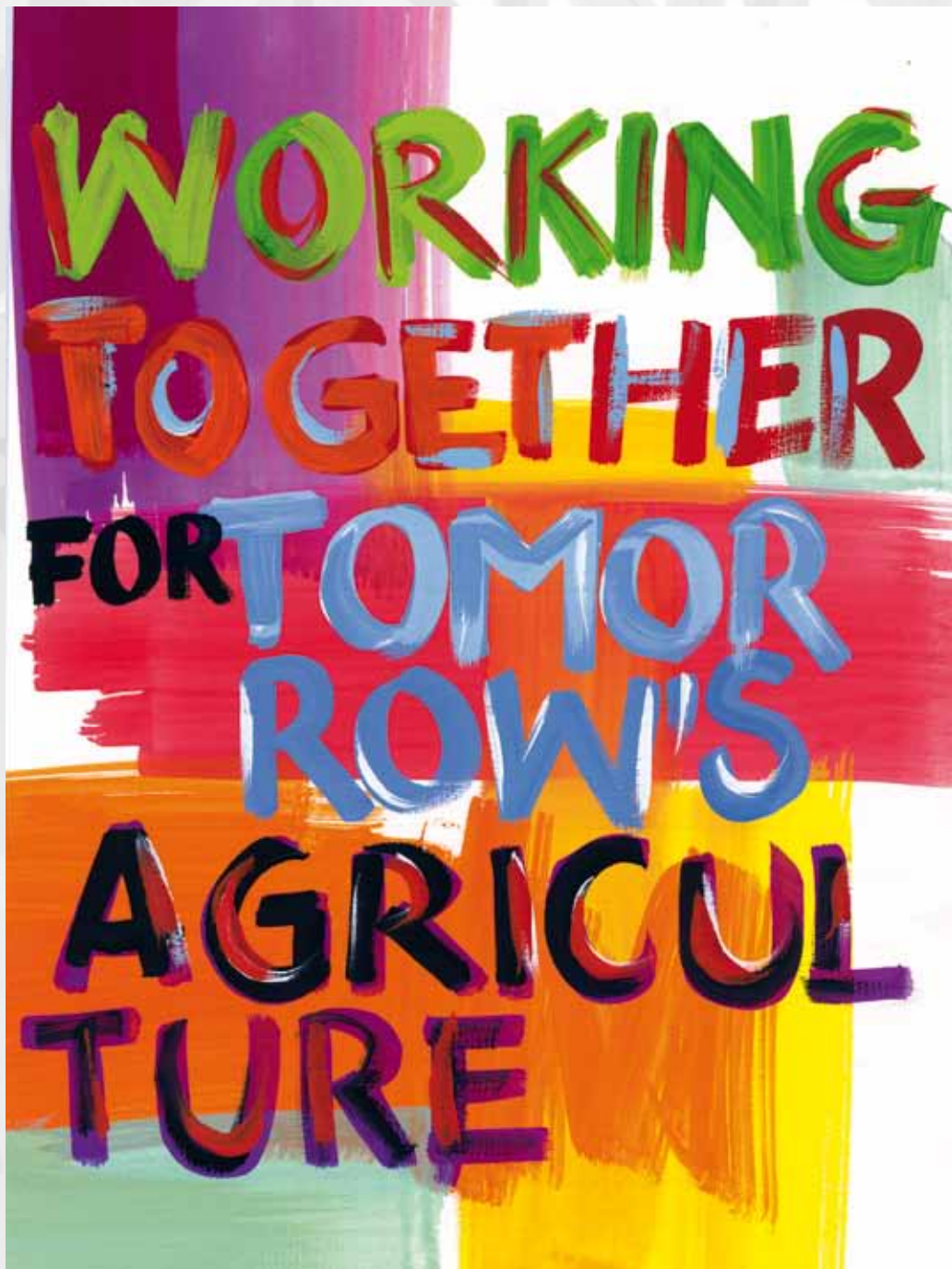


CIRAD 2011





AGRICULTURAL RESEARCH  
FOR DEVELOPMENT

CIRAD, the French Agricultural Research Centre for International Development, is a research centre working with developing countries to tackle international agricultural and development issues.

With those countries, it works to generate and transfer new knowledge, support agricultural development, and contribute to the debate on the main global issues concerning agriculture, food and rural territories.

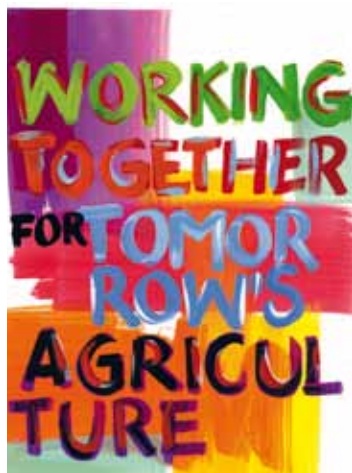
CIRAD has a global network of research and training platforms in partnership and regional offices, through which it works hand in hand with more than 90 countries.

It has a staff of 1800, including 800 researchers. It has an annual budget of 214 million euros, with two thirds provided by the French government.

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# Editorial

As is the case each year, the annual report *CIRAD 2011* aims to provide a dynamic picture of the diversity of CIRAD's scientific and technical production. There is evidently thematic diversity, as the activities presented are organised according to the six strategic project lines. There is also diversity in terms of the nature of projects, the scales dealt with, the objectives and associated forms of partnership. Lastly, there is diversity in relation to the different project achievements (generating knowledge, training, etc.).

I am fully aware that production, CIRAD's "production", owes a great deal to teams from other institutions, whether public or private, in both the South and the North. It owes much to the desire to identify relevant topics with stakeholders in the field. Credit also needs to be given to the choice of working with stakeholders and researchers to find suitable solutions to problems. In addition, production depends on the care taken to implement projects and to ensure that, in parallel, the knowledge developed collectively is shared. All these requirements, which are part of the teams' everyday work routine, are central to our institution's profession. This report, which naturally focuses on the results obtained, would be incomplete and unfair if this dimension were not mentioned here.

That is why CIRAD chose to contribute actively to the conference on agricultural research for development, whose main topic was "Promoting scientific partnerships for food security". It was held in Montpellier in September 2011 within the framework of the G20 summit. Through our contributions, as well as the actions we are implementing with the CGIAR centres and our southern partners, we are calling for the global governance of agricultural research for development based on requirements of balance and fairness.

The results presented in this report provide a direct and indirect illustration of the scope of this fundamental choice: that of strengthening scientific capacity and skills in the most fragile regions and countries in order to support the emergence of more endogenous development dynamics. CIRAD is committed to operating in the framework of research and training networks in partnership, which are developed within the partnerships that have been established with a number of southern institutions. In the same vein, CIRAD is reviewing its approach to the development of the agricultural sectors in French overseas regions so that our professional partners play a central role. In this way, the first workshop on the technical innovation and agricultural transfer network (RITA) in French overseas regions was held in Montpellier, in close cooperation with professional bodies, public authorities and the Association de Coordination Technique Agricole (ACTA).

Gérard Matheron  
President - Director General

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# "Fostering an original approach to development": the *Journées du CIRAD* meeting, July 2011

In 2011, CIRAD launched a process to adapt its strategic guidelines. After initial exchanges and consultations, it organised two days of discussions in July, mobilising the whole institution. This meeting served to identify the major investment priorities for the coming years.

THIS EVENT, ORGANISED BY CIRAD ON 5 AND 6 JULY 2011, was the opportunity for scientists and managers to examine the key issues underpinning the activities of the institution and defining its position within the research for development international community.

## Explaining changes

The discussions revealed how CIRAD would benefit from using its scientific productions to improve its capacity to influence international changes, but also from taking the international scientific communities into the "field" in the South. These prospects are all the more important in a rural world that is "helpless", "in crisis" and "unstable" as a result of the withdrawal of the State, global changes and the associated political, environmental and health risks. This goal is therefore part of a broader movement, in which science is not only called upon to design new technologies, but also to explain changes.

## Hybridising approaches

It is not by chance that CIRAD is able to contribute to developing a new perception of development. The Centre is increasingly establishing itself as a place where the hybridisation of perspectives can be achieved between biological, technical, economic, political and social approaches to the management of living resources, and between scientific input and views about the innovations of rural populations. Its area of expertise, which traditionally developed around biology

and its ecological and agricultural applications, has expanded over the last 20 years. This evolution has led CIRAD to increase the scale of its research, from plants or plots to national and international questions. Today, it has the skills required to develop conceptual and cognitive frameworks linking the molecule to the plant, or the local level to the global. Many of the calls for research are based on these linkages, since the complex issue of the contribution of agriculture to development, especially in the fields of environment, income and employment, climate change and nutrition, makes the use of integrated approaches a necessity.

## Rethinking development

Furthermore, CIRAD is present, through its partnerships, in many regions of the South. Within this broad range of contexts, it is involved in the analysis of innovation and change processes and in the design of responses to specific and local challenges. The links established also enable it to set up comparative mechanisms and to develop an original generic production. Based on the vast spectrum of skills it can mobilise both internally and externally, CIRAD can thus set itself the goal of acknowledging development as a research area and of contributing to an innovative debate on the links between agriculture and development. It should consequently be able to put forward its analyses and proposals concerning the issues discussed within the international bodies. ■

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# CIRAD at the G20 conference on agricultural research for development

In 2010, CIRAD confirmed its desire to participate in the restructuring of agricultural research for development and launched a series of initiatives to enable it to make effective use of its expertise and to share its values. It thus successfully made the case that the French Presidency of the G20 should be the opportunity to put this issue at the top of the political agenda, based on the Action Plan adopted in Seoul in 2010.

APAARI: Asia-Pacific Association of Agricultural Research Institutions  
AARINENA: Association of Agricultural Research Institutions in the Near East and North Africa  
CACAARI: Central Asia and the Caucasus Association of Agricultural Research Institutions  
FAO: Food and Agriculture Organization of the United Nations  
FARA: Forum for Agricultural Research in Africa  
IFAD: International Fund for Agricultural Development  
FORAGRO: Forum for the Americas on Agricultural Research and Technology Development  
GCARD: Global Conference on Agricultural Research for Development  
CGIAR: Consultative Group on International Agricultural Research  
GFAR: Global Forum on Agricultural Research

**UNDER THE FRENCH PRESIDENCY OF THE G20,** France organised a conference on agricultural research for development (AR4D), which was held in Montpellier on 12 and 13 September 2011. It focused on Promoting Scientific Partnerships for Food Security. CIRAD was closely associated with its preparation, took active part in the conference and is involved in the supervision of several of the initiatives proposed or endorsed there.

## **Strengthening cooperation on agricultural research for development**

The two-day conference was attended by almost 130 people, representing Ministries of Foreign Affairs, cooperation agencies and research institutes from 17 of the G20 members as well as representatives of the organisations concerned, whether international (FAO, World Bank, IFAD, GFAR, CGIAR) or regional (FARA, FORAGRO, APAARI, CACAARI, AARINENA). It examined ways to strengthen cooperation on agricultural research for development, but also the efficiency of this cooperation in the field of food security and nutrition.

It began by looking at ways to improve the coherence of investment by means of better coordination. The Conference thus encouraged GFAR to establish the Global Foresight Hub for food and agriculture, proposed in the Montpellier Roadmap (GCARD, 2010).

It then examined the possibilities for developing multi-stakeholder partnerships at the global level, in order to optimise investments and to assure their impacts in the field. Two initiatives were supported: the reform of the CGIAR and the development of its research programmes to ensure other actors can become involved; and mechanisms to finance innovation through the stimulation of the market (agricultural pull mechanisms), which are aimed at guaranteeing market access for innovations developed within a competitive context in low-profit sectors, such as animal vaccines.

One of the important elements of this conference concerned the means of ensuring greater efficiency in partnerships in the field of capacity building, in particular through the development of a Tropical Agriculture Platform, whose goal would be to consolidate partnerships for training and support for innovation systems in countries where there is a significant gap between potential production and actual production.

Finally, the last subject discussed was that of the global governance of agricultural research for development, which is meant to be voluntary and open. This particularly included the role of the GCARD global consultation process and the specific contribution that the G20 countries could make to it. The countries were invited to play an active role in its second conference, which will be held in Uruguay in 2012.

CIRAD, July 2011.  
*Towards an  
orchestration of global  
agricultural research:  
a CIRAD proposal.*



## Towards a global orchestration of agricultural research

To prepare this conference, IDDRI published a proposal on its vision of the global governance of agricultural research for development, entitled *Towards an orchestration of global agricultural research*. This paper is based on a multipolar approach to global research, articulated between competition for excellence and cooperation for an equitable sharing of scientific knowledge.

The conference was also the opportunity for CIRAD's Director of Research and Strategy to lead a high-level round table on the subject

of a shared vision of international agricultural research.

Following on from this conference, CIRAD is actively involved in the implementation of some of its recommendations. It is working with GFAR to develop the Global Foresight Hub for food and agriculture, with a researcher seconded to Rome for this project. Through AGREENIUM, it is also associated with the development of the Tropical Agriculture Platform, particularly proposing its research and training platforms in partnerships as structuring elements of this initiative. Finally, CIRAD is also contributing to several CGIAR research programmes. ■

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## Elinor Ostrom, Nobel Prize winner in Economic Sciences, visits France

*CIRAD jointly organised the visit to France of Elinor Ostrom, winner of the Nobel Prize in Economic Sciences 2009, Professor of Political Science at the University of Indiana and founder member of the Center for the Study of Institutional Diversity (Arizona State University). Over the past few years, several CIRAD research units have developed links with Elinor Ostrom and her team, through the conferences of the International Association for the Study of Common Property, the seminars of the Workshop in Political Theory and Policy Analysis and the National Science Foundation project on the dynamics of rules.*

During her trip to France, Elinor Ostrom gave two lectures, at the CORUM centre in Montpellier and at UNESCO in Paris. The conference in Montpellier, attended by 500 people, was entitled "Neither State nor Market: Community Organisation of Resources". A workshop with researchers from the French scientific community was organised in Montpellier, along with a discussion with PhD students and the presentation of an honorary doctorate from the University of Montpellier I. The talks centred on her work on the collective governance of common pool resources, a category that covers natural resources, such as aquifers, meadows, fisheries and forests, but also the climate and knowledge.

The operational scope of this work for CIRAD emerged through four subjects that were dis-

cussed during the workshops: "change of scale and governance" examined the possibility of transferring the lessons from research on local systems for the management of common pool resources to more interdependent systems that are impacted by more global environmental actions, decisions or processes; "organising interaction" looked at how the different actors, values, moral principles and learning processes are approached in collective decision-making; "social capital and collective action" focused on the State to understand how collective action and the social capital mobilised could serve as a catalyst for public action or induce the State to adapt its intervention; and "socio-ecological systems" questioned the formalisation of these systems and the normative view of research in terms of the sustainability criterion: which dimensions of these systems must be sustainable, for which actors and for what purpose?

Further to this visit, a review of the conferences, discussions with the public and debates during the Montpellier workshop is to be published. Other follow-up action is planned, including special editions of journals based on contributions to the Montpellier workshop, and the French translation of Elinor Ostrom's latest book *Working Together: Collective Action, the Commons, and Multiple Methods in Practice*. In it she talks about the value of associating analytical, theoretical and applied research and refers to the work accomplished with CIRAD. ■

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# CIRAD mobilised for the International Year of Forests

Drawing on its virtually unrivalled expertise in the field of tropical forests and their sustainable management, CIRAD mobilised throughout 2011, which was declared the International Year of Forests by the United Nations. In France and abroad, CIRAD researchers met the general public during different events, including international workshops, exhibitions, conferences, and interviews with the press.

THE CIRAD RESEARCHERS specialising in forests, trees and agroforestry are the heirs of one of the first technical laboratories for knowledge of

tropical timber, created in 1917 in Paris. CIRAD publishes *Bois et forêts des tropiques* which was launched in 1949 by the *Centre technique forestier tropical* (CTFT). This international scientific journal

is now the French language reference on tropical forests. CIRAD's historical presence makes it a leading actor that is acknowledged throughout the world for the sustainable management of tropical forests.

## Meeting the public

As part of CIRAD's research activities, its teams spoke to people from all backgrounds in order to raise awareness about tropical forests and the major role they play in our daily lives. The general public, students, professionals, administrations, and national and international decision-makers took advantage of the permanent or travelling exhibitions organised by CIRAD and the numerous conferences led by its researchers. The teams took part in media events, interviews, live discussions and television programmes, and honoured tropical forests throughout the year.



© Nathalie Le Gall

CIRAD also ran sessions bringing together the scientific community, international sponsors, and public and private operators. At the Paris International Agricultural Show, it arranged two days of round tables on “paying for tropical forests”.

### Mobilisation at the international level

At the request of the French Ministry of Foreign and European Affairs, CIRAD set up a permanent exhibition and organised a series of three side events at the Summit of the Three Rainforest Basins, held in Brazzaville from 29 May to 3 June 2011.

Thanks to its long-standing partnership with international forest and agroforestry centres (CIFOR, ICRAF), CIRAD is closely involved in the planning of global forestry research. In 2011, it

contributed to the development of the CGIAR research programme on Forests, Trees and Agroforestry.

Under the aegis of the International Union of Forest Research Organizations (IUFRO), CIRAD, CIFOR and ECOFOR jointly coordinated an international seminar entitled “Research priorities in tropical silviculture: towards new paradigms” from 15 to 18 November in Montpellier.

Under the patronage of the French Ministry of Foreign Affairs, the conference entitled “Tropical forests, progress report and new challenges: which orientations for French stakeholders?” closed the International Year of Forests on 11 and 12 January 2012. CIRAD's participation was the subject of several papers by researchers who attended the plenaries and thematic sessions. ■

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© Dominique Louppe / CIRAD

### Tropical forests on view

As part of the year of forests, CIRAD helped to set up two exhibitions in Paris: “Tropical forests, discoveries and issues” at the Parc de Bagatelle, and “Tropical Rainforests, the Future of the Earth” at the Palais de la Découverte. In partnership with IRD, it also designed a travelling multilingual exhibition to be displayed in embassies in France and, at the request of the Institut français de Madagascar, “Baobab trees, the mysterious giants”.

The International Agricultural Show was also the occasion to present an exhibition on “The future of tropical forests: a global issue”, which was accompanied by an illustrated information sheet. It enabled the public to find out about the many research projects conducted by CIRAD on Southern forests.

### What does the future hold for tropical forestry?

Since the 1950s, tropical forests have been disappearing at an alarming rate. For economic and political reasons, the creation of conservation areas will not be enough to preserve these forests. Production forests will also have a role to play. This was the basis of the conference entitled “Research priorities in tropical silviculture: towards new paradigms?”. Organised by CIRAD, CIFOR and ECOFOR under the aegis of IUFRO, the conference was held in Montpellier in November 2011 as part of the International Year of Forests, and brought together almost 200 researchers and students.



© Plinio Sist / CIRAD

But the presentations given also clearly revealed that managed forests retain a high level of biodiversity, which is often equivalent to that of primary forests, and that appropriate forestry practices can ensure the long-term, sustainable production of forest products. How then can forest managers be encouraged to implement such practices? This is the challenge for the future of tropical forestry, which will need to strike a balance between the production of goods and the preservation of services, as well as reconciling the expectations of all the stakeholders concerned by their future, whether forestry companies or rural populations.

#### PARTNERS

Center for International  
Forestry Research (CIFOR),  
International Union  
of Forest Research  
Organizations (IUFRO),  
Ecosystèmes forestiers  
(ECOFOR), Agropolis  
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## The Year of the French Overseas Regions: research and innovation

*With over a quarter of its staff members working in the French overseas departments and territories, CIRAD is a key player in agricultural research and development in these regions. It designs and develops innovations for producers and stakeholders in agricultural sectors, but also conducts research in partnership with all scientific and academic establishments and professional organisations. The French government declared 2011 the Year of the French Overseas Regions, and it was the opportunity for CIRAD to promote its work and its expertise. Some highlights of an intense year of conferences and events.*

In March, the heads of the French tropical biological resource centres met in Réunion to pool their efforts on management tools, securing collections and international visibility. Based in Réunion, the French West Indies, French Guiana and Montpellier, these centres joined forces in 2010 as part of the INTER-TROP project in order to more effectively meet their objectives for the conservation, dissemination and enhancement of genetic resources.

In November, CIRAD took part in the regional conference for the French West Indies-Guiana region, which was held in Martinique. There it presented two of the cooperation mechanisms it coordinates at the regional level: monitoring the effects of deforestation activities on greenhouse gas emissions, set up in French Guiana; and adaptation measures concerning animal health as part of the CaribVet epidemiological surveillance network, in the Caribbean.

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Again in November, CIRAD worked with INRA to organise a seminar on sustainable agricultural production and processing systems in the French West Indies and French Guiana. Research findings and innovations for sustainable agricultural systems were presented, especially those concerning banana plantations, crop diversification and livestock systems.

Finally, CIRAD hosted the first workshop of the *Réseau d'innovation et de transfert agricole dans l'outre-mer* in Montpellier in January 2012, a network whose aim is to contribute to the emergence and consolidation of technical institutes, in close consultation with the *Association de coordination technique agricole* (ACTA) and food, agriculture and forestry authorities, as well as to involve the different professional agricultural stakeholders in the overseas departments.

CIRAD also participated in several events organised during the Year of the French Overseas Regions, such as the exhibition "*Un jardin en outre-mer*" ("an overseas garden"), which ran in April and May in Paris, and published a special edition of *Agronews* on the French West Indies, focusing on banana crops. ■



## The world's challenge, feeding 9 billion people

In order to feed nine billion people satisfactorily by 2050, we will have to produce more and more food that meets stringent quality requirements, while preserving the environment. We will also have to allow for the fact that some of the available land will be needed to produce energy and industrial goods, to store carbon or to protect biodiversity. This will mean innovating, reducing loss and waste, cutting excessive, unbalanced food consumption and, at the same time, freeing a billion people from the poverty trap.

Researchers the world over have devoted themselves to these vast issues, and to the possible ways of finding

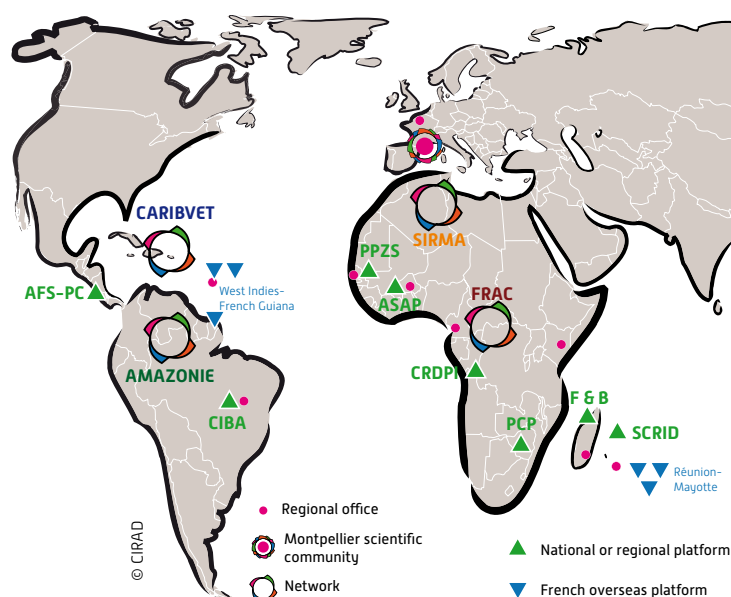
appropriate solutions on a global level. In this book, the Presidents of the two leading French agricultural research organisations, INRA and CIRAD, provide an overview of this research and the questions it raises. Aimed at the general public, it contains a wealth of information, enlightening examples and surprising proposals. We can avoid a cataclysm, but this will require profound changes, particularly in our consumption and production habits.

Marion Guillou and Gérard Matheron,  
*The world's challenge, feeding 9 billion people.*  
Paris, Quae, 2011.



# Research and training platforms in partnership, an innovative instrument for international agricultural research

On the strength of its considerable experience in international cooperation, CIRAD has adopted innovative instruments for fostering its partnerships aimed at developing scientific competences in the South. These are used within the framework of “research and training platforms in partnership” worldwide.



of research and training platforms in partnership, which it has set up jointly with its partners in several regions of the South.

## One objective: contributing to development through high-quality research

The primary goal of these platforms is to produce applicable scientific knowledge to respond to development challenges. But they are also aimed at strengthening the scientific competences of partners through training and higher education and boosting the integration of the scientific communities concerned within the global agricultural research system.

