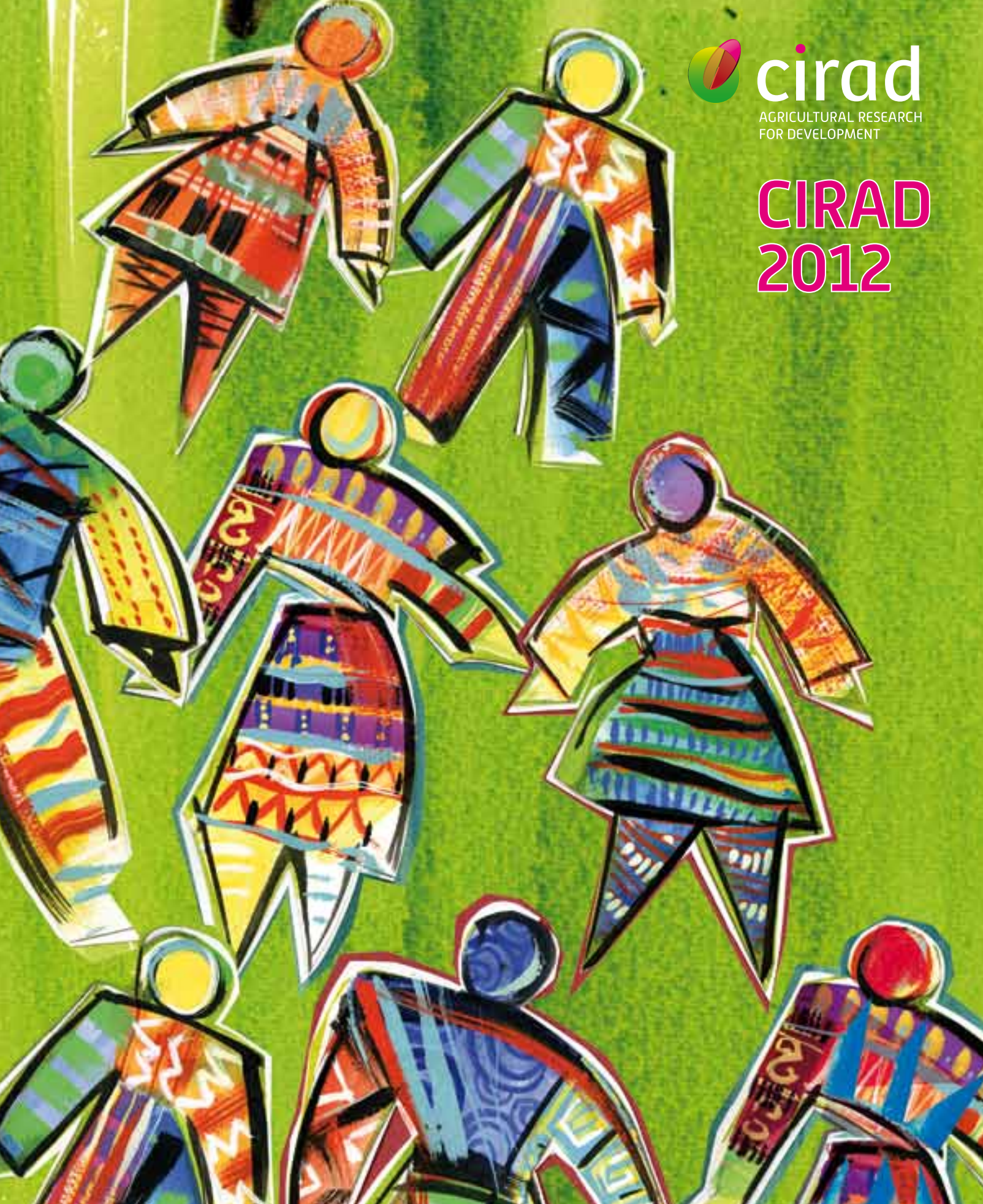




cirad

AGRICULTURAL RESEARCH
FOR DEVELOPMENT

CIRAD
2012



CIRAD 2012
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FOREWORD

Michel EDDI,
President of the Board of Trustees

"In the few years since the start of this new millennium, the way in which the major international bodies perceive development and States view agriculture, its role and its functions, has changed considerably. Little by little, it has become clear that the farming systems that will feed the world in 2050 will be neither those of today, nor an extension thereof. As a result, it will obviously be necessary to rethink the role of agricultural research in innovation processes; this factor should encourage all the various agricultural research stakeholders to work together to build an inclusive form of global orchestration.

It is worth stressing that this reassessment of the role of agriculture and these questions being put to the world of research are part of a context in which public policy instruments are also changing substantially, in France and in most other countries: on the one hand, specialist public bodies are being set up and tasked with this or that function that was previously the responsibility of the State (funding, auditing, etc), and on the other, there has been an exponential increase in the number of cooperative structures and interfaces between research and higher education operators. Within this changing landscape, CIRAD is determined to foster contract-based approaches, since they allow all the different stakeholders to express themselves and benefit from them, in line with their values and objectives.

Whereas the perception of research often centres on promoting innovation, a factor for competitiveness, CIRAD is working to establish support-oriented scientific research, based on partnerships and capable of taking up the challenges of sustainable development. These were the ideas we lobbied for during the "Assises de l'enseignement supérieur et de la recherche" and the "Assises du développement et des solidarités internationales". CIRAD carried the same message to the Global Conference on Agricultural Research for Development in Punta del Este and to Rio+20.

The identity forged by CIRAD now clearly hinges on its attachment and approach to partnerships, and their role in its strategy and the life of its units' research projects. In their work, the organization and its researchers never lose sight of this global vision of partnerships. That vision manifests itself in joint projects with partners, platforms, networks, and novel and diverse scientific operations, all of which are reported in more detail in this year's annual report.

This introduction would not be complete without mentioning the prominent role played by Gérard Matheron, initially as Director General and then as President, in the positive changes in the organization and its scientific and technical operations."



Working together for tomorrow's agriculture

CIRAD, the French Agricultural Research Centre for International Development, is a public-sector industrial and commercial enterprise placed under the dual authority of the Ministries of Higher Education and Research, and of Foreign and European Affairs.

CIRAD works in partnership with the whole range of southern countries to generate and transfer new knowledge so as to support agricultural development in those countries and fuel the debate on the major global issues surrounding agriculture.

It works to support both people and the planet, by tackling complex, ever-changing challenges: food security, natural resource management, inequality and poverty alleviation.

CIRAD is a targeted research organization, and bases its multi-disciplinary scientific programmes on development requirements, from field to laboratory, and from a local to a global level. The aim is to contribute to the sustainable development of rural territories and agricultural supply chains in southern countries, paying particular attention to the poorest people in those countries.

CIRAD is a founder member of Agreenium, the French national consortium for agriculture, food, animal health and the environment, and a member of AllEnvi, the national research alliance for the environment.

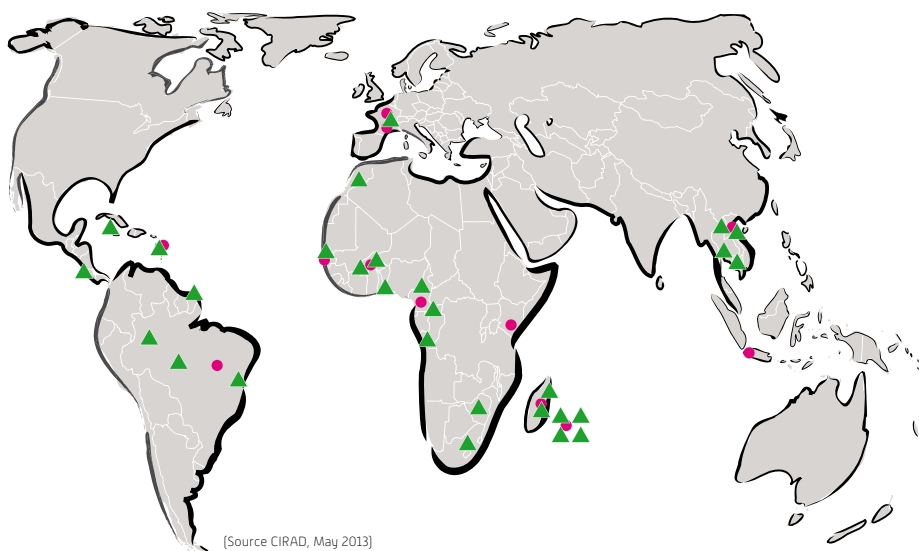
CIRAD is a major player in the dialogue between Europe and southern countries, and a reference in international scientific networks.



A global network of partners

CIRAD centres its work on six priority lines of research that are shared and implemented through a network of research platforms worldwide, backed up by twelve regional offices.

Location of Research and Training Platforms in Partnership (▲)
and regional offices (●)



In the French overseas regions, CIRAD has research centres, experimental stations and advanced technical platforms at which almost 400 staff members work to support local groups and professionals in local agricultural and agrifood supply chains.

Six priority lines of research

Developing ecologically intensive, sustainable production systems, to satisfy people's requirements

Studying innovative non-food uses for biomass, for energy purposes

Promoting sustainable food systems

Anticipating and managing emerging health risks linked to animal and plant pests and diseases

Supporting public action, reducing inequality and poverty

Understanding the relations between production and the environment better, for sustainable management of the living world and rural areas

CIRAD is keen to work with organizations in southern countries and the French overseas regions to build a shared, equitable global agricultural research system

CIRAD in a nutshell

A staff of 1800,
including 800 researchers

Three scientific departments:
Biological Systems (BIOS),
Performance of Tropical Production
and Processing Systems (PERSYST),
and Environment and Societies (ES)

Twelve regional offices
in metropolitan France,
the French overseas regions
and other countries

Some thirty collective
research tools accessible
to partners from developing
countries and Europe

Almost 5 million euros
spent on PhD courses

More than 300 PhD students
supervised each year, 60% of them
from southern countries

International Masters courses
developed with the grandes écoles
and universities

800 researchers and
technicians from all over
the world received and trained
each year

A budget of 218 million euros

www.cirad.fr

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<http://www.cirad.fr/en/research-operations/research-results>

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Institutional Highlights 2012

IDENTITY AND VALUES

The contract of objectives > A management tool

After being submitted to the *Comité d'entreprise* and the Board of Trustees in June 2012, a copy of the audit of the 2008-2011 contract of objectives was given to every employee. In addition to the positive results observed, a change in culture has begun: objectives, indicators and milestones are part of CIRAD's environment; they are presented each year and have served to trigger alerts, adjust the steps to be taken and launch the objective, shared drafting of the new contract for 2012-2016. The contract of objectives has gradually become a tool for CIRAD General Management and its services and a reference framework for its units.

How has CIRAD fulfilled its contract, in view of the four fields of activity determined with its supervisory ministries, broken down into ten objectives?

