targeted operations are conducted, and identical biological efficacy is obtained over the long term.

▸▸ This study opened new research avenues on the clinical efficacy of antibiotics and vaccine improvement. The potential for estimating the epidemiological and economic parameters now has to be strengthened to enhance animal health management in Africa.

Bacteriology research team, Animal Health Programme, EMVT Department

Animal production economics and policy research team, Herd productivity modelling research team, Animal Production Programme, EMVT Department

GIS and remote sensing research team, Rangeland and Wildlife Management Programme, EMVT Department

ATP, Modelling contagious bovine pleuropneumonia (CBPP): case study in the Ethiopian highland region.

Pascal Bonnet, p.bonnet@cgiar.org

APPLICATION

International meeting report

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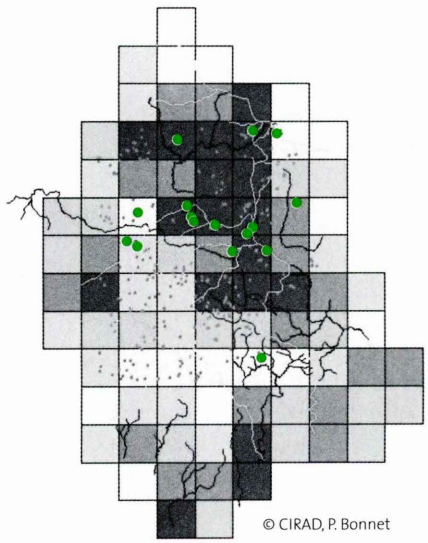
CBPP risk density gradients determined through a study of animal movements (Boji district, West Wellega area, Oromo region, Ethiopia). A serological survey was then conducted to check for the actual presence of the disease. The coloured dots represent detected CBPP-positive herds.



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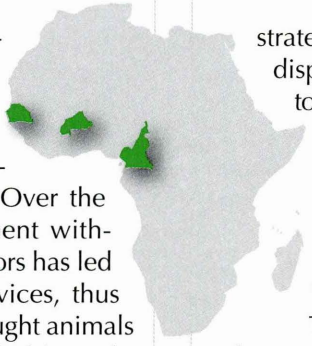
Lesnoff M., Laval G., Bonnet P., Chalvet-Monfrey K., Lancelot R., Thiaucourt F., 2004. A mathematical model of the effects of chronic carriers on the within-herd spread of contagious bovine pleuropneumonia in an African mixed crop-livestock system. Preventive Veterinary Medicine. In press.

Animal power: which research, which services?



Animal traction is an essential element of family agriculture in African savanna regions—to reduce strenuous human labour, enhance yields of production systems and help alleviate poverty. Over the last 20 years, however, government withdrawal from agroindustrial subsectors has led to the dismantling of support services, thus disrupting systems of access to draught animals and equipment. Two types of stakeholders—first farmers and their organizations, and secondly public and private agricultural support services—must now coordinate their activities in order to build a new service system.

CIRAD focused a programmed thematic initiative (ATP) on animal traction, which provided an opportunity for a group of scientists and extension agents to conduct an analysis of current systems in West Africa and investigate the potential for tailoring research and development methods to the conditions that prevail in this region. The proposals are geared towards two stakeholder types: they stress the importance of adapting the services provided and ways to ensure their sustainability; and they take changes in farmers' needs into consideration, ie funding, technical adaptation, agriculture-livestock production synergies, support and advice.

Assessment of needs

The history of animal traction is linked with the expansion of industrial crops (cotton, peanut, rice). Governments empowered regional organizations, companies, agencies and bureaus with rural development responsibility. These operators used public funds to set up a range of coordinated services designed to facilitate the dissemination of working animals in social settings in which livestock production was often not practised. Income generated from industrial crops gradually enabled farmers to acquire draught animals and farming equipment, while developing combined agriculture-livestock production strategies. However, there are still marked disparities with respect to farmers' access to draught animals in sub-Saharan Africa.

Since the economic liberalization, support services have had to adjust to a new economic rationale and the presence of new service providers—farmers' organizations, financial services, veterinarians, blacksmiths, etc.

The peanut-growing belt in Senegal, the cotton-growing area in northern Cameroon and Est province in Burkina Faso were selected for the study because of their contrasting conditions. The ATP team compared animal traction equipment rates of households, the main species used as draught animals and how they are managed, used (cultivation, transport) and integrated into agriculture, as well as the extent to which support services are adapted to meeting farmers' needs.

Enhancing service sustainability

There are currently three imperatives for rebuilding a service system oriented towards animal traction: tailoring services to needs; ensuring the sustainability of the system; management and control. Each service must be in line with the resources and needs of users (farmers, crafts-

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A pack-donkey demonstration in Cameroon.

Partners
Association Tin Tua, Burkina Faso • CIRDES, Centre international de recherche-développement sur l'élevage en zone subhumide, Burkina Faso • IRAD, Institut de la recherche agricole pour le développement, Cameroon • ISRA, Institut sénégalais de la recherche agronomique, Senegal • SADEL, Service d'appui pour le développement local, Cameroon

Application

Summary document

Pearson R.A., Lhoste P., Saastamoinen M., Martin-Rosset W. (Eds), 2003. Working animals in agriculture and transport. A collection of some current research and development observations. Wageningen Academic Publishers, Wageningen, The Netherlands. EAAP, Technical Series, 6, 212 p.

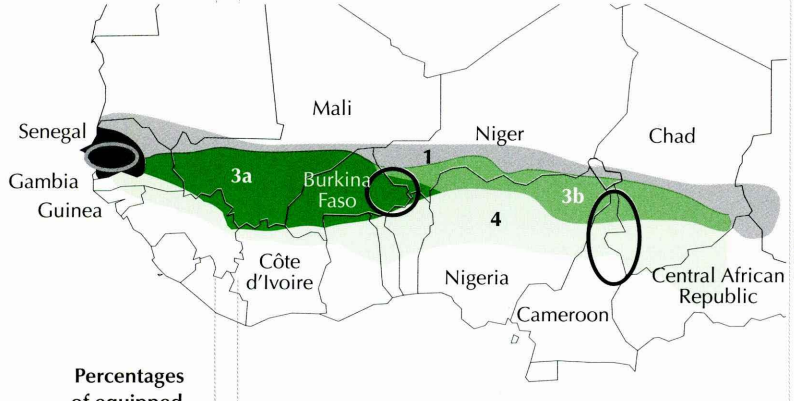
people). This especially concerns emerging services, such as support and counselling, credit provision and veterinarian services, which are having a tough time meeting the demand and achieving sufficient technical and financial autonomy. It is also essential to create stable conditions—financial, organizational and social—for the service system. This involves providing support for new consultants and setting up a regulatory and sanctioning body. Finally, an aggressive agricultural policy is necessary to organize resource distribution and provide incentives for the different stakeholders.

This period is conducive to innovation, despite the fact that technical progress is hampered by the restructuring of social-technical networks. Formerly, the focus was on developing equipment and standards, but nowadays it is essential to come up with new operational strategies. Research has to be multidisciplinary and carried out collaboratively in partnerships. It must be able to foresee changes and provide support when they occur. Research and innovation should indeed go hand in hand.

Dovetailing research and innovation

An international exchange workshop on animal traction was held at Bobo-Dioulasso (Burkina Faso) from 17 to 21 November 2003, coordinated by CIRDES, with the support of CIRAD and the Technical Centre for Agricultural and Rural Cooperation (CTA). Some 60 people from a range of different fields and African countries participated. A number of tangible research activities were proposed: technical and equipment innovations; management of the "career" of draught animals, their feeding and multifunctionality; natural resource management in systems combining crop farming and livestock production; and conducting experiments on an action research initiative to provide young farmers with equipment advice.

Participants unanimously agreed that it was essential to relaunch the "animal traction" network in French-speaking western and central Africa, and Madagascar, with the support of CIRDES, the regional research organization.



Percentages of equipped farms

> 90%

40-75%

20-40%

< 30%

1. Use of animals for carrying, transport and water pumping.

2. Use of horses and donkeys for sowing, weeding, lifting and transport.

3a. Use of oxen for draught cultivation, donkeys and horses for transport.

3b. Use of oxen for draught cultivation, donkeys and horses for transport.

4. Use of oxen for tillage and draught cultivation.

The three ATP animal traction research sites.

Animal traction zoning in West and Central Africa.

Ruminant research team, Animal Production Programme, EMVT Department

Agricultural support services research team, Activity systems, farms and innovation processes research team, Family Agriculture in a Global Economy Programme, TERA Department

A programmed thematic initiative entitled: Animal traction, a key element of farmers' strategies in West and Central Africa: what research is possible after the withdrawal of government support?

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For further information

Havard M., Njoya A., Pirot R., Vall E., Wampfler B., 1999. Challenges of animal traction research and development in West and Central Africa on the eve of the 21st century. International Conference, Empowering farmers through animal traction into the 21st century, Loskop Dam Eco Resort, South Africa, 20-24 September 1999. [Poster].

Vall E., Lhoste P., 2003. Animal power in the West and Central francophone zone of Africa in a renewed context: the issues for development and research achievements. *In:* Working animals in agriculture and transport. Pearson R.A., Lhoste P., Saastamoinen M., Martin-Rosset W. (Eds), Wageningen Academic Publishers, Wageningen, The Netherlands. EAAP, Technical Series, 6, p. 13-25.

Vall E., Lhoste P., Abakar O., Dongmo Ngoutsop A.-L., 2003. La traction animale dans le contexte en mutation de l'Afrique subsaharienne : enjeux de développement et de recherche. Cahiers Agricultures,12 (4) : 219-226.

The Market News Service for fruits and vegetables

The Market News Service (MNS) is a decision-support instrument. As part of CIRAD's Fruit and Horticultural Crops Department, the MNS backs different research and development activities and serves public authorities, international institutions and commercial stakeholders from both developing and industrialized countries.

Analyses conducted by the MNS are based on an information watch—data organized within an efficient information system—and on a steady interaction with a network of professional and institutional contacts worldwide.

This economic intelligence unit disseminates information and studies via many different specialized media that target different audiences, ie monthly magazines and newsletters (*FruiTrop*, *Info Banane*, *BanaNews*, etc.), five weekly market trends reports (on banana, orange, easy peelers, grapefruit and avocado) and an annual statistical directory. The Market News Service organizes and coordinates professional meetings, which provide an ideal setting to foster dialogue between professional stakeholders and scientists. Finally, part of its activity is to provide counselling to companies and public authorities on drawing up effective policies.

▸▸ In 2004, the MNS's potential for conducting prospective studies will be enhanced through a collaboration with French universities. This will lead to the development of predictive models for different European markets with input of realtime data and in-depth knowledge of market functioning.