THE GROWING RISKS facing the world call for greater solidarity between all countries, whether they are in the North or the South. At a time when methods for producing scientific knowledge are exacerbating competition, and therefore exclusion, research for development must promote partnerships with institutions and scientists in those countries where the research system is weak. Building scientific competences and capacities in these countries also implies supporting their development dynamics. CIRAD is working to achieve this by acting within the framework

## One principle: working together

Research and training in partnership is based on working with the partners concerned to identify the development challenges in a given geographical area, and then translating these challenges into research priorities. It also involves sharing the means of generating scientific knowledge with all parties, creating a dynamic portfolio of research projects, disseminating the results in the form of publications and expert reports, and encouraging their use.

### A research and training platform in partnership is:

- A group of partners and the desire to work together;
- Shared outlooks and objectives;
- The long-term commitment of human, material and financial resources to achieve the objectives;
- A shared research theme;
- A defined geographical area;
- A critical mass of multiple competences and activities.

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### One governance system: organisation and resources

To carry out these activities, research and training platforms in partnership involve collective management by all partners and three governing bodies: a steering committee for decision making and planning formed by the management of member institutions; a scientific committee made up of internal and external members; and a coordination team for day-to-day management. Rotating presidencies are planned according to rules established in the agreements, as well as an external evaluation commissioned by the steering committee every four to five years, providing the opportunity to update or define a strategic roadmap. Finally, human, material and financial resources are provided by the member institutions.

### One system: platforms adapted to each situation

The functioning of these platforms in partnership may take various forms depending on their situation and scope: national or regional platforms in the South; French overseas platforms, with

regional influence; transnational thematic networks; and finally, Montpellier's scientific community and its many internationally renowned thematic research groups.

### One scientific strategy centred on the platforms in partnership

CIRAD has placed these platforms in partnership at the heart of its scientific strategy. It provides them with resources through specific incentives, such as equipment, funding for PhDs, postdoctoral research, assignments and exchanges, and the organisation of seminars: 10 million euros of incentive measures; 200 researchers seconded and the equivalent of 200 full-time posts abroad; and 150 researchers in French overseas locations. It offers the opportunity of hosting researchers in all of its laboratories and facilities, in both Montpellier and French overseas locations: 400 international researchers are hosted every year. It develops training modules and provides teaching in partner universities: 3 000 teaching hours by CIRAD researchers in universities in the South in 2011. ■

## "PhD students from the South": training tomorrow's scientists

*CIRAD has an active policy for the training of young researchers. Building and strengthening research capacity in the South is one of its objectives. In 2011, it launched its first special recruitment programme for PhD students from the South.*

The aim of the "PhD students from the South" programme is to support the graduate training of future scientists from countries in the South. Another of its goals is to develop partnerships in the field of research and higher education between CIRAD and teams in these countries. In 2011, 15 thesis grants (for a period of three years) aimed specifically at PhD students from the South were awarded as part of this programme.

Applications were examined by scientific experts, and then by a joint commission made up of members of CIRAD and AIRD (*Agence interétablissements de recherche pour le développement*), which is responsible for the management of grants.



© Marie Adell / CIRAD

The PhD students from the South were chosen in September 2011. Their research will focus on subjects identified as priority areas for CIRAD and its partners. The successful applicants will benefit from scientific supervision and a high-quality working environment within the establishment. They will conduct their research between the South and the CIRAD infrastructures in Montpellier, the French overseas departments, or different countries in the South. ■

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## Future investment: CIRAD in partnership with “laboratories and facilities of excellence”

CIRAD is involved in several projects selected by the “Investissements d’avenir” (Investment for the future) programme launched by the French Ministry of Higher Education and Research; an ambitious programme to fund “laboratoires et équipements d’excellence” (laboratories and facilities of excellence) to meet the challenges facing research and innovation in the years to come.

LAUNCHED IN 2010, the “Investment for the future” programme is aimed at providing facilities and laboratories with sufficient financial resources to enable them to meet their objectives. Judged on their quality, their value for the scientific community and their international scope, the winners were announced in 2011. CIRAD is associated with three of the facilities and four of the laboratories selected.

### Three leading facilities

Géosud, Genepi and Xyloforest are the three projects in which CIRAD is a partner that were chosen following the “facilities of excellence” (EQUIPEX) call for proposals. The first is aimed at developing a platform of satellite data for use by the national scientific community. This platform will provide annual coverage of the whole of

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### The AGRO LABEX, spearheading international agricultural research

The proposal for the agronomy and sustainable development laboratory, submitted by Agropolis Fondation within the framework of the government call for proposals on “Investment for the future”, was selected as a laboratory of excellence. The project was graded A+ by the international panel and came joint first. The AGRO LABEX focuses on plants of agronomic interest. It associates some 30 research units, including 9 that are involved with CIRAD, and over 1 000 scientists, providing a continuum of multi-disciplinary knowledge, ranging from the study of genes to the end use of plants. It has recognised expertise on a large number of temperate, Mediterranean and tropical plant species. Coordinated by Agropolis Fondation, this project will receive 25 million euros as part of the “Investment for the future” programme. Its aim is to make Montpellier the leading global scientific hub for research on plants of agronomic interest, both by generating advanced knowledge and using that knowledge to innovate, in response to the issues surrounding plant adaptation to climate change, demand for plants for food and non-food uses, risk management and sustainable development. The AGRO LABEX was inaugurated on 20 October 2011.

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France, with very high resolution imaging of urban areas as well as images of countries of the South. It should be integrated into the global GEOS infrastructure (Global Earth Observation System of Systems), which is currently being developed in the field of climate science and biodiversity management. With 11.5 million euros of funding, this project is coordinated by the Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture (IRSTEA) and the TETIS mixed research unit, in which CIRAD participates. The GENEPI project, run by CEA (French Alternative Energies and Atomic Energy Commission) and CIRAD, aims to develop an experimental platform to produce second-generation biofuels. This platform, which associates a gasification reactor and a unit to prepare biomass by torrefaction and grinding, will provide data for the industrialisation of the process to turn biomass into biofuel. CIRAD's participation concerns more specifically the identification and quantification of condensable species resulting from the thermo-

chemical conversion of biomass. The Xyloforest project is a platform for research and innovation on planted forests and timber (see box).

### Laboratories of excellence for future research

For the "laboratories of excellence" (LABEX) call for proposals, CIRAD is involved in four projects: AGRO (agronomy and sustainable development, see box), CEBA (study of Amazonian biodiversity), CEMEB (Mediterranean environment and biodiversity) and NUMEV (digital solutions for the environment and living resources).

The aim of the *Centre d'étude de la biodiversité amazonienne* (CEBA) is to study terrestrial biodiversity in French Guiana by identifying the historical, genetic and ecological factors that account for the wealth and organisation of this biodiversity. Two CIRAD research units are connected with this laboratory, which is coordinated by the University of the French West Indies and Guiana. The budget allocated to this project is 16.3 million euros over 10 years.

The *Centre méditerranéen de l'environnement et de la biodiversité* (CEMEB) studies the dynamics and workings of biodiversity and the biological consequences of global changes. CIRAD is involved in this centre through three of its research units. The laboratory, which is managed by the University of Montpellier 2, has been allocated 7.9 million euros of funding over 10 years.

The NUMEV project (digital solutions for the environment and living resources) aims to develop information and communication technologies for observing the environment and living organisms and assistance for people who are ill or disabled. One of CIRAD's research units is participating in this project, which is led by the University of Montpellier 2. ■

## Xyloforest, an EQUIPEX research platform

The Xyloforest platform was designated a facility of excellence (EQUIPEX) by the French Ministry of Higher Education and Research in 2011. This multidisciplinary research tool is dedicated to forest resources in all their aspects. It adopts an integrated approach combining tree biology, forest ecology, and knowledge of wood and the multiple ways of using it. It should make it possible to optimise French forest resources so as to obtain everyday wood-based products in a sustainable way: timber and various composites, oil-based product substitutes (adhesives, solvents, textile fibres), molecules (green chemistry), and bioenergy. As a partner of this platform, CIRAD will be given equipment for chemical analysis and material for an ecotoxicity laboratory. Xyloforest, which has a budget of 10.2 million euros, involves numerous partners, including INRA, two universities and several wood technology schools. It is aimed at all national and international projects, without restriction.

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**Partners** . Institut national de la recherche agronomique (INRA), Ecole nationale supérieure des technologies et industries du bois (ENSTIB), Ecole supérieure du bois (ESB), Ecole nationale supérieure des arts et métiers (ENSAM), Institut technologique forêt cellulose bois-construction ameublement (FCBA), Universities of Bordeaux I and Pau-Pays de l'Adour.

[www.xyloforest.org/](http://www.xyloforest.org/)







## AGREEMENTS, PARTNERSHIPS

Conservation agriculture is central to a new protocol of cooperation signed by CIRAD and the **Yunnan Academy of Agricultural Sciences** in China.

**Pan-genomic breeding** is the focus of the **Sepang Project**, which involves CIRAD and its partners from French overseas territories and three continents. This revolutionary method of plant breeding will be used to study a large range of plants (eucalyptus, palm, rice, coffee, cacao).

**Diversifying taro's genetic base**, as well as other edible aroids, is the aim of the New International Network on Edible Aroids. It is a network of researchers and farmers from 16 tropical countries, supported by the European Union. The SPC in Fiji and CIRAD are responsible for running the project.

**Putting an end to insecticide use on vegetables:** this is now possible thanks to the **Gamour project**, which held its closing seminar in November in Réunion. This innovating project was financed by European, national (Ministry of Agriculture), regional and departmental (Réunion) funds. It is being continued with the Biophyto project (Casdar Fund 2011), which aims to produce insecticide-free mangoes.

**Genetic Improvement and Adaptation of Tropical and Mediterranean Plants** (AGAP), the large joint research unit in Montpellier brings together 13 multi-institutional teams (CIRAD, INRA, INRIA, Montpellier SupAgro). Its aim is to create an international pole.

**Labex Agro**, which focuses on plants of agronomic interest, was officially opened in October in Montpellier. It is coordinated by the Agropolis Fondation and was ranked first by the international evaluation panel for laboratories of excellence.

The **Equipex Xyloforest project**, which is coordinated by INRA, aims to develop an integrated approach that combines tree biology, forest ecology, as well as knowledge and development of the numerous wood products. CIRAD is one of the many partners involved.

## COMMUNICATION, CONFERENCES

In March, CIRAD organised the workshop **Toward a global rice phenotyping and characterization network: developing a global rice phenotyping and multi-environment testing strategy**. It was held in Montpellier within the framework of GRISP (Global Rice Science Partnership), a GCRAI programme.

**An overseas garden:** throughout the month of May, the Jardin d'Acclimatation (Paris) will bear the colours of the overseas departments and territories. IFREMER, IRD, INRA and CIRAD took part in the event by presenting their research work in a fun way.

In the Caribbean, sustainable systems for agricultural production and processing were on the agenda at the **Carrefours de l'Innovation Agronomique**, which was jointly organised by CIRAD and INRA in November.

The **monthly banana market monitoring commission** was organised by ODEADOM (Office de Développement de l'Agriculture d'Outre-mer) in June in Montpellier. It provided the opportunity to bring together all the stakeholders in the banana sector.

## PUBLICATIONS

**Lignes directrices pour l'accès aux ressources génétiques et leur transfert.** This book was published by CIRAD, INRA and IRD. It sets out to facilitate the procedures for exchanging genetic material for scientists and managers of research organisations.

**Association du cacaoyer avec les fruitiers. Association du cacaoyer avec le palmier ou le cocotier.** R. Bourgoing, H. Todem. These two technical guides were published by CIRAD and IRAD (Cameroon) and are

designed to help producers who want to diversify their sources of income.

**Productions fruitières sous contraintes hydriques et salines.** This is the subject of a special edition of the review Fruits.

**Hétéroptères phytophages et prédateurs d'Afrique de l'Ouest.** W. Poutouli, P. Silvie, H.P. Aberlenc. Ed. Quae. This book provides a brief description of the main species found in West Africa that are predominantly seen on cotton, maize, cowpea, soya and sorghum. It is designed for people working in the field.

**Forests and climate change toolbox.** A. Angelsen et al., Ed. Cifor. This toolbox deals with questions linked to "forests and climate change": reduction, adaptation, compatibility and the carbon market, biofuels, etc.



**Forêts des régions chaudes, Cirad-Vip n° 17, Bois tropicaux et méditerranéens, Cirad-Vip n° 18.** Cirad-Vip. The CIRAD newsletter, which is dedicated to innovation and development, is coming out again with a new look.

**Calculation of demographic parameters in tropical livestock herds. A discrete time approach with LASER animal-based monitoring data.** M. Lesnoff et al., Ed. Quae. The main concepts involved in defining and calculating the demographic rates for farms with extensive animal production.

# Rubber tree: identifying sources of long-term resistance to SALB

South American Leaf Blight disease (SALB) is rampant in Latin America and represents a major threat for rubber tree (*Hevea brasiliensis*) plantations in Africa and Asia. Disease control involves breeding resistant varieties and, therefore, the use of genetic resources that have been preserved in French Guiana and Brazil where resistant trees have been identified. A research project, coordinated by CIRAD, on the genetic and genomic bases of this resistance has just been completed. It made it possible to identify the genes involved in long-term resistance, which could be used to create new productive and resistant varieties.

**S**ALB, WHICH IS CAUSED BY THE FUNGUS *MICROCYCLUS ULEI*, is slowing down the development of *Hevea* cultivation in Latin America and constitutes a real threat to world natural rubber production. If the disease were accidentally introduced in existing production zones in South-East Asia and West Africa, the rubber plantations would be wiped out in no time because they consist of extremely sensitive varieties.

In 2008, a research project was launched to identify the disease-resistant genes. It set out to characterise *Hevea's* natural resistance on a genetic and

genomic level with the aim of accelerating the creation of varieties, which combine high yields in rubber and resistance to *Microcyclus*. CIRAD coordinated the project, which was conducted in partnership with the company Michelin and the State University of Santa Cruz in Brazil.

## Genetic resources rich in resistant genes

Three natural rubber tree varieties from the Brazilian or Peruvian Amazon, with various sources of resistance have been identified. The genetic determinism of their resistance was analysed using molecular genetic mapping.

One of the first results of the study was to show that determinism for

Young rubber tree leaves attacked by *Microcyclus ulei*.  
© Marc Seguin / CIRAD

Healthy leaves from a variety of rubber tree resistant to *Microcyclus ulei*. © Marc Seguin / CIRAD

## PARTNERS

Michelin France and Brazil,  
State University of Santa Cruz (Bahia, Brazil),  
Agence Nationale de la Recherche (ANR, Génomplante): contract ANR/Génomplante n° GPLA07017C "GENESALB".

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Doaré F., Mattos C.R.R.,  
Condina V., Couturier C.,  
Chambon A., Weber C.,  
Espéout S., Seguin M.,  
2011. A rubber tree's durable resistance to *Microcyclus ulei* is conferred by a qualitative gene and a major quantitative resistance factor. *Tree Genetics and Genomes*, 7: 877-889.  
Doi: 10.1007/s11295-011-0381-7.





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A SALB-resistant variety  
of rubber tree.

© Marc Seguin / CIRAD

this resistance is simple. In fact, each of the sources of resistance is governed by only one or two major genetic factors, or loci, which are all different and are located in independent regions of the genome. In total, four major loci of resistance, as well as five loci with weaker effects, were identified and located on the *Hevea* genetic map. Another major and unexpected result: this simple genetic determinism was also found for long-term resist-

ance, whose efficacy has been maintained in French Guiana and Brazil for several decades.

### Candidate genes identified and sequenced

Parallel to this analysis, a "candidate gene" approach was used on varieties with different resistance profiles. It consists of determining whether or not a gene thought to be involved in resistance is actually involved. Leaves (which may or may not have been inoculated

with the fungus) were used for the preferential cloning of differentially expressed genes. As a result, 7 000 distinct DNA sequences were sequenced and identified. These molecular resources have already been used to develop 125 additional genetic markers. The programme will continue thanks to new genotyping techniques. These resources have also made it possible to conduct a functional analysis of genes in relation to the expression of the disease. Thus, over 400 candidate genes have been selected according to their putative function or their expression profile over time after the inoculation of the fungus in sensitive or resistant varieties.

The collections of *Hevea* genetic resources that have been preserved by Michelin in Brazil and CIRAD in French Guiana constitute an irreplaceable reservoir of diversity. This was confirmed by the project's results. The diversity can be used more effectively for plant breeding with the help of the genomic tools and methods that are used to identify, mark and select gene forms (alleles) and combinations.



## South Green Bioinformatics Platform

INTERNATIONAL PLANT GENOME RESEARCH PROJECTS generate considerable amounts of genetic data, which are heterogeneous and evolve by nature. New bioinformatic methods need to be developed in order to integrate and analyse the data. In association with Bioversity, IRD and INRA, a team from CIRAD has developed innovative tools in this field, which have been brought together on a bioinformatics platform called South Green.

The platform is based on the capacities of major calculations (50 To of data, 208 processors, 1.5 Tflops). It can manage the analyses of large-scale projects, such as annotating the genomes of cocoa, banana and

clementine. The Iso9001 certification of the calculation system is underway.

In addition, we organise practical courses on bioinformatics, both in France and abroad, to meet the needs of scientists and students.

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Bioversity International, Institut de Recherche pour le  
Développement (IRD), SupAgro

Dereeper A. *et al.*, 2011. SNIPlay: a web-based tool for detection, management and analysis of SNPs. Application to grapevine diversity projects. *BMC Bioinformatics*.

<http://southgreen.cirad.fr>

# In Nicaragua farmers and scientists are working together to create new varieties of sorghum

*In dry regions of Central America, sorghum has gradually replaced maize, the traditional staple crop for a majority of small farmers. In Nicaragua, CIRAD and CIAT collaborated on a participatory sorghum breeding programme. The aim of the 6-year programme was to create varieties specially adapted to the cropping conditions and needs of small farmers, as well as to develop new methods for participatory plant breeding.*

## PARTNERS

Centro Internacional de Acentro Internacional de Agricultura Tropical (CIAT, Colombia), Instituto Nicaragüense de Tecnología Agropecuaria (INTA, Nicaragua), Programme Régional FP-MA (Guatemala), Centro para la Promoción, la Investigación y el Desarrollo Rural y Social (CIPRES, Nicaragua), the farmer cooperatives of Unile, Pueblo Nuevo and Totogalpa (Nicaragua), French Ministry of Foreign Affairs.

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On-farm validation trial with the variety Blanco Tortillero in Cayantu, Totogalpa. © S. Aguirre/Cipres

**I**N CENTRAL AMERICA WHITE-GRAIN SORGHUM is used to make tortillas and other food products, to feed farm poultry and straw is even used as fodder during the dry season. In some areas it plays a major role in food security for resource-poor farmers. Scientists have worked with farmers on the diversification and improvement of sorghum varieties in order to obtain higher and more stable yields and better grain and fodder quality. This research has been conducted in close partnership with farmer groups, national NGOs and the national agricultural research institute.

On-farm assessments were conducted with farmers using a novel genetically diverse set of varieties



Plant selection carried out by Cleotilde Vargas Soto to develop *tortillero* sorghum lines in Musuli, Palacagüina. (Plot belonging to Silverio Ríos). © Gilles Trouche / CIRAD

of predominantly African origin. As a result, about ten high-yielding varieties with superior grain quality were identified and soon adopted by farmers, particularly the varieties Blanco Tortillero and Coludo Nevado. They are well suited to existing cropping systems. They are more early maturing and more productive than local cultivars. In addition, their grain quality is suitable for making tortillas.

In the second phase of the project, breeding programmes were implemented on-farm with volunteer farmers. In order to test the efficiency of this participatory breeding approach, the same programmes were conducted in parallel on-station under optimal conditions. The selection targeted the following traits: grain yield, earliness, plant height, grain size, grain quality and fodder quality according to farmers' appreciation.

The selection carried out on-station under favourable condi-

tions produced lines with higher grain yield compared to the selection conducted by farmers in their own fields. However, the farmers' selection produced lines with the best combinations of agronomic traits, for example the combination of yield and earliness, and the quality criteria required for grain and straw. These lines are very close to the ideal varietal types sought by farmers in these regions.

The results show the pertinence of associating researchers, farmers and farmer organisations in order to create varieties of food crops. The association made it possible to increase the number of good quality varieties available to farmers and improve the productivity of cropping systems.

Trouche G., Lançon J., Aguirre Acuña S., Castro Briones B., Thomas G., 2012. Comparing decentralized participatory breeding with on-station conventional sorghum breeding in Nicaragua: II. Farmer acceptance and index of global value. *Field Crops Research*, 126: 70-78.





## A Caribbean network for agro-ecological horticultural systems

Field trip in Haiti.

© Paula Fernandes / CIRAD



### PARTNERS

Instituto de Investigación Hortícola 'Liliana Dimitrova' (IIHLD, Cuba), Instituto de Investigaciones en Fruticultura Tropical (IIFT, Cuba), University of Ciego de Avila (UNICA, Cuba), Ministry of Agriculture, Natural Resources and Rural Development (MARNDR, Haiti), Faculty of Agronomy and Veterinary Medicine (FAMV, Haiti), Ohio State University (OSU, United States), Station d'Essais en Cultures Irriguées (SECI-CG972, Martinique)

IN THE CARIBBEAN, increasing food production and environmental conservation are major preoccupations, which have been exacerbated by the recent food crises and the rise in prices of imported inputs and foodstuffs. Thus, there is an increasing demand for horticultural systems that produce safe food with high added value. However, they still require a large amount of chemical inputs to control pests and diseases, which are particularly aggressive in these regions. A radical change in production methods is now necessary. The priority is to develop cropping systems that make the most of local organic and biological resources and protect the environment and the health of consumers, as well as producers.

The aim of the Devag project, which is coordinated by CIRAD, is to develop systems of this kind and create a regional network to diffuse and develop agro-ecological horticultural production. In order to achieve this, the researchers have given priority to developing pest management methods, by introducing companion plants in particular. In order to design cropping systems adapted to local conditions, they are also trying to substitute artificial fertiliser with locally available organic matter and are breeding resistant varieties adapted to low-input systems. This research is being conducted jointly with professionals and leads to technical courses, which bring together participants from the partner countries.

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Agroecological Functioning and Performances of Horticultural Cropping Systems

Fernandes P. *et al.*, 2011. The Interreg-Devag project: a regional network for the development of agroecological cropping systems for horticultural crops in the Caribbean. *Acta Horticulturae*, 894: 147-151.

<http://devag.tropical-agroecology.org/>

## A handbook on sorghum seed production in Mali



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CIRAD HAS PUBLISHED A TECHNICAL GUIDE on the production of sorghum seeds on smallholdings in Mali, available in French and Bambara. It is designed for farmers, as well as technicians and development agents, and aims to help them produce their own quality seeds according to the rules and standards for certified seed production. The guide provides detailed practical and educational information on all the steps involved in seed production and storage. It gives advice on choosing land and the variety, information on cropping practices, seed treatment and storage and explains how to obtain certification. With the help of this guide, farmers will be able to produce a large quantity of identical seeds of certified quality, which they can sell at a profit.



Sidibé A., Vom Brocke K., Coulibaly H., Evrard J.C., 2011. *Production de semences de sorgho en milieu paysan au Mali*. Montpellier, CIRAD, 43 p.

# Understanding the biology of citrus reproduction to optimise varietal breeding programmes



Seedless fruit from a triploid hybrid. © Jean Bouffin / CIRAD

CIRAD is developing genetic breeding programmes for citrus fruit in the Mediterranean Basin that will meet agronomic constraints, market expectations and consumer demand. The programmes set out to create varieties of seedless fruit and rootstocks resistant to abiotic constraints, such as salinity or water deficiency. From a genetic point of view, the chosen strategies produce triploid varieties and tetraploid rootstocks from predominantly diploid genetic resources.

**T**HE AVAILABLE GENETIC RESOURCES for citrus fruit are predominantly diploid. Nonetheless, polyploidy can give citrus fruit interesting characteristics. Thus, the genetic breeding programmes aim to create triploid varieties, which are sterile and produce seedless fruit. In addition, recent research at CIRAD has shown that tetraploidy makes rootstocks better adapted to salinity and water deficiency.

## Developing natural polyploid plants to create varieties

Diploid citrus fruit naturally produce seeds that include polyploid individuals. These natural polyploid plants can be very useful for genetic breeding projects. CIRAD and its partners are study-

ing these natural polyploidisation mechanisms and their involvement in the genetic structure of individuals. Research is particularly focused on the transmission of parental heterozygosity to the polyploid progeny. This is actually a key element that drives the phenotypic diversity within polyploid populations.