The highlights of the 2008-2011 audit

The objectives that had largely been achieved, with specific highlights or improved indicators, were considered as strong points. For instance:

- CIRAD is deeply committed to a scientific approach shared with southern countries (co-publications with partners in the South, number of PhD students supervised, etc);
- the quality and diversity of research outputs is on the up (articles in international journals, success rate for calls for proposals, etc);
- the building of joint approaches with INRA (Agrimonde foresight exercise), higher education (Agreenium, *Conférence des présidents d'universités*) and other research organizations (AllEnvi) has strengthened national partnerships;
- the labelling of research and training platforms in partnership (DPs) overseas and regional thematic research platforms in the French overseas regions has concentrated efforts and resources;
- CIRAD has associated partners in southern countries and ultra-peripheral regions in EU projects (number of CIRAD's partners in projects, co-publications) and international activities (GCARD 2010; G20 2011);
- a quality approach is gradually being adopted by all CIRAD units,

management procedures are being simplified, and progress has been made on building an integrated information system.

These results put the organization in a position to consolidate its role in global orchestration of agricultural research.

Progress

Efforts have been made to support integrative research approaches and innovation drives associating the various stakeholders and respecting local know-how. The organization's image and communication tools have evolved to support its scientific strategy. These efforts should be sustained.

Areas for improvement

Despite their initial impact, the priority lines of research chosen by CIRAD are not yet fully functional in terms of mobilizing research forces. In addition, the organization needs to plan its financial and human resources better so as to put them at the service of its strategy.

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<http://www.cirad.fr/en/who-are-we/our-strategy>



The *Rencontres du CIRAD*, in July, are an opportunity for the whole of its staff to take stock of the organization's strategy and its implementation © M. Adell/CIRAD



Partnerships > The view of the Joint Consultative Committee on Ethics

Since the founding of CIRAD, anchored in the experience of the institutions that preceded it, partnership has played a central, vital role in the organization's operations. After the CIRAD Science Council in 2011, it was the turn of the Joint Consultative Committee on Ethics in Agricultural Research to highlight this aspect of the organization: being a partner means working with someone else to produce more than one could have produced alone. It is recognizing differences that makes it possible to find new, shared operating methods.

The Committee feels that its role is not to "talk ethics", but to foster an ethical attitude by providing pointers. It considers that an ethical partnership approach can be based on reflection, encouraging debate between free, equal partners and sketching the outlines of the operations each and every partner intends to embark upon. An ethical approach to debate is one that remains independent of the specific characteristics of the organization, and also of those of the partner organizations with which it works.

Associating people from different fields, professions and organizations and a range of cultures within a partnership approach means asking questions about the epistemic status of knowledge. Not all countries have the same concept of time, place and science. This can be seen as a source of competitive advantage and be questioned, if not disputed, in practice. Other sources of tension may appear, including the values of the different partners, the targets and objectives set for partnerships, balance within partnerships, and equity between partners, particularly as regards each partner's contribution, sharing of research results and economic benefits, researcher training, and governance.

Moreover, right from the project design stage, it is vital to bear in mind the medium- and long-term impact of technology development on future generations and the environment, and also the disputes and conflicts of interest that could affect public confidence.

The recommendations made are intended to facilitate the work of those tasked with designing and sustaining partnerships in the field, and to support the desire of research teams to ensure that their partnerships are ethical.

In 2012, the Ethics Committee also issued a statement on nanoscience and nanotechnologies.

CONTACT

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INRA-CIRAD JOINT Consultative Committee on Ethics in Agricultural Research, 2012. Statement on multiple partnerships for research. 32 pp. <http://www.cirad.fr/media/documents/qui-sommes-nous/avis-du-comite-d-ethique/avis-sur-le-partenariat> (as of 01/02/2013) [In French]

All statements issued by the Ethics Committee:
<http://url.cirad.fr/eng-consultative-committee>
(as of 01/02/2013)

CIRAD Science Council, 2011. Partnerships at CIRAD.
<http://www.CIRAD.fr/en/who-are-we/our-partnerships> (as of 01/02/2013)



A cycle of seminars looking into the development concept

The Office of the Director General in charge of Research and Strategy organized three half-day seminars with international experts, for CIRAD staff members and other interested parties:

• 27 June 2012

How, in 2012, can we build development based on history?

With Frederick Cooper (a global and historical approach to the development concept) and Pierre Jacquemot (the French perspective on development and aid).

• 22 October 2012

A retrospective of the changing role of agriculture in development.

With Fridolin Krausmann (the long history of the use of raw materials, biomass and energy – an analysis in terms of metabolic transition) and Jean-Luc François (new issues surrounding the role of agriculture in development).

• 27 November 2012

The new geopolitical context for development.

With Serge Michailof (geopolitical restructuring in the South, the case of fragile States).



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Research and training platforms in partnership labelled for four years

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What is a research and training platform in partnership (DP)?

To be labelled,
a DP must:

- > **Have been built jointly** by partners based on a clearly defined scientific project
- > **Tackle** topics that fit in with CIRAD's scientific priorities and those of its partners
- > **Involve** significant financial and human resources at CIRAD and its partner organizations, in the field and over time (co-investment)
- > **Ensure** quality scientific outputs
- > **Associate** national agricultural research systems
- > **Have** a local, regional and/or continental impact
- > **Foster** collaboration with French, European, overseas and international research partners
- > **Commit** to higher education operations
- > **Introduce** governance mechanisms and auditing procedures that are contracted out to partners (co-governance)
- > **Generate** major projects in its field

Since 2009, CIRAD has been centring its partnerships on research and training platforms in partnership (DPs). The aim is to respond more effectively to the main development issues by generating knowledge and building capacity among its partners. The idea is also to promote these scientific communities within the global research sector. DPs operate in various forms: platforms centring on one or more countries, trans-national thematic networks, etc. Research centres in the French overseas regions are associated with this approach and are joining forces within DPs.

In 2012, twenty research and training platform in partnerships were labelled for a four-year period (2012-2016), with another two structures judged suitable. Of the new structures, two work on public policy and governance: a regional platform, Public Policies and Governance (PP&G) in South Africa and Mozambique; and a trans-national network covering ten countries, Public Policies and Inequality in Latin America (PP&I-LA). The Agroforestry Systems in Africa platform is the second DP devoted to agroforestry, after the Agroforestry Systems in Latin America platform (PCP AFS-PC), with which it works in synergy, on joint projects (see page 20).

The other platforms have been consolidated, notably through the signing of long-term agreements and contracts between partners. They have boosted their visibility by organizing workshops, seminars and symposiums and by publishing, particularly reference works. They have also built and implemented research projects and training operations.



Reconciling agricultural production and natural resource conservation in southern Africa
© D. Cornélis/CIRAD

For instance, in **Africa**, in Madagascar, after ten years of active partnership, the University of Antananarivo, FOFIFA and CIRAD made a further ten-year commitment to the Forests and Biodiversity platform by signing a contract in November. The Farming System Sustainability in the Highlands platform (SPAD) has taken over from SCRID and diversified the topics covered (integration of crop and animal farming, innovative cropping systems, etc) and associated two new partners (FIFAMANOR and the IRD). The Spatial Information Systems in West Africa platform (SISTO) was officially launched in late June, with the support of a dozen partners from the CILSS and WECARD.

In **Asia**, the six founding members of the GREASE animal and veterinary public health research network signed a draft official agreement in Bangkok in May, the fruit of two years' research, training and debate

(see page 44). In Vietnam, the Markets and Agriculture Linkages for Cities in Asia (MALICA) platform has renewed a partnership built up over ten years in Vietnam and extended to Laos in 2011.

In **Latin America**, EMBRAPA and CIRAD signed a five-year general agreement in Brasilia in November, which strengthens collaboration between the two organizations within the International Advanced Biology Consortium (CIBA) and the Territorial Development in Amazonia (AMAZONIE) network. An agreement has also been signed between EMBRAPA, CIRAD and representatives of the banana supply chain in the West Indies (UGPBan and IT2: Guadeloupe and Martinique) to fight banana black Sigatoka, a serious disease affecting banana plantations in Latin America and the Caribbean. This last agreement involves the Campus agroenvironnemental Caraïbe (ex-PRAM).



Consult the list of platforms and partners:
<http://url.cirad.fr/research-and-training-platforms> (as of 01/02/2013)

CIRAD, Agreenium and training of junior researchers

Since 2009, CIRAD has been one of the six founder members of Agreenium, alongside INRA and the main French agricultural colleges. The aim of this public scientific cooperation establishment is to improve the visibility of what France has to offer in terms of research and higher education and facilitate access to it. CIRAD's regional offices worldwide are in charge of representing all the partners in Agreenium. In return, within Agreenium, CIRAD's higher education capacity has been boosted. In June 2012, Agreenium added AgroSup Dijon to its list of founder members and Bordeaux Sciences Agro to that of associate members.

In 2012, the Agreenium international research school, EIR-A, was launched, to offer junior researchers further training to prepare them for the world of work, open to international students and to the main issues surrounding food and farming system sustainability. EIR-A enables its students to build up a professional network. CIRAD has nine PhD students from the first two intakes working on theses in its laboratories, including two in Réunion.

Agreenskills, an EU programme to foster international mobility so as to help junior scientists begin their career, has enabled CIRAD to receive two post-doc researchers, one (working on modelling water and nitrogen management techniques according to their ability to maintain high quality of fruit production on apple and peach trees) within the Genetic Improvement and Adaptation of Mediterranean and Tropical Plants Joint Research Unit (UMR AGAP) and the other (working on molecular epidemiology of rodent and tick-borne pathogens) at the Centre for Biology and Management of Populations (UMR CBGP).

Lastly, CIRAD has made an active contribution to the "Science Without Frontiers" programme launched by Brazil, by submitting 22 proposals to receive junior scientists in its laboratories: 15 PhD students and seven post-docs. The programme, whose agricultural component is being coordinated by Agreenium, consists in matching requests from Brazilian junior researchers with what is on offer in French laboratories. The grants offered by Brazil amount to € 1300/month for PhD students and € 2100 for post-docs, with host laboratories or organizations funding operating costs and supervision.

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Consult
the Agreenium website:
<http://www.agreenium.org>



EIR-A 2012-2013 intake © Agreenium

CoopIST, cooperating on scientific and technical information

The CoopIST [cooperating on scientific and technical information] website, which has been accessible since February 2012 and was developed by information specialists at CIRAD, is the fruit of experiments conducted with partners. Its aim is to fulfil CIRAD's mandate for scientific information and training of IST researchers and professionals from southern countries.

Most of the content, resources and tools on offer are free to access and free of charge, to facilitate the dissemination of knowledge and foster exchanges.