Market News Service, FLHOR Department

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Partners
Subsector network

For further information

FruiTrop journal: http://passionfruit.cirad.fr/fruitrop/fruitrop.html [31-05-2004]

ODM (Market News Service), weekly reports. news on the European banana, avocado and citrus fruit markets: marketed volumes, import, wholesale and retail prices, market trends. http://passionfruit.cirad.fr/conjonc/conjonc.html [31-05-2004]

The quality of fresh and processed citrus fruits: New responses to the expectations of professionals. CIRAD-FLHOR 2002 Professional Meeting, Montpellier, France, 10-11 October 2002. http://citrus2002.cirad.fr/fr/communications_fr.html [31-05-2004]

Application

Market News Service website. http://www.passionfruit.cirad.fr [31-05-2004]

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Fruit and vegetable market in Brazil.

Some perspectives

A survey coordinated in 2003 by the International Scientific Exchanges Unit provided a picture of the extent of CIRAD training operations, particularly overseas. It highlighted the close links between training, research, transfer of results and improvements in skills in developing countries, which are essential prerequisites for solid, long-term partnerships. Moreover, the research structure and installations in French overseas regions mean that CIRAD can obtain results locally and rapidly concerning issues of international scope. Its operations in these regions are supported by the local authorities, professional organizations and regional bodies. They contribute to development, but also to improving the image of France and Europe in neighbouring countries. Lastly, CIRAD is already recognized on an international level in some of its fields of expertise, but is now introducing a quality strategy covering the whole of its research operations.

Training and skill sharing

The construction in developing countries of scientific teams that fit into the regional and international communities is acknowledged to be a crucial factor for development. CIRAD's mandate includes the provision of training. It therefore supports such teams by training scientists for and through research. It also works to satisfy the requirements of the authorities in developing countries, development stakeholders and producers. According to a staff survey, in 2003, more than 400 members of CIRAD staff were involved in receiving students, training doctoral students, teaching, on-the-job training, project design, and open and distance learning (ODL).

Adaptations tailored to requirements

CIRAD's training operations are adaptable and evolutional. An increase in the number of individual students taking a given course may prompt it to organize a group course. In turn, recognized group training courses may prompt partners to ask CIRAD to organize sessions based on their specific requirements.

The increasing demand for group training and the limited availability of either tutors or participants often call for distance learning facilities.

Training through research

CIRAD has close links with higher education establishments in both industrialized and developing countries. In particular, these links result in the reception of doctoral students. In 2003, the CIRAD research teams that took part in the survey helped to supervise 266 doctoral students and participated in 173 doctorate advisory committees, in France and abroad; 41% of the students concerned were European and 59% from developing countries.

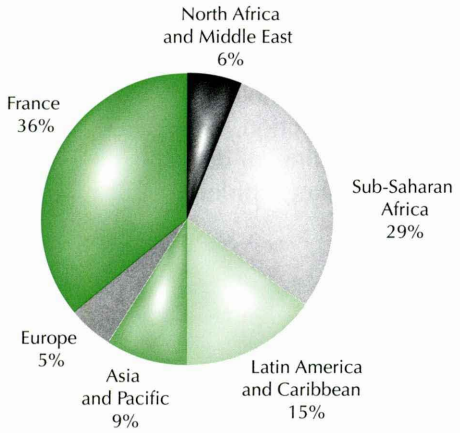

Figure 1. Origin of the 266 doctoral students at CIRAD.

The main fields concerned are agronomy, environmental and natural resource management (33% of doctoral students), animal production and veterinary science (13%), technology (13%), plant studies and improvement (13%), and economics and sociology (12%).

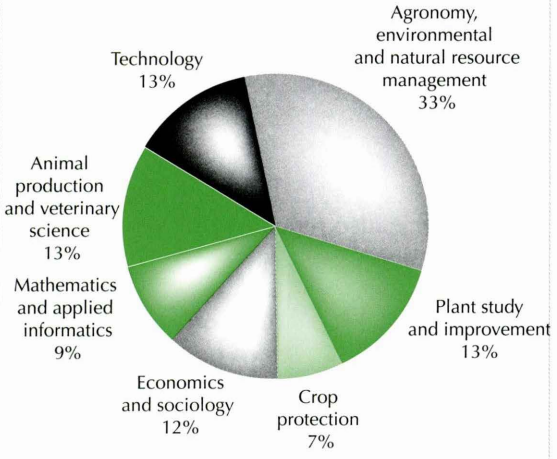

Figure 2. Fields under study by doctoral students.

Diploma training

CIRAD researchers are heavily involved in higher education: 389 of them contributed to diploma courses in 2003, totalling 4 200 hours of teaching over the year. This is the equivalent of 29 full-time teaching posts.

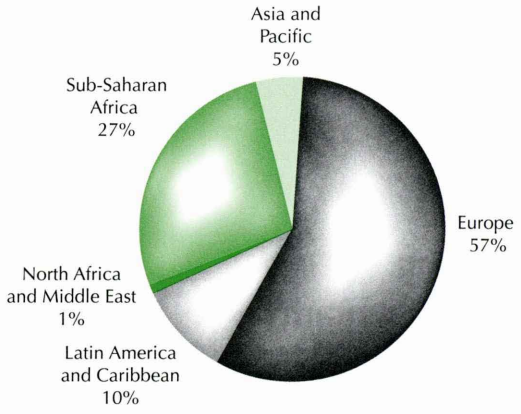

Figure 3. Geographical distribution of the 4 200 hours of teaching dispensed in the higher education sector.

CIRAD also helps some establishments to set up diploma courses, such as the international Master's in Food Science and Technology in Southeast Asia and the new Master's in Mediterranean and Tropical Products and Resources in Montpellier. It is a member of several consortiums aimed at supporting higher education in developing countries, particularly in the French-speaking world. For instance, it is directly involved in a project headed by the French Foreign Ministry's priority solidarity fund, aimed at training researcher-teachers in Cambodia.

Many students on diploma courses also spend time at CIRAD: 580 in 2003, primarily engineering students and others on undergraduate or post-graduate courses. Of those students, 36% were from developing countries and 2% from elsewhere in Europe.

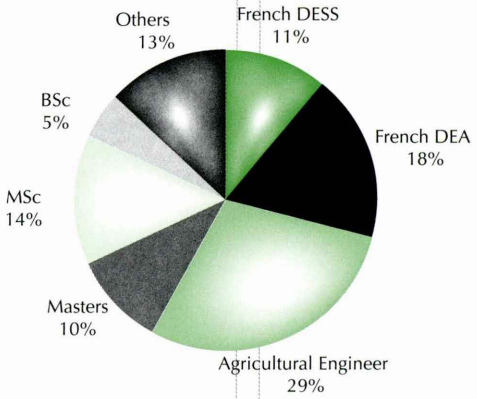

Figure 4. Types of diploma courses taken by the 580 students at CIRAD.

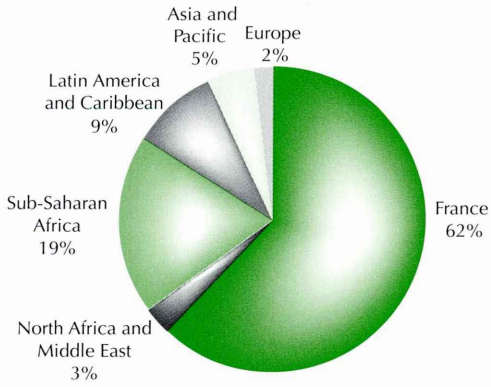

Figure 5. Geographical origin of students.

Epidemiology training: diversity and complementarity

Partners. Ecoles nationales vétérinaires d'Alfort et de Toulouse, France • EISMV, Inter-State School of Veterinary Science and Medicine, Senegal • National Veterinary Institute of Debre Zeit, Ethiopia • IAV, Institut agronomique et vétérinaire Hassan II, Morocco • MAE, ministère des Affaires étrangères, France • PACE, Pan-African Programme for the Control of Epizootics • European Union

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Inter-State School of Veterinary Science and Medicine, Dakar, Senegal.

To begin with, one-off modules were designed for in-house training of technical assistants at the French Foreign Ministry. These were subsequently supplemented and integrated into degree courses offered by the veterinary colleges at Alfort and Toulouse, which ensured their sustainability and offered the advantage, for partners in developing countries, of a formal qualification. EMVT department's training project design capacity subsequently enabled it to respond to requests to transfer this training abroad and adapt it to the specificities of its various partners. Distance learning emerged as an effective tool for building partnerships with teaching establishments in developing countries and for harmonizing the existing knowledge of students participating in the modules. The department also offers more specific individual courses.

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FOR FURTHER INFORMATION

Epidemiology training courses:
http://www.cirad.fr/en/prest_produit/formation/professionnel.php [31/03/2004]

Epitrop network projects and tools:
http://epitrop.cirad.fr/fr/epidemio/index.html (in French) [31/03/2004]]

PROFESSIONAL TRAINING

Professional training, directly geared towards development, is an important aspect of CIRAD's operations. It may be provided in the form of modules or tailor-made for individual scientists, and is increasingly an element in partnership agreements with universities in developing countries.

In 2003, CIRAD scientists carried out more than 150 training modules, lasting an average of a week, half of which took place abroad. More than 3 700 students took part.

The courses were intended for professionals in a given sector (such as chocolate sensory analysis or fibre technology), researchers (animal health and production, natural resource management, modelling) or development managers (agricultural policy, epidemiology).

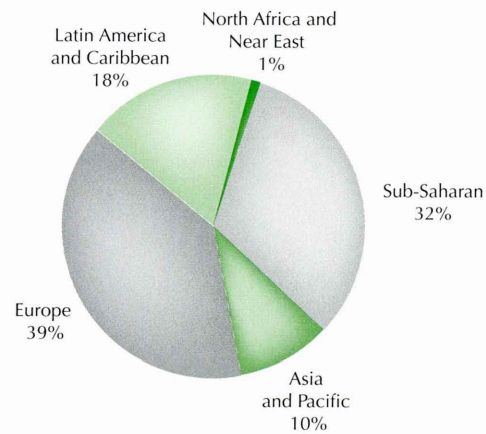

Figure 6. Geographical distribution of training modules organized by CIRAD.

CIRAD teams also receive scientists for individual professional training: in 2003, they trained 169 people, either abroad, in the French overseas departments and territories, or in Montpellier. These people were primarily scientists from developing countries who wanted to familiarize themselves with various techniques and methods (GIS, biotechnologies, data processing, etc).

e-learning

Partners. CIRED, Centre international de recherche sur l'environnement et le développement, France • IEDES, Institut d'études du développement économique et social, France • INRA, Institut national de la recherche agronomique, France • INRIA, Institut national de recherche en informatique et en automatique, France • RichCongress, France • SOLAGRAL, Solidarité agricole et alimentaire, France • Université de Montpellier II, France

The training offered by CIRAD is geared towards a very dispersed audience. Bringing together tutors and students in one place for a training course is a complex business, and limits the number of students trained each year. Although distance learning via the Internet, now easily accessible in many areas, is still in its infancy, it offers very exciting prospects, given the specificities of CIRAD.

To enable research teams to overcome at least some of the geographical and time constraints involved in training, the Ganesha e-learning platform was chosen because of its simplicity, reliability and adaptability. Two training modules developed by the AMAP Joint Research Unit and the Ecopol Programme have been accessible on the Internet since September.