Two main mechanisms lead to the formation of polyploid individuals in diploid seeds. The first is the doubling of the chromosomal stock in the seed tissues of maternal origin [nucellus]. These doubled diploids have the same genetic heritage as the maternal variety. Therefore, the selection of tetraploid plants from diploid rootstocks with good agronomic characteristics has real potential for improving their tolerance to some abiotic stress with little or

no impact on their other characteristics. The doubled diploids are also used as parents to create triploid varieties. The second mechanism is the formation of non-reduced ovules by restitution in the second division of meiosis [SDR]. This mechanism produces triploid hybrids in the hybridisation between diploids. These hybrids inherit about 40% of the maternal heterozygosity and the polymorphism of triploid populations is high. Although this phenomenon is uncommon, it is routinely exploited to produce triploid hybrids by using embryo rescue and flow cytometry.

## Understanding the meiosis of polyploid parents

Research conducted on the meiosis of a somatic tetraploid hybrid between mandarin and

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Sterile male flowers from a triploid hybrid.  
© Patrick Ollitrault / CIRAD

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lemon revealed predominantly tetrasomic type segregations and, therefore, the absence of marked preferential chromosomal association. This type of parent generates populations that are highly polymorphic.

These new insights have now been integrated into the strategies for varietal improvement, which use natural mechanisms of polyploidisation. In parallel, CIRAD is developing approaches based on somatic hybridisation. This method uses cell fusion and makes it possible to add all

the genes from the two parents. It opens up very interesting prospects for improving the management of ploidy and heterozygosity. [REDACTED]

Aleza P., Froelicher Y., Schwarz S., Agusti M., Hernandez M., Juarez J., Luro F., Morillon R., Navarro L., Ollitrault P., 2011. Tetraploidization events by chromosome doubling of nucellar cells are frequent in apomictic citrus and are dependent on genotype and environment. *Annals of Botany*, 108: 37-50. Doi: 10.1093/aob/mcr099

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Kamiri M., Stift M., Srairi I., Costantino G., El Moussadik A., Hmyene A., Bakry F., Ollitrault P., Froelicher Y., 2011. Evidence for non-disomic inheritance in a *Citrus* interspecific tetraploid somatic hybrid between *C. reticulata* and *C. limon* using SSR markers and cytogenetic analysis. *Plant Cell Report*, 30: 1415-1425. Doi: 10.1007/s00299-011-1050-x



# A partnership platform for agroforestry systems in Central America

*In 2007, CIRAD signed an agreement with five Central American partners to work together on agroforestry systems based on perennial crops. This region is particularly active in terms of setting up systems to pay for the environmental services provided by agriculture. The partnership research mechanism has one main objective: to quantify and develop all the environmental products and services provided by these systems in order to improve the competitiveness of the agricultural sector.*



© Bruno Rapidel / CIRAD

## PARTNERS

Centro Agronómico Tropical de Investigación y Enseñanza [CATIE, Costa Rica], Bioversity International, Promecafé, CABI (United Kingdom), INCAE (Costa Rica), Agence Nationale de la Recherche (ANR), European Union, Inter-American Development Bank (IDB), International Climate Initiative (Germany), Fondation de Recherche sur la Biodiversité.

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Tropical and  
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Cropping System  
Functioning and  
Management [System]

**A** GROFORESTRY SYSTEMS that combine trees and crops constitute an excellent option for the ecological intensification of agricultural production. The idea is to explore the environment's resources in a more efficient way, by associating plants with different functional characteristics, for example, species whose roots take up nutrients at different depths, thus allowing for better nutrient recycling. It also involves exploiting the greater resilience of ecosystems in which several species have the same function. However, agroforestry systems also have their weaknesses: species can compete, the microclimate can encourage certain crop pests. Therefore, it is important to quantify the advantages and disadvantages for farmers and for society in Central America's environmental and economic context.

In 2007, CIRAD signed a 10-year agreement with five research institutions working in Central America in order to conduct joint research on agroforestry systems

based on perennial crops. The partner research mechanism set up should help maintain and increase the competitiveness and sustainability of the agricultural sector in Central America. It aims to quantify and develop all the environmental products and services provided by these systems.

In Central America, the two perennial agroforestry crops are coffee and cocoa. Coffee is grown in dense or partial shade in an area covering more than 1 million hectares. It is the primary agricultural export in several countries. Cocoa production is less important both in terms of value and land area, with only 65 000 hectares. However, cocoa is grown by marginalised and indigenous populations in biodiversity hotspots.

The research teams are particularly interested in the development and adaptation of methods of evaluating agroforestry systems as environmental service providers – for example, reduced soil erosion, carbon sequestration to slow down climate change, maintenance of a continuum

between biodiversity conservation zones. They plan to use a participative approach to design competitive, diversified and sustainable strategies to manage these systems. Their research work also aims to evaluate the impact of these systems on the subsistence of rural populations and to provide producers with the means to sell ecological products from these systems. Lastly, it concerns the strategies to develop and differentiate agroforestry products and services.

In this region, which is particularly active in terms of setting up payment systems for environmental services, the research should help to establish contracts on an objective basis with agroforestry producers in order to preserve the environment and provide services to the society over and above food or wood.

Rapidel B., DeClerck F., Le Coq J.F., Beer J. [Ed.], 2011. *Ecosystem services from agriculture and agroforestry: measurement and payment*. Earthscan, London, 430 p.



# Evaluating cocoa agroforestry systems to design new cropping systems

In central Cameroon, cocoa producers have developed a complex agroforestry system, which allows them to produce yields that are lower than in an intensive model, but can be maintained over a much longer time period without fertiliser applications. CIRAD researchers have analysed the dynamics of this cocoa production system to understand its function, evolution and the factors involved in order to propose a new sustainable and environmentally-friendly model for cocoa production.



The agroforestry cocoa trees in central Cameroon provide farmers with a stable long-term cocoa yield with no mineral fertiliser applications. © Patrick Jagoret / CIRAD

## PARTNERS

Institut de Recherche Agricole pour le Développement (IRAD, Cameroon), Dschang University (Cameroon), Fédérations d'Unions de Producteurs de Cacao Fuprocal, Fuprocan and Fuprocac (Cameroon), Ministry of Foreign Affairs.

This research was conducted within the framework of the PCP Agroforestry-Cameroon.

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Performance of Tree  
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**T**ODAY, 75% OF WORLD COCOA PRODUCTION is of African origin. In Africa, cocoa production is based on shifting production zones to the detriment of forests, which have practically disappeared in the main producer countries. When farmers are faced with degraded production conditions in old cocoa plantations, they actually prefer abandoning them and setting up new ones on cleared forest land.

In this context, the central basin in Cameroon provides a counter-example. The main part of the cocoa orchard is made up of old plots where cocoa trees are associated with a multitude of fruit and forest species. Despite its ecological interest, there has been little research on this complex agroforestry model because of its low yields in commercial cocoa.

## Stable cocoa production in the very long term

The technical model proposed to farmers generally gives priority to the intensive management of cocoa as a single crop or with light shade. With this model, yields are high during the first years of cocoa production. However, after 30 to 40 years, yields collapse because of the lack of mineral fertilisation.

On the contrary, in central Cameroon, where 80% of cocoa plantations are over 40 years old, farmers manage to obtain cocoa yields, which though lower than for an intensive model, are maintained over a much longer time period with no fertiliser inputs. The main factors that explain the longevity of this cocoa production system include: continually replanting cocoa stands, coppic-

ing senescent cocoa trees and the spatio-temporal management of the numerous fruit and forestry species, associated with cocoa trees of several different generations. The management of the system is also very flexible. In fact, when old cocoa plantations are taken over by a new generation of farmers, their trajectory often involves a phase of rupture followed by a revival after which the cocoa yields recover their former level.

## Cocoa yields linked to the structure of cocoa trees

The research conducted by CIRAD on these systems proves that interactions occur between the cocoa stand and associated trees. The cocoa yield is closely linked to the density of cocoa trees and the structure of the associated stands (density, number and type





Evaluating agroforestry cocoa trees involves an inventory and a description of numerous woody species associated with cocoa.

of species]. The average basal area per cocoa tree is a major determining factor in cocoa yield. This variable is linked to the average number of pods per cocoa tree. The positive relationship between the average number of trunks per cocoa tree and the average basal area per tree, due to the coppicing of senescent cocoa trees, appears to have an important role in the long-term maintenance of cocoa yields.

This research has identified the factors limiting cocoa yield in agroforestry systems and has helped farmers improve the systems in which cocoa remains the principal component in terms of use value. However, the overall evaluation of these systems does show the importance that farmers

give to other species, which meet different household needs and fulfil ecological functions. The results confirm that the technical innovations that seek to improve cocoa agroforestry systems should take account of their multi-functionality and the complexity that is attributed to them by farmers.

Thanks to this research, a new technical model for cocoa production can be proposed, which is sustainable and more environmentally friendly than the current model.

Jagoret P., Michel-Dounias I., Malézieux E., 2011. Long-term dynamics of cocoa agroforests: a case study in central Cameroon. *Agroforestry Systems*, 81: 267-278.

## Coconut palms and man

THE FINDINGS OF A RECENT STUDY CONDUCTED BY CIRAD, based on the DNA analysis of 1 322 coconut palms of diverse origins, show that the history of the coconut palm is closely linked to that of man. It was domesticated independently in South-East Asia and India and then travelled with human migrations, which have fashioned the species' current distribution.

This study also provides the basis for new strategies to improve the species, which is now an integral part of the way of life of millions of small farmers in the tropics. The research has provided knowledge on the genealogy of current populations, which means that it will be possible to use their diversity to improve yields, environmental adaptation and disease control.

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Gunn B.F., Baudouin L., Olsen K.M., 2011. Independent origins of cultivated coconut (*Cocos nucifera* L.) in the Old World tropics. *PLoS One*, 6: e21143. Doi: 10.1371/journal.pone.0021143

Perera L., Baudouin L., Bourdeix R., Bait Fadhl A., Hountondji Fabien C., Al-Shanfari A., Harries H.C., 2011. Coconut palms on the edge of the desert: genetic diversity of *Cocos nucifera* in Oman. *Cord*, 27: 9-19.



Dwarf coconut palms destined for the production of seeds resistant to lethal yellows (Ghana).  
© Luc Baudouin / CIRAD

# Sugarcane Yellow Leaf in the Caribbean

## PARTNERS

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**S**UGARCANE YELLOW LEAF is caused by a polerovirus, the Sugarcane yellow leaf virus (SCYLV). The affected plants show early leaf yellowing, which starts at the leaf midrib. In order to further our understanding of how the epidemic spreads and to develop effective control measures, a CIRAD team has studied its transmission and the structure of viral populations.

## How does this virus spread

The virus is transmitted in two ways: via infected cuttings or aphid vectors, predominantly *Melanaphis sacchari* in Guadeloupe and Martinique. Virus transmission by the vector occurs in two phases. Initially, the alate vector lands at random in the early stage of plant growth, before the soil is covered by the leaf canopy and then wingless aphids move from plant to plant, spreading the virus across distances of around 2 metres per month.

During controlled trials, the CIRAD team showed that rainfall slows down primary infection linked to the vector's arrival in the plots. In industrial plots, rainfall in the first few weeks after planting is partly responsible for the variations observed in infection between plots. Rainfall

Sugarcane yellow leaf was diagnosed for the first time in Guadeloupe in 1996 and in Martinique in 1997. Affected plants show early leaf yellowing, which starts at the leaf midrib. This emerging disease is caused by a virus present in numerous sugarcane production zones. In order to control the epidemic, which now affects over 20% of sugarcane in commercial plantations, we need to understand its local dynamics. A team from CIRAD has set itself this task.

seems to affect the vector's population dynamics, directly or indirectly, by modifying the size and diversity of populations of its predators and by influencing the development of Gramineae, which can alter the attractiveness of plots for aphids.

## Three viral genotypes for one epidemic

In Guadeloupe, the rate of infected plants in commercial plantations has increased progressively over the last decade: from 0.6% in 2000, 1.7% in 2003, 14% in 2005 and 26% in 2010. On the other hand, in Martinique, the prevalence of the virus was considerable from the early years, with 30% in 1999. However, it has only evolved a little since then: 32% in 2005. Both islands have experienced different epidemic conditions, particularly in terms of the distance between the suspected source of introduction and the plantations, and the presence of distinct predominant viral genotypes. Nonetheless, an evolution in the structure of viral populations has been observed in Guadeloupe

over the past 5 years, with the transition from one main genotype to a combination of three genotypes of SCYLV.

In the French Caribbean Islands, there are actually three viral genotypes –BRA-PER, CUB, REU–, that can be identified using molecular diagnosis. They differ in terms of their capacity to infect sugarcane as shown by a study conducted on 40 varieties: the correlation between the prevalence of the virus and the prevalence of the viral genotype was 0.61 for BRA-PER, 0.67 for REU and 0.93 for CUB. Therefore, the CUB genotype is predominant and should be the focus of control measures, even though the diversity of varietal responses to infection by different genotypes suggests the existence of several genetic determinisms for resistance in the genus *Saccharum*. ■

Daugrois J.H., Edon-Jock C., Bonoto S., Vailant J., Rott P., 2011. Spread of *Sugarcane yellow leaf virus* in initially disease-free sugarcane is linked to rainfall and host resistance in the humid tropical environment of Guadeloupe. *European Journal of Plant Pathology*, 129: 71–80.



1. Leaf symptoms of the yellow leaf virus.
2. Positive diagnosis of SCYLV via immunoblotting of leaf tissue.
3. Syrphid fly larva chasing its meal.
4. *Melanaphis sacchari* in its flightless form.
5. *Melanaphis sacchari* in its winged form.

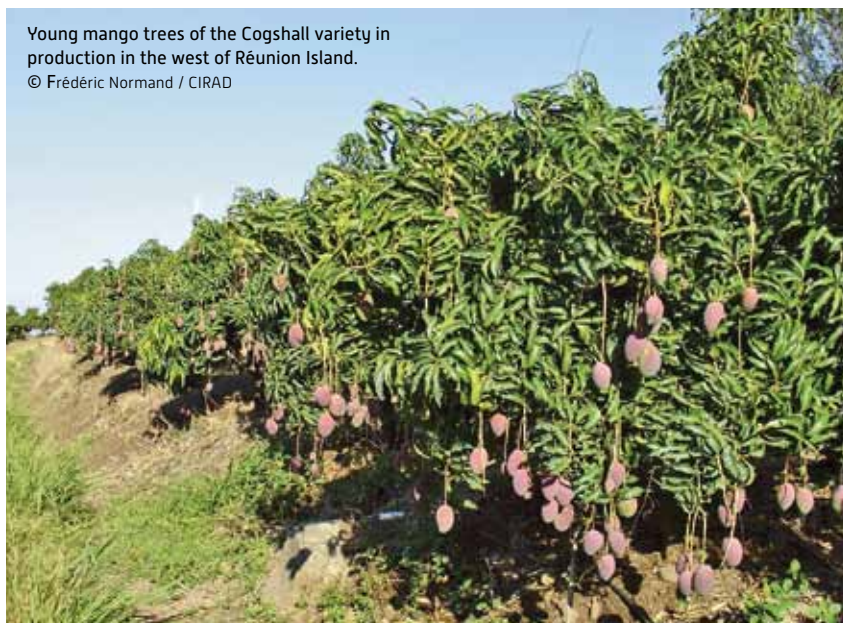
© Jean-Heinrich Daugrois / CIRAD



# Linking stakeholders, agronomy and quality for integrated mango production in Réunion Island

*How does the flavour and nutritional quality of mango develop on the tree? At what stage of maturity should it be harvested? Which postharvest practices should be chosen for which commercial outlets? How should the mango orchard be managed to regulate production, reduce pesticide use and improve fruit quality? In Réunion, all these questions are being addressed directly by a team from CIRAD. This integrated approach has led to the development of sustainable technical innovations across the sector.*

Young mango trees of the Cogshall variety in production in the west of Réunion Island.  
© Frédéric Normand / CIRAD



## PARTNERS

Institut National de la Recherche Agronomique (INRA), Universities of Réunion, Avignon and Montpellier, AgroParisTech, SupAgro, Institut National de Recherche en Sciences et Technologies pour l'Environnement et l'Agriculture (IRSTEA), Réunion Chamber of Agriculture, Association Réunionnaise pour la Modernisation de l'Économie Fruitière Légumière et Horticole (ARMEFLHOR), Lycée Agricole de Saint-Paul, Association Réunionnaise des Organisations de Producteurs de Fruits et Légumes (AROP-FL), the Regional Council of Réunion Island, the European Commission.

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**I**NTEGRATED FRUIT PRODUCTION is based on three principles: providing fruit that satisfy consumer demands, limiting the environmental impact of production and proposing economically viable methods of orchard management. The objective of CIRAD's Piman programme (integrated production of mango, pineapple and other tropical fruit) is to adapt this concept to a tropical context. Researchers started by applying it to mango, an important crop in Réunion. They examined the development of fruit quality on the tree, the choice of its maturity at harvest, the maintenance of postharvest fruit quality as a function of the markets, and the orchard management.

The novelty of the approach is to address the different questions directly by conducting multi-disciplinary studies at different levels: fruit, tree, orchard, farm and

sector. Fruit quality, which is considered as a continuum from the flower to the consumer, provides the link between these levels. Fruit quality is in fact directly dependent on farmer practices, which result from both farm management and stakeholder strategies further down the sector. It is possible to develop sustainable technical innovations by involving all of the stakeholders of the sector with the help of different mechanisms and tools.

The Piman programme has provided precise information on: how the mango tree functions; the biological cycle of its main pests and their relationships with the tree; mango physiology pre- and post-harvest; as well as farmer practices and the determining factors involved; and the function of the local and exported mango sectors. These results have made it possible to develop integrated tech-

nical measures for mango production and marketing in Réunion.

Parallel to this work, new research is being conducted on indicators of the sustainability of farms adapted to the tropical context and on adding value to mangoes from integrated production. Besides mango, the programme also seeks to develop generic methods that can be applied to other fruit crops and in different contexts.

Joas J., Vulcain E., Desvignes C., Morales E., Léchaudel M., 2011. Physiological age at harvest regulates the variability in postharvest ripening, sensorial and nutritional characteristics of mango (*Mangifera indica* L.) cv Cogshall due to growing conditions. *Journal of the Science of Food and Agriculture*. Doi: 10.1002/jsfa.4696.

Joas J., Léchaudel M., Normand F., Urban L., 2011. Une méthode de détermination de la maturité d'une mangue en vue de sa récolte. Patent application n° 2 957 673, Bulletin officiel de la propriété intellectuelle, n° 38 of 23rd September 2011.



## AGREEMENTS, PARTNERSHIPS

The **3BCAR network (Bioenergy, Biomolecules and Biomaterials from Renewable Carbon)** was awarded the Institut Carnot label by the French Ministry of Higher Education and Research. CIRAD is one of its nine members (AgroParisTech, CIRAD, CNRS, INP Toulouse, INRA, INRA Transfert, INSA Toulouse, Montpellier Supagro, and the University of Montpellier 2).

The **biomass-energy testing platform** is evolving in response to the growth of its activities and in order to host new pilot programmes that will enable it to conduct studies on the different methods of thermochemical biomass conversion: torrefaction, pyrolysis, gasification and combustion.

The **Genepi EQUIPEX** project, which associates CEA and CIRAD, aims to develop an experimental platform to produce second-generation biofuels.

## PUBLICATIONS

**Guide technique pour une utilisation énergétique des huiles végétales de la Cedeao.** P. Girard and J. Blin. Ed. L'Harmattan. This guide by the 2iE Foundation presents the oil crops available for fuel production that are of economic and social importance for the ECOWAS (Economic Community of West African States) countries.

### **Food or biofuels: must we choose? The example of Burkina Faso.**

*Perspective n° 8.* Would the Southern countries benefit from producing biofuels? This is the subject of heated debate. Using the case of Burkina Faso, Marie-Hélène Dabat and Joël Blin demonstrate how this question can be answered at country level.

### **Production durable de biomasse : la lignocellulose des poacées.** D. Pouzet.

Ed. Quae. A comprehensive publication on the production of lignocellulosic biomass, a major source of fibre for energy, biomaterials and green chemistry.



© François-Régis Goebel / CIRAD

# Estimating land available for sustainable biofuel production

Faced with growing demand for energy in both the North and the South and the predicted depletion of fossil fuels, there are high hopes for biofuels. But where can land be found to produce biomass for energy? And how can areas that could be suitable for this production be quantified? CIRAD and its partners have developed an original method to assess these parameters, which takes into account sustainability principles, land use systems and their possible evolution.

**F**OR THE LAST 15 YEARS, a number of studies have attempted to estimate the areas potentially available for the production of biofuels over the next 30 to 50 years. In methodological terms, these theoretical studies are almost all top-down in nature. They are primarily based on exogenous demand for agricultural products –plant and animal food products, fibres and materials, biofuels– that are redistributed across areas believed to be available. These estimations,

which are generally made at the global level, are unconfirmed and raise a certain number of questions. The strongest criticisms concern the choice of lands considered (savannah, meadows, forests), the reality of their availability, the production models and the failure to take into account existing cropping systems.

## An original method

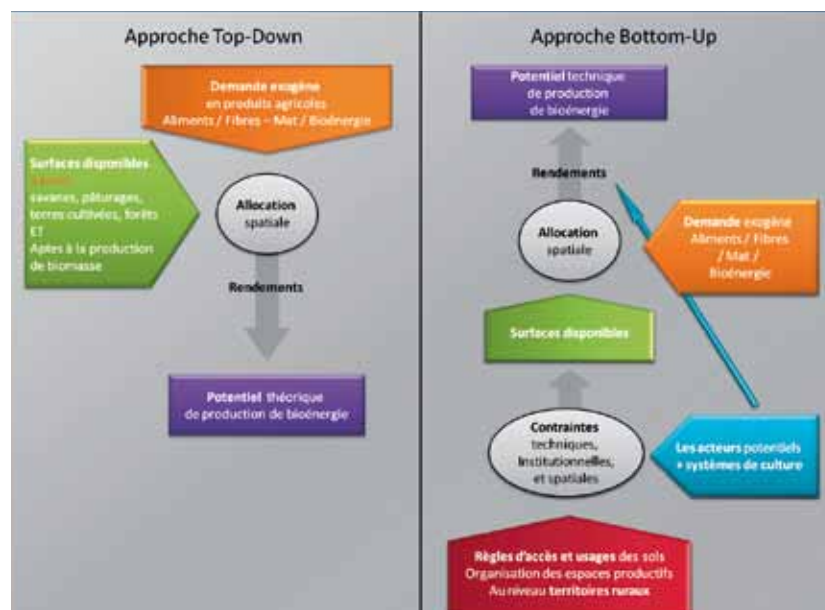
Against this backdrop, CIRAD, in cooperation with the Total research division, has developed an original bottom-up method to assess the potential for producing biomass for energy purposes. It first

considers the land use rules and spatial organisation of productive areas and, second, the actors potentially involved in production and their cropping systems. This method was applied at the national level in three countries of the South: Madagascar, Mali and Brazil's Bahia region.

Potential areas were estimated using sustainable development scenarios based on a schematisation of the land use systems that could be concerned by this process. For each of the countries in question, two major production scenarios were studied and evaluated. The first, based on family farming, explores the possibilities for diversifying current agricultural production systems

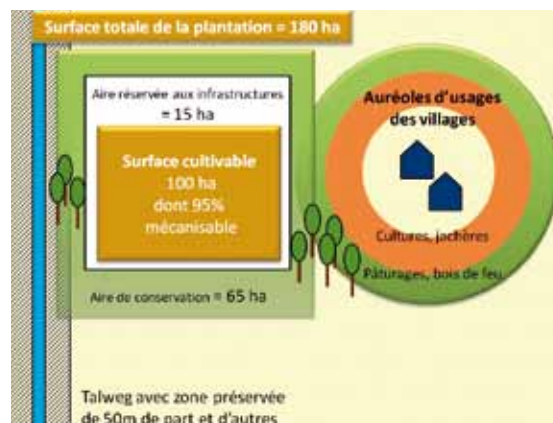
## PARTNERS

Total S.A. research division,  
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Centre national  
de recherche appliquée  
au développement rural  
(FOFIFA, Madagascar)



The top-down and bottom-up approaches.

© Laurent Gazull / CIRAD



Spatialised technical model of an industrial plantation at the scale of a Malian village. © Laurent Gazull / CIRAD





The landscapes of western Madagascar, which are highly valued for energy plantations. © Laurent Gazull / CIRAD

with a view to introducing new biofuel crops, without harming food crops. The second, which focuses on industrial farming, examines the options for creating new industrial plantations in areas that are not currently cultivated. The organisational structure considered is that of large capital-intensive plantations (mechanisation, improved seed and inputs, monitoring and technical inspections).