Scientific and technical information training workshop, Madagascar © CIRAD

The site centres on four aspects:

- > **Documentary resources.** Free sources of on-line information (databases, scientific journal catalogues, thematic websites) in the field of agricultural research and similar sciences.
- > **Publication support.** Methods and tools for communicating research results.
- > **Information management.** Advice and software for organizing documentation centres and processing information.
- > **Cooperation.** Documentary resources produced by French-language organizations working with CIRAD, or from international IST projects.

CoopIST's leading product is the *Où publier ?* information base (<http://ou-publier.CIRAD.fr/>) launched in late 2012, which lists almost 1000 journals covering the life sciences, social sciences and engineering sciences applied to agriculture.

Via a simple query, the author of an article can pinpoint the most appropriate journal: the journal's scientific field, types of articles published, existence of an editorial committee, impact factor, description of the journal, editorial policy as regards copyright and archiving and publication costs.

CONTACT Scientific and Technical Information Service,
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<http://coop-ist.cirad.fr>

Two CIRAD journals boost their impact

The journal *Bois et Forêts des Tropiques* now has an impact factor, according to Thomson Reuters (ex-ISI). It is the third CIRAD journal, after *Fruits* and *Cahiers Agricultures*, to receive such international recognition. Its first impact factor of 0.439, calculated for the year 2011, places it 45th of the 59 publications listed in the "Forestry" category.

As for the journal *Fruits*, its much improved 2011 impact factor (0.764) bumped it up from the 4th to the 2nd quartile of journals on its topic: "Horticulture".

These results recognize the quality of the editorial work being done at CIRAD.



« A society cannot develop in the long term unless it itself produces the knowledge it needs to conceive and build its future. »

2012-2022 Strategic Vision

France > CIRAD General Management's contributions to national consultations

CIRAD set out the values and directions that will be steering its operations over the next ten years in its 2012-2022 Strategic Vision. They are governed by one major ambition: to make research a real tool for development. On the basis of this collective vision for the establishment, CIRAD General Management contributed in late 2012 to two major national debates launched by the Minister of Higher Education and Research and the Junior Minister for Development.

Contribution to the *Assises de l'enseignement supérieur et de la recherche*:

<http://url.cirad.fr/eng-assises-ens-sup-et-recherche>



National consultation and *Assises de l'enseignement supérieur et de la recherche* (higher education and research assises)

The aim is "to give know-how – its production, transmission and sharing – its full role within our society" [...]. In this respect, CIRAD stresses the importance of integrating "southern countries into international mobility and hosting policy, with the associated instruments and partnerships between teams in those countries and "French" thematic platforms, not forgetting support of national and regional capacity-building in terms of research, training and innovation".

Assises du développement et de la solidarité internationale (development and international aid assises)

CIRAD is in favour of "supportive research and working for scientific diplomacy". This prospect has consequences in terms of operational priorities: "1) Renewing practices, investing in training, strengthening partnerships with scientific communities in the South in order to build their skills and independence; 2) Boosting the capacity of research to pinpoint the most relevant issues by making optimum use of combined biological x technical x institutional viewpoints. Generating tried and tested knowledge and fitting into innovation systems, in partnership with professional organizations in the South, the authorities and each and every development player. Imposing innovation as a research topic and field, taking account of its many facets and participating actively in the debate on the links between innovation and public action; 3) Promoting complementary skills and possible synergies between French operators in the fields of administration, development (including NGOs), research and education (including the university sector) within international development initiatives, backed up by the inter-institutional instruments developed to this end (Agreenium, AIRD, research alliances); 4) Contributing to laying the foundations of a new form of global agricultural research orchestration through scientific diplomacy, in conjunction with our supervisory ministries." CIRAD's Contractual Objectives for the coming years will be determined with its supervisory ministries with this in mind.

Contribution to the *Assises du développement*:

<http://url.cirad.fr/eng-assises-development>



CONTACT Patrick Caron, Director General in charge of Research and Strategy, patrick.caron@cirad.fr

Assises de la recherche, 15, October 2012. © CIRAD



CIRAD praised for its excellent management methods

The European Commission recently awarded CIRAD a certificate of methodology.

This is a certificate of excellence, which guarantees the management method used for agreements or contracts signed by the establishment with its various donors to fund its research projects. It seals the confidence placed in the establishment by one of its largest donors and exempts it from various financial procedures and audits.

Europe > A year of dialogue

The year 2012 was marked by CIRAD's substantial involvement in drafting the future Framework Programme for Research and Innovation "Horizon 2020" (2014-2020), which is part of the Europe 2020 strategy.

The establishment was involved in numerous initiatives and debates on an EU and French level (Ministry of Higher Education and Research, *Association nationale de la recherche et de la technologie* - ANRT). It contributed its vision of the role of agricultural research for development (AR4D) and international aid in EU policy. CIRAD's contributions took various forms: meetings with the various European Commission Directorates General (notably Research and Innovation, and Agriculture and Rural Development), drafting of position papers, participation in public consultations, contribution to think tanks working on financial

aspects, intellectual property law, and structuring and coordination of the future Horizon 2020 programme.

CIRAD also continued its drive to respond to calls for proposals concerning scientific projects and science and technology (S&T) dialogue projects between the European Union and third party countries. Moreover, by late 2012, CIRAD's involvement in FP7 amounted to participation in 50 projects, 14 of them as coordinator (including individual grants).

Regarding S&T dialogue projects, CIRAD is involved in bi-regional and bilateral projects: SEA-EUNET for Asia, CAAST-NET for Africa, ABEST for Argentina, ALCUE-NET and EULARINET for Latin America, and EUCARINET for the Caribbean.

As regards AR4D, the organization is continuing to participate in and

support the instruments it helped to build to federate European AR4D players: this is the case with Agrinatura (which associates the EU economic interest group ECART and the Agrinatura association), the European Initiative for Agricultural Research for Development (EIARD), of which it is Executive Secretary, and the European Forum for Agricultural Research for Development (EFARD). It is also involved in the ERANET ERA-ARD II project, which could act as the main basis for ambitious AR4D initiatives.

All these operations serve to boost recognition of our organization by European Commission services and its legitimacy as regards drafting future policy and programmes.

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International > CIRAD at RIO+20

Twenty years after the Earth Summit, the Rio+20 conference in Rio de Janeiro from 20 to 22 June 2012 brought together world leaders and thousands of representatives of the private sector, NGOs and other groups, to look at how to alleviate poverty, promote social justice and protect the environment on our increasingly densely populated planet.

For CIRAD, the question can be posed in these terms: how can agricultural research take up increasingly global, complex challenges when the agricultural research system is becoming increasingly multi-polar and polymorphous

and the gaps between countries are growing? The contribution it submitted to the United Nations set out its proposals for involving those countries with the most fragile research systems.

CIRAD's views were formulated at events such as the workshop on foresight analyses of forest



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ecosystems in the Congo Basin, organized in Montpellier (20-21 March 2012) with COMIFAC, and through declarations such as *Climate smart agriculture-Science for action*, with the University of Wageningen (2011). Its researchers have contributed to reports such as *Sustainable Land Use for the 21st century* (United Nations), which was officially presented on 17 June, and *Systèmes de production durables en zones sèches : quels enjeux pour la coopération au développement ?*, produced by IRAM, the *Institut de recherches et d'applications des méthodes de développement*.

CIRAD General Management was present throughout *Rio+20*, notably in the France Pavilion, as a member of the French delegation. It called for the establishment of global orchestration of agricultural research for development, based on strategic intelligence built and shared by all concerned, notably through the celebration of the 20th anniversary of the Rio conventions, on 21 June. Patrick Caron and Etienne Hainzelin spoke at the *Rio+20: agrosience takes up the challenge* conference, organized with INRA on 21 June, during a round table: *What partnership structures are required to tackle the major issues: from Rio 1992 to Rio 2012?* and at the conference organized by the *Alliance nationale pour l'environnement* (AllEnvi) on 20 June. CIRAD researchers also presented papers and posters at associated events.



CIRAD's contribution:
<http://www.cirad.fr/media/documents/actualites-doc/contribution-du-cirad-a-rio-20> (in French)

CIRAD at *Rio+20*:
<http://url.cirad.fr/rio-202>

"The future we want"
(Rio + 20 final resolution):
<http://www.uncsd2012.org/thefuturewewant.html>

VALUES

International > GCARD, on the road to development through research

The second Global Conference on Agricultural Research for Development (GCARD), organized by GFAR and the CGIAR at the end of October 2012 in Punta del Este, Uruguay, confirmed the existence of a community of thought and saw the emergence of prospects in which partnerships will take on a new degree of importance.

The conference centred on the following issue: how best to respond to the needs of farming systems in the South so as to ensure food security and sustainable resource management and alleviate poverty. It was organized around three main concepts – capacity-building, partnerships and foresight exercises – and associated a large number of participants whose rich, comprehensive contributions gave rise to major new ideas.

CIRAD was able to explain and promote its positions: capacity-building cannot be restricted to training, and development cannot be sustainable unless it is backed up by domestic capacity to generate knowledge, not just transfers of knowledge generated elsewhere. In the current climate of scientific competition, it is thus research capacity-building in the least advanced countries that should be our prime target.

Partnerships are much more than a means of conducting research. The partnership experiments conducted by WECARD with various French institutions, including the CIRAD-IRD platform, in West and central Africa, show that they are a means of building capacity. The launch of the Tropical Agriculture Platform by the FAO, with the support of the G20, should serve to



Patrick Caron speaking at GCARD 2012 © GCARD 2012

capitalize on and disseminate the results of these experiments.

To go further, the next step is to identify and promote the experiments already conducted, improve consultation of players outside the research sector, and structure an ongoing strategic reflection capacity, centring on foresight exercises and a culture of impact. This is what WECARD proposed, in the form of a test to be conducted for GCARD 3, in order to draft a research agenda that is not a juxtaposition of individual actions, but a process initiated, led and managed by the relevant regional organizations, to which all the global players contribute.

GCARD could be seen as a learning process for such an approach, and the next event will provide an opportunity of measuring the progress made.

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ACRONYMS

WECARD/CORAF > West and Central African Council for Agricultural Research and Development/Conseil ouest et centre africain pour la recherche et le développement agricoles

GFAR > Global Forum on Agricultural Research

IDDRI > Institut du développement durable et des relations internationales

CGIAR > Consultative Group on International Agricultural Research

<http://url.cirad.fr/eng-global-conference>





What is a RITA?

RITAs are lightweight collaborative structures that associate, in each French overseas region, the various players involved in research-development-training operations: research organizations, the three local technical institutes (ARMEFLHOR in Réunion, IT2 in the West Indies and IKARE in the West Indies and French Guiana), in partnership with the national technical institutes in the ACTA network, local technical centres, Chambers of Agriculture, training centres, and local and regional authorities and Directorates of Agriculture, Food and Forestry (DAAFs).