The introduction of IT tools is backed up by studies of training project design methods and of how to improve teaching practices within CIRAD.

Information Systems Team, Innovation and Communication Office

National Policy and International Talks Team, Ecopol Programme, AMIS Department

AMAP (Botany and Bioinformatics of Plant Architecture) Joint Research Unit (CNRS, EPHE, INRA, IRD, UM2)

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FOR FURTHER INFORMATION
e-learning platform:
http://elearning.cirad.fr/ (in French)
[31/03/2004]

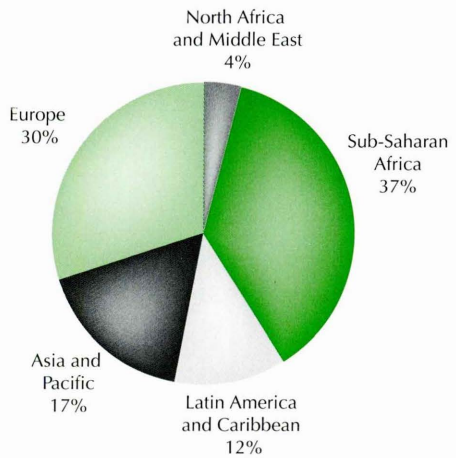

Figure 7. Geographical origin of the 169 scientists received for individual training.

TRAINING PROGRAMME DESIGN

Donor agencies often call upon CIRAD's experience of designing training programmes. Experts analyse the training requirements of partner organizations (research institutes, directorates, and development players), and help to draw up and implement training strategies. Donor agencies also often appoint CIRAD as project leader in such operations.

CIRAD has extensive experience of designing innovative teaching tools in conjunction with its partners. These are generally intended for use by trainers or development staff: trainer manuals, teaching packages, etc. For instance, CIRAD coordinated the compilation of a teaching package funded by the World Bank, aimed at helping management staff at official sanitary and phytosanitary monitoring services to diagnose the situation in their service, pinpoint its training requirements and draw up training strategies.

HUMAN AND FINANCIAL RESOURCES

CIRAD expanded its project design capacity in 2003. Several departments set up services with a view to offering their partners solutions tailored to their requirements.

Along with this, the development of new open and distance learning (ODL) skills enabled CIRAD to broaden its customer base in terms of modular training and to participate fully in the Montpellier Languedoc-Roussillon Open University, supported by Agropolis.

Also, to support its policy of increasing training capacity among its partners in developing countries, additional incentive funding (290 000 euros) was released for individual

training of scientists, over and above the amount (330 000 euros in individual grants) obtained from other sources. Of the 575 foreign students on individual training courses at CIRAD, 94 benefited from financial support out of CIRAD funds.

International Master's in Food Science and Technology

Partners. CTA, Technical Centre for Agricultural and Rural Cooperation, The Netherlands • ENSIA, Ecole nationale des industries agricoles et alimentaires, Montpellier, France • SEAMO, Regional Centre for Graduate Study and Research in Agriculture, Philippines • University of Greenwich, United Kingdom • University of Kasetsart, Thailand • Putra University, Malaysia • European Union

The International Master's in Food Science and Technology is part of a European Union programme, Asia Link. It is offered by the section of ENSIA Montpellier devoted to agrifoods industries in warm regions, and CIRAD, in conjunction with Asian and European higher education institutions.

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Asia Link International Masters.

The course marks the establishment of a promising link between Southeast Asia, which is engaged in developing its agrifoods processing sector, and Europe. It associates regional and European research organizations and commercial firms, with a view to building up human resources capable of serving the industry in terms of research and development. It offers future management staff from private companies and national or international organizations the possibility of building a network of international professional contacts.

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FOR FURTHER INFORMATION

Asia Link Programme:
http://www.ai.asialink.ku.ac.th
[31/03/2004]

A STRONG COMMITMENT

The operations conducted by CIRAD researchers in conjunction with their counterparts in developing countries, for both research training and professional training, were prompted by the current situation of strong demand for increased scientific skills in developing countries.

CIRAD's closer links with universities have resulted in it not only providing teaching services and supervising students, but also assigning researchers directly to universities in developing countries: 23 in 2003, on three continents.

CIRAD is now embarking on a move to make use of the latest communications technologies, in relation with other French and international partners such as the Agence universitaire de la francophonie or the FAO, through consortiums associating French and foreign higher education establishments, and within the framework of Agropolis.

Lastly, CIRAD's involvement in the European Research Area, currently being set up, will also mean increased mobility for its scientists, and also exchanges of training methods between European research centres.

International Scientific Exchanges Unit

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FOR FURTHER INFORMATION

Training courses offered by CIRAD:
http://www.cirad.fr/en/prest_produit/formation/index.php
[31/03/2004]

CIRAD partnerships:
http://www.cirad.fr/en/le_cirad/partenariat/index.php
[31/03/2004]

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CIRAD sensorial analysis laboratory in Montpellier, coffee tasting in an individual booth.

The Université paysanne africaine (African Farmers' University)

Partners. APM Afrique, réseau Agriculture paysanne et modernisation, Cameroon • CIEPAC, Centre international pour l'éducation permanente et l'aménagement concerté, France • FPH, Charles Léopold Mayer Foundation for the Progress of Humankind, Switzerland • MAE, ministère des Affaires étrangères, France

The African Farmers' University (UPAFA) is an offshoot of the APM Afrique network, in which CIRAD is heavily involved. UPAFA receives farmers' organization leaders for an international block release training course: six modules, each lasting around two weeks, spread over two years. The course aims to improve the participants' ability to help in drawing up agricultural and rural policies and in implementing those policies on a local, national and regional level. The methods used centre on individual and collective thought processes and on optimizing individual experiences. Each participant produces a personal file based on the actual situation at their organization. UPAFA is mobile, with each module taking place in a different country. The first group of students comprised 25 farmers' representatives from 12 countries. The next two groups will see the numbers of African tutors increase and farmers' organizations be fully represented on the UPAFA curriculum committee. UPAFA also offers tailor-made training courses, which may involve students from the national authorities, a given commodity chain or a sub-regional farmers' organization.

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ENGREF students on a course in Cameroon.

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FOR FURTHER INFORMATION

Mercoiret M.-R., Minla Mfou'ou J., Goudiaby B., 2001. Université paysanne africaine UPAFA : rapport technique. CIRAD, Montpellier, France, 37 pp.

Information and registration:
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The French overseas regions, an ambition and an asset

There are almost 400 CIRAD staff members working in the French overseas regions. CIRAD has permanent installations in the four overseas departments (DOM)—Guadeloupe, Martinique, French Guiana and Réunion—and in the three overseas countries and territories (PTOM)—New Caledonia (in partnership with the Institut agronomique néo-calédonien), French Polynesia, and Mayotte. It also carries out numerous missions to Wallis and Futuna. CIRAD's operations fit into those of the French C3I scientific interest group set up with IFREMER, INRA and IRD in June 2000 to strengthen consultation and cooperation on research operations in French overseas regions in the tropics.

CIRAD also benefits from regional research and experimentation facilities in the DOM and PTOM. These installations are an asset in fulfilling its mandate, but also bring public-service responsibilities in terms of economic and social development in each of the areas concerned.

CIRAD supports crop and animal production chains, including product processing, with a view to satisfying local and European market demand. Along with professional bodies and State services, it also works to establish strategies

Partners
Agricultural producers' associations and organizations • Caribbean universities and research centres • European Union • Indian Ocean universities and research centres • International organizations • Local and regional communities • NGO • Pacific Ocean universities and research centres • World Bank

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Landscape in northern Mayotte island.
In the foreground, banana plants

Websites

French Guiana
http://kourou.cirad.fr/
[30-03-2004]

Institut agronomique néo-calédonien
http://www.iac.nc/index.php
[30-03-2004]

and tools for ensuring the economic and social sustainability of farms, and for optimizing their very particular situation in France and Europe. It takes account of the relations between agriculture, the environment and natural resource conservation when developing new crop practices for production systems in insular areas. The plant collections held by CIRAD provide a basis for genetics work aimed at creating varieties that satisfy the expectations of both producers and consumers.

Development-oriented research provides immediate and concrete local results in the French overseas departments and territories, relating to issues of international importance: relations between an economically important host—be it animal or plant—and a biothreat (insect, bacterium, virus, etc); relations between cropping systems and water quality; interactions between the urban, forest and rural worlds in relation to land use; and biodiversity conservation and utilization.

The relevance and quality of CIRAD's work in these fields are recognized by agricultural professionals and local communities, given their impact on local development. The local authorities help to fund the work through State-Region programme contracts and single programming documents. Some professional organizations also make voluntary contributions.

The CIRAD researchers and technicians in the DOM and PTOM work at centres of excellence, alongside other research establishments and universities. These centres receive French and foreign researchers and students keen to work in the tropics, and in a scientific environment of international standard.

This scientific presence in the outer reaches of the European Research Area is a major asset for France and Europe in terms of regional cooperation and of the scientific and cultural image of overseas areas.

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For further information

CIRAD operations and partners in each DOM or PTOM
http://www.cirad.fr/en/le_cirad/cirad_monde/outre_mer_francais.php
[30/03/2004]

The quality concept in research

The CIRAD Quality Unit was formed in March 2003 to draw up and implement the institute's quality strategy. A steering committee, which proposed a quality promotion plan for the 2003-2005 period, was also created. The main priority is the collective improvement of scientific production processes: traceability and reliability of results, and laboratory certification and accreditation. Every member of staff at CIRAD is involved, including management and research support services.

Partners

AFAQ, Association française d'assurance qualité, France •
AFNOR, Agence française de normalisation, France •
BVQI, Bureau Veritas Quality International •
COFRAC, Comité français d'accréditation, France

The priorities

Targeted operations are under way to increase awareness of quality aspects among CIRAD staff and to provide training. In all, 165 people, representing 10% of CIRAD training operations as a whole, have taken part in quality training.

CIRAD was also involved in organizing two collective events. A seminar at La Grande-Motte, France, in September, with the Groupe Qualité Languedoc-Roussillon (CIRAD, CNRS, INSERM and IRD), was attended by 130 participants from research organizations, and two training sessions in the French West Indies—Guadeloupe and Martinique—in December involved 108 participants from research organizations, 80% of them from CIRAD.

A cross-disciplinary metrology project is headed by two researchers from the AMIS and Forestry departments. The project has allowed CIRAD to acquire a shareware system that manages measuring devices, scientific equipment and links with standard measurement systems, and calculates the degree of uncertainty linked to measurements and research results. Specific training operations are under way. Laboratory registers are increasingly being used.

Plans of action centring on quality in every department and service

CIRAD's various departmental management teams are gradually putting together their plans of action in terms of quality, based on the three-year CIRAD plan. For instance, the EMVT department is deeply committed to a quality approach aimed at maintaining the international accreditation (OIE, FAO, MAAPAR) of its animal health laboratories. It embarked upon this quality strategy in 2003. Its aims include accreditation under ISO 17025 and environmental certification for its Animal Health Programme's serology, immunology and virology laboratories under ISO 14001. The budget allocated to this quality strategy allowed for the installations required, the acquisition of specific equipment in 2003 and 2004 and recruitment of a quality specialist.