### Family farming or industrial plantations?

The findings reveal that taking into account the spatial organisation of rural areas, as well as the environmental and social rules and the technical constraints that apply to the future actors involved in this production—whether small farmers or large industries—considerably reduces the potential,



Aerial photograph of a Malian village territory. [Source Google Earth 09/04/2010]

by a factor of 5 to 10 in relation to a theoretical top-down approach. They also show that industrial plantation models cannot be generalised to all countries and that family farming may provide the same potential.

Gazull L., Burnod P., Fallot A., Saïdi S., 2010. *Une évaluation bottom-up des potentialités de plantations énergétiques : application à Madagascar, au Brésil et au Mali*. CIRAD/ Total research agreement. Montpellier, CIRAD, 125 p.

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# Wood in French Guiana: a new source of energy for power stations

*Since 2008, French Guiana has been building wood-fired power stations in order to meet its growing energy requirements. To accompany the development of this new source of energy and to prepare supplies for these power stations, CIRAD has been asked to conduct studies on the characteristics of forest species and methods for storing wood. The findings of these studies will be used to improve the management of this new energy sector.*

## PARTNERS

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**E**NERGY REQUIREMENTS ARE INCREASING RAPIDLY in French Guiana due to the fact that its population is growing at a rate of 3.9% per year. It has chosen biomass resources as a means of meeting this new demand for electricity.

The first wood-fired power station was opened in 2008, and several new ones are in the pipeline for inauguration from 2013. These installations will supplement current power supply, which combines oil products, hydroelectricity and solar photovoltaic power. The regional energy saving programme decided to accompany the development of biomass energy by supporting studies on the properties and characteristics of wood for energy use and

on methods for storing this wood for periods of four to six months. This research was conducted by CIRAD teams in 2010 and 2011. It complements specific analyses by Guyane Consult and the *Office National des Forêts* on ways of using wood.

The purpose of better characterising wood that can be used as fuel is to prepare supplies for future wood-fired power stations. The energy value, humidity, ash content and mineral composition of French Guianan forest species have therefore been determined. This data will be used by power station professionals in the design of their wood-fired installations.

The wood used in these power stations comes from sustain-

ably managed forests and from recovery in forests converted to farmland or urban areas during regional development. Its long-term storage is planned in order to limit transport in forests during low rainfall periods and to preserve the environment within the framework of forest certification. The research has shown that storing woodchips under shelter favours the natural drying of the wood, but that the additional cost of this type of storage in relation to log storage is prohibitive. ■

Pinta F., Beauchêne J., 2011. *Qualification des essences de bois de Guyane pour un usage biocombustible*, Final study report. CIRAD, 77 p.

Pinta F., Valette J., Volle G., 2011. *Caractérisation des essences de bois de Guyane pour un usage biocombustible*, Final study report. CIRAD, 26 p.

The sustainable management of certain forest plots is aimed at creating a permanent supply of fuelwood.



Storage of fuelwood logs during an experiment in a French Guianan forest.



# Energy from sugarcane

*Producing fibrous sugarcane in order to generate electricity is the objective of a research programme conducted by CIRAD in Guadeloupe and Réunion. It is based on a set of agricultural and technical studies to develop a new energy system to meet the requirements of island regions.*

## PARTNERS

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**I**N ORDER TO REDUCE ENERGY DEPENDENCE, especially in island regions, energy recovery from biomass is one option. CIRAD has explored the possibilities provided in this field by sugarcane, and more specifically by whole sugarcane grown with the sole purpose of producing biomass for use as fuel in small power plants. A research programme has been launched, combining approaches based on plant varieties, ecophysiology, agronomy, technology, environment and economics.

The aim is to identify varieties that are high in fibre, which will produce better fuel, to understand the determinism of the production of biomass and to optimise this production per unit of time and area. The technical and environmental aspects are also being studied in order to maximise elec-

tricity output and to establish the carbon and energy balance of the process.

Finally, it is crucial to take into account the economic aspects to ensure the system is attractive: drawing up specifications for production and setting a price for biomass produced.

This research is being conducted in specific contexts. In Guadeloupe, it is part of the REBECCA programme (research on sugarcane biomass-energy in Capes-terre) and focuses on a very humid region, where sugar yields are mediocre and where pollution by chlordecone (a pesticide used for several years in banana plantations) means certain food crops are banned. In Réunion, the research is aimed at converting new areas in the highlands to energy production.

Sabatier D., Dardenne P.,  
Thuriès L., 2011. Near infrared  
reflectance calibration  
optimisation to predict  
lignocellulosic compounds  
in sugarcane samples with  
coarse particle size.  
*Journal of Near Infrared  
Spectroscopy*, 19: 199-209.

## Energy recovery from agricultural waste



© Joël Blin / CIRAD

AGRICULTURAL WASTE CAN BE USED INDUSTRIALLY to produce energy. But what is its real potential in this field? Numerous studies have been conducted on the possibilities of energy recovery from this biomass, but interpreting their results is proving difficult without a better understanding of the conditions in which this waste can actually be used for energy production.

India's experience is particularly interesting in this respect, as the country has set up hundreds of cogeneration projects using agricultural waste under the Clean Development Mechanism (CDM). These were analysed by comparing the biomass expected to be mobilised by these projects and the evaluation of the country's potential. The findings of this analysis show that if there is no improvement in conversion technologies, especially in terms of output, then the apparent success of Indian bioenergy projects is not borne out in the long term. There are two reasons for this: the rapid exhaustion of the most sought after waste, and its increasing price. Indian experience shows that the rising price of biomass is impossible to offset with CDM carbon credits, and must therefore be passed on downstream to electricity prices to ensure energy recovery from waste remains viable. Problems of declining soil fertility could also lead to a reallocation of primary and secondary waste to soil and livestock requirements.

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Variety trial for fibrous  
sugarcane in Guadeloupe  
© Jean-Louis Chopart / CIRAD



## AGREEMENTS, PARTNERSHIPS

CIRAD has welcomed Dr **Bolanle Otegbayo**, a well-known professor and researcher from Bowen University in Iwo (Nigeria) under the auspices of the Agropolis Fondation. She benefited from the project Award (*African Women in Agricultural Research Development*), financed by the Bill and Melinda Gates Foundation as part of the GCRAI. This event strengthens the partnership to characterise the diversity of tropical starchy resources.

**Edes** is an ACP-EU programme (Africa-Caribbean-Pacific - European Union) financed by the 9<sup>th</sup> European Development Fund. Its aim is to improve the **food safety of ACP foods** exported to Europe and maintain the access of ACP countries to local, regional and European markets. It brings together nine European partners. CIRAD is coordinating the programme's training courses.

The **Cabaré project** should help diffuse new **banana varieties, which are free from health risks**, in the Caribbean region. CIRAD is coordinating the project, which is funded by the programme Interreg IV Caraïbes and being conducted with three Cuban research institutions and one institution from the Dominican Republic.

## COMMUNICATION, CONFERENCES

The **International Cocoa Awards**, created by Bioversity International, CIRAD and Event International, seek to bring farmers and chocolate makers closer together to celebrate the remarkable sensory characteristics of cocoa and to maintain its diversity. The 2011 edition awarded 16 prizes to different cocoas from around the world at the Salon du Chocolat, in Paris in October.

In April, the **Global Horticultural Initiative, GlobalHort**, celebrated its fifth birthday at Agropolis International (Montpellier). The consortium was launched in 2006 and aims to reduce global malnutrition, in particular. CIRAD, AVRDC and ISHS are the founding members (the FAO has joined the consortium).

The partners of the **Sustainable Banana** plan presented their results in June in Guadeloupe. The plan, which was launched in 2008 by the Ministry of Agriculture on the initiative of Caribbean producers (UGPBAN), sets out to halve the use of chemical pesticides between 2006 and 2013. Research is being conducted by IT2, IRSTEA and CIRAD.

## PUBLICATIONS

**Rained food crops in West and Central Africa: elements of analysis and proposals for action.** M. De Raïssac, N. Bricas, F. Maraux, P. Remy, D. Simon (Ed.). Ed. AFD. The publication summarises the research carried out by AFD, CIRAD and FIDA, which was conducted with African regional centres (AGRHYMET, CORAF), as part of the West and Central African dynamic.

**Fonio, an African cereal.** J.F. Cruz and F. Béavogui, with the collaboration of Djibril Dramé. Ed. Quae. The book focuses on making the most of this plant, which is useful for food security and environmental conservation.



**Danger dans l'assiette.** S. Dragacci, N. Zakhia-Rozis, P. Galtier. Ed. Quae. Which moulds are dangerous? Are there any high-risk foods or more vulnerable populations? The book describes daily food dangers that affect everyone and their food choices.

**Price volatility and food security**, a major HLPE report (Committee on World Food Security, CFS), was conducted by four scientists (Bangladesh, Canada, Mali, France) and coordinated by Benoît Daviron. It recommends defining new rules for market regulation.



© Christophe Maillet / CIRAD



# Sustainable food: DuALIne's long-term forecast

*Until now, the question of world food systems has been examined predominantly from the point of view of production. Now, the sustainability of these systems is being questioned: what is their impact on health?*

*What is their impact on the environment and biodiversity? What impact do they have on social equity and economic resilience in an unstable and uncertain context? A forecast, launched by CIRAD and INRA, provides some answers to these questions and opens up new fields for research.*

**PARTNER**  
Institut national  
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**"S**USTAINABLE FOOD SYSTEMS" can be defined as multi-functional food, which not only guarantees health and well-being, it creates employment, reduces social inequality and protects the environment. It will undoubtedly be a major topic of research for years to come. The downstream sectors, from the field to the consumer's plate, should be analysed from this point of view.

INRA and CIRAD have spent 18 months mobilising over 125 experts in the sector – academics, public and private institutional stakeholders – in order to study the trends in world food systems in terms of their impact on sustainable development. Their forecast "Sustainability of food systems faced with new issues" (DuALIne), presents a panorama of changes in these systems and identifies critical points. Thus, it has helped identify directions for future research programmes.

The first observation is that the agrifood sector, including processing, marketing, catering, food consumption, has a major impact on the environment, health and social equity. Yet, little research has been done on these questions. There are considerable losses and wastage in the industrialised sectors. There is a great deal of room for manoeuvre in this domain for increasing food availability and facing up to population growth. It is now necessary to develop new processing methods, review the organisation of distribution and transport, focus on domestic activities, rethink forms of public intervention and the responsibility of stakeholders in order to make the food system more sustainable. However, the DuALIne exercise is also an invitation to rethink research objectives, take more account of combinations (procedures, businesses, diets), coordinate scales, from local to global, and to improve the tools for

measuring and observation. DuALIne sets out a research agenda to achieve this, not only with new topics, but also with new ways to deal with them.

The research findings were presented and discussed with the stakeholders in the sector at a conference organised in Paris in 2011. A summary report, published at the end of 2011, presents the change in consumption patterns, the organisation of the processing and distribution sector, the supply of large towns, the problems of wastage and international trade. In addition, it examines the questions raised by the forecast and the methods for measuring the environmental and social impact of food systems. ■

Esnouf C., Russel M., Bricas N., 2011. Pour une alimentation durable : réflexion stratégique DuALIne. Paris, Quae, 288 p.

<http://www.cirad.fr/publications-ressources/editions/etudes-et-documents/dualine>

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## Two new courses on sustainable food systems

IN 2011, TWO NEW COURSES ON SUSTAINABLE FOOD SYSTEMS were launched in Montpellier. The first leads to a specialist Engineering Degree in "Innovations in global agricultural and agrifood systems" (ISAM). The second is a Masters Honours Degree that has been approved by the *Conférence des Grandes Écoles*, which enables professionals to better understand, support and anticipate the "Innovations and Policies for Sustainable Food" (IPAD). These courses are designed for those with the equivalent of a masters degree. They are supervised by Montpellier SupAgro and CIRAD and supported by the Chair on the World's Food Systems. The latter was created by Montpellier SupAgro and members of Agropolis International and was recently approved by UNESCO.

These courses address the new issues involved in global food systems. It is essential for the stakeholders in these systems to be able to identify the most pertinent innovations, which will guarantee their sustainability. This involves evaluating the different categories of impact: health, environment, biodiversity, social inequalities, resilience in an unstable universe. It also involves measuring the impacts, developing the capacity for prospective analysis, understanding the globalisation of these systems or implementing new forms of public-private partnership.

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# Developing traditional African products: bissap in Senegal

The European project After, coordinated by CIRAD, aims to develop traditional African products and related know-how. Thus, it is making a direct contribution to improving the competitiveness of these products and helping food-processing businesses to use them, as well as facilitating their commercialisation on African and European markets. One of the project's main products is bissap, a traditional Senegalese drink made from hibiscus.

## PARTNERS

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Dried hibiscus leaves  
© Isabelle Vagneron / CIRAD



Sensory test.

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**T**HE PROJECT AFTER was launched in September 2010 for 4 years. It has mobilised interdisciplinary African and European teams. The primary objective is to find out about current know-how, food patterns and the technologies and processes associated with the traditional products studied. Proposals will then be made to optimise the traditional processes in order to improve the health and nutritional quality of products, while conserving their gustatory characteristics. The project concerns three families of products: meat and dried fish products, cereal-based fermented foods and products made from plant extracts. The research findings and the methods used to evaluate the traditional products and processes will be shared with other countries throughout the world. The results will be widely distributed within the scientific community involved in food research in developing countries.

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Nanofiltration. © Dominique Pallet / CIRAD

### Bissap, a traditional Senegalese drink

CIRAD is interested in the methods used to process the calyx of roselle (*Hibiscus sabdariffa*) into bissap, a traditional refreshing drink consumed in Senegal. Information on bissap has been collected including current know-how, consumption patterns and production techniques. This data has helped identify several areas of research.

A specific study was conducted in Dakar, Senegal, on consumer acceptance of bissap-based products. The methodology used

is based on a set of descriptors, which were identified in discussion groups and using consumer surveys. The study shows that the consumption of bissap juice and squash is determined by sensory criteria.

### Developing the anthocyanins in the hibiscus calyx

Hibiscus contains high levels of anthocyanin, which can be extracted. In order to improve extraction, CIRAD has developed pilot equipment to test several nanofiltration membranes, which concentrate the anthocyanins from the hibiscus calyx. The trials reproduced on a pilot scale, using the membrane that was selected after the test, showed that all the anthocyanins were retained. Their concentration was multiplied six-fold. In addition, the quality of the concentrate is not altered in any way during the operation. The exportation of hibiscus, in the form of a plant extract rich in anthocyanins, could be an interesting alternative for adding value.

Cisse M., Vaillant F., Pallet D., Dornier M., 2011. Selecting ultrafiltration and nanofiltration membranes to concentrate anthocyanins from roselle extract (*Hibiscus sabdariffa* L.). *Food Research International*, 44: 2607-2614. Doi: 10.1016/j.foodres.2011.04.046

<http://www.after-fp7.eu/>





# Oil palm fruit: an original model

Oil palm fruit is exceptionally rich in lipids and provitamin A carotenoids, which have essential nutritional properties for humans. What are the molecular mechanisms underlying these qualities and how are they integrated within the fruit ripening process? By using the very latest transcriptome sequencing technologies, scientists from CIRAD/IRD have just revealed the molecular determinants of lipid and carotenoid biosynthesis that occurs during the ripening of this unique fruit. This is a first for the species.

## PARTNERS

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**IL PALM** (*Elaeis guineensis*) is the plant species that accumulates the highest amount of oil in its fruit. The fruit also contains exceptional quantities of carotenes, or provitamin A, which play a major role in human health and nutrition. However, compared to dicotyledonous species that have been well studied, such as tomato or grapevine, little research has been done on the molecular bases of the development and ripening of this fleshy monocotyledonous fruit. A team from CIRAD/IRD conducted a study on the biosynthetic pathways that occur in the mesocarp, the fleshy part of the fruit, in order to elucidate the underlying mechanisms. The team used high-throughput transcriptome sequencing, a technique used to quantify all the transcribed products, or transcripts, of a genome in a given tissue and which quantifies gene expression.

## Oil biosynthetic pathways

Thanks to this technique, it was possible to annotate and identify 29 034 transcripts in the mesocarp. In total, only 2 629 genes were differentially expressed during mesocarp development. The researchers then studied these genes in order to identify the mechanisms that could explain the

exceptional accumulation of oil and carotenoids in the mesocarp.

By conducting a detailed analysis of gene expression patterns, they decoded the biosynthetic pathways for oil and revealed a very high level of transcriptional regulation at the early stages of the *de novo* formation of fatty acids, which occurs in the plastids. They also found that there was little transcriptional regulation of triglyceride assembly (three fatty acids esterified to a glycerol molecule) that occurs in the endoplasmic reticulum. The transcription factor Wrinkled (WRI1), known to be associated with the regulation of seed lipid biosynthesis, was also identified in the oil palm mesocarp. Interestingly, the WRI1 activators described in oilseeds were not found, which suggests other regulatory factors are involved in this fruit.

## An original ripening process

The massive accumulation of carotenoids, followed by that of abscisic acid, are two original characteristics of oil palm fruit rip-

ening. As found for fatty acids, the main transcriptional regulation occurs during the early stages of carotenoid biosynthesis.

The researchers revealed the coordinated expression of genes associated with the production and signalization of ethylene, a key hormone in climacteric fruit ripening. In addition, they identified MADS-box transcription factor regulatory genes, described for some model dicotyledonous species as major regulators of fruit ripening. On the basis of the expression of these genes, the analyses revealed a new group of MADS genes that are potentially associated with ripening. Therefore, there is a divergence between the regulatory mechanisms involved in fleshy fruit ripening in monocotyledons and those identified in model dicotyledonous species.

For the first time with this species, the results reveal the molecular determinants of oil biosynthesis, a key component of agronomic yield. In the future, the oil palm can be considered as an original model for studying fruit ripening in tropical monocotyledonous species.

Tranbarger T.J., Dussert S., Joët T., Argout X., Summo M., Champion A., Cros D., Omere A., Nouy B., Morcillo F., 2011. Regulatory mechanisms underlying oil palm fruit mesocarp maturation, ripening and functional specialization in lipid and carotenoid metabolism. *Plant Physiology*, 156: 564-84.



Unsorted ripe oil palm fruit, Benin.  
© T. Tranbarger / IRD



Cross-sections of oil palm fruit.  
© T. Tranbarger / IRD

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## AGREEMENTS, PARTNERSHIPS

The **Centre National d'Expertise sur les Vecteurs (CNEV)** was set up for 5 years under the auspices of the ministries of health and agriculture, in liaison with ANSES. It includes a central coordinating laboratory, the joint research unit MIVEGEC (IRD, CNRS, Universities of Montpellier), which specialises in human diseases, and three associated laboratories, the joint research unit CMAEE (CIRAD, INRA), EID-Méditerranée and EHESP. There are 35 associate partners with complementary expertise in vector control.

**Biology and control of vector-borne infections in Europe** constitutes the EDENext programme (2011-2014). The project is part of the European Commission's 7<sup>th</sup> Framework Programme, involving CIRAD and its 46 partners (22 countries) and follows on from Eden (2004-2010). EDENext will focus on the social and economic factors that increase the risk of contamination and propose preventive action adapted to the constraints faced by populations at risk.

The **GRIPAVI project** presented its findings in Montpellier in November, by organising the conference *Dynamics and management of avian influenza: at the interface between virus, birds and man*. GRIPAVI, which is coordinated by CIRAD and financed by the Ministry of Foreign Affairs, has conducted research work on the ecology and epidemiology of avian influenza in order to support surveillance and health management programmes in southern countries. In partnership with teams from six African countries and Vietnam, it has supervised 11 graduate theses with students from southern countries, fieldwork and 30 master's work placements.



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## COMMUNICATION, CONFERENCES

In May, the **World Assembly of OIE Delegates** held its 79<sup>th</sup> annual general meeting in Paris. Researchers from CIRAD and INRA presented the first of the two technical topics of the session: the contribution of veterinary activities to world food security for foodstuffs derived from terrestrial animals.

The **International Conference on Animal Health Surveillance** brought together all the scientific and political stakeholders involved in epidemiological surveillance for animal health in Lyon, in May. Five talks were given by researchers from the CIRAD research unit AGIRS at this important meeting.

In March, the **6<sup>th</sup> CARIBVET Steering Committee, Caribbean Animal Health Network** was held in Guadeloupe for the first time. It was organised by CIRAD, the Secretariat of the Caribbean Community (CARICOM) and the United States Department of Agriculture (USDA). The meeting was designated as the **Vet 2011 Event**, which celebrates the 250<sup>th</sup> anniversary of the veterinary profession in the world. CIRAD, the Guadeloupe Region and Europe play a major role via the project Interreg IV Caraïbe. The International Office of Epizootics (OIE) and CARIBVET are working together on numerous projects.

In the Caribbean, one of CIRAD's three poles is dedicated to emerging diseases and animal health. These topics were on the programme at the **Carrefours de l'Innovation Agronomique** symposium on sustainable agricultural production and processing systems, organised by CIRAD and INRA in November.

CIRAD took part in the **30<sup>th</sup> World Veterinary Congress, Caring for animals: healthy communities**, in Cape

Town, South Africa in October 2011. This congress, the highlight of the World Veterinary Year, provided the occasion for CIRAD and its partners from the research platform "Production and conservation in partnership" to chair three sessions and present 11 papers.

The **Global foot and mouth disease alliance's** conference "Surveillance, epidemiology, vaccination and control of foot-and-mouth disease" was held in South Africa in June 2012. CIRAD presented its results relating to the monitoring of foot-and-mouth in the Great Limpopo cross-border park. It has joined this research network as a collaborative member.

CIRAD has joined the working group **Wildlife and ecosystem health**. This working group was created in July 2011 on the initiative of two international organisations, the UNEP and the FAO. It sets out to promote trans-disciplinary research on health problems that are at the interface between man, domestic animals and wild animals. These issues are the focus of the congress **One health** (Melbourne, Australia), where CIRAD presented several papers.

## PUBLICATIONS

**Surveillance épidémiologique en santé animale** (3<sup>rd</sup> edition). B. Dufour, P. Hendriks. Ed. Quae. A practical handbook for stakeholders in surveillance networks, illustrated with real examples that underline an identical methodological approach.

**La fièvre aphteuse**. G. Charbonnier, M. Launois. Ed. CIRAD. A new educational booklet on foot-and-mouth disease, one of the most dreaded animal diseases that affects cattle, pigs, goats and sheep.

# Improving the management of foot-and-mouth disease in southern countries

Foot-and-mouth disease (FMD), a well-known disease in the veterinary field, still has a devastating effect in developing countries. Its recrudescence in southern Africa reveals some weaknesses in the existing disease control systems. While in South-East Asia, systems for detecting outbreaks are lacking. In partnership with local research institutions, CIRAD is proposing tools to improve the management of the disease, based on precise methods of risk analysis or the active participation of farmers.

**F**MD HAS BECOME INCREASINGLY IMPORTANT in recent years. In Sub-Saharan Africa and South-East Asia, the disease is very common and has a considerable impact on the economy of small-scale farmers and on the international trade of beef exports.

## Analysing the risk of infection in southern Africa

In southern Africa, free-ranging buffalo are a constant source of infection for cattle on the edges of many protected areas in the region. Two principal methods are used for disease control: erecting physical barriers to separate buffalo from livestock and vaccinating livestock in regions where contact with infected buffalo is possible. These methods have achieved good results for decades. However, over the last 10 years, the disease has re-emerged throughout the region.

This recrudescence is primarily due to the degradation of fences, which are often damaged by rural communities that want to gain access to natural resources, by elephants or flooding rivers. Equally, it is technically difficult to produce vaccines that remain effective in the middle and long term because of the extreme variability of the FMD virus found



An FMD lesion on a water buffalo's tongue (*Bubalis bubalis*), Cambodia.

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in buffalo. An additional factor that further complicates the situation is the expansion of trans-boundary protected areas, which facilitate the virus' circulation between several countries. Therefore, FMD control systems have to face serious challenges in the region. CIRAD has designed methods to evaluate the FMD control strategies, so that veterinary services can concentrate their resources more effectively in areas with a high risk of disease emergence. It has also developed a model to analyse the risk of transmission of the viral infection between wild buffalo and domestic livestock in order to quantify and compare the risk in different regions with wildlife/livestock interfaces.