ACRONYMS

FREDON > Fédération régionale de défense contre les organismes nuisibles

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

IKARE > Institut caribéen et amazonien de l'élevage

IT2 > Institut technique tropical

RITAs > Agricultural innovation networks in overseas regions

RITAs, which are agricultural innovation and transfer networks in the French overseas regions (DOMs), were created in late 2011, at the request of the ministries in charge of agriculture and the DOMs, to support local development. The aim was to foster the endogenous development of crop and animal diversification chains. In effect, agricultural production in the French overseas regions currently supplies only a part of what is consumed locally: between 20 and 70% depending on the supply chain and the region. ACTA and CIRAD are the coordinators of these networks on a national level.

RITAs were set up for the co-construction and implementation of research and development operations, experiments, demonstrations and transfers, in response to requirements expressed locally by professionals.

There is a RITA in each DOM (Guadeloupe, Martinique, French Guiana, Réunion and Mayotte), steered by a local committee chaired by the local DAAF (food, agriculture and forestry authority).

CIRAD, along with ACTA, plays a vital role: prior to the creation of RITAs, it was asked by the Ministry of Agriculture to provide support for decision-makers and conduct a foresight study. It is the largest research network in the French overseas regions, and by virtue of its part-public, part-private status, it was able to facilitate funding and drafting of the project and the various agreements involved. It also organized the first national RITA workshop with ACTA in Montpellier, from 24 to 26 January 2012.

To date, fourteen research, experimentation, demonstration, extension, dissemination and training projects are under way for the period 2012-2016. 2012 saw the

launch of these projects and the installation of the RITA management structure. 2013 will see the stepping up of training and transfer operations to benefit producers. It will also be marked by increased collaboration between the French overseas regions, as requested by the various stakeholders, and by the preparation of a new cycle of projects for 2014-2020.

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Participants in the RITA meeting held during the Paris International Agricultural Show © CIRAD



<http://www.rita-dom.fr/>



Investissements d'avenir > A new consortium to foster technology transfer to the South

17 December 2012 saw the birth of Valorisation Sud, one of five thematic promotion consortiums (CVTs) set up under the *Investissements d'avenir* funding programme. The aim is to foster technology transfers from national research centres to tropical and equatorial regions. The contract for the consortium was signed with the ANR, and associates the IRD, CIRAD, the Institut Pasteur and the four universities in the French overseas regions.

France has more than 7000 researchers working to develop know-how and technologies suited to southern countries. Their research has resulted in more than 450 patents. The difficulty is finding economic partners capable of promoting and disseminating these innovations in emerging or developing countries. However, all the relevant indicators suggest

that southern countries offer new economic development prospects for the coming years. They already account for more than 10% of French exports.

The partners propose making their knowledge of the realities of the South available to development structures, notably to the technology transfer acceleration firms (SATTs) established in some ten French regions, to pinpoint and exploit results that could be of use in the South. Eventually, around twenty staff members will be offering "à la carte" services: intellectual property management

support; constitution of a portfolio of around a thousand patents with marketing authorizations; technology marketing and promotion; pre-industrial studies, licensing contracts; and advice on developing innovative enterprises.

Valorisation Sud is being coordinated within the framework of the *Agence inter-établissements de recherche pour le développement* (AIRD), and has a ten-year budget of 9 million euros. It intends to contribute to the economic growth of partners in cooperation between France, southern countries and the French overseas regions.

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A new CIRAD offshoot: RD2

Identifying the research requirements of NGOs, or governments and firms keen to offer growers, for instance coffee farmers, an opportunity to optimize production, and supporting them along the way is the *raison d'être* of RD2, a new firm being set up by Christophe Montagnon with the support of CIRAD.

West Indies > Birth of the *Campus agroenvironnemental Caraïbe*

After becoming part of the *Université Antilles Guyane*, PRAM, the *Pôle de recherche agroenvironnementale de la Martinique*, is now known as the *Campus agro-environnemental Caraïbe*. This is a real step forward for the platform, which since 2002 has associated CIRAD, the IRD and IRSTEA in Martinique. The new partnership agreement was signed at a ceremony at the Petit-Morne site in Le Lamentin, Martinique, on 14 December. The five Presidents – Gérard Matheron, Michel Laurent for the IRD, Jean-Marc Bournigal for IRSTEA, Pascal Saffache, Administrator to the University, and Patrick Quénèhervé, President of the *Campus agroenvironnemental Caraïbe* – were all there.

The move is proof of the partners' desire to strengthen cooperation between higher education and research organizations. It also opens the campus up to the wider Caribbean region, in which PRAM had already made its mark thanks to the operations undertaken with its many scientific partners. This is a pivotal period for the development of Martinique that is seeing the end of structural funding contracts and the negotiation of future operational programmes. Research and innovation have officially been strategic priorities for the European Union for a year now.



Jean-Marc Bournigal, Gérard Matheron, Michel Laurent and Pascal Saffache © CIRAD

50 years of research and innovation for agriculture in Réunion



Gilles Mandret opens the ceremony marking 50 years of research in Réunion © CIRAD



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Regional website:
<http://www.agriculture-biodiversite-oi.org/en>



In 1962, the first research station was set up in Réunion by one of the institutes that went on to make up CIRAD: IRAT, the *Institut de recherches agronomiques tropicales et des cultures vivrières*. Agriculture in Réunion at the time centred on two crops, primarily grown for the export market: sugarcane and perfume plants (primarily geranium). Food crops (maize, beans, *brèdes* [leaves used like spinach], etc) and small-scale backyard livestock rearing served to satisfy the needs of rural households, but barely supplied any of what was sold on local markets. Réunion imported almost everything it consumed.

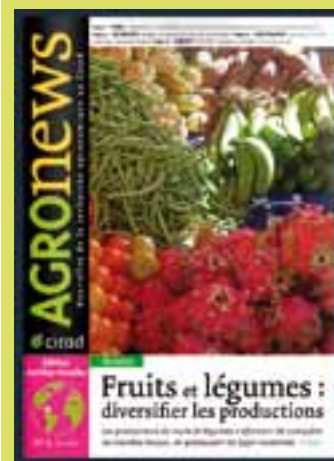
Fifty years on, the island satisfies almost 80% of its food requirements thanks to locally produced milk, meat, fruit and vegetables. This impressive result is the fruit of 50 years of close-knit partnerships.

CIRAD and its founder institutes have supported the sustainable

development of supply chains in collaboration with experimental centres in Réunion and professional organizations in the agricultural sector: animal production, agrifoods, fruit and vegetables. They have also supported the sugarcane supply chain, land use planning, environmental protection and biodiversity on the island.

Through their top-level scientific research, they have contributed to the regional and international image of Réunion. That research led to the founding of the Plant Protection Platform (3P) in 2002, and Qualitropic, the only overseas competitiveness cluster, in 2005.

CIRAD is now working, from its base in Réunion, with Mayotte and the Indian Ocean Commission (IOC) countries, in the fields of plant health, animal health, food quality and biodiversity. It has also opened up to southern Africa, Southeast Asia, India, China and Australia.



Agronews, the CIRAD journal for the French overseas regions

Agronews publishes news of agricultural research in the French overseas regions by CIRAD and its partners. It was launched in Réunion in 2009, with the aim of keeping CIRAD's partners, and any other interested parties, informed about agricultural research progress. Each issue contains a thematic report.

In 2012, *Agronews Antilles-Guyane* no. 2 looked at the diversification of fruit and vegetable production activities using rational farming methods, and *Agronews Réunion-Océan Indien* no. 5 at agro-ecology (reconciling agriculture and ecology).



Distinction

Emmanuel Guiderdoni, a plant breeding and genetics specialist, was awarded the Dujarric de La Rivière prize on 27 November 2012, at the Institut de France. This four-yearly prize recognized his discoveries on rice using in vitro culture methods.



Emmanuel Guiderdoni (left) and Philippe Taquet, Vice-President of the Académie des sciences.
© Brigitte Eymann - Académie des sciences

Accreditation

ISO 17025:2005 accreditation for the CIRAD Technology and Characterization Laboratory for Natural Fibres (LTC). This covers the instrumental characterization of cotton fibre samples using an integrated measurement system. The accreditation provides the laboratory's clients with a guarantee of good calibration and testing practices, and of their traceability. The laboratory is one of the six international laboratories involved in drafting reference standards for calibrating fibre characterization measurement apparatus.

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Serge Lassus, a researcher with the LTC, measuring cotton fibre quality [HV1000 apparatus] © T. Erwin/CIRAD

Agreements & Signatures

FRANCE, EUROPE

With the Institut Pasteur, on 10 October. Gérard Matheron, CIRAD President Managing Director, and Alice Dautry, Director General of the Institut Pasteur, signed a general agreement to strengthen international collaboration between the two organizations on infectious diseases and anthroponoses, particularly with respect to emerging pathogens and the link between health and environment.



AFRICA

With the Institut National Polytechnique Félix Houphouët Boigny (Ivory Coast) on 28 February, in Paris. Dr Koffi N'Guessant, Director General of the institute, and Gérard Matheron signed a general agreement committing the two organizations to cooperate on teaching and research for the coming five years. An agreement was also signed with Montpellier SupAgro, represented by its Director Etienne Landais.



With the International Centre of Insect Physiology and Ecology (ICIPE), in Kenya, on 15 October.

Under the aegis of His Excellency Etienne de Poncins, French Ambassador to Kenya, Daniel Barthélémy (CIRAD) and Jean Albergel (IRD) signed two new general agreements with Professor Christian Borgemeister, ICIPE Director General.

With the New Partnership for Africa's Development, on 16 November. Patrick Caron signed a general agreement with Dr Ibrahim Assane Mayaki, Executive Secretary of the African Union on the New Partnership for Africa's Development (NEPAD). The agreement maintains the fruitful relations established within the framework of the World Bank RuralStruc programme. It aims to develop the Rural Futures programme, a NEPAD initiative aimed at coordinating sectorial dynamics with a view to ensuring sustainable territorial development.



AGROPOLIS INTERNATIONAL

With the Instituto Nacional de Tecnología Agropecuaria (INTA), Argentina, in March, in Montpellier, on the occasion of the inauguration of the INTA Labintex wall-less laboratory at Agropolis International, based on EMBRAPA's LaBex (Brazil). Carlos Casamiquela, INTA President, and Gérard Matheron signed a partnership agreement. The priority topics are biotechnologies, animal health and emerging diseases, agri-food product processing and quality, market organization, and the question of certification. In addition to its involvement in scientific projects, CIRAD is participating in governance of the Agri-terris inter-institutional laboratory set up by INTA in Argentina, in which INRA is also involved.



Photos © CIRAD

AGROPOLIS INTERNATIONAL

With Mohammed Khider University (UMK) and the Centre de recherche scientifique et technique sur les régions arides (CRSTRA), in Algeria, in May. Water management, livestock and agro-pastoralism systems, animal production and also ecological intensification and date palm systems are the topics at the heart of this agreement. The establishment will also be participating in Masters courses, supervising PhD students and drafting joint research projects. The signing of the agreement supplements the work already undertaken with the *Ecole nationale supérieure d'agronomie* in Algiers, via an agreement signed with the Agropolis International association.