An initial management review of CIRAD's quality policy was conducted in May 2004.

Quality Unit, Office of the Director of Finance and Administration

Interorganizational quality network (CEMAGREF, CIRAD, CNRS, INSERM, IRD)

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Partners
CTBA, Centre technique du bois et de l'ameublement, France • ENSIA-SIARC, Ecole nationale supérieure des industries agricoles et alimentaires, section industries alimentaires régions chaudes, France • MAAPAR, ministère de l'Agriculture, de l'alimentation, de la pêche et des affaires rurales, France • OIE, World Organisation for Animal Health, France

Laboratories recognized outside CIRAD

Four laboratories that have implemented a quality strategy are recognized in their field:

Water-soil-plant analysis laboratory (Languedoc-Roussillon)
The laboratory's organizational system has been certified by AFAQ under ISO 9001, 2000 version, since November 2003.

Wood preservation laboratory (Languedoc-Roussillon)
The laboratory has embarked upon a quality strategy aimed at satisfying requirements in terms of the quality and traceability of wood preservation product efficacy tests. Its operations have been acknowledged by CTBA to satisfy ISO 17025. COFRAC accreditation should be awarded at the end of 2004.

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Wooden roof structure, Butare Museum, Rwanda.

Animal health laboratory (Languedoc-Roussillon)
The laboratory is recognized as a reference laboratory by the World Organisation for Animal Health (OIE) for rinderpest and peste des petits ruminants, and by the French Direction générale de l'alimentation (MAAPAR) for bluetongue in sheep.
It has also embarked upon a quality strategy aimed at accreditation under ISO 17025.

Animal health laboratory (Guadeloupe)
This laboratory is recognized as a reference laboratory by the OIE for heartwater (cowdriosis). It also has Direction générale de l'alimentation approval for bluetongue serology.

Indicators

Indicators

CIRAD signed a contractual agreement with its supervising ministries in 2002. As explained in CIRAD 2002, monitoring indicators were chosen for the agreement, to indicate the priorities and any changes in activity: scientific policy, geographical choices, and partnerships. They were supplemented in 2003 by indicators of scientific production (publications) and of application of results (patents, certification, development projects). Comparisons have been made for the preceding three years. As a result, the way in which the indicators are presented has changed slightly, so as to integrate the new information as logically as possible. Moreover, not all the indicators set out in the initial contractual agreement are included, either to make the report easier to read or because an intermediate value may not be available. This is the case, for instance, for collective and individual assessments, for which the procedure is currently being validated, and records of staff members undergoing training, which is one of the data items due to be integrated into the new CIRAD human resources information system in 2004.

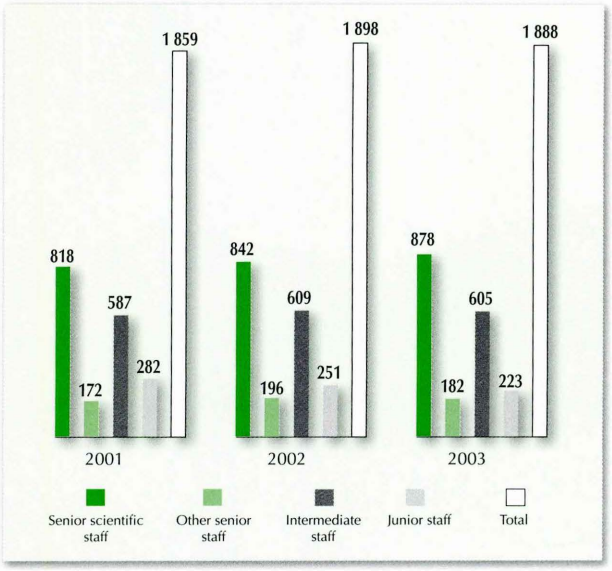

Figure 1. Changes in CIRAD staff (associate researchers and ATD not included).

Human resources and changing skills

▸ Human resources

Staff breakdown

In 2003, the 57 associate researchers and technical assistants for development (ATD, French Foreign Ministry) were included in CIRAD staff numbers; they were not included in 2002. Even without these staff members (figure 1), overall senior staff numbers increased (+22), while senior non-scientific staff numbers decreased (–14). The number of collaborators and supervisors fell by 30, as a result of promotions and early retirements in the French overseas departments and territories (the "LOOM" scheme). These data reflect the priorities given to scientific production

and to promoting a certain number of employees. At the end of 2003, senior staff numbers in metropolitan France were up (+28), to the detriment of expatriates (–12), corresponding to the immediate savings necessitated by blanket budget restrictions (figure 2). Nevertheless, researchers assigned to other organizations and ATD are generally assigned outside metropolitan France.

Missions were down from 112.7 full-time-post equivalents in 2002 to 95.3, primarily to Africa (figure 3).

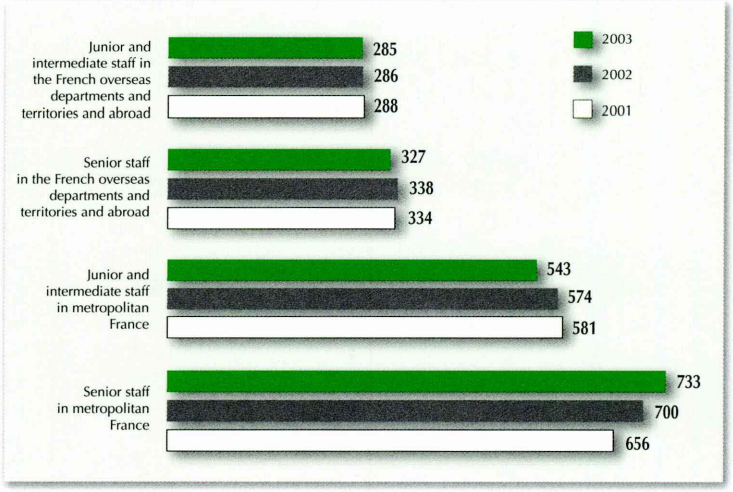

Figure 2. Location of CIRAD staff (associate researchers and ATD not included).

Changes in researcher origin

The contractual agreement set a target of 5% European researchers. The figure has increased from 2.9% in 2000 to 4.6% in 2003 (figure 4).

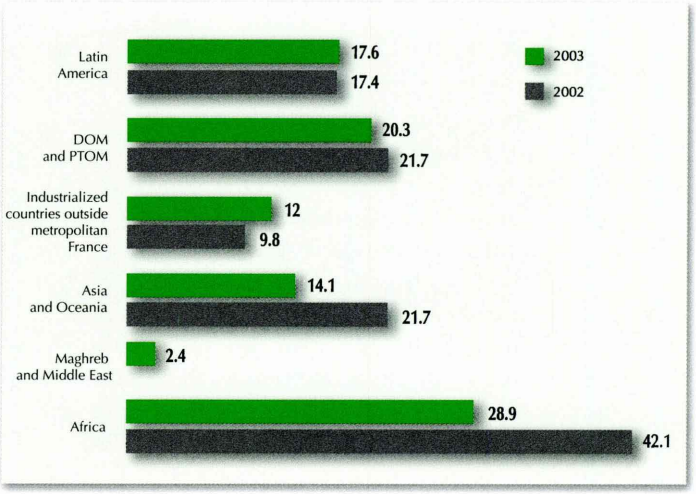

Figure 3. Missions, in full-time-post equivalents.

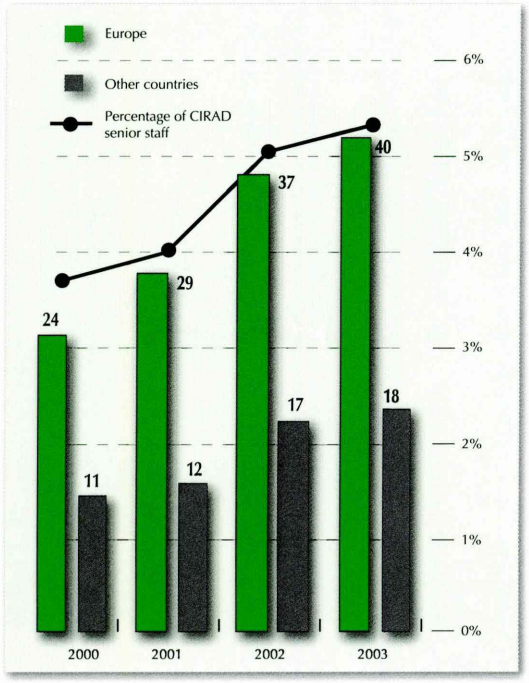

Figure 4. Changes in the origin of senior staff members.

Proportion of women among senior staff

Between 2002 and 2003, the number of women among the senior staff at CIRAD was up by 38, increasing from 21% to 24% (figure 5).

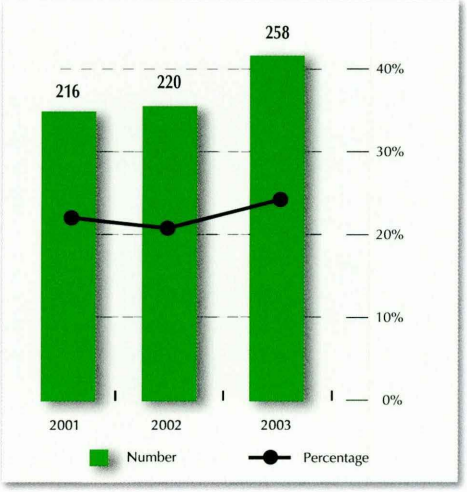

Figure 5. Changes in the number of women on the senior staff..

Changing skills

Senior scientific staff numbers

In 2003, the number of researchers (ie senior scientific staff members primarily assessed according to scientific criteria) was up from 842 to 878 (table 1). There were also a further 57 associate researchers and French Foreign Ministry ATD, representing 6% of CIRAD senior scientific staff. Doctoral students are not included under this heading. New recruits were integrated into existing research teams at CIRAD's various departments.

Table 1. Changes in staff numbers per department (excluding associate researchers and ATD)

	2001	2002	2003
Annual Crops	154	158	160
Tree Crops	128	127	133
FLHOR	82	87	89
EMVT	95	98	108
Forestry	87	90	95
TERA	87	92	96
AMIS	140	145	152
General Management	45	45	45
Total	818	842	878

PhDs and authorizations to supervise research

The proportion of researchers with doctorates or the equivalent has increased, and all the new scientific recruits have them (table 2). The proportion of researchers authorized to supervise research (HDR) is up. The fact that a further 66 staff members with doctorates were recorded in 2003 is due to the late compilation of the data for 2002.

Table 2. Theses and authorizations to supervise research

	2001	2002	2003	2003*
Researchers	818	842	878	935
Doctors	408	419	473	485
%	49.9	49.8	53.9	51.9
HDR	58	67	72	77
%	7.1	8	8.2	8.2

* In 2003, including ATD and researchers on assignment

Priority topics

In accordance with the contractual agreement, the priorities of changing and strengthening scientific skills should result in recruitment and in-house training in several fields: applying genome studies to agronomy, ecology and the environment, mathematics and applied informatics, and agrifoods.