## Involving farmers in Asia

In Asia, where the role of wildlife in FMD transmission is less important, CIRAD is looking for ways to improve farmers' detection and perception of risks by using participatory methods. In Cambodia, a recent study shows that participatory epidemiology helps to rectify the absence of farmers' declarations. This approach is based on the triangulation method, which involves linking three sources of data collection – local knowledge, field observations and secondary data sources (bibliographies, serological analyses, etc.). It is a way of checking the quality of the data collected and has been used successfully to

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Herd of buffaloes,  
Kruger National Park,  
South Africa.

© Ferran Jori / CIRAD



Conducting  
a participative survey  
with the maintenance  
team for a veterinary  
fence, Kruger National  
Park, South Africa.

© Ferran Jori / CIRAD



describe the epidemiological situation of FMD in different villages in Cambodia. Greater use of participatory tools would enable managers to increase farmers' involvement and establish priorities for disease control.

The work conducted in Asia and southern Africa is perfectly complementary. It also provides the opportunity to improve the control of the disease via the exchange of experiences and methods between the two continents and the two research platforms in partnership involved: the platform 'Production and Conservation in Partnership' (RP-PCP) in southern Africa and the network to manage emerging epidemiological risks in South-East Asia (GREASE).

Bellet C., Vergne T., Grosbois V., Holl D., Roger F., Goutard F., 2012. Evaluating the efficiency of participatory epidemiology to estimate the incidence and impacts of foot-and-mouth disease among livestock owners in Cambodia. *Acta Tropica*, 123: 31-38.

Jori F., Brahmabhatt D., Fosgate G., Thompson P.N., Budke C., Ward M., Ferguson K., 2011. A questionnaire-based evaluation of the veterinary cordon fence separating wildlife and livestock along the Kruger National Park, South Africa. *Preventive Veterinary Medicine*, 100: 210-220. Doi: 10.1016/j.prevetmed.2011.03.015

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## Avian influenza: vigilance is still required in Sub-Saharan African

THE H5N1 HIGHLY PATHOGENIC AVIAN INFLUENZA (HPAI) VIRUS, which is still rife in Asia, has never been widespread in Africa despite its continued presence in Egypt since 2006. Yet, Africa is not free from risk. Although not a single healthy wild bird carrying the H5N1 HPAI virus was detected among the thousands of individuals tested, influenza viruses of low pathogenicity are found there all the year round in wild bird populations, particularly in ducks. Contact between wild and domestic birds has been confirmed: viral strains common to wild and domestic birds have been detected.

This contact presents a real risk and should, therefore, be closely monitored: all highly pathogenic influenza strains originate from strains of low pathogenicity found in wild birds. Health surveillance strategies should involve farmers and take account of how they perceive and react to health crises for maximum efficacy.

These were the main conclusions drawn for Africa at the international conference, held in Montpellier at the end of 2011 to mark the end of the research project on the ecology and epidemiology of avian influenza in southern countries (GRIPAVI). The 5-year project was financed by the Ministry of Foreign Affairs and managed by CIRAD with multi-disciplinary teams from five African countries and Vietnam.

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De Visscher M.N., Chevalier V., Gaidet-Drapier N., 2011. *Gripes aviaires en Afrique : cibler la vigilance*. Montpellier, CIRAD, Perspective n° 13.

<http://gripavi.CIRAD.fr/>



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# Livestock producers, essential actors in epidemiological surveillance

Epidemiological surveillance is unavoidable in southern countries given the recent increase in emerging animal diseases. Surveillance is based on information networks and requires collaboration between numerous stakeholders, particularly livestock producers. For several years now, CIRAD has been conducting research in Africa and Asia to evaluate and improve the national epidemiological surveillance networks.

**E**MERGING ANIMAL DISEASES have multiplied in recent years and epidemiological surveillance has become a major tool for managing the health risks that they cause. Between 2009 and 2011, CIRAD conducted several research projects in Africa and Asia on the effectiveness of the national epidemiological surveillance networks. It particularly focused on the numerous stakeholders in the networks, primarily the farmers.

## Rethinking the farmers' role

The research actually shows that in practice, the role attributed to farmers in the surveillance networks is reduced to that of informer – they report cases of

notifiable diseases to veterinary agents – then to that of executor of management policies as defined by the authorities without prior consultation. Often, only a few farmers join the networks as a result, which limits their effectiveness in terms of the number of cases declared.

Although farmers collaborate little with the surveillance networks set up by the authorities, they do implement a series of disease management and surveillance practices. Thus, "informal" surveillance networks do exist, where information on health is transmitted rapidly over a radius of no more than a few kilometres. They are based on a definition of "cases" determined by local knowledge of diseases. They encourage farmers

to adopt measures on their farms in order to minimise the predicted effects of disease, for example, by selling sick or exposed animals, rather than tackling the causes. Therefore, farmers' perception of diseases is different to that of veterinary agents: farmers do not operate on the same "epidemiological territory", do not define diseases in the same way and do not target the same objectives for control.

## Networks based on a shared vision of the disease

To be viable, epidemiological surveillance should be based on a network of stakeholders who share common or at least compatible interests, benefit mutually from the operation of the network and interpret the information that circulates in the same way. In other words, the stakeholders should share a common perception of the disease to be monitored and use the same definition for a notifiable case.

Therefore, it is important to take into account the numerous stakeholders – farmers, consumers, traders – who are involved, in a more or less independent capacity, in the management of risks and crisis situations associated with the emergence of diseases. However, the aim should not simply be to identify the human factors that

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Village poultry, Luong Son, Vietnam. .  
© Marisa Peyre / CIRAD

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contribute to disease spread, it should also include methods of joint risk management.

The research on surveillance networks is part of a broader objective. Thus, CIRAD is working on the development of epidemiological surveillance tools capable of integrating the epidemiological, as well as ecological, socio-cultural and economic aspects of health risks. This "systemic surveillance" will be based on syndromic and participative approaches. At a local level, the aim is for the communities and stakeholders concerned with surveillance to be involved in defining and implementing risk management policies. This kind of surveillance complements the existing types of surveillance. It should be able to take into account the changes in and dynamics of the social, as well as the environmental contexts linked to disease emergence. The



Slaughterhouse for pigs in a village in Vientiane Province, Laos.  
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project is part of a more general framework of studies on the interactions and processes of systems and communities using interdisciplinary approaches.

Desvaux S., Figuié M., 2011. Formal and informal surveillance systems. How to build bridges? *Bulletin de l'AEEMA*, n° 59-60: 352-355.

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<http://www.grease-network.com>

<http://revasia.CIRAD.fr>

## Infectious diseases: setting priorities to improve management

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**MANAGING DISEASES IS EXPENSIVE.** In order to improve the allocation of increasingly limited resources for disease surveillance and control, a team from CIRAD and Liverpool University came up with the idea of using an index that is usually applied to measure the productivity and scope of research: the H-index. Instead of being applied to a researcher's scientific publications, it is applied to publications that concern a pathogenic agent. In this way, it is possible to determine the interest shown by the scientific community for the disease in question. Currently, 1 414 pathogenic agents have an H-index. The index for zoonotic diseases is higher than that for infectious diseases that only affect humans. The same applies for emerging diseases in comparison to non-emerging diseases. Its pertinence has been confirmed by comparing the index for 27 human diseases to their DALY [*disability adjusted life years*], an index used by the WHO, which reflects their impact on health or human well-being. Calculating the H-index in a transparent and automatised way is quick and easy. It could be used to rank and prioritise infectious diseases as a function of their real impact on health and to monitor their evolution almost immediately. CIRAD is also exploring other approaches in this field, such as the evaluation and selection of pertinent health and socio-economic criteria using multivariate statistical analyses in order to prioritise zoonoses in South-East Asia.

**PARTNERS** Liverpool University (United Kingdom), University of Maastricht (Netherlands) University of Kasetsart (Thailand), Centre National de la Recherche Scientifique (CNRS), École Nationale Vétérinaire de Toulouse (ENVT), United Nations' Food and Agricultural Organisation (FAO), International Office for Epizootics (OIE), World Health Organisation (WHO).

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[www.liv.ac.uk/enhance](http://www.liv.ac.uk/enhance)

[www.grease-network.com](http://www.grease-network.com)



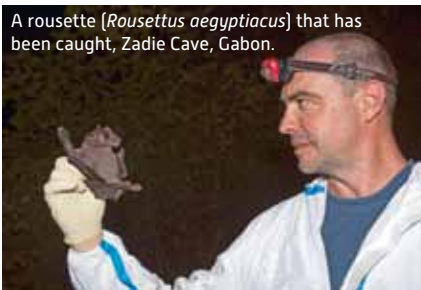


## Bats and emerging diseases

WITH OVER 1 100 REGISTERED SPECIES, bats constitute the second largest order of mammals after rodents. Their diversity, their capacity to fly (unique among mammals) and their proximity to man make them formidable actors with regard to the maintenance and transmission of infectious agents. Their role is recognised in the persistence and transmission of the Ebola, Marburg, Nipah and SARS viruses and in the emergence of diseases, such as rabies, encephalitis, haemorrhagic fevers and acute respiratory syndromes in animals and man.

In Gabon and South-East Asia, CIRAD and its partners have been studying these animals in order to identify the viruses that they carry and to understand the mechanisms of contact between these species, which are reservoirs of pathogens, and the sensitive hosts. They are particularly interested in determining the factors that govern disease emergence or the outbreak of an epidemic and evaluating the health risks that bats cause among human and animal populations. This research has given CIRAD the opportunity to develop exchanges and scientific partnerships between Central Africa and South-East Asia.

A rousette (*Rousettus aegyptiacus*) that has been caught, Zadié Cave, Gabon.



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Maganga G.D., Bourgarel M., Ebang Ella G., Drexler J.F., Gonzalez J.P., Drosten C., Leroy E.M., 2011. Is Marburg virus enzootic in Gabon? *Journal of Infectious Diseases*, 204: S800-S803.

## Insect vectors of bluetongue virus in Europe

Bluetongue is an emerging disease in Europe. It is now found throughout the Mediterranean Basin, where it is transmitted by *C. imicola*, a midge from the genus *Culicoides*. It was introduced to northern Europe in 2006, although *C. imicola* is not found there.

This phenomenon, which reveals the importance of indigenous species in transmitting the virus, led CIRAD to examine these species' vectorial role.



A sticky cover, an original baited trap.  
© E. Viennet/CIRAD

**B**LUETONGUE VIRUS, which is transmitted to wild and domestic ruminants by blood-sucking midges from the genus

*Culicoides*, is an example of a virus that is emerging in Europe. Bluetongue was considered as exotic until 1998 and can now be found throughout the Mediterranean Basin. There are several viral serotypes as a result of the fact that *Culicoides imicola*, its principal Afro-Asian vector, spread northwards. From August 2006, the serotype 8 was introduced into northern Europe, although *C. imicola* was absent. CIRAD's

medical entomology team examined the role played by indigenous *Culicoides* species, particularly those from the group *Obsoletus*, in viral transmission.

### Understanding the mechanisms of viral transmission

Insect vectors transmit viruses when they feed on vertebrates' blood. Therefore, the contact between host and vector is a key stage in transmission. Understanding the mechanisms involved, by trapping insects when they are feeding, is a prerequisite to preventive action and control.

**PARTNERS** Institut National de la Recherche Agronomique (INRA), University of Strasbourg, Ministry of Agriculture





How do you catch *Culicoides* on animals to estimate the host/vector contact? The drop trap (top) and the suction trap (bottom).

© E. Viennet/CIRAD

There are several methods for trapping midges: the light trap, traditional baited traps and a new baited trap developed by CIRAD, which consists of a sticky cover put directly on the animal.

The first step involves comparing the effectiveness of the different methods of capture, determining the bias of each method and, in the case of the light traps, quantifying the link between the abundance of *Culicoides* and the biting rate on the animal. Although the light traps usually used for catching *Culicoides* during the surveil-

lance programmes are actually practical, they do not give a correct representation of the level of biting on the animal, which is a major component of the risk of transmission.

### Vector behaviour and specificity

Baited traps have demonstrated that the horse was the domestic host, which attracted the most *Culicoides*, particularly *C. scoticus*. A complementary approach using molecular biology has shown that cattle were the almost exclusive hosts of *C. chiopterus*.

This study also confirmed that *Culicoides* mainly bite at dusk and that species, such as *C. obsoletus*, were capable of entering buildings to feed.

These preliminary results concern the European species suspected of transmitting bluetongue virus. They should help identify the risk of transmission. They should lead to the development of preventive and control measures for the disease, as well as for other diseases transmitted by *Culicoides*, such as African horse fever or epizootic haemorrhagic disease of deer. ■

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### Update on animal health overseas

CIRAD SCIENTISTS have contributed to the special issue of the Bulletin épidémiologique de l'Agence Nationale de Sécurité Sanitaire de l'Alimentation, de l'Environnement et du Travail (ANSES). This issue is devoted to animal diseases in French overseas departments and territories. The contributions include reviews on stomoxys, orbivirus and cowdriosis, as well as articles on the CARIBVET and AnimalRisk networks for the Caribbean region and for the Indian Ocean, respectively.

French overseas departments and territories actually play the role of advanced European platforms in a tropical environment in terms of the research and surveillance of emerging diseases, whose impact on health or whose recent evolution mobilises health managers and stakeholders in the animal production sectors and research. CIRAD has conducted comparative studies on these islands and territories, each of which has its own specific environment. It has set up regional animal health networks, which provide the basis for the development of health observatories. These networks provide the opportunity to examine complex questions on a regional scale, such as the emergence of infectious diseases, which is determined by numerous factors: evolution of pathogenic agents and their vectors, bioecology of vectors, environmental and socio-economic changes.

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Numéro spécial Dom-Tom. Bulletin épidémiologique : santé animale, alimentation, June 2011, n° 43, 60 p.

*Culicoides nubeculosus* female under a binocular microscope.

© J.B. Ferré / EID-Med

# Trypanotolerance in West African cattle

*Bovine trypanosomiasis is slowing down the development of livestock production in West Africa. Current control measures are largely geared towards controlling tsetse flies, which transmit the disease. However, they are not sufficiently effective. There are other options to explore for reducing the negative impact of trypanosomiasis: namely developing small West African taurines, which are smaller than zebus, but have the advantage of being tolerant to the disease. A team from CIRAD has examined the genetic mechanisms of this tolerance with a view to integrating taurines into breeding programmes in order to associate productivity and trypanotolerance in cattle.*



A zebu cow, a breed sensitive to trypanosomiasis, infected by *Trypanosoma congolense*. © Sophie Thévenon / CIRAD

## PARTNERS

Centre International de Recherche-Développement sur l'Élevage en Zone Subhumide (CIRDES, Burkina Faso), University of Abomey-Calavi (Benin), Institut National de la Recherche Agronomique (INRA), AgroParisTech, Institut de Recherche pour le Développement (IRD), SupAgro, Ministry of Foreign Affairs (CORUS), Bureau des Ressources Génétiques (BRG), Fondation pour la Recherche sur la Biodiversité (FRB), Fonds National pour la Science (NFS).

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Host-Vector-Parasite Interactions in Infections by Trypanosomatidae (InterTryp)

**B**OVINE TRYPANOSOMIASIS is a parasitic blood disease caused by several species of trypanosomes, essentially transmitted by tsetse flies. Current control measures – trapping flies, use of insecticides and trypanocide medicines – have failed to contain the disease. A CIRAD team examined the possibilities offered by the animal resources in West Africa, which could be used to help control this endemic disease.

The region does actually have a great variety of cattle breeds, some of which have demonstrated a remarkable tolerance to the disease. These are local taurine breeds, which are able to control the pathogenic effects of trypanosomes and remain productive in enzootic zones. However, these small West African trypanotolerant taurines are less productive

than zebus and less suitable for animal traction.

The first stage of research focused on the genetic mechanisms involved in trypanotolerance. These studies were conducted with several regional partners, in particular CIRDES, in Burkina Faso, and the University of Abomey-Calavi, in Benin.

Five hundred cattle, raised by Peul herders were monitored for 2 years. They were subjected to monthly blood tests and a trypanosomiasis diagnosis. The level of anaemia, one of the main symptoms of the disease, was also measured. Their individual capacity to control anaemia during the entire duration of the monitoring period was estimated using statistical models. The genetic analyses conducted on the cattle helped identify a microsatellite marker

associated with anaemia and a candidate gene, close to the marker, involved in immune response.

In partnership with INRA, CIRAD is now researching genetic polymorphisms, which have been selected by the environment and man in West African cattle breeds, using high-throughput genotyping and sequencing tools. The next stage is to identify the polymorphisms responsible for trypanotolerance from among the selected genes, which can then be applied in cattle genetic improvement and crossbreeding programmes.

Dayo G.K., Gautier M., Berthier D., Poivey J.P., Sidibé I., Bengaly Z., Eggen A., Boichard D., Thévenon S., 2012. Association studies in QTL regions linked to bovine trypanotolerance in a West African crossbred population. *Animal Genetics*, 42 : 123-132, Doi : 10.1111/j.1365-2052.2011.02227.x



An N'Dama bull, a trypanotolerant breed of taurine.  
© David Berthier / CIRAD



# RNA interference to combat morbillivirus infections

Measles, rinderpest, peste des petits ruminants and distemper are all serious diseases caused by morbilliviruses. Although rinderpest has just been eradicated, the other infections still cause high rates of mortality despite the available vaccines. CIRAD has been exploring therapeutic alternatives for several years. One consists of inhibiting viral replication using RNA interference.

## PARTNERS

Friedrich Loeffler Institute (FLI, Germany), Centre d'Étude et de Recherches Vétérinaires et Agrochimiques (CERVA, Belgium), Faculdade de Medicina Veterinária (Portugal), Centro de Biología Molecular Severo Ochoa (CBMSO, Spain), Laboratoire National d'Appui au Développement Agricole (LANADA, Côte d'Ivoire), Institut National de la Santé et de la Recherche Médicale (INSERM), Médéxis Pharma, University of Stockholm (Sweden), Epizone Network of Excellence, ASFRISK project.

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**M**ORBILLIVIRUSES CAUSE serious diseases in man and domestic animals. Although vaccines do exist, sources of infection persist and mortality remains high. In fact, vaccines are rarely used systematically to prevent reinfection and are only effective 7 to 10 days after being administered. Hence, the need for complementary therapeutic solutions. For the past few years, CIRAD has been exploring the potential of RNA interference (RNAi). RNAi interference is achieved by the delivery of small interfering RNAs (siRNA) in the cell cytoplasm where they combine specifically with the virus' target messenger RNA. Thus, they inhibit the virus' multiplication by preventing the translation into

proteins. In order to develop the therapeutic RNAi vaccines, CIRAD has chosen to work on the virus that causes peste des petits ruminants, a major disease in southern countries. Its laboratory is a world reference for this disease.

## Specific siRNAs

After sequencing the genome of the vaccine virus, the researchers began by examining the *N* gene, which codes for the viral nucleoprotein. This structural viral protein is also involved in the ribonucleoprotein complex, ensuring the transcription of viral genes and genome replication. They identified three zones of 20 nucleotides in length, found on the *N* gene, which are targeted by the siRNAs, with a reduction of at least 90% of viral replication *in vitro*. The same target zones are found on other human and bovine morbilliviruses, which are genetically close. The RNAi targets and their complementary siRNA molecules were patented by CIRAD in 2005.

## A vaccine delivery system

Then, the team focused on the delivery of the interfering RNAs *in vivo*. Four systems were tested: two viral vectors (adenovirus and baculovirus), a peptide that penetrates the membrane and a liposome. The systems should protect

the interfering RNAs from the nucleases found in the organism and ensure that they penetrate the cell cytoplasm, without having a toxic effect on the organism. The first three systems were proven to be effective *in vitro*. The fourth requires biochemical modifications through a transmucosal passage in order to be effective and, therefore, can only be tested *in vivo*.

To compare and select these delivery systems, the team developed a model using mice, which does not involve viral infection and limits the number of animals used. A kinetic approach was used on the live animal using bioimaging. With the help of the model, the team was able to demonstrate that a marked preventive effect could be achieved with one siRNA.

The systemic preventive effect will soon be evaluated using the four delivery systems in the "mouse" model. The long-term objective is to prove that it is possible to interfere effectively with the replication of a virus that produces a systemic disease in a large species (small ruminant).

Nizamani Z.A., Keil G.M., Albina E., Holz C., Minet C., Kwiatek O., Libeau G., Servan de Almeida R., 2011. Potential of adenovirus and baculovirus vectors for the delivery of shRNA against morbilliviruses. *Antiviral Research*, 90: 98-101.





## AGREEMENTS, PARTNERSHIPS

Developing the concept of **bio-economy between Europe and the Latin America and Caribbean region** is the aim of the new European project ALCUE-KBBE, led by CIRAD.

The *Pôle de recherche sur le foncier rural dans les pays du Sud*, based in Montpellier, associates CIRAD, IAMM, IRD and SupAgro. Its thematic meeting in September concerned large-scale land acquisitions. The *Journées doctorales*, in December, enabled PhD students to discuss land issues in developing countries over four days.

## COMMUNICATION, CONFERENCES

During the **3rd European Forum for Rural Development** in March in Palencia, Spain, CIRAD organised a work session on **Linking smallholder farmers to efficient markets**, with its partners from the University of Wageningen and the National Research Institute, which are also members of Agrinatura.

ESSA 2011, the **7th conference of the European Social Simulation Association**, was hosted in Montpellier (Agropolis International) in September. It was organised by IRSTEA, CIRAD, IRD, IRMM and the University of Cheikh Anta Diop, Dakar.

In May, CIRAD, IRSTEA and the University of Montpellier organised an international seminar on **life cycle assessment (LCA)** in its social, economic and environmental components, at Agropolis International (Montpellier). As part of the ELSA platform, the teams in Montpellier (CIRAD, IRSTEA, INRA, Supagro, UM1, etc.) make up one of the first research groups on this subject in Europe.

**Should we pay for tropical forests?** This was the subject of two days of round tables organised by CIRAD at the 2011 Paris International Agricultural Show in February.

**The recommendations made by researchers are not being applied by managers.**

How then can they be encouraged to introduce sustainable forestry? This was the issue discussed by experts at the international conference on "Research priorities in tropical silviculture: towards new paradigms" organised in Montpellier in November.

## PUBLICATIONS

**Rural transformation and late developing countries in a globalizing world: a comparative analysis of rural change.** B. Losch, S. Fréguin-Gresh, E. White. World Bank, Washington. The findings of the World Bank programme coordinated by B. Losch, RuralStruc, insist on the importance of jobs for the future of the agricultural and rural economy. They tie in with the new orientations adopted by the World Bank.

**Regulating the globalised economy: Articulating private voluntary standards and public regulations.** *Perspective* n° 11. Private stakeholders are multiplying the standards of good social and environmental practices. M. Djama shows that these standards complement public regulations and should not be interpreted as the privatisation of sustainable development policies.

**Payments for environmental services and development: Combining conservation incentives with investment.** *Perspective* n° 7. A. Karsenty suggests that future PES serve to fund not only the opportunity cost of ecological efforts, but also the investments required to change farming practices.

**Land rights and the rush for land: findings of the global commercial pressures on land research project.** W. Anseeuw et al., International Land Coalition, Rome. More than 40 organisations collaborated on the Global Commercial Pressures on Land Research Project, which synthesised 27 case studies, thematic studies and regional overviews.

**Investissements agricoles en Afrique.** This section of the journal *Afrique contemporaine* was coordinated by J.J. Gabas from CIRAD's ART-Dev Research Unit. Several CIRAD researchers contributed to it.

**Large-scale acquisition of rights on forest lands in Africa.** A. Karsenty. Ed. CIRAD. This report seeks to determine whether timber concessions allocated in Central Africa can be considered as part of the large-scale land acquisition (LSLA) process that is currently the subject of international debate.

**Transformations et diversification du conseil pour des agricultures en mouvement,** G. Faure and C. Compagnone (ed.). A special issue of *Cahiers Agricultures* on agricultural advisory services, a topic that is back on the agenda.

**La réforme agraire en Afrique du Sud : le maintien d'une ségrégation agricole postapartheid.** W. Anseeuw. Editions universitaires européennes. The persistent inequalities in South Africa in terms of land tenure and agriculture, to the detriment of the populations marginalised by apartheid, 16 years after the advent of democracy.



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**The domestic market for small-scale chainsaw milling in Cameroon.**

P.O. Cerutti, G. Lescuyer.  
Ed. CIFOR. A quantitative and qualitative evaluation of Cameroon's domestic timber market.