ASIA

With the Asian Institute of Technology (AIT), on 30 October, in Bangkok, Thailand. Gérard Matheron and Professor Said Irandoust, President of the Asian Institute of Technology, renewed a general cooperation agreement, to run for two years, in the field of sustainable management of water as a resource for agriculture and rural development.



With the National Science and Technology Development Agency (NSTDA), on 25 October, in Thailand. This is the first general agreement between the two institutions. Gérard Matheron, CIRAD President Managing Director, and Professor Thaweesak Koanantakool, President of the National Science and Technology Development Agency, signed the five-year agreement covering the fields of environment management, agriculture, food production and processing, control of animal diseases, and biotechnologies.



Photos © CIRAD

Communication & Events

CIRAD's Communication Coordinator, Anne Hébert, is coordinating communication for the Alliance nationale de recherche pour l'environnement, AllEnvi, as of 2012. François Houllier, INRA President Director General, is President of the Alliance. AllEnvi, which was founded on 9 February 2010 at the behest of the Minister of Higher Education and Research, has twelve founder members working on four major issues: Food, Water, Climate and Territories. The Alliance has a light, flexible structure, and has opted for a coherent, programme-based, practical approach, to ensure effective research that can also contribute to development in southern countries.



Part of the CIRAD stand at the 2012 Paris International Agricultural Show © Marie Adell/CIRAD

Animal production and southern countries at the 2012 Paris International Agricultural Show. Animal production plays a fundamental role in food security and economic development in southern countries. In Sahelian zones, it can amount to up to 40% of agricultural GDP! CIRAD presented the current issues during the show: conferences-debates, interviews, animal product tasting sessions, and more... numerous documents are available on the topic.

Fête de la science in Montpellier. As in previous years, CIRAD opened its doors to the public to present its researchers and their activities: an afternoon of discovery with tours of greenhouses (cocoa, lemon, coffee and rubber plants), conference-debate on

the biodiversity of the canopy (a tale of an extraordinary trip on the "raft of the sum-mits"), an exhibit on rice and its diversity (paddy rice, cargo rice, bleached rice, red rice, long grain rice, round grain rice, and so on), and a showing of a documentary, "Mission baobabs", with scientists from CIRAD working to preserve this age-old tree in Madagascar.



An arboretum in Réunion. CIRAD inaugurated an arboretum for schoolchildren at its La Bretagne station on 9 November, as a foretaste of the Fête de la Science. Visitors will be able to dive into the very heart of a semi-dry forest, immerse themselves in the shade of vanilla plants, and learn about exotic curiosities! More than 150 plant species make up the arboretum, set up on the initiative of CIRAD, with financial help from the EU and CINOR and support from the State, the Réunion Regional Council, APLAMEDOM, the IRD and the CBNM.



Photos © CIRAD



A courgette plot bordered by maize
in Réunion. © A. Ratnadass/CIRAD

ECOLOGICAL INTENSIFICATION

Ecological intensification means designing more productive, sustainable production systems that save on inputs and are less harmful to the environment. It also means developing varieties better suited to their environment, and inventing new pest and disease control techniques.

Lastly, it means understanding how nature functions so as to exploit its resources without destroying it, producing more, and breaking with practices based on excessive, massive use of pesticides, chemical fertilizers, water and fossil fuels.

<http://url.cirad.fr/ecological-intensification>



WHICH AGROFORESTRY SYSTEMS FOR IMPROVING THE LIVING CONDITIONS OF RURAL POPULATIONS?

Agroforestry has become increasingly important at CIRAD during the course of 2012. The Research and Training Platform in Partnership 'Agroforestry Cameroon' was approved and two projects have been launched during the year. Because of the many advantages they offer, agroforestry systems could help address the major challenges facing tropical countries: poverty, food insecurity, climate change and loss of biodiversity.



© P. Jagoret/CIRAD

> PLATFORM IN PARTNERSHIP 'AGROFORESTRY CAMEROON'

An integrated approach of ecologically intensive cropping systems

The Research and Training Platform in Partnership 'Agroforestry Cameroon' was approved by CIRAD in 2012. It assesses the potential of complex agroforestry systems to contribute to the household food and income of rural families in developing countries while also providing a wide range of ecosystem services. It also identifies ways to improve these systems in order to develop new, better performing ones. In October 2012, the research teams involved were active participants in the international conference on cocoa research organised in Yaounde by the Alliance of Cocoa Producing Countries (COPAL) and the INAFORESTA days which followed. These events helped to build bridges between the 'Agroforestry Cameroon' Platform and the 'Mesoamerican Scientific Partnership Platform on Agroforestry Systems with Perennial Crops' located in Costa Rica.

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Anon, 2011. Scientific framework of the DP-PCP Agroforestry Cameroon, 44p.



Combination of cocoa and coconut trees. © D. Snoeck/CIRAD

> AFS4FOOD PROJECT

Agroforestry for food security

Three very different study areas, but all betting on the same belief: with agroforestry systems, there is no incompatibility between market-oriented perennial crops and production of crops for local consumption. This agro-ecological approach improves the food security, incomes and well-being of African farmers in rural areas. This is the hypothesis that researchers are trying to demonstrate through the AFS4Food project.

Coordinated by CIRAD, the project is under way in three African countries: Cameroon (cocoa-based agroforestry systems), Kenya (coffee-based agroforestry systems) and Madagascar (clove-based agroforestry systems).

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<http://afs4food.cirad.fr/>

> SAFSE PROJECT

The search for trade-offs between production and other ecosystem services provided by agroforestry systems

What are the trade-offs and synergies between productivity and other ecosystem services? This is one of the questions the SAFSE project aims to answer. By increasing our knowledge of the biophysical and socio-economic mechanisms underlying the functioning and dynamics of agroforestry systems, the project should provide a generic basis for optimising the trade-offs between provisioning services (production) and other ecosystem services (support, regulation), thereby contributing to a greater resilience of these agro-ecosystems and the societies which depend on them.

Studies will be undertaken in contrasting situations, (i) in the humid tropics of Central and East Africa and Central America, on multi-strata agroforestry systems with perennial crops (principally cocoa and coffee), (ii) in the dry sub-Saharan Africa region, on the tree and shrub parklands supporting the growing of cereals in rotation with other crops.

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Coffee growing in the shade of bananas in Kenya. © CIRAD

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WB <http://safse.cirad.fr/>

MEETINGS / EVENTS

The summer school '*Using functional traits for designing multi-species cropping systems*', co-organised by CIRAD and INRA (HortSys and Astro units), took place between 5 and 8 June in Martinique. It allowed more than 40 researchers and engineers involved in innovation transfer to discuss and build on ecological tools and concepts for designing more ecologically intensive cropping systems. Participants and lecturers from all continents shared their knowledge and questions. Presentations were recorded on video.

The thematic school '*The facilitation process for nutrient acquisition in multi-species plant communities*' was held from 18 to 22 June at Montpellier SupAgro. The objective was to share with researchers and PhD students from around the globe the theories and concepts of ecology applied to the functioning of multi-species plant communities. Some 45 students completed the training organised by S. Boudsocq, H. Guillemain, P. Hinsinger and E. Le Cadre of the Eco&Sols joint research unit.

TRAINING

CIRAD organised training on the molecular detection of diseases in sugar cane in Montpellier from 12 to 16 November 2012. The course brought together industry professionals faced with sugar cane diseases, including growers and researchers. Ten participants from eight different countries were hosted in the molecular biology laboratories of the Biology and Genetics of Plant-Pathogen Interactions joint research unit. They were able to achieve in practice the detection of major viral diseases and bacteria in sugar cane. Participants in the group from ACP countries received financial support from the European Union.

Researchers from the HortSys research unit are involved in the design and implementation of two Masters dedicated to horticultural crops: GEDAH (sustainable management of horticultural agroecosystems) in Senegal and HORTIMET (Mediterranean and tropical horticulture) in France. They are co-directed by Professor Karamoko Diarra, from UCAD, and Dominique Bordat, from CIRAD. The HORTIMET course offering a Masters in the Science and Technology of Agriculture, Agronomy and Food Processing takes place in Montpellier SupAgro and the Angers site of Agrocampus Ouest. The HortSys research unit provides a teaching module and offers Masters placements for students. The first three classes have welcomed students from Haiti, Morocco, Algeria, Thailand and the Ivory Coast.

RESEARCH AND TRAINING PLATFORMS IN PARTNERSHIP (DP)

The *Hevea Research Platform in Partnership* (HRPP) held its fourth annual scientific seminar in Thailand from 23 to 26 October: '*Towards Sustainable Development of Natural Rubber Production in Thailand and South East Asia*'.

The *Conservation Agriculture Network for South East Asia* (CANSEA) organised in Hanoi, Vietnam, from 10 to 15 December, its **3rd International conference on conservation agriculture in South East Asia**: '*Conservation Agriculture and Sustainable Upland Livelihood: Innovations for, with and by Farmers to Adapt to Local and Global Changes*'.

Field visit. © M. Jannoyer/CIRAD





> BIODIVERSITY AND PEST AND DISEASE REGULATION

Study of tomato fruitworm regulation on okra using trap plants in Niger. © P. Ryckewaert/CIRAD

Using plants to replace pesticides

In tropical regions, farmers are faced with a range of very worrying crop protection issues, primarily linked to the use of pesticides, which are either harmful or too costly. To find alternatives to pesticides, CIRAD has launched a vast research programme aimed at exploring the potential of introducing plant species into farming systems with a view to controlling pests and diseases. In concrete terms, researchers were interested in the cleaning effects of plants, used either as inter-crops or in rotation, on white grubs and a parasitic plant which affect upland rice in Madagascar, and on tomato bacterial wilt in Martinique. They also looked at the effect of trap plants on the tomato fruitworm, which attacks market garden crops in Martinique and Niger, and of a food attractant combined with a biological insecticide against vegetable flies in Réunion. Researchers have also determined the effectiveness of combining trees and bushes to control plant bugs and black pod rot in cocoa crops in Cameroon and examined the effects of landscape mosaics on leaf rust incidence and coffee berry borer abundance in Costa Rica.

The ways in which plant species can be combined with crops vary considerably, and they sometimes have the opposite effect to what is expected. It is therefore important to create the tools required to strike compromises for managing conflicts or creating synergies between the spatiotemporal deployment of specific plant diversity and the regulation of pest and disease complexes. One of the first results of the programme is a modelling tool intended to optimise the spatiotemporal deployment of trap plants in plots to regulate pests. This was based on a model for the tomato fruitworm, using maize as a trap plant.