The target for 2005 is a further 40 staff members by the end of the agreement. As a result of arrivals and departures in 2002 and 2003, there are now a further 13 staff members (table 3). Fourteen people joined these fields in 2003, through recruitment, mobility or internal promotion. They replaced some of those who had left, but the agrifoods field had a net loss of two staff members.

Table 3. Changes in researcher numbers in the priority fields identified by the contractual agreement

	2002	2003
Applying genome studies to agronomy	+ 2	+ 1
Ecology and the environment	+ 5	0
Mathematics and applied informatics	+ 3	+ 4
Agrifoods	0	- 2
All fields	+ 10	+ 3

Policy on scientific operations and partnerships

▸ Partnerships

Five federative projects

Five interdepartmental federative projects were launched in 2003, and are of major importance for the organization as a whole (table 4). The aim is to mobilize scientific teams to work on innovative strategic topics relating to sustainable development, with outside partners.

Table 4. Federative projects in 2003

Federative project	Purpose	CIRAD departments French partners	Foreign partners
DURABILIS	Sustainable agriculture and socio-technical innovations	CIRAD: CA, CP, EMVT, FLHOR, TERA France: CEMAGREF, ENGREF, IFREMER, INRA, IRD, UAG, University of Nancy	Other countries: EMBRAPA, IAPAR (Brazil), VASI, NAFRI (Vietnam), INERA, IER, ICRISAT, CEFE, CIRDES, (Mali, Burkina Faso),
GRENAT	Tools for evaluating and managing the environmental risk linked to use of waste and pollutant products in agriculture	CIRAD: AMIS, CA, CP, Forestry, EMVT, FLHOR, TERA France: BRGM, CEMAGREF, CEREGE, IFREMER, INRA, IRD, Universities (Lyon, Montpellier, Réunion) Isautier SA, Lesaffre SA	Europe: UCL (Belgium) Other countries: Pt Smart (Indonesia), University of São Paulo (Brazil)
ECOFORBAC	Forest ecosystem management and conservation in the Congo Basin	CIRAD: Forestry, EMVT, AMIS, TERA France: CNRS, IRD	Europe: Universities (Aberdeen, Edinburgh, Gembloux, ULB) Other countries: ADIE, RIFFEAC, RAPAC, CORAF, NARS in the sub-region, CNRA, NGOs, higher education
ORYZON	Rice, from gene to field and field to gene	CIRAD: CA, AMIS France: CFR Camargue, Ecole Centrale de Paris, Génoplante, INRA , INRIA	Other countries: IRRI (Philippines), FOFIFA (Madagascar), CSIRO, University of Queensland (Australia), CAU, CAS (China) Challenge program (CGIAR)
QUALCER	Tropical product qualification and certification	CIRAD: AMIS, CA, CP, EMVT, FLHOR, Forestry, TERA France: CNRS, GIS SYAL, INAO INPI, INRA	Europe: DOLPHINS network Other countries: MALICA JSC (Vietnam), AGROBRAS JSC, EMBRAPA, SEBRAE (Brazil), IICA (Latin America), PIP (ACP), ICCRI (Indonesia), universities, local, regional and interprofessional groups

Inter-organizational projects in France

The INRA-CEMAGREF-CIRAD transverse mechanism on the multifunctionality of agriculture, which was launched in 2002 and scheduled to run for two years, reached its peak in 2003. A debriefing seminar is planned for the end of the first half of 2004, to conclude the various projects. CIRAD has been involved in nine different projects (table 5, CD-ROM).

The special fund launched in 1999 to support scientific collaboration projects involving teams from INRA and CIRAD has been used for 33 projects, bringing together teams from the French overseas departments and territories and numerous INRA centres in metropolitan France (table 6, CD-ROM). A debriefing seminar is scheduled for 2004. Other types of funding from INRA and CIRAD were used for new collaborative projects in 2002. As a result of budget cuts, no new projects were launched in 2003.

Joint research units

With the renewal of the existing joint research units (UMR) and the signature of new agreements in 2003, CIRAD is contractually involved in 17 joint research units. From 12 in 2001, the total number should be 20 UMR in 2005 (table 7).

Four UMR are headed by CIRAD researchers and three others by an associate scientist or former CIRAD staff members.

CIRAD's main partners in the UMR are the Ecole nationale supérieure agronomique de Montpellier (Agro.M), INRA, IRD and the University of Montpellier II (UM2).

The proportion of CIRAD senior scientific staff working for UMR is up from 15% in 2001 to almost 27% in 2003 (figures 6 and 7).

Table 7. List of joint research units agreed with CIRAD in 2003

UMR agreed as of 31.12.2002	Purpose	Director	CIRAD's partners
BEPC	Biology of cultivated tree crop development	F. Dosba	Agro.M, INRA, UM2
PIA	Polymorphisms of agricultural value	J.-C. Glaszmann	Agro.M, INRA
AMAP	Botany and bio-informatics of plant architecture	D. Barthélémy	CNRS, INRA, IRD, UM2
BGPI	Biology and genetics of plant-parasite interactions	J.-L. Notteghem	Agro.M, INRA
CBGP	The Center for Biology and Management of Populations	S. Morand	Agro.M, INRA, IRD, UM2
LSTM	Tropical and Mediterranean plant symbiosis laboratory	B. Dreyfus	Agro.M, INRA, IRD, UM2
Ecologie des forêts en Guyane	Forest ecology in French Guiana	M. Fournier	ENGREF, INRA
SYSTEM	Tropical and Mediterranean cropping systems—functioning and management	J. Wéry	Agro.M, INRA
ERRC	Ruminant production in warm regions	F. Bocquier	Agro.M, INRA
CIRED	International centre for research on the environment and development	J.-C. Hourcade	CNRS, ENGREF, ENPC
Innovation	Innovation, technical change, apprenticeship and coordination in the agricultural and agrifoods sectors	F. Dreyfus	Agro.M, CIHEAM-IAMM, CNEARC, INRA
SAGERT	Agrarian systems and sustainable management of agricultural use of tropical and Mediterranean resources and territories	E. Torquebiau	CNEARC, ENGREF
PVBMT	Plant populations and biothreats in tropical environments (Réunion)	B. Reynaud	University of Réunion
UMR agreed in 2003	**Purpose**	**Director**	**CIRAD's partners**
MOISA	Markets, institutions and stakeholder strategies	J.-L. Rastoin	Agro.M, CIHEAM-IAMM, INRA
ITAP	Information and technologies for agroprocesses	V. Bellon-Maurel	Agro.M, CEMAGREF, ENSIA
Génie des procédés	Bioproduct development process engineering	A. Grasmick	ENSIA, UM1, UM2
IATE	Agropolymer engineering and emerging technologies	S. Guilbert	Agro.M, ENSIA, INRA, UM2

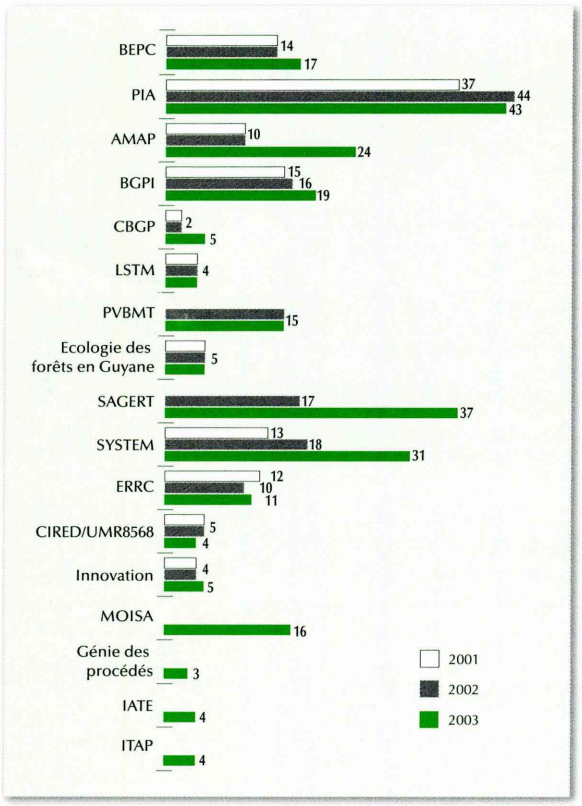

Figure 6. Changes in the number of CIRAD researchers working in joint research units.

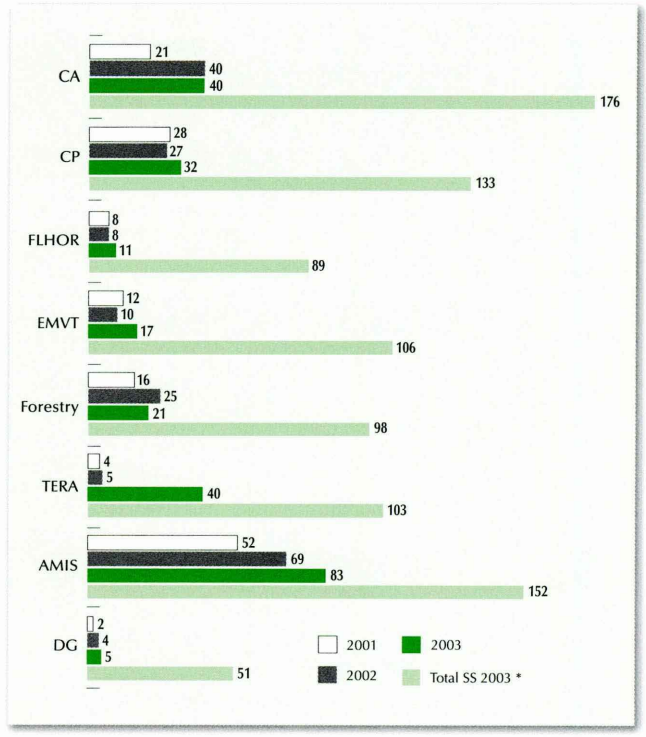

Figure 7. CIRAD department participation in joint research units.
(Total SS: total number of senior scientific staff members in the department)

CIRAD participation in the 6th European PCRDT

CIRAD has submitted 37 proposals to the various programmes under the 6th PCRDT: 12 as coordinator and 25 as a partner (table 8). In all, 11 were approved in 2003, six of them coordinated by CIRAD (table 9). The 6th PCRDT has introduced new structures aimed at pooling expertise: networks of excellence (NOE) and integrated projects (IP). One of the ten proposals in which CIRAD was a partner was approved: Pharmaplant (science for health). CIRAD is also coordinator of five specific targeted research projects (STREP) and a specific support action (SSA).