**Stabilising cereal prices? Adapting the response to the market.** *Perspective n° 10.*  
F. Galtier distinguishes several types of markets: domestic markets in developing countries that are subject to food insecurity, domestic markets in developed countries, or international markets

**Managing agricultural price volatility in Africa - Context matters for policy effectiveness.** *Perspective n° 12.*  
E. Maître d'Hôtel, A. Alpha, R. Beaujeu, F. Gérard and L. Levard show that in order to be effective, a policy measure must be based on robust knowledge; it must be predictable; its funding must be secured; and its enforcement must be monitored.

**Les marchés mondiaux 2011 : le printemps des peuples et la malédiction des matières premières.** Coord. P. Chalmin.  
Ed. Economica. The 25th *CycloPope* report puts its readers at the heart of commodity markets, from automobiles to zirconium. Researchers from CIRAD contributed to this reference work, which has become a must in this particularly volatile environment.

**Alimentación, semillas, patentes: agrobiodiversidad, derechos de propiedad intelectual sobre lo vivo y el mejoramiento de especies agrícolas.** Coord. Didier Bazile.  
A Chilean edition of *Monde diplomatique*. In the South, imported crops such as rice are playing a growing role in relation to local crops, particularly traditional varieties. How does this affect agrobiodiversity? What rights do farmers have?

# The "rush for land": commercial pressures and land rights

Following a series of highly publicised transnational agreements involving the lease of land areas of unprecedented size, the International Land Coalition (ILC) Secretariat launched a vast research programme on the global commercial pressures on land. Coordinated by CIRAD, this programme provides accurate analysis of several case studies, as well as thematic and regional research. Its findings create new possibilities and inform the debate at different decision making levels.

## PARTNERS

International Land Coalition (ILC), International Institute for Environment and Development (IIED), AGTER, Center for International Forestry Research (CIFOR), RRI, OECD-SWAC, World Trade Institute, CEPES (Peru), Observatoire du Foncier (Madagascar), SCOPE (Pakistan), Kenya Land Alliance, ARNow! (Philippines), RCN justice et démocratie (Rwanda), Centre for Development and Environment (CDE, Switzerland), German Institute of Global and Area Studies (GIGA, Germany), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ, Germany)

**L**ARGE-SCALE LAND TRANSACTIONS recently made the headlines. But under what conditions is this phenomenon developing and what are its repercussions? A global research programme launched by ILC and coordinated by CIRAD provided answers to these questions. It was based on 28 case studies, thematic studies and regional overviews. It involved more than 40 organisations from the countries concerned and from civil society, universities and research institutes from around the world; this broad participation was evidence of its ownership and use by all stakeholders.

## Key failures of governance

The findings of this project suggest that the negative impacts of this "rush for land" are due to four key failures of governance, which encourage this investment and exacerbate its consequences.

The first of these is the weakness of democratic governance:

despite advances in democratisation around the world, huge deficits of transparency, accountability, and popular empowerment exist and contribute to elite capture of resources.

The second concerns land governance that fails to secure land rights: many national legal systems centralise control over land and undermine or fail to legally recognise the land rights of local landholders, thereby paving the way for lawful –if unjust– large-scale allocations of land.

The third is linked to economic governance and international trade, which fail the rural poor: The international trade and investment regime provides robust legal protection to international investors, while fewer and less effective national arrangements have been established to protect the rights of the rural poor or to ensure that greater trade and investment translate into sustainable development and poverty reduction.



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Finally, the last of these failures concerns the sidelining of smallholder agriculture: agricultural development policy has increasingly been captured to the benefit of large-scale commercial ventures, undervaluing the potential of family farms and excluding smallholders as partners. Despite the mixed track record of large-scale agriculture in Africa, the perception that large farms are needed to modernise the sector remains dominant among policy-makers.

## A complex phenomenon

Since this study, it has become clear that this land grabbing phenomenon is really more diverse, of a larger scale, and perhaps less novel that it had first appeared. While the most publicised deals have been transnational in nature

and focused on food and biofuel production, they are hard to separate analytically from wider trends of increasing commercial pressures on land characterised by a broader range of actors, scales, and economic drivers. They are part of longer-term historical processes of economic and social transformation. Yet with the intensification of commercial pressures on land since the food price crisis of 2008, these processes have entered a new phase. It is in this sense that this report speaks of a new "land rush". ■

Anseeuw W., Alden Wily L., Cotula L., Taylor M., 2012. *Land rights and the rush for land*. Rome, International Land Coalition, Research report, 84 p.

<http://www.commercialpressuresonland.org/>

[www.landportal.info/landmatrix](http://www.landportal.info/landmatrix)

## Land Matrix, a database of land transactions

Faced with the massive increase in land transactions, a partnership between ILC, CIRAD, CDE, GIGA and GIZ was established in 2009 to collate information on large-scale land acquisitions and leasing throughout the world. The database thus developed, called Land Matrix, concerns more than 2 000 transactions, which entail a transfer of rights to use, control, or own land through sale, lease, or concession, and generally a conversion from land used by smallholders to large-scale commercial use. It highlights the six main reasons behind this global rush for land: food, fuel, timber, carbon sequestration, tourism and mineral extraction. Land Matrix will be publicly accessible from April 2012. It is hoped it will lead to greater transparency in land investment.



# Sharing and coordinating research on rural land tenure in the South

*In the South, the high demand for land from new economic operators, whether national or international, and rapid changes in land policies are a major challenge for populations and governments. This is compounded by mounting pressure on natural resources and a commodification of land. The Montpellier-based Pôle de recherche sur le foncier rural dans les pays du Sud, formalised by the launch of a scientific interest group, was created to lead and disseminate research on these issues. It associates CIRAD, IAMM, IRD and SupAgro.*



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## PARTNERS

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THE WORK OF THE MEMBERS of the *Pôle foncier* is articulated around several activities: the coordination of multidisciplinary research on land tenure in the South; teaching and training; expertise; and information sharing and dissemination. In addition to its close partnerships, its connection with the *Comité foncier et développement* and its links with the *Maison des sciences de l'homme*, the *Pôle foncier* involves partners from the South in its activities (including Algeria, Côte d'Ivoire, Cameroon, Madagascar and Mexico). It also strives to strengthen the relationships established with French and foreign institutions working on land tenure issues: teaching and training institutes, and international organisations such as FAO and the World Bank.

In 2011, the *Pôle foncier* organised three events, two of which were in partnership with the *Maison des sciences de l'homme*: "Public intervention and land disputes in the South" in March; "Land and environment" in June; and "Agricultural investment and large-scale land purchases" in September.

The *Pôle foncier* also launched the *Journées doctorales*. From 12 to 15 December 2011, 17 PhD students from French and foreign institutions were able to present their research, benefit from advice from researchers and share views on their work. This meeting was of interest because of the range of disciplines involved (geography, economics, political science, sociology, anthropology, and law) and subjects covered (land rights, the dynamics of land-grabbing, agricultural contracts and land gov-

ernance). Another strong point of this event was that the work of the students concerned more than 10 countries: Colombia, Mexico, Madagascar, Burkina Faso, Mali, Senegal, Côte-d'Ivoire, Benin, Algeria, Thailand and New Caledonia. Buoyed by the success of this first edition, which brought together more than 60 people over four days, the *Pôle foncier* hopes to renew this meeting on a yearly basis.

Burnod P., Papazian H., Tonneau J.P., Jamin J.Y., 2011. Régulations des investissements agricoles à grande échelle : études de Madagascar et du Mali. *Afrique contemporaine*, n° 237, p. 111-129.

Burnod P., Anseeuw W., 2011. Acquisitions foncières à grande échelle dans le secteur agricole : une montée en puissance de (nouvelles) firmes agricoles ? In: *Colloque de Cerisy: Agriculture et alimentation dans un monde globalisé*, Cerisy-la-Salle, France, 22-28 September 2011.

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# Entrepreneurs or land grabbers? Land investment in the Office du Niger irrigation schemes in Mali

*The massive influx of foreign investors in agriculture in the countries of the South is attracting widespread attention. Mali, a land- and water-rich country, is not exempt from these land acquisition ventures. CIRAD's research aims to understand this process and its integration into a complex land tenure system in order to better determine the reality of these projects and to analyse their impact at the local and national levels.*

## PARTNERS

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IS IT POSSIBLE FOR INDUSTRIAL AGRICULTURE to coexist with small-scale agriculture in a sector requiring major investment, without jeopardising ecological and social balances? In Mali, in order to offset an increasing lack of capital for the development of new land, the government launched a call for investment in the irrigated farming sector at the *Office du Niger*. Based on geographical, historical, agricultural, sociological and political approaches, CIRAD examined the formal and informal aspects of the management of this sector. The implementation of laws, rules and regulations, and especially the "arrangements" made by stakeholders, was studied. The primary aim of this research is to analyse stakeholder practices and the relations between them as well as with others.

In 2009, at the peak of land allocation, 870 000 hectares were temporarily allocated to national and foreign investors, both public and private. The law states that before signing a lease, investors must conduct technical, environmental and social studies. But the majority of projects implemented by investors fail to meet all of the obligations: 390 000 hectares were revoked in 2011, but many projects led by investors are still underway, despite the discrepancies noted in relation to the



Equipment on the plot of a new Malian investor. © A. Adamczewski / CIRAD

law. This does not prevent the signing of new allocations, sometimes at the highest State level. The investors liaise with different people and, in certain cases, are granted land by the Presidency or by ministers (agriculture, housing, industry), whereas the rules stipulate that only the *Office du Niger* is responsible for this allocation. The conditions for installation and for access to water resources, which are very restrictive in the dry season, are also the subject of negotiations.

Analysis of the productivity of the different stakeholders' projects, from family farms to agro-industrial ventures, shows that the contribution of land investment to the government's development targets remains low. Of the 870 000 hectares allocated to investors, only 11 000 are cultivated, and 80% of these by family farmers, who are either employed by the investors or subtenants

of land placed on the market, which is illegal. Only five major public or private projects have produced any visible results in the field, or less than 4% of all the projects presented. The predominant agricultural model is that of family farming, which combines rice growing and market gardening, and provides most of the rice consumed in Mali.

The challenge is therefore to determine whether or not it is possible to set up a new type of public-private partnership capable of bringing together farmers and investors to guarantee the sustainable development of the *Office du Niger* irrigated land. ■

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Adamczewski A., Jamin J.Y., 2011. Investisseurs libyens, paysans maliens. *Le Monde diplomatique*, 58 (690): 20-21.

Adamczewski A., Jamin J.Y., Tonneau J.P., 2011. Investisseurs versus paysans locaux : vers quelle agriculture irriguée au Mali ? L'exemple du secteur sucrier. *Transcontinentales*, 10-11: 10 p.

# Participatory processes and the territorialisation of public policies in Brazil

*The international demands of the 1990s and 2000s encouraged countries to tailor their public policies to new processes and instruments: territorialisation and participatory democracy. In Brazil, the democratic transition provided new political opportunities for rural organisations. In the context of the federal policy to support rural areas implemented in 2004, CIRAD analysed these new orientations by assessing their strengths and weaknesses for the promotion of family farming.*

## PARTNERS

University of Brasília (Brazil), Ministry of Agrarian Development (Brazil), Colegiado Territorial das Águas Emendadas (Brazil).  
Agence nationale de la recherche (ANR), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, Brazil).

**P**ARTICIPATORY DEMOCRACY has opened up new prospects for stakeholders who were hitherto excluded from public policies, especially the representatives of landless farmers or smallholdings. Significant progress has been observed in terms of training and participation in public policy making for these new stakeholders. But taking a closer look, it is more specifically local leaders, the traditional representatives of agricultural communities, who have benefited from these new modes of participation. They have learnt how to profes-

sionally negotiate public policy projects for rural development.

These participatory procedures have strengthened the stakeholders' capacity to negotiate with public service technicians, thereby enabling them to become "transactional leaders" essential to the proper functioning of these public policies. The role played by these different actors is decisive in the implementation of policy guidelines, and participatory democracy paradoxically remains secondary. Moreover, territorialisation is hampered by the administrative structure, which is still dependent on the

federal system. Bureaucratic procedures to pay for and implement projects are proving overly restrictive. In spite of these new policy guidelines, farmers remain dependent on the expertise of technicians and agronomists. The latter are organised into socio-professional networks and have the capacity to select or even divert projects.

Massardier G., Sabourin E., Lecuyer L., Avila M., 2012. La démocratie participative comme structure d'opportunité et de renforcement de la notabilité sectorielle : le cas des agriculteurs familiaux dans le programme de développement rural territorial durable territorial au Brésil, territoire Aguas Emendadas. *Participation*, n° 2.

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# Rural advisory mechanisms

*After years of State withdrawal and the implementation of privatisation policies, there is renewed interest in agricultural advisory services. A special edition of Cahiers Agricultures was published to take stock of the debates underway in this field. CIRAD contributed to its coordination. It compiles research by several institutions from the North and the South.*

**A**GRICULTURAL ADVISORY SERVICES are back on the agenda. Their organisation at the regional level is the outcome of political choices and social relations between stakeholders, which have evolved over the course of time. These services swing constantly between a rationale of supervising farmers and one of supporting them; these are often led by different operators and may be contradictory. The growth in the number of stakeholders interacting within the agricultural and rural sphere, and the high increase in the risks and uncertainties surrounding agricultural production prompt questions about the role of advisory services, particularly within

innovation systems. A special edition of Cahiers Agricultures provides an overview of research in this field and brings together a number of studies conducted by CIRAD researchers.

After a literature review of scientific productions in the field of advisory services over the last 10 years, several contributions describe the public policies implemented for these services and examine their impact on farmers' access to advice in Europe and America. These policies materialise in the specific establishment of farm support schemes. But these are deployed in a social arena in which other potentially competing mechanisms are already present.

Further articles explain the schemes and strategies of the organisations that implement advisory services in African countries. Private firms are setting up original mechanisms aimed at providing advice associated with the sale of their products, as is the case in France. Finally, several articles focus on the activities of advisors, how they conduct them, the resources available to them and the way they interact among themselves and with farmers. ■

Faure G., Compagnone C. (coord.), 2011. Transformations et diversification du conseil pour des agricultures en mouvement. Cahiers agricultures, 20, n° 5. <http://www.cahiers-agricultures.fr/>



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## AGREEMENTS, PARTNERSHIPS

The **World Agriculture Watch (WAW)** was launched in October at the FAO headquarters in Rome. Its aim is to characterise production structures and to analyse their impacts using environmental, social and economic indicators. The systemic approach and the involvement of stakeholders in its governance are what make the initiative original. The WAW involves FAO, the French Ministries of Agriculture and Foreign Affairs, IFAD, CIRAD and numerous experts.

The **Alliance nationale de recherche pour l'environnement**, AllEnvi, created in February 2010, has published its first progress report. Its goal is to plan and coordinate environmental research at the national level, focusing on food, water, climate and regional issues.

The **Centre d'Etude de la Biodiversité Amazonienne (CEBA - French West Indies and Guiana)** has been designated a **laboratory of excellence (LABEX)** as part of the French investments for the future programme. Through CEBA, the whole biodiversity community has been strengthened in French Guiana, but also in the Amazon-Caribbean area, within the scope of the multi-regional University of the French West Indies and Guiana.

The aim of the **Géosud EQUIPEX** project coordinated by IRSTEA is to develop a national **satellite data infrastructure** for use in regional management, environmental monitoring and the prevention of natural risks (floods, fires), etc. It involves 14 institutions, including CIRAD.

Snake gourd flowers, Réunion.  
© Michel Roux-Cuvelier / CIRAD



## COMMUNICATION, CONFERENCES

CIRAD hosted the annual conference of the **Plant Virus Ecology Network (PVEN)** in Montpellier in May. The aim of these annual conferences is to bring together two communities, ecologists and virologists, in order to lay the groundwork for a new discipline: plant virus ecology.

The **Réseau des irrigants méditerranéens (RIM)**, led by CIRAD, ENAM, ENSA, Farm Foundation and Montpellier SupAgro, organised a seminar in October in Montpellier on saving water in irrigated systems.

The first summer school of the European **Imagine 2020 - Art and Climate Change** Network, in connection with the International Year of Forests, brought together scientists and artists around the theme of trees and forests for three days in Montpellier in August.

**Rare species, endangered plants.** Photographs from the CIRAD, CNRS and IRD archives on the theme of biodiversity were exhibited in June at the Collège de France, Paris. The exhibition was organised by the magazine *La Recherche* with *LVHM Recherche*, within the framework of the *Science, Recherche et Société* forum.

The managers of the **French tropical biological resource centres (BRCs)** met in Réunion in March, at the Plant Protection Platform (3P). The five French BRCs, based in Réunion, the French West Indies, French Guiana and Montpellier, joined forces through a project, Inter-Trop, to pool their efforts in terms of plant collection management and protection, and to make up one of the world's leading tropical plant reserves.

## PUBLICATIONS

**Savoirs et développement rural : le dialogue au cœur de l'innovation.** Coord. D. Clavel. Ed. Quae. To what kind of rural development do we need to return? The author describes several innovative African initiatives, which respect the identity of rural populations.



**Companion modelling: a participatory approach to support sustainable development.** Coord. M. Étienne. Ed. Quae. To implement participatory approaches in the sustainable management of renewable natural resources, companion modelling is a particularly original method.

**Le travail en agriculture : son organisation et ses valeurs face à l'innovation.** Coord. P. Béguin, B. Dedieu, E. Sabourin. Ed. L'Harmattan. A book on the innovation strategies and organisation of animal and crop farmers, and the values attached to their professions.

**Quels nouveaux défis pour les agricultures irriguées ?** A special issue of *Cahiers Agricultures* on the new questions surrounding irrigation, the challenges they raise and the main changes underway.



## PUBLICATIONS

**Fruits et légumes lontans, fruits et légumes d'antan.**

M. Roux-Cuvellier, D. Vincenot. Ed. Orphie.  
A comprehensive overview of *lontan* fruit and vegetables, which have been grown since the 18<sup>th</sup> century in Réunion. These fruit and vegetable varieties are now coming back into favour.

**Tropix 7.0: technological characteristics**

**of 245 tropical wood species.** CIRAD. This new version of the Tropix software presents the technological characteristics of 245 tropical or temperate wood species. Tropix allows multi-criteria searching of species.

**Prise en compte de la biodiversité dans les concessions forestières d'Afrique centrale.**

A. Billand, J. Fournier, L. Rieu, O. Souvannavong. CIRAD, FAO. A study based on a survey of 26 forestry firms, along with official services, research consultancies and NGOs in the countries of the sub-region.

**A paradigm shift in livestock management: from resource sufficiency to functional integrity.**

B. Hubert, T. Kammili, J.F. Tourrand. Ed. Cardère.  
In the field of sustainable resource management, livestock rearing is the subject of considerable criticism. But is the reality that simple? The authors explore novel approaches to managing livestock systems throughout the world.

**Ecosystem services from agriculture and agroforestry measurement and payment.**

B. Rapidel, F. DeClerck, J.F. Le Coq, J. Beer. Ed. Earthscan.  
The authors analyse the implementation of payments for ecosystem services in central Europe and South America and draw some lessons from these.

**Baobabs between sky and earth - When satellites observe *Adansonia grandidieri*.**

DVD. This documentary shows how satellite images can be used to find out more about these trees and the biodiversity of Madagascar.

**Special reports of the journal *Bois et forêts***

**des tropiques:** n° 305 focuses on carbon storage and planted forests; n° 306, on baobabs; n° 307, on landscape dynamics; and n° 308, on ecological structures and indicators.

**Vibrations de poutre : caractérisation acoustique du matériau bois pour son utilisation en structure.**

L. Brancheriau. Ed. Universitaires Européennes.  
A book analysing the range of non-destructive methods that serve to improve classification of wooden joists for use in construction.

# Resilience: a school of thought for adapting and transforming social-ecological systems

The school of thought of resilience offers a specific reading of interdisciplinary concepts to deal with changes in social-ecological systems, especially adaptation and transformation. Researchers that have developed these concepts are gathered within the Resilience Alliance association, of which CIRAD is a member. In 2011, researchers from CIRAD organised several scientific events with their partners.

**T**HE RESILIENCE ALLIANCE ASSOCIATION is the initiative of a group of scientists structured around the concept of social-ecological resilience. The members of the association form a network of some 20 geographical "nodes" throughout the world. Today, this network is one of the global references on the linkages between society and environment. CIRAD is the main operator of the French node, which includes CNRS, INRA and IRSTEA.

**The adaptation and transformation of social-ecological systems**

Social-ecological resilience, unlike physical resilience, concerns complex systems and describes their ability to absorb disturbance and still retain their basic functions and structure. This school of thought examines changes and trajectories of social-ecological systems through two complementary concepts, adaptation and transformation, both of which are based on learning processes and

collective action. While adaptability is the capacity to strengthen the resilience of a given function and structure of a social-ecological system, transformability is the ability to actively change these in order to move away from undesirable situations.



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## PARTNERS

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## Resilience, water, aquatic environment and foresight

In January 2011, CIRAD and IRSTEA organised a seminar on "Resilience, water, aquatic environment and foresight" with the support of the French Ministry of Ecology. This seminar brought together more than 80 researchers and practitioners involved in water and regional management. The aim was to foster discussions within the French community on the mobilisation of concepts of resilience, viability and vulnerability of social-ecological systems and adaptive management in connection with regional governance and foresight studies. Several articles were published

further to this seminar to disseminate these theoretical frameworks and tools among the French public.

### Comparing the different schools of thought

The disciplinary and thematic development of the school of thought on resilience makes its comparison with other schools increasingly necessary and promising. During the second international conference dedicated to resilience thinking, "Resilience 2011", held in Phoenix, United States, researchers from CIRAD and IRSTEA led a session on participatory modelling approaches involving multiple levels of organisation, including the COMMOD

approach developed by CIRAD. The identification of the specific issues associated with climate change was also addressed. The next international conference, which will be held in 2014 in Montpellier, will be the opportunity to pursue this momentum between the different schools of thought on numerous subjects: development, innovation and learning, ecosystem services, and participatory and foresight approaches.

Botta A., Barreteau O., Bousquet F., Deffuant G., Litrico X. *La résilience de l'eau et des milieux aquatiques comme fil rouge d'une prospective sur l'eau et les territoires*. Chromatiques éditions, collection Le point sur. [forthcoming].





# Red locusts, pests under close surveillance in Madagascar

To address the risk of potentially catastrophic plagues of locusts, CIRAD has been using its scientific expertise to help the Madagascan authorities for over ten years, especially at the Centre national antiacridien (CNA), which is responsible for the permanent monitoring and control of two species, red locusts and migratory locusts. Its research on red locusts now helps to better identify risk areas and to detect at a very early stage conditions favourable to the development of outbreaks.



© Michel Lecoq / CIRAD

## PARTNERS

Centre national de recherche appliquée au développement rural (Fofifa, Madagascar), University of Tulear (Madagascar), Centre national antiacridien (CNA, Madagascar), French Ministry of Foreign Affairs, African Development Bank.

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Pests and Diseases:  
Risk Analysis and Control

**M**ADAGASCAR HAS SUFFERED frequent plagues of locusts in the past, and the last one, which occurred in 1997-1999, was primarily due to the migratory locust, *Locusta migratoria*. But from the north to the south of the island, the Madagascan authorities have also had to deal with numerous swarms of red locusts, *Nomadacris septemfasciata*, a major pest for crops and grasslands. Research conducted in the field is aimed at furthering knowledge of the ecology of the red locust and improving monitoring and control strategies. The latest findings, published in 2011, have provided a clearer understanding of what determines outbreaks and a precise definition of the areas most suited to the development of swarms.

## Ecology of red locusts

Red locusts produce just one generation per year and make considerable seasonal migrations within

the island. They spend the duration of the dry season in reproductive diapause, and reproduction takes place during the rainy season. Mating and egg-laying occur in November and December, and eggs and larvae develop from December to February. Fledglings appear in March and April. The quantity and regularity of rainfall in December and January is decisive: it can result in very high mortality for eggs and larvae.

## Closer monitoring in the rainy season

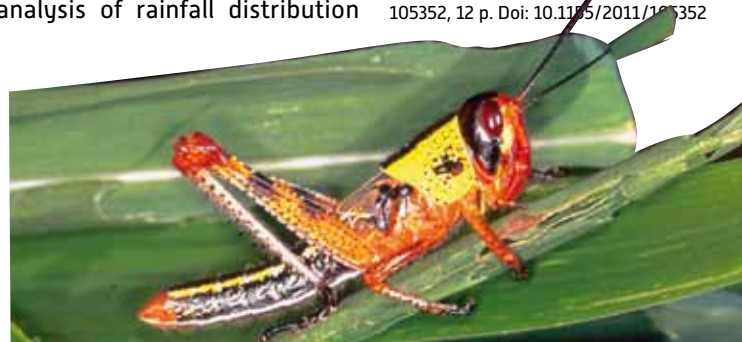
Monitoring must therefore be increased in the main breeding areas at the beginning of the rainy season. One small south-western fringe, which is currently insufficiently monitored by the CNA, has been identified as having the strongest probability of gregarisation and outbreak. Better monitoring of local rainfall levels and distribution in December and January is also recommended. The optimal amount of rainfall for red locusts is between 250 and 300 mm per month. Real time analysis of rainfall distribution

makes it possible to determine this risk, which increases when rainfall is regularly distributed in time and diminishes during dry spells of more than three weeks. Finally, better monitoring of deforestation, which creates new habitats favourable to outbreaks, is also needed.