Study of regulation of tomato pith necrosis using service plants in Martinique. © P. Deberdt/CIRAD



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Ratnadass A., Fernandes P., Avelino J., Habib R., 2012. Plant species diversity for sustainable management of crop pests and diseases in agroecosystems: a review. *Agronomy for Sustainable Development*, 32: 273-303. Doi: 10.1007/s13593-011-0022-4

WE <http://omega3.cirad.fr>

Right: *Earias* sp. larva on a cotton flower. Two morphologically similar species of the genus *Earias* are found in sub-Saharan Africa: *E. insulana* et *E. biplaga*. © P. Silvie/CIRAD

> COTTON IN AFRICA

A crop increasingly less dependent on pesticides

Chemical control of cotton pests relies on two methods: treatments applied according to a predetermined calendar, or spraying triggered by the degree of infestation or extent of damage. The latter method was developed in the 1980s in several French-speaking countries in West Africa and increasingly used by growers, partially or completely. Since then, a series of protection programmes combining the two methods and variations thereon have been implemented in the countries concerned. After more than 20 years of trials, it is now possible to take stock of their advantages and constraints. This is what a team from CIRAD, working alongside its African partners, has recently done. Conventional programmes are still in widespread use, but programmes focusing on pest monitoring are making progress. For instance, in Benin, two types of targeted staggered control are practised, depending on the extent of damage. In Mali, Cameroon and Senegal, programmes based on true thresholds are being developed. In Togo, a treatment calendar has been implemented based on observations of *Helicoverpa armigera*. In Ivory Coast, true thresholds are used only at the start of the cycle, while in Burkina Faso, they are used after the first two spraying rounds in the calendar. These programmes have real financial advantages for smallholders since they require less pesticides. In Mali, for example, insecticide consumption in cotton plantings fell from 5.5 litres per hectare in 1997 to 4 litres in 2008. The development of such programmes over vast areas and the research being done on other control techniques are making cotton crops in Africa steadily less dependent on pesticides.

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Renou A., Togola M., Téréta I., Brévault T., 2012. First steps towards "green" cotton in Mali. *Outlooks on Pest Management*, 23: 173-176. Doi: 10.1564/23aug07

Silvie J.P. et al., 2013. Threshold-based interventions for cotton pest control in West Africa: What's up 10 years later? *Crop Protection*, 43: 157-165. Doi: 10.1016/j.cropro.2012.09.006



Female *Docus demmerez* laying eggs in a courgette.
© J.P. Deguine/CIRAD

> RÉUNION

Maize plants that trap vegetable flies

In Réunion, vegetable flies (Diptera, Tephritidae) are seen as the main pests on horticultural crops such as courgettes, chayotes, cucumbers, pumpkins etc.

For several years now, a CIRAD team has been working with partners in Réunion on the possibilities of managing fly populations agroecologically as an alternative to chemical control. They have demonstrated the major role plants can play in attracting and trapping flies outside crop plots.

Maize plants have proved wholly effective as traps: the flies concentrate on the plants and can be killed using a food bait mixed with a tiny quantity of bio-insecticide. There is a further advantage as maize plants also harbour other, useful insects which are both pollinators and predators, and are also indicators of a more balanced ecosystem.

Today, using maize plants as fly traps has been successfully adopted by producers in Réunion, in the form of borders around vegetable plots or patches and bands inside them. In this situation, no insecticide is sprayed on cucurbits and production losses are minimal or negligible.

Combined with other techniques such as fly population surveillance and collecting fallen fruits, using plant traps guarantees agroecological pest management.

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> LIFECYCLE ANALYSIS

A platform for tropical products

In order to create sustainable agricultural production systems, it is first necessary to have reliable environmental assessment methods such as lifecycle analysis (LCA). For agricultural production in temperate zones, these methods are well developed. However, for tropical agricultural products, there is still much to do. Since 2009, CIRAD has been developing an ambitious project for analysing the lifecycle of these products, including a team of scientists specialising in this new field of research, calculation software tools and pooled databases. This team works on diverse public and private projects. For example, since September 2010, it has been involved in the ADEME Agri-Balyse project, whose objective is to provide the LCA inventory data for a wide range of agricultural products consumed in France according to a harmonised method. Lifecycle analysis for several chains has been conducted as part of this project: clementines from Morocco, coffee from Brazil and rice from Thailand. The work is continuing with the analysis of the chains involving mango and cocoa from Brazil and palm oil from Indonesia. The team is also involved in the ANR Flonudep project, which is developing a method and an evaluation tool for measuring the sustainability of horticultural supply chains according to nutritional, socio-economic and environmental criteria. Finally, the team is working on improving estimation methods for fluxes in the field better adapted to tropical conditions and is developing the impact categories currently missing (impacts linked to the use of fresh water and biodiversity). Together with colleagues from the ELSA platform, the CIRAD team also contributes to developing impact pathways to assess socio-economic impacts within LCA along with environmental ones.

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Bessou C., Basset-Mens C., Tran T., Benoist A., 2013. LCA applied to perennial cropping systems: a review focused on the farm stage. *The International Journal of Life Cycle Assessment*, 18 : 340-361. Doi: 10.1007/s11367-012-0502-z

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> PEANUT (*ARACHIS HYPOGAEA*)

Interspecific introgression and genetic analysis of traits of interest

In order to enhance the genetic diversity available in wild peanut species, an important introgression programme has been conducted from a cross between a variety grown in Senegal and a variety, developed by EMBRAPA in Brazil, produced by the hybridisation of two wild species. This marker-assisted selection programme was seeking to develop a collection of chromosome segment substitution lines (CSSL) to broaden the genetic base of cultivated peanut while also producing experimental material for the genetic analysis of traits of interest. This collection of lines represents the entire wild genome in the form of overlapping chromosome segments, mapped and introgressed into the genome of the cultivated variety. Phenotypic comparison of each line to the cultivated parent makes it possible to analyse the effects of each segment of wild origin. A genetic study conducted during the construction process of the population showed the existence of wild alleles which have a positive effect on the components of yield and maturity. Following this work, a first characterisation of the CSSLs has confirmed the interest of the population for dissecting the genetic control of the morphological traits involved in the development of the plant. This CSSL population, developed through an international collaboration for the exchange of genetic material, is an important resource for the discovery of favourable wild alleles and the study of the genetic control of traits of agronomic interest.

Angélique D'Hont and the banana genome

After three years of research*, the banana genome has delivered the secrets of its sequence. It's a major step, which carries the hopes of the banana sector, whose plantations are currently threatened by several diseases. For more details, we talk with Angélique D'Hont, who coordinated the sequence analysis.

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* This work, published in the prestigious journal *Nature*, was conducted by CIRAD and CEA-Genoscope, accompanied by several international teams, with financial support from France's National Research Agency (ANR).



Angélique D'Hont (in the flowery blouse) surrounded by her team. © CIRAD



The banana genome sequence is freely available on the following website:
<http://banana-genome.cirad.fr>

Does this mean the banana no longer has any secrets?

Angélique D'Hont: We can't say that. We have deciphered 472 million base pairs of the 520 million which constitute the 11 chromosomes of the banana. On this sequence, 36,500 genes coding for proteins have been identified but, for the most part, we do not yet know their precise function. The sequenced genome is a form of the species *Musa acuminata* involved in edible bananas (dessert and cooking bananas). To unlock the secrets of this fruit, we must first study the genetic diversity in other forms.

What is the importance of knowing the banana genome?

A. D'H.: This sequence serves as a reference for identifying genes that are of agronomic interest. Knowing them, we can search those from which sequence or expression changes best predict the characteristics we are interested in, disease resistance, of course, but also fruit quality or the components of production. There is plenty still to do

for the different CIRAD teams who contributed to this sequencing!

It should be noted that this sequencing comes in a very particular context...

A. D'H.: Indeed. Some 50% of the world production is based on the Cavendish variety, which is the variety used by all the export supply chains. However, all these Cavendish plants are identical as they are clones produced using vegetative reproduction. This homogeneity, associated with monoculture in the plantations, has favoured the emergence of diseases and leads to significant use of pesticides. So today, the banana sector is threatened worldwide by various diseases, especially Panama disease and black Sigatoka. The sequencing will facilitate the characterisation and the mobilisation of new resistances to renew the varieties available either through conventional crossing or using *in vitro* techniques. At CIRAD, we favour the first approach as it is more open in terms of biological diversity and international partnerships.

A cross being conducted on the flower of cultivated peanut. © D. Foncéka/CIRAD



Foncéka D., Tossim H.-A., Rivallan R., Vignes H., Lacut E., de Bellis F., Faye I., Ndoye O., Leal-Bertioli S.C.M., Valls J.F.M., Bertioli D.J., Glaszmann J.C., Courtois B., Rami J.F. Construction of Chromosome Segment Substitution Lines in peanut (*Arachis hypogaea* L.) using a wild synthetic and QTL mapping for plant morphology. 2012. *PLoS One*, 7 [11]

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> GENETIC DIVERSITY IN RICE

Representation through a population growth model Implications for phenotyping and the exploration of varietal ideotypes

CIRAD is studying the genetic determinants of rice productivity and tolerance to drought in the CGIAR [Consultative Group on International Agricultural Research] GCP Programme. To do this, the genetic diversity of rice from the japonica group represents a considerable source of interesting characteristics.

However, combining vigour [the ability to develop rapidly] and tolerance to water stress involves analysing genetic diversity for a combination of not necessarily independent characteristics. This type of study is difficult to achieve experimentally. However, through modelling we can analyse the parameters explaining the diversity of phenotypes within a species according to the environment [Fig. 1].

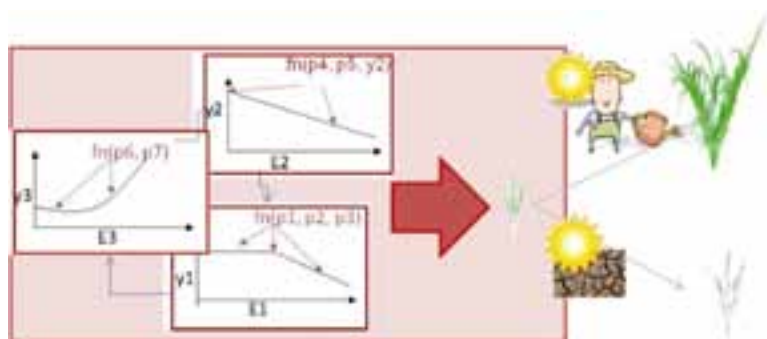


Figure 1. The principle of modelling for a complex system such as a growing plant. The equations formulate the response of a biological process to an environmental variable E, according to genotypic parameter values (pn). The variables simulated can together influence and generate phenotypic dynamism. © D. Luquet



Figure 2. Study conducted in a greenhouse on the growth of 200 genotypes of japonica rice [IRRI, M.C. Rebolledo, Sept. 2010]. For each genotype, an irrigated plant and a plant lacking water are side-by-side. © M.C. Rebolledo

DVD

Agroecology and Conservation Agriculture. Combining texts, videos, useful charts and photos, this interactive DVD offers all you need to know about conservation agriculture and agroecology. The collection of practices presented are a response to the challenges of agricultural development, environmental protection and climate change. It was financed by France's development agency (AFD) as part of a research project offering national support to agroecology created by Madagascar's Groupement Semis Direct in partnership with CIRAD.