Table 8. CIRAD participation in the 6th PCRDT

Instruments	Proposals submitted (2002-2003)			Projects approved in 2003		
	Coordinator	Participant	Total	Coordinator	Participant	Total
NOE, IP	0	10	10	0	1	1
STREP	10	8	18	5	1	6
CA	0	4	4	0	1	1
SSA	2	3	5	1	2	3

Table 9. European projects

Programme, priority*	Instrument	Acronym	Title	Department	Contact at CIRAD
CIRAD as coordinator					
6-1	STREP	GREEN FUEL CELL	SOFC Fuel cell fuelled by biomass gasification gas	Forestry	P. Girard
INCO	STREP	FOREAIM	Bridging restoration and multi-functionality in degraded forest landscapes of Eastern Africa and Indian Ocean islands	Forestry	
INCO	STREP	RP/PPR MARKVAC	Development of marker vaccines, companion diagnostic tests, and improvement of epidemiological knowledge to facilitate control of rinderpest and "peste des petits ruminants" viruses	EMVT	G. Libeau
INCO	STREP	EPIGENEVAC	Epidemiology and new generation vaccines for *Ehrlichia* and anaplasma infections of ruminants	EMVT	D. Martinez
INCO	STREP	TRYPADVAC 2	Development of an "anti-disease" vaccine and diagnostic tests for African trypanosomosis	EMVT	L. Authié
6-1	SSA	KASSA	Knowledge assessment and sharing in sustainable agriculture	AMIS, CA	J.-L. Khalfaoui
CIRAD as partner					
1	IP	PHARMAPLANT	Recombinant pharmaceuticals from plants for human health	EMVT	L. Dedieu
INCO	STREP	AFRICANUANCES	Exploring tradeoffs around farming livelihoods and the environment: the Africa NUANCES framework	CA	F. Forest
INCO	CA	ICTTD	Integrated control of tick-borne disease	EMVT	E. Camus
6-3	SSA	MULTAGRI	Capitalisation of research results on the multifunctionality of agriculture and rural areas	TERA	P. Caron
6-3	SSA	CLARIS	A Europe-South America network for climate change assessment and impact studies	AMIS	B. Barbier

* Priority 1: genome studies
Priority 6-1: sustainable energy systems
Priority 6-3: global change and ecosystems
INCO programme: international cooperation

Overseas research centres

The development of cooperative projects with French research organizations and universities within UMR fits in with the plan to consolidate the Montpellier international advanced research platform, Agropolis. To open this community up to international partners, joint programmes have been launched with centres belonging to the Consultative Group on International Agricultural Research (CGIAR), and researchers from those centres are currently working in Montpellier. An agreement has also been signed between Agropolis and EMBRAPA, the Brazilian state agricultural research body. The overseas research centres complement this structure, working to satisfy requirements in developing countries.

Joint skills centres (JSC) are set up in response to an issue identified during consultations with development players. Partner organizations decide to pool their resources in a consortium-type contractual structure, to tackle the issue on a long-term basis (around 10 years). This may involve a single scientific topic or several, with one or more multi-disciplinary teams set up for a three-to-four-year

period. At the end of their mandate, the teams are assessed based on what they have achieved (training, improved varieties or races, spatial representation tools, methodological tools, etc), their impact in terms of consolidating scientific capacity, and the dissemination of research results. The necessary funding is generated by pooling the partners' resources and by submitting joint applications for additional funds. By the end of 2003, seven JSC were fully operational, compared to just two in 2001. The target set in the contractual agreement was ten (table 10).

In addition to this structure, there are also regional centres, which are the result of the long-term collaboration between CIRAD and its regional partners: UR2PI in the Democratic Republic of Congo, CIRDES in Burkina Faso and CARBAP in Cameroon (table 11).

In 2003, 36 CIRAD researchers were involved in JSC; the 2002 figure was 27. Eleven were working at regional centres (table 12).

Table 10. Joint skills centre agreements signed in 2001, 2002 and 2003

Acronym, country	Topic	CIRAD departments	Partners
CERAAS, Senegal	Plant adaptation to drought	AMIS, CA	ISRA, region, Cheikh Anta Diop University
PPZS, Senegal	Pastoral resource management in dry zones	EMVT, Forestry, TERA	CSE, ISRA, universities
MALICA, Vietnam	Markets and agriculture linkages for cities in Asia	FLHOR	VASI, RIFAV, ICARD, IOS, IAE, AIT
PRISE, Vietnam	Intensification of animal production systems	EMVT	NIAH, University of Can-Tho
F and B, Madagascar	Forests and biodiversity	Forestry	FOFIFA, University of Antananarivo, other partners
SCRID, Madagascar	Sustainable rice-based cropping systems	CA	FOFIFA, University of Antananarivo
GESED, Mali	Savannah ecosystem management	CA, Forestry,TERA, EMVT	IER, IPR
..., Cameroon	Integrated management of family farms in humid agroforest ecosystems	CP, FLHOR,TERA	Pending

Table 11. Regional centres

Acronym, country	Topic	Characteristics	Partners
CARBAP, Cameroon	Improvement of plantain and other banana production for local consumption	Regional centre	IRAD, MAD
CIRDES, Burkina Faso	Research on the development of animal production in sub-humid zones	Regional centre	MAD, ILRI
UR2PI, Democratic Republic of Congo	Sustainable management of fast-growing forest species	Association under Congolese law	

Table 12. Scientists at regional centres in 2003

Acronym, country	CIRAD	Partners	Total
CERAAS, Senegal	2	9	11
PPZS, Senegal	5	9	14
MALICA, Vietnam	2	6	8
PRISE, Vietnam	9	7	16
F and B, Madagascar	4	25	29
SCRID, Madagascar	5	17	22
GESED, Mali	9	13	22
CARBAP, Cameroon	4	6	10
CIRDES, Burkina Faso	4	11	15
UR2PI, Democratic Republic of Congo	3	8	11
Total	47	111	158

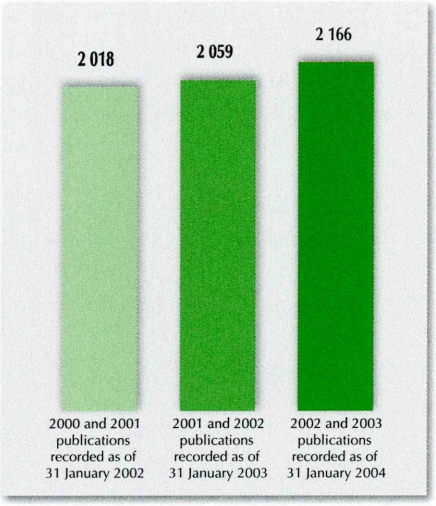

Figure 8. Changes in the number of publications.

Scientific and technical publications

The figures concerning publications by CIRAD researchers were drawn from the Agritrop institutional database: journal articles, books, book chapters, proceedings, conference papers, and theses (figure 8). As output, and thus recording, of publications for a given year may be spread over two and even three consecutive years, the figures compared here represent the records for two years of publications, on the same anniversary (31 January).

Typology

The number of publications, which has increased slightly, is primarily split between conference papers and articles (figure 9). The number of books published is down, but the number of book chapters has risen.

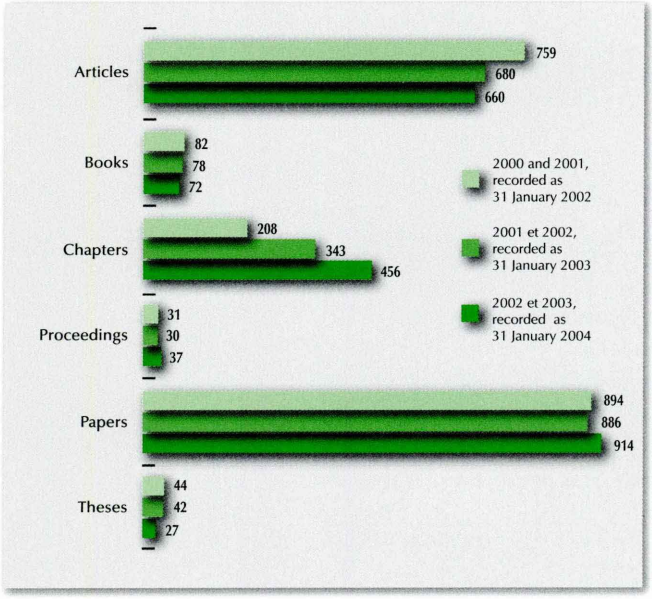

Figure 9. Changes in the number of publications according to the type of document.

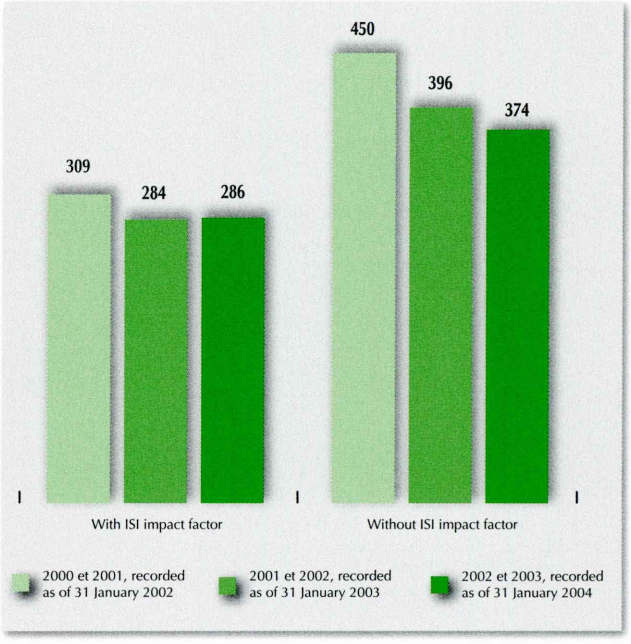

Figure 10. Changes in the number of articles published in journals.

Publications in impact-factor journals

Journal articles account for around 33% of the 3 480 publications from 2001 to 2003, recorded as of 31 January 2004. Compared to 2002, the number of articles published in 2003 was down slightly (figure 10).

Publications under the "plant science and production" heading of the FAO categorization scheme represent the major share of CIRAD publications. They account for 44% of articles published in impact-

factor journals (most-quoted journals, according to the Institute for Scientific Information, United States) between 2001 and 2003. Plant genetics and breeding, which belong to this category, account for 25% of articles. Articles published in non-impact-factor journals fall primarily under the topic "agricultural economics, development and rural sociology" (39%). A large number of recorded documents also fall under other topics.

Supervision and reception of students

Training is a major part of CIRAD's mandate, and the organization receives a large number of doctoral and other students (figure 11).

Doctoral students

During 2003, 183 doctoral students were received in metropolitan France. In addition, some 90 doctoral students were also supervised overseas.

Other students

In metropolitan France alone, 461 students from developing countries spent time at CIRAD in 2003, ie 106 full-time-post equivalents, 17 fewer than in 2002 (figure 12). Each CIRAD senior scientific staff member thus supervised a student for an average of 1.45 months. The actual figure is in fact higher, given the number of students received and studies supervised in the French overseas departments and territories and abroad. It reflects the high level of motivation among CIRAD researchers for this activity.