By applying this strategy for the prevention and management of red locusts, it is now possible to better predict and control outbreaks in Madagascar. However, this pest has a tendency for frequent small and local swarms. The CNA will therefore need to take measures to combat potential plagues as well as to provide locust-control assistance to rural communities.

Lecoq M., Andriamaroahina T.R.Z., Solofonaina H., Gay P.E., 2011. Ecology and population dynamics of solitary Red locusts in Southern Madagascar. *Journal of Orthoptera Research*, 20: 141-158.

Lecoq M., Chamouine A., Luong-Skovmand M.H., 2011. Phase-dependent color polyphenism in field populations of red locust nymphs [*Nomadacris septemfasciata* Serv.] in Madagascar. *Psyche, a Journal of Entomology*, Special issue on Locusts and grasshoppers: behaviour, ecology, and biogeography, ID 105352, 12 p. Doi: 10.1155/2011/105352



© M. Lecoq / CIRAD

# Nematodes, bioindicators of soil quality

In banana agrosystems that are currently being converted to more sustainable cropping methods, the goal is to reduce pesticide use and to adopt cropping practices based on ecological intensification. To determine the biological quality of soil and to assess the impact of cropping practices on soil food webs, a team from CIRAD has used analysis of the structure and functional diversity of soil nematode communities.

## PARTNERS

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**I**N AGROSYSTEMS, the study of soil biological functioning provides a clearer understanding of the impact of cropping practices or of any other disturbance (pollution, climate change, etc.). Living organisms in the soil play a key role in the breakdown of organic material, carbon sequestration, the recycling and mineralisation of nutrients and biological regulation.

Nematodes are one of the most abundant taxa among soil invertebrates (several tens of millions of individuals per square metre). They are first-rate bioindicators for monitoring the biological quality of soils. They have a significant impact on soil processes, especially through their influence on biomass and microbial populations. Nematodes also play a role in mineralisation. Their specific trophic and functional diver-

sity, as well as their ecology, make them sensitive to anthropogenic or environmental disturbances. A team from CIRAD monitored soil nematode communities in banana plantations being converted to ecological intensification practices.

## Monitoring soil biological quality using nematodes

The study was conducted by coupling the abundance of functional groups of soil nematodes to the use of diversity indicators and ecological indicators, based on these same functional groups and describing the condition of the "soil environment". The team thus showed, using microcosm studies, that soil amendment using certain raw or composted organic materials results in a decrease in the nematode populations in the banana plant roots, the intensity of this regulation depending on the species of plant-parasitic nematode. The mechanisms at work are not yet fully understood, but the organic amendments were marked by a differentiated increase in populations of microbivorous nematodes.

Lignocellulosic materials, which are slow to biodegrade, favour the increase in fungivorous nematode populations, whereas those that biodegrade more rapidly, mostly made up of hemicelluloses and soluble fractions, stimulate

Multispecific association of cover crops  
to reintroduce biodiversity into banana agrosystems.

© H. Tran Quoc/CIRAD





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growth in bacterivorous nematode populations. Some organic materials, after having increased fungivorous nematode populations, also cause an increase in predatory nematode populations, even though no causal relationship with the biological regulation observed has yet been demonstrated.

**Field tests**

Field research has shown that tillage decreases the number of functional groups of nematodes, especially by reducing the omnivores and predators at higher trophic levels. Other studies show that adding a cover crop to a banana agrosystem increases the

abundance and diversity of non-plant-parasitic nematodes, while making the soil food webs more complex through the development of higher levels.

All of this research points the way towards the cautious implementation of ecological intensification strategies. The use of cover crops or of exogenous organic materials could then be dependent on their capacity to improve the biological functioning of soils and to foster certain biological regulation processes.

Cephalic region and oral cavity of a predatory nematode showing a tooth (Mylonchulidae). © J.M. Risède/CIRAD

Tabarant P., Villenave C., Risède J.M., Roger-Estrade J., Thuriès L., Dorel M., 2011. Effects of different organic amendments on banana parasitic and soil nematode communities. *Applied Soil Ecology*, 49: 59-67.

**Pl@ntWood: a tool for the identification of Amazon trees****PARTNERS**

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WOOD ANATOMICAL CHARACTERISTICS are widely used by specialists to identify trees. In order to make this expertise available to a large number of people, CIRAD designed a software programme for interactive, user-friendly identification, based on the IDAO computer-aided identification system.

In total, 110 species belonging to 34 neotropical families were chosen. The samples and microscopic images of these trees come from CIRAD's tropical wood collection in Montpellier, one of the largest in the world. The 22 anatomical characters selected to describe them, with their 96 states, are based on anatomical descriptions from the literature and from the international InsideWood database.

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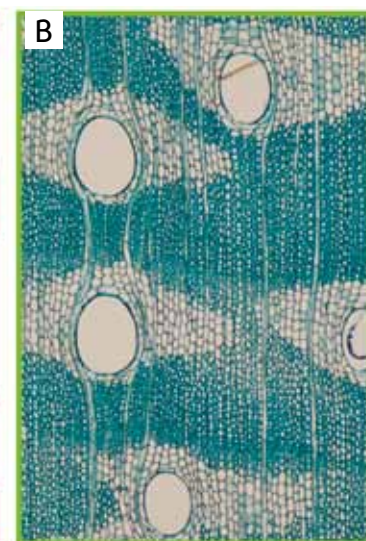
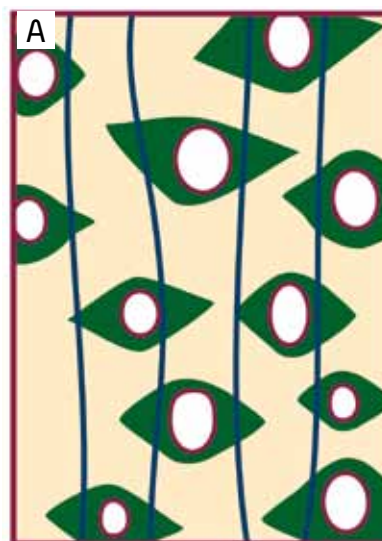
Pl@ntWood will naturally be used in the fields of conservation biology and forest science, but also in that of training. It is a free application available on the site of the Pl@ntNet project.

Sarmiento C., Detienne P., Heinz C., Molino J.F., Grard P., Bonnet P., 2011. Pl@ntWood: A computer-assisted identification tool for 110 species of Amazon trees based on wood anatomical features. *Iawa Journal*, 32: 221-232.

<http://community.plantnetproject.org/pg/file/read/4240/plntwoodexe>

Cross section of wood *Ormosia paraensis* (Fabaceae). Observation of isolated vessel elements, paratracheal axial parenchyma aliform and fibres (support): A) example of vector graphics, B) photograph of thin section.

© C. Sarmiento / CIRAD



# Defining indicators to certify sustainable palm oil production

*The production of palm oil is often blamed for the degradation of natural resources and for environmental problems. Faced with these accusations, the Roundtable on Sustainable Palm Oil (RSPO) led in 2007 to the adoption of a certification scheme shared by more than 500 operators in the sector. CIRAD, which is strongly committed to the implementation of a policy on the sustainable development of palm oil production, actively supports this process.*

## PARTNERS

Roundtable on Sustainable Palm Oil (RSPO), Center for International Forestry Research (CIFOR), SMARTRI, New Britain Palm Oil Limited, Centro de Investigación en Palma de Aceite (CENIPALMA, Colombia), Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), Institut national de la recherche agronomique (INRA), Institut de recherche pour le développement (IRD), Zoological Society of London (ZSL, United Kingdom), Cambridge University, Agence nationale de la recherche (ANR), ASEAN-EU, ICOPE Series

THE CERTIFICATION SCHEME adopted in 2007 by the RSPO, recognisable by its logo CSPO (Certified sustainable palm oil), is based on the definition of 39 criteria grouped around eight principles. They take into account all factors for sustainable production in view of global threats. To be effective, these criteria must be accompanied by new tools and quantified indicators of the socio-economic and environmental impacts of the numerous oil palm production systems.

CIRAD is contributing to several projects that will help to increase the scientific credibility of the certification scheme. A web platform, PALMINET, was launched in 2011 by the international network on sustainable palm oil indicators. Coordinated by CIRAD, this platform aims to inform all actors in the sector, to pool research and experience sharing efforts, and to foster the creation of indicators and tools for sustainable development. It also works to encourage new partnerships and to ensure information reaches a wide audience throughout the world. Furthermore, the teams played a part in the development of a greenhouse gas calculator for an RSPO working group. In 2012 and for a period of three years, CIRAD will lead the sustainable palm oil production (SPOP) project. The goal is to characterise the different palm

oil production systems in Indonesia and Cameroon. Their agricultural, ecological and social impacts will be assessed using robust indicators. A multi-agent model will be used to model land use change scenarios.

These scientific elements will serve as the basis for the revision of the principles and criteria of RSPO certification, which will begin in 2012. In the long run, they will help to improve the assessment of sustainability in this sector.

Chase L., Bessou C., 2011. Introduction to PalmGHG. The RSPO greenhouse gas calculator for oil palm products. In: *RSPO Roundtable 9*, 22-24 November 2011, Borneo, Malaysia.

Palm oil and palm kernel oil, agreement on an incomparable oil output, but not on nutritional qualities or environmental impacts.

Manure spreading: what are the impacts of the different means of treatment and of organic fertiliser application?

A year-round harvest that employs a large workforce. © C. Bessou / CIRAD



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## Sustainable Amazon wood extracts

DURING THEIR EVOLUTION, trees have developed defence mechanisms enabling them to protect themselves against attacks from insects and fungi. To do so, they activate secondary metabolic pathways, resulting in the synthesis of protective molecules. Every ligneous species thus produces its own chemical defences, and their biological properties are highly diverse. The French Guianan laboratory of molecules and materials is studying the potential of these molecules, in particular the possibilities for using them to transfer resistance to attacks from durable species to non-durable species.

The research focused on the antifungal properties of extracts from several Amazonian species: *Andira surinamensis*, *A. coriacea*, *A. intermis*; *Manilkara huberi*, *M. bidentata*; *Tabebuia serratifolia*, *T. impetiginosa*; *Bagassa guianensis*, *Qualea rosea*, *Sextonia rubra* and *Vouacapoua americana*. It showed that these extracts can confer resistance to wood species that have none. Produced using waste from sawmills and forest slash in French Guiana, these extracts will generate considerable added value for this waste and will provide active agents for wood treatments. Their production has been patented.

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*Extraits de bois durables amazoniens, leur procédé d'obtention et leur utilisation comme agent biocide. Patent n° BIP206417FR00.*

Amazonian wood extracts.  
© N. Amusant / CIRAD



## Predicting the quality of organic matter using rapid analysis techniques

*Near infrared spectroscopy (NIRS) is an interesting analytical method for rapidly characterising organic matter. It has many uses in this field. CIRAD uses it in particular in Réunion to analyse the organic status of soils.*

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**N**EAR INFRARED SPECTROSCOPY (NIRS) is an analytical technique widely used to characterise organic matter. Once the calibration equation has been developed to convert a spectrum into a parameter of interest, such as the concentration of a constituent (water, organic compounds), this technique provides an inexpensive and very rapid way to determine this parameter (spectral acquisition and interpretation in just a few minutes).

It is used to characterise organic matter for several purposes. During above-ground transformations, it is used to control or model the processes at work and to monitor the production of organic fertilisers in order to achieve a given quality. It also serves to develop typologies of

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NIRS can be used to qualify the agricultural potential of poultry litter directly in the hen house. © T. Rottatinti/CIRAD



organic matter with a view to assessing strategies for potential uses, whether for energy, through combustion or anaerobic digestion, or for agriculture. During transformations in soil, it is used to predict or model the evolution of organic matter added to the soil, such as the transformation of nitrogen and the mineralisation of carbon. It is also a means to develop indicators of the quality of organic matter, to adapt these to standardisation or to the introduction of new standards, or to define technical recommendations concerning methods and quantities for the spreading of organic products, with the possibility of intervention in the field.

Near infrared spectroscopy may be used on new organic matter from agro-industry and urban areas, or on "traditional" organic matters, whose quantity and quality evolve with the adoption of new production systems. It is currently being used to analyse the organic status of soils in Réunion.

Peltre C., Thuriès L., Barthès B., Brunet D., Morvan T., Nicolardot B., Parnaudeau V., Houot S., 2011. Near infrared reflectance spectroscopy: a tool to characterize the composition of different types of exogenous organic matter and their behaviour in soil. *Soil Biology and Biochemistry*, 43: 197-205. Doi: 10.1016/j.soilbio.2010.09.036

Sabatier D., Dardenne P., Thuriès L., 2011. Near infrared reflectance calibration optimisation to predict lignocellulosic compounds in sugarcane samples with coarse particle size. *Journal of Near Infrared Spectroscopy*, 19: 199-209.

## Composting: recycling waste to produce fertilisers

### PARTNERS

Agence de l'environnement et de la maîtrise de l'énergie (ADEME), Pôle régional de recherche appliquée au développement des systèmes agricoles d'Afrique centrale (PRASAC, Chad)

IN THE SOUTH, the agricultural value of organic matter from waste is more topical than ever: this matter has often become the main input for production systems and conditions food security. This agricultural use is also a response to the proliferation of household waste in urban areas, which poses a serious problem for the environment and public health. Using the expertise acquired during projects conducted in diverse contexts, CIRAD and its partners have developed

methods for achieving agricultural waste recovery through composting, which can be adapted to local specificities.

To disseminate these methods and to promote a real policy for the agricultural management of this organic matter, CIRAD, ADEME and PRASAC organised a seminar in Douala, Cameroon, in September 2011. This seminar brought together 20 participants

—researchers and managers— from 8 countries, mainly belonging to the Central African Economic and Monetary Community (CEMAC), to discuss challenges and conditions for the use of organic matter from household and organic waste in the South.

CONTACT Denis Montange, [denis.montange@cirad.fr](mailto:denis.montange@cirad.fr), Recycling and Risk



Household waste in the landfill site in Douala. © D. Montange / CIRAD



Visit to the landfill site in Douala. © D. Montange / CIRAD

## Towards integrated waste management in Réunion

### PARTNERS

Chambre d'agriculture de la Réunion, Fédération régionale des coopératives agricoles de la Réunion (FRCA), Société industrielle des engrais de la Réunion, Etablissement public local d'enseignement et de formation professionnelle agricole de Saint-Paul (Eplefpa), La Créole, Communauté d'agglomération Territoire de la Côte Ouest (TCO)

AGRICULTURE IN RÉUNION depends on imported chemical fertilisers. At the same time, patterns of production and consumption are generating increasing amounts of refuse, which ends up in landfill sites, despite the recognised agricultural potential of some of this waste. In particular, animal manure, droppings and slurry, green waste and sewage sludge can be recycled to produce organic fertilisers locally. This is

a simple idea in theory, but is difficult to put into action at the level of a sub-urban area in Réunion of 200 000 people. The team of the GIROVAR project, which has just begun, has identified three major problems: a lack of technical knowledge; a dearth of social capital between stakeholders; and the predominance of a "waste" rationale, which must be converted into a "product" approach.

The aim of this research, conducted in partnership with professionals in Réunion, is to design, explore and assess scenarios for the integrated management of organic waste on a regional scale. The project's participatory structure is based on a "policy" steering committee, which is separate from the "technical" committee made up of representatives of the different stakeholders. Workshops organised with farmers are the opportunity to disseminate the findings of the project, to foster social learning among participants and, in return, to inform scientific teams about research issues.

[www.girovar.com](http://www.girovar.com)

CONTACT Tom Wassenaar, [tom.wassenaar@cirad.fr](mailto:tom.wassenaar@cirad.fr), Recycling and Risk

Workshops organised with farmers are the opportunity to disseminate the findings of the project and to foster social learning among participants.

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# Indicators

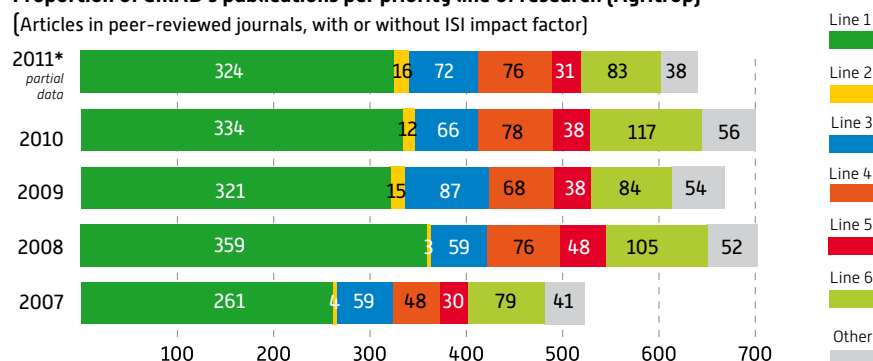
In 2011, CIRAD has continued to apply the *State-CIRAD Agreement on Objectives*, which is nearing completion after the 2008-2011 4-year plan, in accordance with the commitments made to its supervisory ministries. The *Agreement* is based on four main priorities: sharing science to meet the challenges facing southern countries, producing scientific output that is varied and of high quality, opening up national agronomic research to Europe and the rest of the world, adapting the organisation's structure and resources to meet new challenges.

## Sharing science to meet the challenges facing southern countries

"The aim of sharing science to meet the challenges facing southern countries" is to adapt existing forms of scientific partnerships in order to address research issues that are pertinent for development in southern countries. Mobilising teams to work on the six priority areas of action set out in CIRAD's strategy, as well as building capacity in southern countries, are central to this challenge.

### Proportion of CIRAD's publications per priority line of research (Agritrop)

[Articles in peer-reviewed journals, with or without ISI impact factor]



\*The publication indicators reflect the status of the institutional database, Agritrop, at closing on 28th February 2012. The data and indicators shown for 2011 are partial.

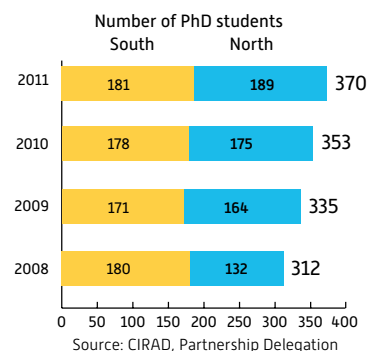
CIRAD has chosen to develop a balanced and sustainable partnership with its scientific partners in southern countries. This is shown by the share of joint publications with southern countries (almost 50 % of all the co-publications in 2011, partial data) and the regular increase in the percentage of co-publications between CIRAD and southern institutions smoothed over a 3-year period, between 2007 and 2010 (from 43.26 % to 47.03 %). The increase in the number of PhD students from southern countries, supervised by CIRAD's researchers, slowed down in 2009 but went up in 2010 and 2011.

### Co-publications with researchers in developing countries<sup>1</sup>

Researchers from southern countries	2005	2006	2007	2008	2009	2010	2011 partial data
Number of co-publications	186	194	238	309	329	329	318
Annual average smoothed over 3 years	---	---	206	247	292	322	325
Total number of publications analysed	443	448	522	702	667	701	640
Share [%]	41.99	43.30	45.59	44.02	49.33	46.93	49.69
Share [%] of annual average smoothed over 3 years	---	---	25.62	27.45	27.50	25.41	25.15

1. A country is classified as a developing country if it is on the OECD list of countries that receive public development aid. Source: Agritrop. Data for 2011 is incomplete (as at closing on 28th February 2012)

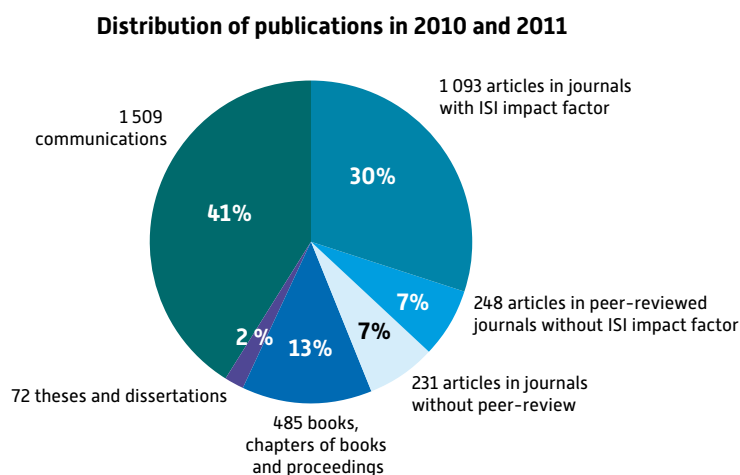
### Supervision of PhD students by CIRAD researchers



# Diversified and high quality scientific output

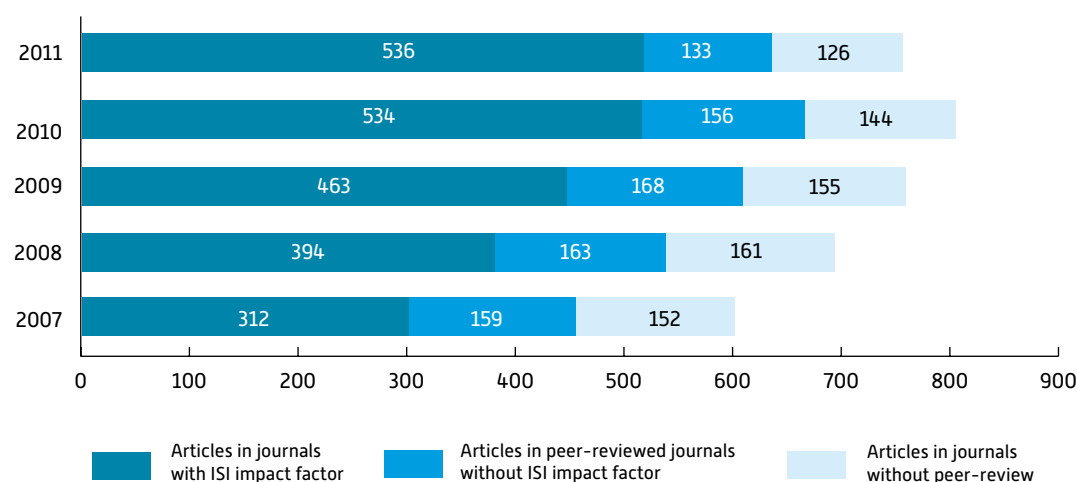
In order to ensure that science for development attains the highest international scientific level and yet remains relevant to the issues, areas and partnerships specific to southern countries, CIRAD is striving to improve the quality of its scientific publications and the competitiveness of its teams. At the same time, CIRAD is ensuring the diversity of its outputs, which are aimed at different audiences.

The quality of the scientific output is progressing, with a considerable increase in the number of articles published between 2007 and 2010, particularly in reviews with a high impact factor (ISI). CIRAD researchers are gradually becoming more qualified (number of directors of research). The success rate for calls to tender for projects (ANR) went up again in 2011. CIRAD researchers were more involved in training activities in and through research in 2011 (number of hours of practical work equivalent in Masters courses in southern countries and number of "consultant professors"). Technology transfer and development output has dropped slightly.



Source: Agritrop. Data for 2011 is incomplete (as at closing on 28th February 2012)

## Change in the number of articles published in journals since 2007 smoothed over 3 years



Source: Agritrop. Data for 2011 is incomplete (as at closing on 28th February 2012)



### CIRAD's participation in ANR competitive calls to tender

	2007	2008	2009	2010	2011
Number of projects submitted	75	72	49	65	81
Number of projects funded	23	19	14	12	17*
Success rate [%]	31	26	29	18	22*

Source: CIRAD, European Delegation, ANR Mission.

\*These two figures are incomplete on 15/03/2012 (definite figures available end of June)

### CIRAD's involvement in teaching and training development for Masters and PhD courses in developing countries

	2007	2008	2009	2010	2011
Number of hours (practical work equivalent) of teaching and training development for Masters and PhD courses in developing countries	3978	4249	4439	4368	4531

Source: CIRAD, Partnership Delegation.