The Ecomeristem model, simulating the growth of rice under different water conditions, was used to explore the phenotypic diversity of a collection of 200 japonica rices [Fig. 2]. For each genotype, the growth parameters [appearance and size of leaves, branching, sugar reserves versus structural growth] depending on abiotic conditions [temperature, light, water] were estimated [thesis M.C. Rebolledo, CIRAD].

The collection of japonica rice has shown a wide variety of behaviours [Fig. 3]. Particularly notable is the negative correlation that was observed between vigour and tolerance to water stress, demonstrating the complexity of simultaneously breeding for these two characteristics.

To validate the relevance of modelling for the analysis of phenotypic and genetic diversity, genetic association studies are being planned. The Ecomeristem model is already being used to explore varietal ideotypes maximising the vegetative vigour of rice in a given abiotic environment.

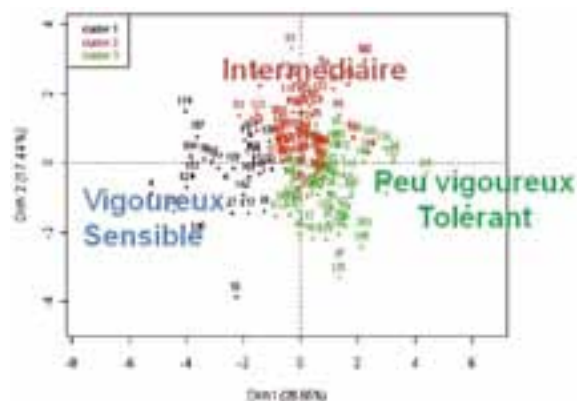


Figure 3. Principal component analysis (PCA) using the parameter values of the EcoMeristem model characterising the initial vigour and tolerance to water stress (maintaining transpiration and leaf growth under water deficit) of a genotype. PCA revealed three behavioural groups, notably two opposing groups: vigorous with low tolerance to water stress and less vigorous but tolerant. © D. Luquet

Luquet, D., Rebolledo, M.C., Soulié, J.C. 2012. Functional-structural plant modelling to support complex trait phenotyping: Case of rice early vigour and drought tolerance using Ecomeristem model. In: Kang, M., Dumont, Y., Guo, Y. (eds). *Plant growth modeling, simulation visualization and applications*. Proceedings. Beijing, China: Institute of Electrical and Electronics Engineers, p.270-277. IEEE International Symposium. 4 [PMA'12], 2012/10/31-2012/11/03, Shanghai, China.

> TARO IN VANUATU

Preserving genetic diversity

Taro (*Colocasia esculenta*) is grown throughout the humid tropics for its large corms, which are rich in starch. In Vanuatu, a Melanesian archipelago, it is the main starch plant. Ensuring its future is necessary because its poor genetic diversity makes it vulnerable to new pathogens.

A South East Asian and Melanesian network has established a representative sample of the genetic diversity of taro, in terms of agronomic performance, quality of the corms and geographical origins. After sanitation and propagation, these varieties have been distributed to different producers to broaden the genetic base.

This new method for managing genetic resources seeks to maintain diversity in the form of alleles rather than in the form of fixed varieties (genes rather than genotypes). The principle is simple: distribute as broadly as possible *ex situ* collections. The presumed recombinations between introduced and local gene pools via sexual reproduction introduces genes for resistance to environmental changes in local populations, thus maintaining some of the local gene pool.

The suitability of this method has been validated in 10 villages on the 10 main islands of Vanuatu by counting the clones adopted by producers and an evaluation of the diversity using molecular markers. The results show that producers now possess a high allelic diversity for taro which does not threaten existing varieties, but instead enriches their varietal portfolio. They are therefore ready to pre-empt environmental changes.

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Portugal > CIBIO-Azores (University of the Azores). Vanuatu > Centre Technique de Recherches Agronomiques du Vanouatou (CTRAV)



A peeled taro corm, ready for cooking.
© V. Lebot/CIRAD

Sardos, J., Noyer J.L., Malapa, R., Bouchet, S. and Lebot, V. 2012. Genetic diversity of taro (*Colocasia esculenta* (L.) Schott) in Vanuatu (Oceania): An appraisal of the Distribution of Allelic Diversity (DAD) with SSR markers. *Genetic Resources and Crop Evolution*. Vol. 59 [5]: 805-820.



Pueraria phaseoloides.
© S. Lakhia/CIRAD

> BANANA CROPPING IN THE WEST INDIES

Biodiversity, agrosystem services and functional traits of plants

Cover plants offer multiple benefits for agrosystems. They can limit the growth of weeds, regulate pests and improve the physical properties and fertility of soil. But how do we choose the most suitable species? And when in the crop cycle should they be used? A team from CIRAD proposes the adoption of an approach based on the analysis of the functional characteristics (functional traits) of these plants to maximise the ecological services they can provide in the agroecosystem. This approach has the advantage of describing the plants according to simplified indicators of their functioning. Researchers have implemented the approach on a collection of tropical cover plants for banana cropping systems in the West Indies, measuring for each of these plants a dozen characteristics which are easy to estimate in the field. They then grouped the plants according to their potential to provide the expected services in these agroecosystems. Plants which are non-hosts of plant-parasitic banana nematodes have, for example, been identified. Planted during the fallow period, they decontaminate the soil and avoid the use of chemical nematicides after the replanting of banana. Plants with the ability to quickly cover or permanently cover the ground have also been identified. Planted during the fallow period or grown in association with bananas, they reduce weed populations. Ultimately, this approach should make it possible to assess and manage innovative cropping systems based on spatio-temporal associations between bananas and cover plants.

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Damour G., Ozier-Lafontaine H., Dorel M., 2012. Simulation of the growth of banana (*Musa* spp.) cultivated on cover-crop with simplified indicators of soil water and nitrogen availability and integrated plant traits. *Field Crops Research*, 130 : 99-108. Doi: 10.1016/j.fcr.2012.02.013

PUBLICATIONS

Le bananier. Un siècle d'innovations techniques. A. Lassoudière [Ed. Quae]. This book traces the history of the production of dessert bananas, focusing on technical innovations. Throughout the twentieth century, researchers have been asked to respond to the priority issues of the sector: the need for a product for exports, production, varieties that performed well and offered disease resistance, and production techniques for sustainable development.

Selective logging in tropical forests helps conserve a major share of the biodiversity and carbon reserves initially found in primary forests. This was shown by a study published recently in the journal *Conservation Letters*, in which two CIRAD researchers, Sylvie Gourlet-Fleury and Plinio Sist, took part. The analyses primarily concerned non-certified logged forests.

Apprendre à innover dans un monde incertain. Concevoir les futurs de l'agriculture et de l'alimentation. É. Coudel, H. Devautour, C. Soulard, G. Faure, B. Hubert. [Ed. Quae]. Urged on by new expectations of society, key rural players experiment with different agricultural and food systems, showing proof of creativity and stubbornness faced with the ever-dominant mass production. This work examines key questions: what type of sustainable development are societies seeking? How do we choose the innovations to achieve it? What role can research and public policies play to support the emergence of these innovations?

> MODELLING ROOT GROWTH

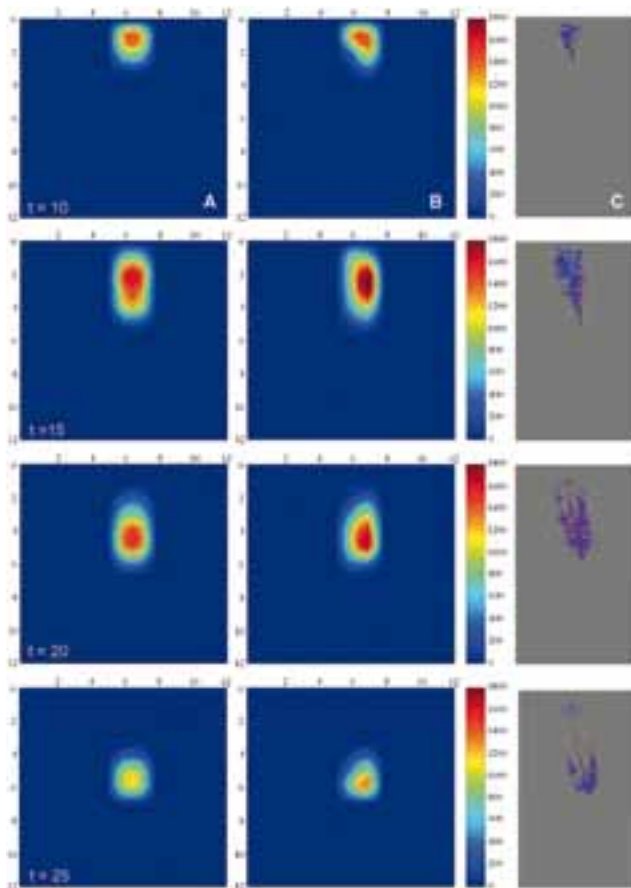
C-root: a generic, minimalist and continuous model

The root system is the 'hidden face' of a plant. Yet its role is very important! Indeed, it not only anchors the plant in the soil, absorbing water and nutrients, but it also transports nutrients to the aerial parts of the plant. Therefore its modelling is an important issue in formalising our knowledge and to help us better understand how it functions. CIRAD has developed a generic and continuous model for root growth, called C-root, in order to aggregate architectural and functional knowledge at different spatial and temporal scales. The C-root model has been successfully applied to the growth of horizontal roots of eucalyptus (Pointe-Noire, Congo). However, this is a 'generic' model, which can be applied to different types of root systems. It is also a 'minimalist' model, in the sense that it involves a minimum number of parameters to simplify their estimate and to perform reliable simulations, in a reasonable time. Finally, the continuous formalism is not only helpful to study theoretically and numerically the model with mathematical tools, but it also facilitates [strong] coupling with other physical models, like water and nutrients transfers models. C-root is a first step towards hybrid mixed models, which aim to include or link more complex architectural models, simulated, for instance, with AMAPsim.