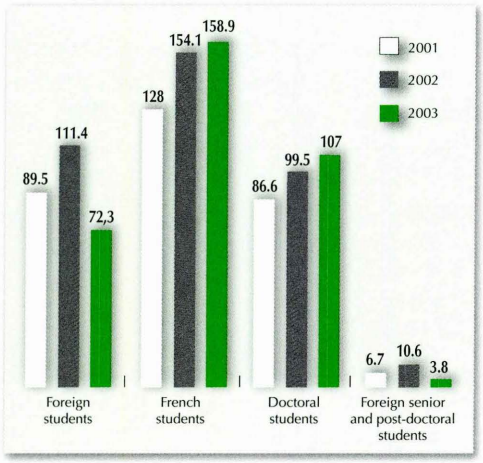

Figure 11. Scientists received, in full-time-post equivalents.

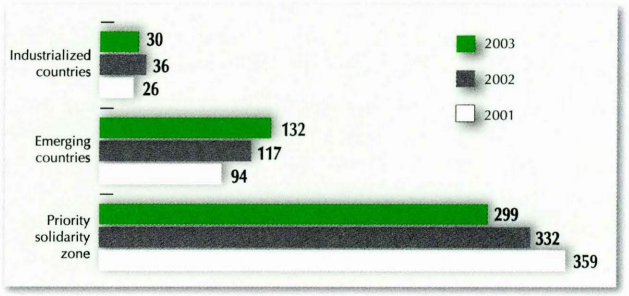

Figure 12. Origin of foreign students.

Post-doctoral students

In 2003, CIRAD received 17 French post-doctoral students, who participated in its laboratories' scientific operations: ten under its annual agreement with the French Ministry for Research, two under the previous agreement, two with specific CIRAD funding and three with various types of external funding.

Senior researchers

Eighteen foreign senior researchers and post-doctoral students were associated with CIRAD's research operations, a figure that was stable compared to 2002. They came from 12 different countries: Belgium, Brazil, Cameroon, China, Côte d'Ivoire, Egypt, India, Indonesia, Japan, Sene-

gal, Thailand and the United States. This range of origins demonstrates CIRAD's attractiveness to students, and its ability to build strong links with their organizations. However, the average length of stay was down in 2003, as a result of cuts in the corresponding funding (from eight months in 2002 to under three months in 2003).

Under the contractual agreement, CIRAD should eventually receive 30 foreign senior researchers and post-doctoral students each year. Over and above the attractiveness of CIRAD worldwide, the necessary funding will have to be made available if this target is to be reached.

Application of results

Patents, trademarks, softwares and plant variety protection certificates

In 2003, CIRAD had a portfolio of 28 patents, of which eight were covered by a marketing agreement (table 13, CD-ROM). The portfolio also included 15 registered software programs, eight trademarks and 31 plant variety protection certificates.

Missions

CIRAD is also committed to promoting its expertise in numerous fields, in the form of missions and training (figure 3).

Laboratories with outside recognition

Under the contractual agreement, 20% of CIRAD's teams should have quality certification by 2005. As of 31 December 2003, the proportion was 8.3 %, counting those laboratories that had satisfied the standards laid down under the CIRAD quality strategy (2% at the end of 2002). Two out of the seven departments met those standards, while three others should do so shortly.

Four laboratories have quality certification or are recognized as reference laboratories in their field: the water-soil-plant analysis laboratory (Languedoc-Roussillon); the wood preservation laboratory (Languedoc-Roussillon); and two animal health laboratories (Languedoc-Roussillon and Guadeloupe).

Development projects

The portfolio of major development projects (budget of more than 100 000 euros) under way in 2003 comprises 51 projects, with a total budget of over 38 million euros (table 14, CD-ROM). These projects were financed from State funds (French [31%], European [31%] and foreign [14%]), and private funds (24%).

Financial resources

The State research and development subsidy (BCRD) covered 61% of operating costs in 2003, a figure that has been reduced yet again (63.2% in 2001, 61.9% in 2002), as a result of budget cuts.

Origin of contractual resources

Overall contractual turnover has been slightly reduced (– 0.4%). Whereas the contractual agreement set a target of 15% increase by the end of 2005 in relation to the initial situation, the net figure by the end of 2003 was just 1.93%. Funding was primarily drawn from French, European and foreign public-sector organizations (figure 14).

The target set by the contract for the share of private funds was largely exceeded (9.6% of overall CIRAD resources for a target of 5%). However, the share of European Union funding in relation to contractual funding as a whole needs to be assessed in more detail, since third-party "clients" may disguise the true origin of funding (territorial authorities, third-party countries, etc).

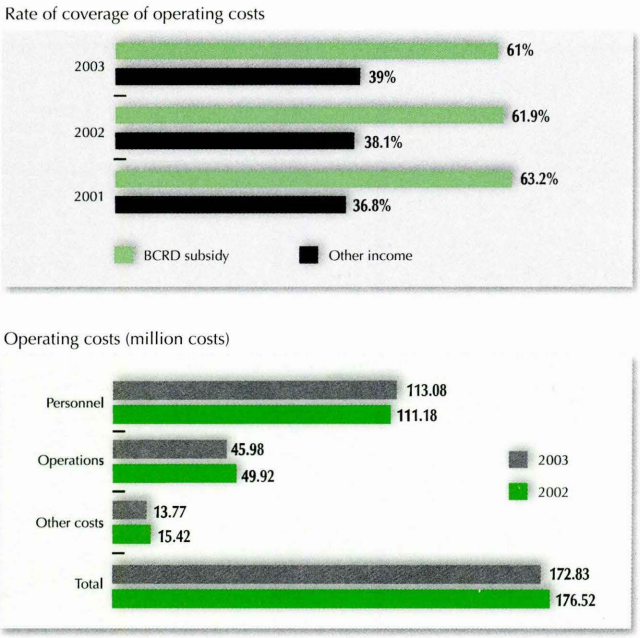

Figure 13. Income and expenditure.

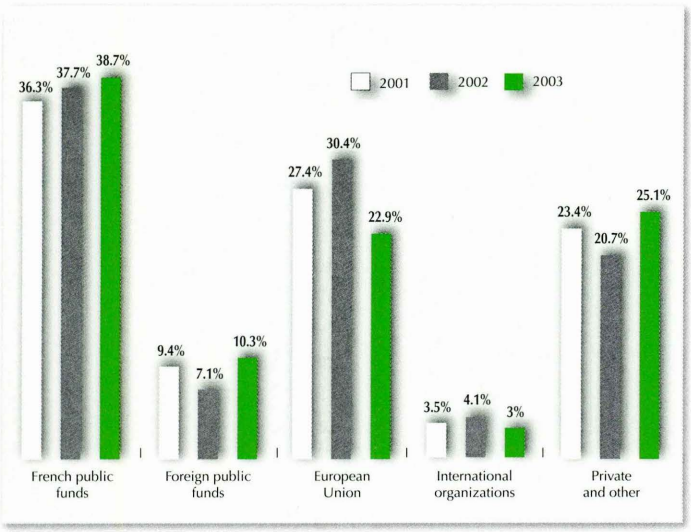

Figure 14. Contractual resource distribution per type of funding.

CIRAD
at a glance

Organizational Chart of CIRAD in April 2004

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Coordinator, Partnerships, **Michel Déat**
Coordinator, Marketing and Forward Studies, **Léandre Mas**

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Agrosystems, **Francis Forest**
Cotton, **Jacques Pagès**
Food crops, **Pierre Fabre**
Sugar cane, **Robert Domaingue**

Tree Crops (CP)

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Coconut, **André Rouzière**
Coffee, **Christophe Montagnon**
Oil Palm, **André Rouzière**
Rubber, **Jérôme Sainte-Beuve**

Fruit and Horticultural Crops (FLHOR)

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Deputy Director for Research, **Jacky Ganry**
Deputy Director for Management Support, **Jacques Nolin**
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Banana, Plantain and Pineapple, **François-Xavier Cote**
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Market Garden and Horticultural Products, **Rémi Kahane**

Animal Production and Veterinary Medicine (EMVT)

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Animal Health, *appointment pending*
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Forestry (Forêts)

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Forest Products, **Christian Sales**
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Trees and Plantations, **Bernard Mallet**

Territories, Environment and People (TERA)

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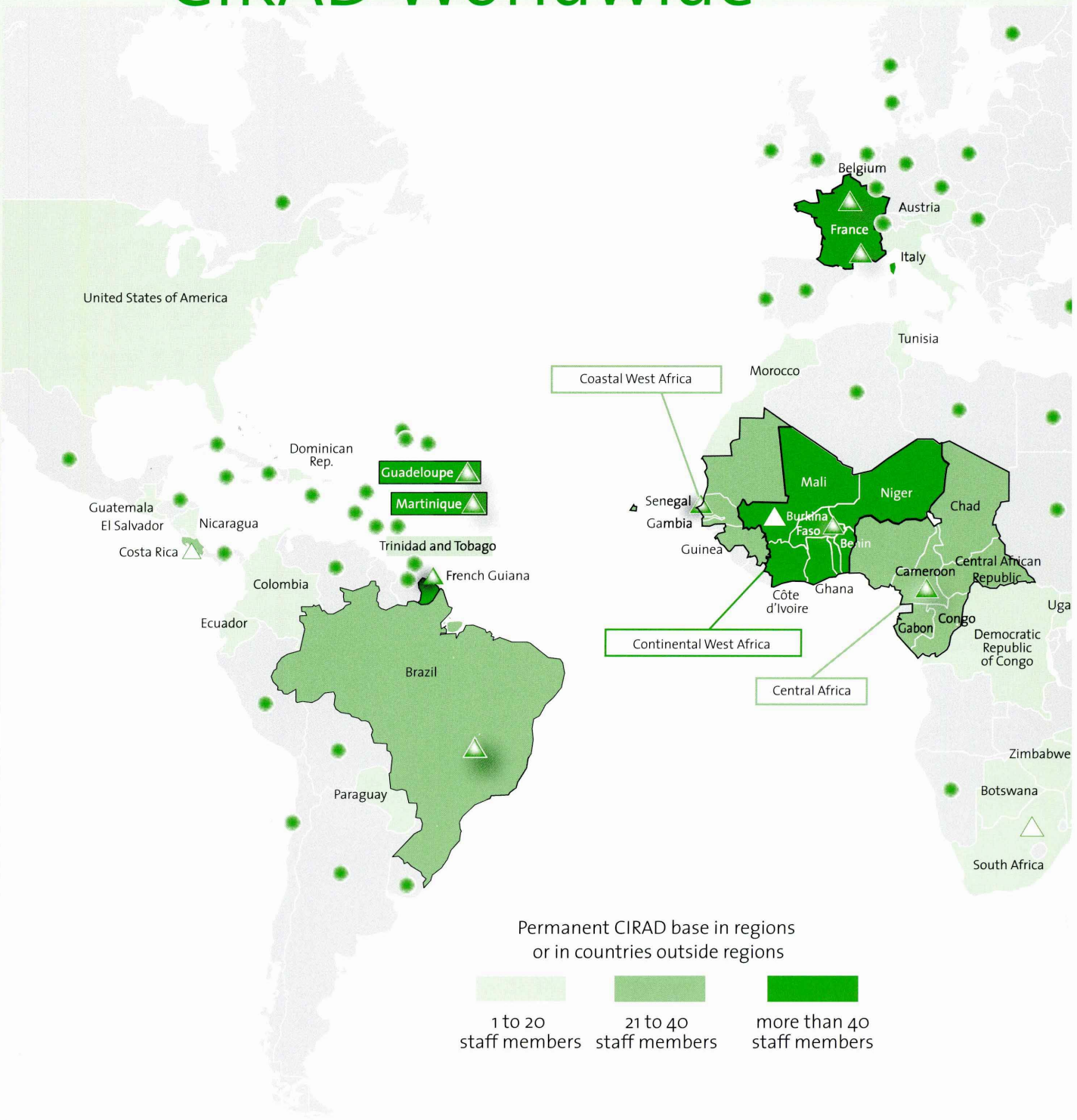