### Training for CIRAD's senior scientific staff

	2007	2008	2009	2010	2011
Number of research directors at CIRAD	82	90	99	102	132
Number of consultant professors at CIRAD	n.c.	36	52	53	61

Source: SIRH (HDR) Partnership Delegation.

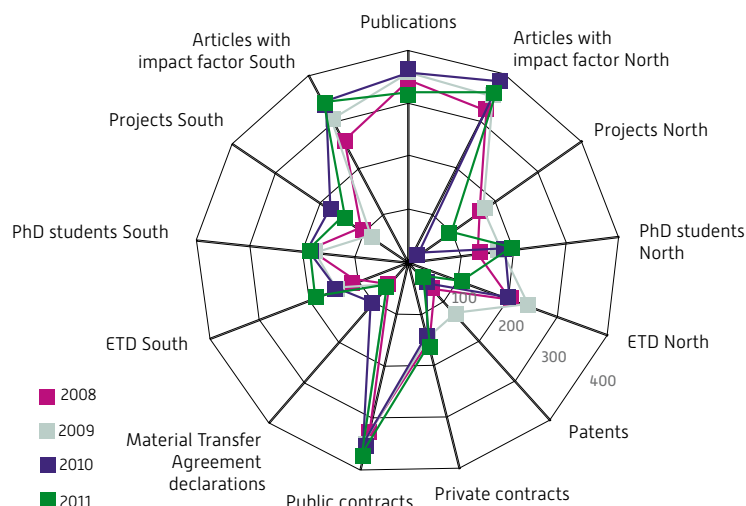
### Technology transfer and development: patents, proprietary variety protection certificates and software programmes

	2007	2008	2009	2010	2011
Number of applications for patents, proprietary variety protection certificates and software programmes (in brackets: number of patents attributed)	8 [2]	13 [0]	26 [4]	10 [5]	8 [2]

Source: CIRAD, Delegation for technology transfer and development.

### Assessing the diversity of CIRAD's scientific outputs

The set of outputs presented below illustrates the diversity of CIRAD's missions and activities. The diversity indicator for CIRAD's output was developed in 2010. The star-shaped diagram was designed on a pilot basis for the years 2007, 2008 and 2009 at the behest of the scientific committee. In 2012, the diversity indicator for the establishment's output was recalculated for the years 2007-2011. It is based on a selection of outputs that are weighted: firstly, publications (articles in peer-reviewed journals, with and without an impact factor: IF articles), PhDs supervised (PhD students), hours of Masters and PhD teaching (HPWE), participation in ANR and EU FP7 competitive projects ("projects"). For these indicators, the activities directly associated with researchers in developing countries are shown on the left opposite those that are directly associated with researchers from industrialised countries, shown on the right. Output that cannot be divided North/South is then added: books published, patents, PVPCs and software programmes, Material Transfer Agreement declarations (MTA), and contracts funded by the private and public sectors. 2011 was marked by an improvement in the weight attributed to outputs oriented towards developing countries (projects, teaching, supervision of PhD students).



## National agricultural research open to Europe and the rest of the world

Between 2008 and 2011, CIRAD has been operating on different levels: regionally, within research and training organisations, (PRES in Languedoc Roussillon and the French overseas departments and territories; the sustainable development campus in Nogent); nationally, in France as part of its alliance with INRA, which expanded in 2009 to become Agreenium, the national consortium, and with other research organisations involved in Programme 187, particularly IRD, and more recently with research alliances, such as AllEnvi; then, in Europe, with partnerships that have been reinforced; and lastly, internationally, with the renewal of its partnerships in southern countries via the research platforms in partnership and the strengthening of its links with the Consultative Group on International Agricultural Research [CGIAR]. In particular, the evolution in co-publications illustrates the priority in developing countries, Europe and internationally. In 2011, the overseas assignments carried out by CIRAD

researchers progressed (particularly in Asia, Latin America and French overseas departments and territories), with greater concentration on fewer platforms in partnership (21 PRPs, including 14 internationally and 7 in French overseas departments and territories). Moreover, there were fewer overseas missions in Asia, though more in Latin America.

### Co-publications with French, European or international researchers

*In order to eliminate annual fluctuations and identify trends more easily, it is common practice to consider certain indicators for publications by smoothing data, or proportions, over 3 years. The calculations indicate presence (non-additive values because, for example, the same article could be signed by a French researcher, as well as by an international researcher).*

Co-publications with French, European or international researchers – annual average smoothed over 3 years	2006	2007	2008	2009	2010	2011 <i>partial data</i>
French researchers (including INRA) (*)	---	210	256	289	306	299
European researchers (EU27 excluding France) (*)	---	51	72	82	100	101
International researchers (excluding EU27) (*)	---	234	284	336	372	370
Southern researchers (*)(**)	---	<206	247	292	322	325
Researchers from P187 (*) (***)	---	121	153	173	175	168
INRA (*)	---	78	105	116	119	110
Total number of publications analysed	---	471	557	630	690	669

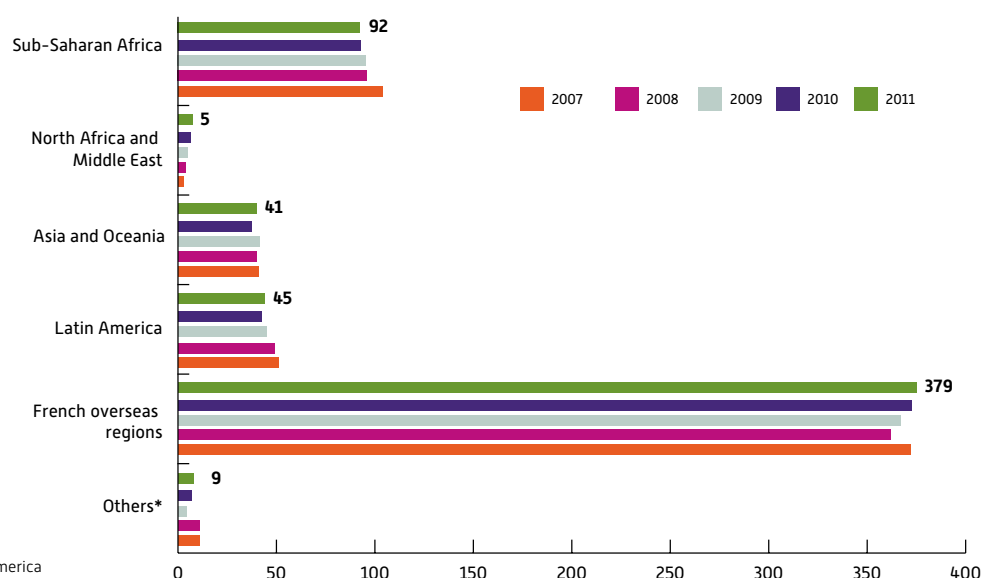
Source: Agritrop.

### CIRAD co-publications with each organisation in the LOLF Programme 187

Number of co-publications, data smoothed over 3 years	2005	2006	2007	2008	2009	2010	2011
BRGM	0	0	0	0	0	0	1
CEMAGREF	4	3	5	16	14	12	7
IFREMER	0	0	2	0	1	1	0
INRA	59	74	101	139	108	109	112
IRD	34	41	63	51	61	54	57
Total number of publications	443	448	522	702	667	701	640

Source: Agritrop.

### Distribution of overseas assignments (in full-time post equivalent). Source: SIRH

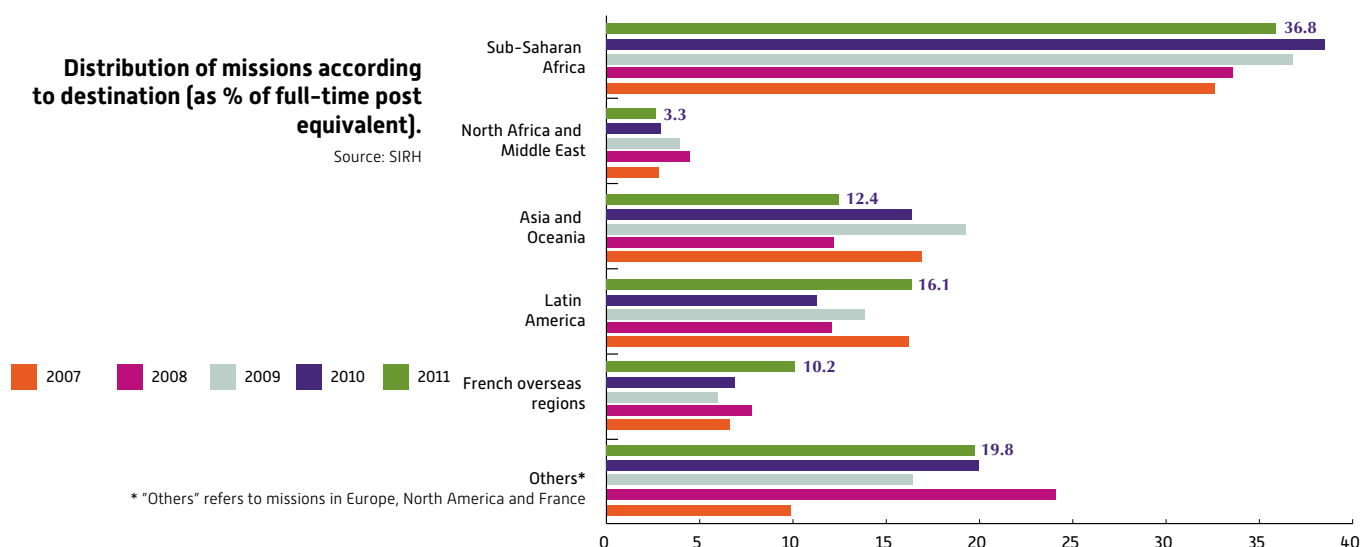


\*Others\* refers to assignments in Europe and North America



### Distribution of missions according to destination (as % of full-time post equivalent).

Source: SIRH



### Number of senior scientific staff assigned to platforms in partnership/number of senior scientific staff on overseas assignments (full-time post equivalent)

**2008:** 111 senior scientific staff at 18 platforms in partnership out of 291 expatriate scientific staff.

**2009:** 137 senior scientific staff at 23 platforms in partnership (20 international PRPs + 3 PRPs in French overseas departments and territories) out of 267 expatriate scientific staff.

**2010:** 149 senior scientific staff at 27 platforms in partnership (20 international PRPs + 7 PRPs in French overseas departments and territories) out of 273 expatriate scientific staff (5 more PRPs including 4 in French overseas departments and territories; 1 PRP less).

**2011:** 175 senior scientific staff at 21 platforms in partnership (14 international PRPs + 7 PRPs in French overseas departments and territories) out of 276 expatriate senior scientific staff (6 international PRPs less, following changes in the rules governing certification).

Region	National platforms in partnership (PRPs)	Regional PRPs	French overseas regions	PRPs in French overseas regions
<b>Africa</b>				
	URP PPZS, Senegal, Lines 1, 5, 6	ASAP, West Africa, Line 1	Réunion	3P, Line 1
	PRP-PCP, Zimbabwe, Lines 1, 4, 6	DPFAC Congo Basin forests, Central Africa, Lines 1, 2, 4, 6		Reagir, Line 6
	CR2PI, Congo, Lines 1, 6			Kappa, Line 3
	URP SCRID, Madagascar, Line 1			
	Forest biodiversity, Madagascar, Lines 2, 6			
<b>Asia</b>				
	HRPP PCP, Thailand, Line 1	RCP CANSEA (RACASE), South-East Asia, Line 1		
		GREASE Animal health and emerging diseases, Line 4		
<b>Latin America</b>				
	PCP-AFS-PC Agroforestry Systems with Perennial Crops, Central America, Lines 1, 2, 5, 6	Amazonia, Amazonian Basin, Line 6	Caribbean Guiana	Forests
	CIBA, Brazil, Line 1			Agro-ecology and multi-species cropping systems
				Biodiversity and genetics
				Animal health and emerging diseases, Line 4
<b>Mediterranean</b>				
	SIRMA, Maghreb, Lines 1, 3, 5, 6			

Source: CIRAD, Partnership Delegation

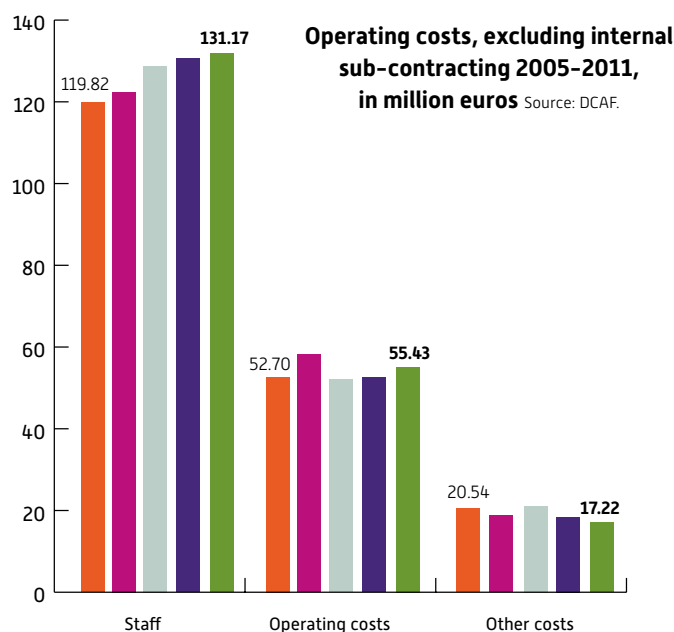
### CIRAD's EU research and development projects (FP7) between 2007 and 2011

Source: CIRAD, European Delegation.

	2007	2008	2009	2010	2011
Number of projects submitted	36	23	23	18	21
Number of projects funded	10	7	11	7	5
Success rate (%)	28	30	48	39	24
Number of projects coordinated by CIRAD	0	4	3	2	3

# A structure and resources adapted to meet new challenges

In addition to simplifying and modernising its management methods so that they are more effectively driven by its scientific objectives, CIRAD is making the most of its human and financial resources by ensuring a degree of stability.



CIRAD is still working on the stabilisation of its operating costs as a result of the stagnation in public subsidies, which has an impact on the change in the number of agents (full-time staff and grant-funded students). The increase in contracted resources linked to the European structural funds has facilitated an internal redistribution (incentives). The quality approach, which aims to simplify and improve efficiency, assigned even more scientific and administrative staff in 2011.

## Total number of CIRAD staff (full-time post equivalent)

FTPEs at CIRAD	2007	2008	2009	2010	2011
Number of "classified paid" permanent contracts	1770	1755	1764	1752	1739
Number of grant-funded PhD students	24	48	71	83	81

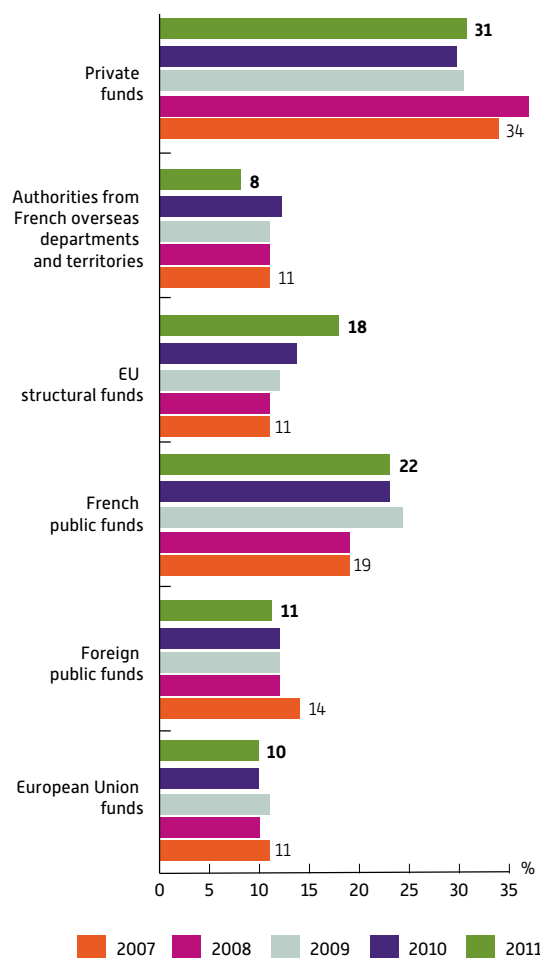
Source: CIRAD, SIRH.

## Number of units (in number of staff) applying a quality approach

	2007	2008	2009	2010	2011
No. of units (in no. of staff) applying a quality approach					
Levels 1/2 to 5	375	445	853	929	1279
Levels 3 to 5	115	265	353	439	546

Source: CIRAD, Quality Delegation.

## Resources generated by CIRAD: amount and annual breakdown as a percentage (excluding joint contracts)



## Annual breakdown of "classified paid" jobs per category (including grant-funded research students with CIRAD contracts), as a percentage

	2007	2008	2009	2010	2011
Senior staff	59	58.8	59.2	59.6	60.6
Grant-funded PhD students	1.3	2.7	3.9	4.6	4.5
White-collar staff	31.6	31.8	31.4	31.5	31.6
Ancillary staff	8	6.7	5.5	4.4	3.4

Source: SIRH.



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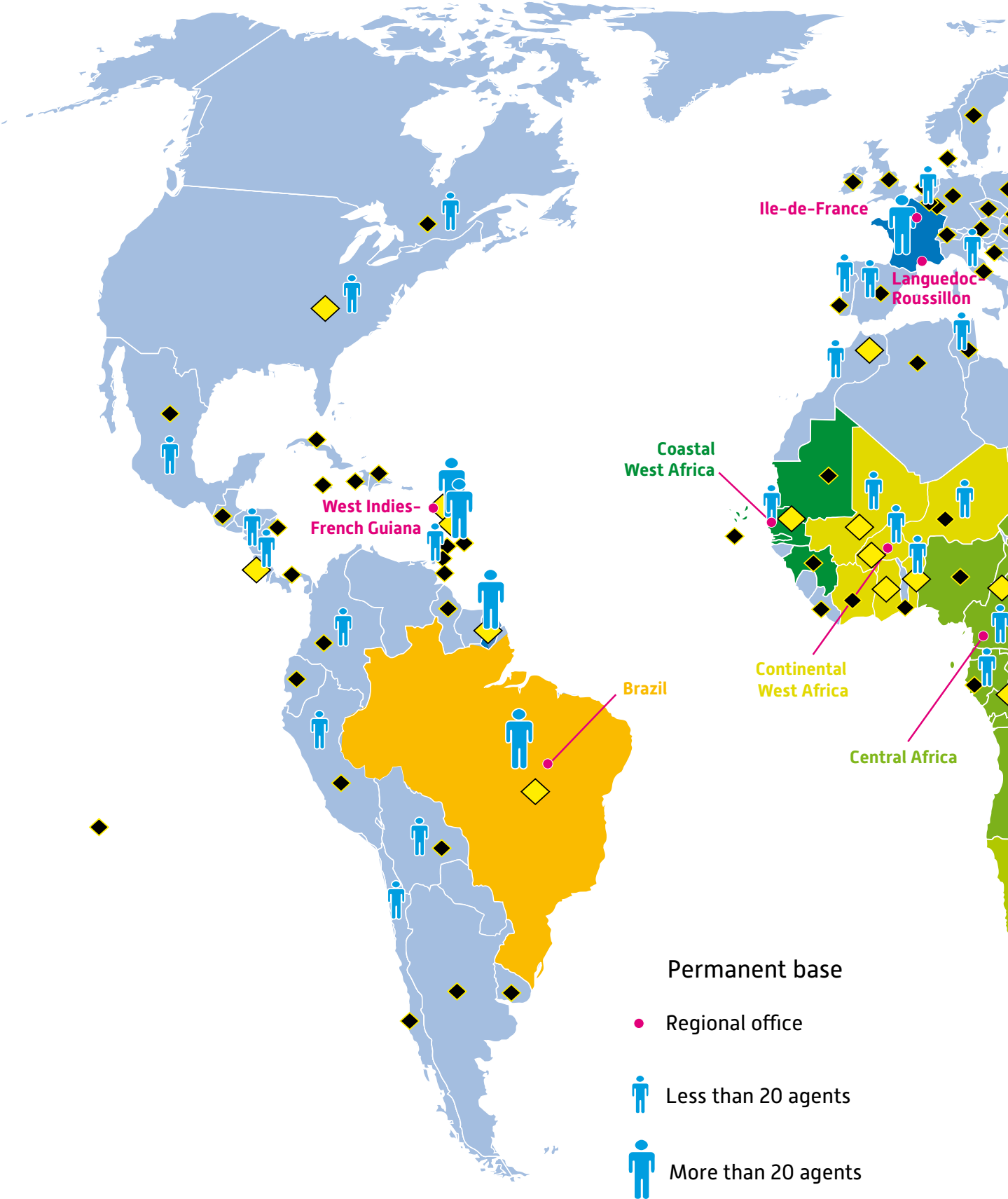
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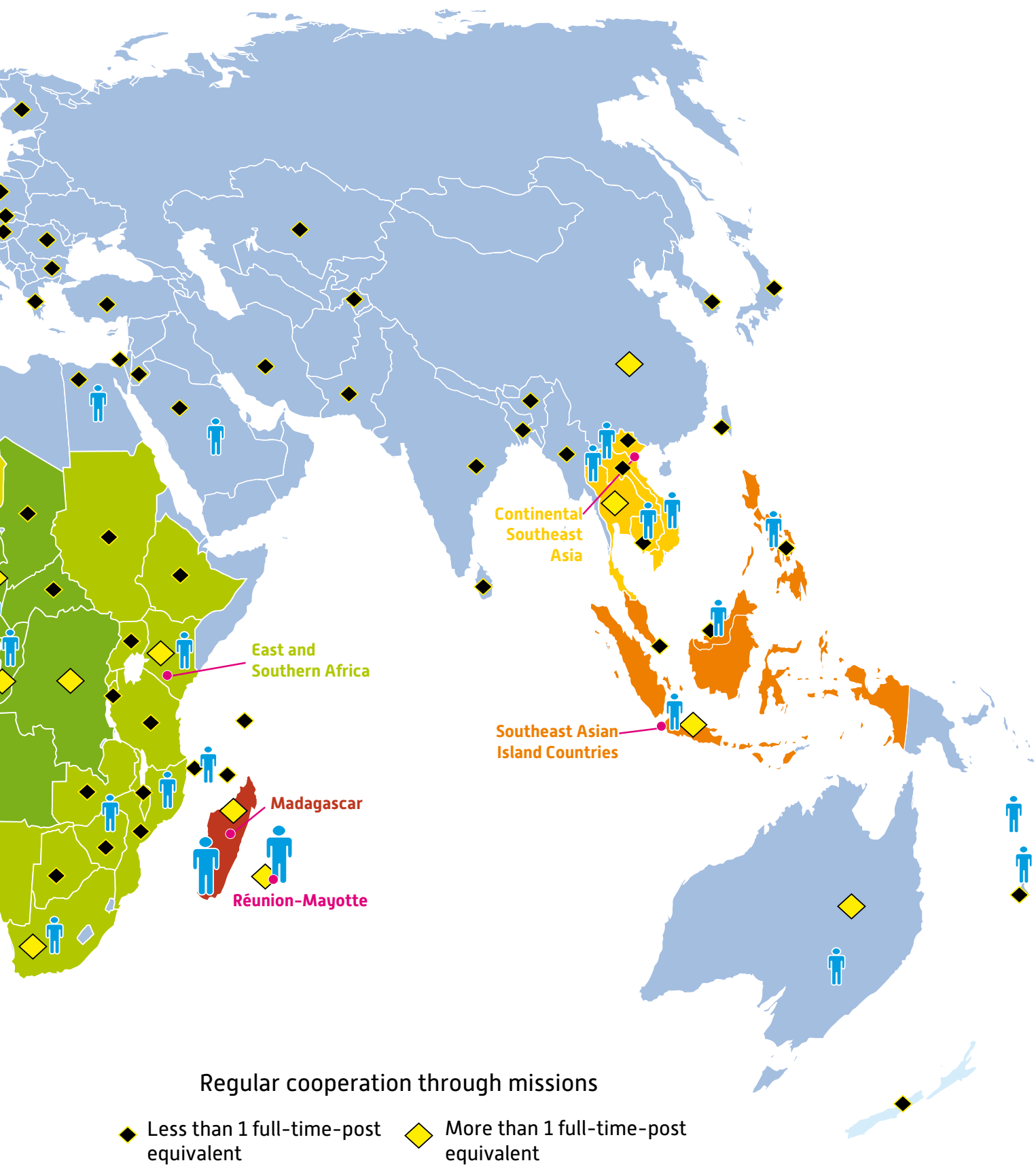
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