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Australia
Mayotte
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Reunion
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Regional centre
CIRAD correspondent

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ADIE, Association pour le développement de l'information environnementale, France

AFAQ, Association française pour l'assurance de la qualité, France

AFD, Agence française de développement, France

AFNOR, Agence française de normalisation, France

AFOCEL, Association forêt-cellulose, France

Agricultural producers' unions and groups

Agro.M, Ecole nationale supérieure agronomique de Montpellier, France

Agropolis, France

AIT, Asian Institute of Technology, Vietnam

APM Afrique, International Agriculture Peasant and Modernisation Network, Cameroon

APTA, Agência Paulistana de Tecnologia e Agronegocios, Brazil

ARMEFLHOR, Association réunionnaise pour la modernisation de l'économie fruitière, légumière et horticole, Réunion

Association Tin Tua, Burkina Faso

BCCCA, the Biscuit, Cake, Chocolate and Confectionery Association, United Kingdom

BRGM, Bureau des ressources géologiques et minières, France

BSES, Bureau of Sugar Experiment Stations, Australia

CARBAP, African Centre for Research on Banana and Plantain, Cameroon

CAS, Chinese Academy of Science, China

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

CAU, China Agricultural University, China

CCAD, Comisión Centroamericana de Ambiente y Desarrollo, El Salvador

CEFE, Centre d'écologie fonctionnelle et évolutive, France

CEMAGREF, Institut de recherche pour l'ingénierie de l'agriculture et de l'environnement, France

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

CEREGE, Centre européen de recherche et d'enseignement des géosciences de l'environnement, France

CERES, Centro de Estudos de la Realidad Económica y Social, Bolivia

CERF, Centre d'étude, de recherche et de formation, Réunion

CFR, Centre français du riz, France

Chambers of Agriculture, France

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

CIFOR, Center for International Forestry Research, Indonesia

CIHEAM, Centre international de hautes études agronomiques méditerranéennes, France

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

CINVESTAV, Centro de Investigación y de Estudios Avanzados, Mexico

CIRDES, Centre international de recherche-développement sur l'élevage en zone subhumide, Burkina Faso

CIRED, Centre international de recherche sur l'environnement et le développement, France

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

CNERV, Centre national d'élevage et de recherche vétérinaire, Mauritania

CNRA, Centre national de recherche agronomique, Côte d'Ivoire

CNRE, Centre national de recherches sur l'environnement, Madagascar

CNRRI, China National Rice Research Institute, China

CNRS, Centre national de la recherche scientifique, France

COFRAC, Comité français d'accréditation, France

College of Veterinary Medicine, University of Addis Ababa, Debre Zeit, Ethiopia

COPCAF, Coopérative des producteurs de café de la Guadeloupe, Guadeloupe

COPERSUCAR, São Paulo, Brazil

CORI, Coffee Research Institute, Uganda

COVAPE, Compagnie ouest-africaine pour la valorisation et l'amélioration des produits d'élevage, Senegal

CRU, Cocoa Research Unit, Trinidad and Tobago

CSE, Centre de suivi écologique, Senegal

CSIRO, Commonwealth Science and Industry Research Organisation, Australia

CTA, Technical Centre for Agricultural and Rural Cooperation, The Netherlands

CTBA, Centre technique du bois et de l'ameublement, France

CTICS, Centre technique interprofessionnel de la canne à sucre, Guadeloupe

EARO, Ethiopian Agricultural Research Organization, Ethiopia

ECO SA, Société Eucalyptus du Congo

Ecole centrale de Paris, France

Ecole nationale vétérinaire d'Alfort, Ecole nationale vétérinaire de Toulouse, France

EDE, Etablissements départementaux d'élevage des Dom, France

EISMV, Inter-State School of Veterinary Science and Medicine, Senegal

EMBRAPA, Empresa Brasileira de Pesquisa Agropecuária, Brazil

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

ENSIA-SIARC, Ecole nationale supérieure des industries agricoles et alimentaires, section industries alimentaires régions chaudes, France

EPHE, Ecole pratique des hautes études, France

European Union

FAO, Food and Agriculture Organization of the United Nations, Italy

FOFIFA, National Centre of Applied Research and Rural Development, Madagascar

FPH, Charles Léopold Mayer Foundation for the Progress of Humankind, Switzerland

GTZ, Deutsche Gesellschaft für Technische Zusammenarbeit, Germany

IAC, Institut agronomique néo-calédonien, New Caledonia

IAE, Institute of Agricultural Economics, Vietnam

IAMM, Institut agronomique méditerranéen de Montpellier, France

IAPAR, Instituto Agronômico do Paraná, Brazil

IAV Hassan II, Institut agronomique et vétérinaire Hassan II, Morocco

ICAFE, Costa Rican Coffee Institute, Costa Rica

ICARD, Information Center for Agriculture and Rural Development, Vietnam

ICCRI, Indonesian Coffee and Cocoa Research Institute, Indonesia

ICGD, International Cocoa Germplasm Database, United Kingdom

ICRAF, World Agroforestry Centre: Southeast Asia, Indonesia

ICRISAT, International Crops Research Institute for the Semi-Arid Tropics, India

IDDRI, Institut du développement durable et des relations internationales, France

IDF, Institut pour le développement forestier, France

IEB, Institute of Experimental Botany, Czech Republic

IEDES, Institut d'études du développement économique et social, France

IEFC, European Institute for Cultivated Forest, France

IER, Institut d'économie rurale, Mali

IFB, Institut français de la biodiversité, France

IFN, Inventaire forestier national, France

IFREMER, Institut français de recherche pour l'exploitation de la mer, France

IGN, Institut géographique national, France

IHCAFE, Instituto Hondureño del Café, Honduras

IICA, Instituto Interamericano de Cooperação para a Agricultura

IIE, Instituto Internacional de Ecologia, Brazil

IIHR, Indian Institute of Horticultural Research, India

ILRI, International Livestock Research Institute, Ethiopia

IME, Fraunhofer Institute for Molecular Biology and Applied Ecology, Germany

INAO, Institut national des appellations d'origine, France

INA-PG, Institut national agronomique de Paris-Grignon, France

INERA, Institut de l'environnement et des recherches agricoles, Burkina Faso

INIBAP, International Network for the Improvement of Banana and Plantain, France

INIFAP, Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Mexico

INPI, Institut national de la propriété intellectuelle, France

INRA, Institut national de la recherche agronomique, France

INRIA, Institut national de recherche en informatique et en automatique, France

Instituto Polis, Brazil

IOC, Indian Ocean Commission (Comoros, Réunion, Madagascar, Mauritius, Seychelles)

IOS, Institute of Sociology, Vietnam

IPGH, Instituto Panamericano de Geografía e Historia, Mexico

IPR, Institut polytechnique rural, Mali

IRAD, Institute of Agricultural Research for Development, Cameroon

IRD, Institut de recherche pour le développement, France

IRRI, International Rice Research Institute, Philippines

Isautier SA, France

ISRA, Institut sénégalais de recherches agricoles, Senegal

IUCN, World Conservation Union

Lesaffre SA, France

Local, regional and interprofessional bodies

Mahidol University, Thailand

Ministries

MRB, Malaysian Rubber Board, Malaysia

MSIRI, Mauritius Sugar Industry Research Institute, Mauritius

NAFRI, National Agriculture and Forestry Research Institute, Laos

NAHRC, National Animal Health Research Centre, Ethiopia

NARS, National Agricultural Research System, Ethiopia

National parks

National Veterinary Institute of Debre Zeit, Ethiopia

NIAH, National Institute of Animal Husbandry, Vietnam

NIAS, National Institute of Agrobiological Sciences, Japan

NRI, Natural Resources Institute, United Kingdom

OIE, World Organisation for Animal Health, France

ONF, Office national des forêts, France

PACE, Panafrican Programme for the Control of Epizootics

Palmas del Espinos, Peru

PARM, Pôle agroalimentaire régional de la Martinique, Martinique

PIP, European Union Pesticides Initiative Programme (ACP)

Pontian United Plantations Berhad, Malaysia

PRAM, Pôle de recherche agronomique de Martinique, Martinique

PRI, Plant Research Institute, The Netherlands

PROMECAFE, Regional Cooperative Programme for Technological Development and Modernisation of the Coffee Industry in Central America, Dominican Republic and Jamaica

PSI, Pôle systèmes irrigués, Senegal

PT SMART, Indonesia

PT SOCFINDO, Indonesia

Putra University, Malaysia

RAPAC, Network of Protected Areas in Central Africa

RichCongress, France

RIFFEAC, Forestry Schools in Central Africa Network

RIFV, Research Institute for Fruits and Vegetables, Vietnam

RRIT, Rubber Research Institute of Thailand, Thailand

SADEL, Service d'appui pour le développement local, Cameroon

SAED, Société d'aménagement et d'exploitation des terres du delta et de la vallée du fleuve Sénégal, Senegal

SAPHYTO, Burkina Faso

SASEX, South African Sugar Association Experiment Station, South Africa

SEAMO, Southeast Asian Ministers of Education Organization, Philippines

SEBRAE, Serviço Brasileiro de Apoio às Micro e Pequenas Empresas, Brazil

SEMOI, Réunion

SOLAGRAL, Solidarité agricole et alimentaire, France

SOSUCO, Burkina Faso

SPV, Services de la protection des végétaux, France

SUAD, Services d'utilité agricole et de développement des Dom, France

TIGR, The Institute for Genomic Research, United States

UAG, Université des Antilles et de la Guyane

UA-IBAR, Inter-African Bureau for Animal Resources, Ethiopia

UCAD, Université Cheikh Anta Diop, Senegal

UCB, Universidade Católica de Brasilia, Brazil

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UMSS, University of San Simón, Bolivia

UNICAMP, University of Campinas, Brazil

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UPAFA, Université paysanne africaine, Senegal

UPLB, Union des producteurs laitiers du Burkina Faso, Burkina Faso

UR2PI, Unité de recherche sur la productivité des plantations industrielles, DR Congo

URCF, Unité de recherche coton et fibres, Benin

USDA, United States Department of Agriculture, United States

VASI, Vietnam Agricultural Science Institute, Vietnam

WECARD, West and Central African Council for Agricultural Research and Development

WICSCBS, West Indies Central Sugar Cane Breeding Station, Barbados

World Bank, United States

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