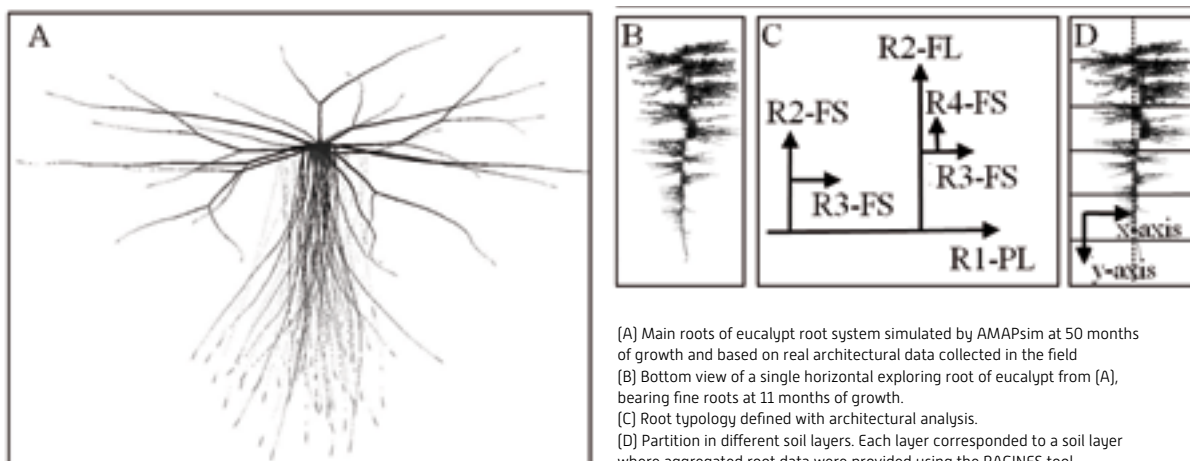
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A. Bonneu, Y. Dumont, H. Rey, C. Jourdan, T. Fourcaud. A minimal continuous model for simulating growth and development of plant root systems, *Plant and Soil*, 354 [1-2] (2012), 211-227.



(A) C-root simulation of apex number density for a horizontal eucalyptus root at different time [in months] iteration [distance in m.]. (B) Apex number density deduced from (C). (C) Architecture of a horizontal root and its network of fine roots simulated using AMAPsim.



(A) Main roots of eucalypt root system simulated by AMAPsim at 50 months of growth and based on real architectural data collected in the field (B) Bottom view of a single horizontal exploring root of eucalypt from (A), bearing fine roots at 11 months of growth. (C) Root typology defined with architectural analysis. (D) Partition in different soil layers. Each layer corresponded to a soil layer where aggregated root data were provided using the RACINES tool.

Flux tower,
and the Turrialba volcano.
© H. Rey/CIRAD

> COFFEE-FLUX IN COSTA RICA

An observatory for ecosystem services in coffee agroforestry

Ecosystems provide many services, but these services are not always those that we expect. In reality, ecosystem services vary considerably across time and space. It is therefore essential to observe them in the longer term, to quantify and model the services of an ecosystem in order to have a good idea of their importance. Since 2008, CIRAD and its partners have been conducting this kind of monitoring in a coffee-based agroforestry system in Costa Rica through the Coffee-flux observatory. They are particularly interested in hydrological, erosion control and carbon services. They have observed that surface run-off and erosion were lower in plots than in non-plots (roads, footpaths) and that trees providing shade reduced erosion in plots but had a negligible impact on erosion at the watershed scale. In fact, the high permeability of the andisol allows rainwater to seep into the aquifer and be discharged into the river. At the basin scale, sediments are mainly from the bed of the river, and from unstable roads and verges which need to be protected. The researchers have also shown that, despite a stable aerial biomass, carbon is accumulated in the ecosystem. This could be due to the incorporation of a fraction of the surface litter into the soil's organic matter. Indeed, crops transfer lots of carbon into those parts of the plant which undergo rapid renewal, in contrast to forests which stock it in perennial biomass. However, this facet of crops is not taken into account by conventional assessments of carbon storage, which are mainly based on the increase in aerial biomass. These examples demonstrate that it is essential to assess, objectively and without prior assumptions, the impact of agrosystem management on the ecosystem services they actually provide. It justifies research efforts to verify the actual impacts of major development projects and help orientate them.

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<http://www5.montpellier.inra.fr/ecosols/Recherche/Les-projets/CoffeeFlux>

PUBLICATIONS

Florule des biotopes du criquet pèlerin en Afrique de l'Ouest et du Nord-Ouest à l'usage des prospecteurs de la lutte antiacridienne. J.-F. Duranton, A. Foucart, P.-E. Gay. Co-ed. FAO-CLCPRO, CIRAD 2012. This lavishly illustrated book contains comprehensive information on the flora of the main biotopes of the desert locust *Schistocerca gregaria* (Forskål, 1775) in West and North-west Africa. It is designed to provide survey staff involved in locust control operations with useful information in describing the state of the plant cover in the biotopes in which locust populations are found, whose development and dynamics they need to assess and whose biological potential they need to determine.

Le palmier à huile. J. Jacquemard [Ed. Quae]. Palm oil is today the leading source of vegetable fats and oils on the world market. From a crop meeting the goal of sustainable production to the effects of palm oil consumption on human health, this work addresses all aspects of the plants and its products: market, morphology and biology, the creation and operation of a palm stand with an environmental and socio-economic impact study.

Gomez-Delgado F., Rouspard O., Le Maire G., Taugourdeau S., Perez A., van Oijen M., Vaast P., Rapidel B., Harmand J.M., Voltz M., Bonnefond J.M., Imbach P., Moussa R., 2011. Modelling the hydrological behaviour of a coffee agroforestry basin in Costa Rica. *Hydrology and Earth System Sciences*, 15: 369-392. Doi: 10.5194/hess-15-369-2011



A compost heap after the thermophilic phase in a ventilated channel covered with a tarpaulin (Valid® process): there is considerable heterogeneity, linked to the aeration system and to condensation under the tarpaulin. © J.M. Paillat/CIRAD

> POULTRY FARM EFFLUENT COMPOSTING

Modelling gas emissions

While composting produces organic matter that can be used directly by crops, it also results in greenhouse and harmful gas emissions. To better understand the processes and transformations involved in organic matter degradation, researchers from CIRAD have opted for dynamic modelling. The model they developed and parameterized has allowed them to precisely analyse the different phases of windrow composting by passive aeration and to determine the key parameters. During the thermophilic phase, nitrogen availability is the factor that most rapidly limits organic matter organisation. Compaction exacerbates heat losses from the windrow by conduction, solid/liquid/gas exchanges and organic matter organisation. This results in reduced gas emissions. The initial fractionation of the organic matter and initial microbial biomass content are key factors for predicting carbon and nitrogen organisation. The specific parameters of water, ammonia and nitrogen protoxide emissions are linked to the initial conditions (type of substrate, porosity and humidity). An additional statistical analysis of the results should help assess to what extent these parameters could be predicted effectively based on prior knowledge of the windrow or whether trials are still required to calibrate them. The model can be adapted to suit various operational constraints and be used on an industrial scale, provided a few changes are made. Eventually, it should therefore help poultry farmers control the environmental impact of the process better, so as to produce standard compost.

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Oudart D., Paul E., Robin P., Paillat J.M., 2012. Modeling organic matter stabilization during windrow composting of livestock effluents. *Environmental Technology*, 33: 2235-2243. Doi: 10.1080/09593330.2012.728736

> NO-TILL WITH COVER CROP

A solution to improve soils in Laos savannahs

The grassland savannahs in Laos are depleted acid lands that today are little used. A team from CIRAD has been working on the development of their agricultural potential. For different cropping techniques, they analysed changes in the soil's physicochemical properties and microbial communities, two essential components of soil fertility. Despite the limited number of years of crop production, cropping practices have had a major impact on the soils' characteristics. The effect was particularly significant in the plots cultivated using no-till with a cover crop which, unlike the plots managed under ploughing, showed improvements in the soil's physicochemical characteristics: the structural stability and organic matter content of the soils increased and there was an improvement in the cation exchange capacity, which measures plant nutrient availability. Direct sowing also had a positive effect on microbial abundance, with an increase in total biomass, as well as bacterial and fungal densities. This study is one of the most comprehensive



Rice emergence on ploughed land, 25 days after sowing: the bare, uneven soil increases the risk of erosion and evaporation, and irregular soil humidity is visible - with damp and dry zones - and, therefore, the water supply to plants is not constant.

© P. Lienhard/CIRAD

Rice emergence, 25 days after direct sowing under finger millet (*Eleusine coracana*) and pigeon pea straw (*Cajanus cajan*): on the level covered soil, the residues form a physical barrier against rainwater runoff, which limits the risk of erosion, especially because the soil surface is smoother. The cover also provides protection against the sun and helps maintain soil humidity for longer.

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environmental assessments of agricultural practices undertaken in a tropical acid environment. In practical terms, it has led to a number of recommendations for developing grassland savannahs in Laos and, more generally, in tropical environments with the same constraints. In this kind of environment, managing crops with no tillage and encouraging maximum restitution of harvest residues is highly recommended. In this way, the soil's physical, chemical and microbial properties can be improved rapidly to provide the basis for a lasting agricultural system.

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> REDOX POTENTIAL, pH, RESISTIVITY

A new perspective on the functioning of agricultural systems

The pH, which characterises the activity of protons, is a key parameter in agronomy. In contrast, the redox potential, or oxidation/reduction potential [Eh], which concerns the activity of electrons, is rarely studied. Starting with a review of the work conducted on redox potential in various disciplines and then integrating all of this data, a CIRAD agronomist has opened up new avenues for defining an 'ideal' soil and explaining the phenomena taking place. The hypothesis underlying this work is that plants operate within an internal and specific Eh-pH range, and they change these parameters in the rhizosphere to ensure homeostasis in their cells. The 'ideal' soil for a particular crop is a soil in which energy efficacy is at its maximum, where the photosynthetic products can be used for the growth of the plant and associated micro-organisms, and where production of vegetation is optimised. Under these conditions, Eh and pH are maintained at favourable levels and the system is stable. Alongside these two parameters, we can add the electrical resistivity of the soil, used in precision agriculture to characterise the soil and measure its properties. By defining optimal Eh-pH-resistivity ranges, it will be possible to develop cropping systems in which plants, micro-organisms and growing practices make it possible to create favourable conditions for the soil. This analytical framework provides a new perspective on the functioning of agricultural systems. While it may raise many agronomic questions, it also opens up new perspectives, for example, on how to address the interactions between genotypes, the environment and agricultural practices, the role of organic matter, and the process of restoring soil fertility.

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Plants change the environment in their rhizosphere and thus promote the development of specific micro-organisms. We note here high levels of biological activity in the rhizosphere of *Brachiaria brizantha*. © O. Husson/CIRAD

> CLIMATE CHANGE AND AGRICULTURAL PRODUCTION

Early warning systems in West Africa

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In the coming years, two factors - beside political crises - will increase food insecurity in West Africa: the strong population growth and climate change, which will have significant impacts on agriculture, which is mainly rain-fed in this region. A sharp rise in temperatures and more frequent extreme rainfall are predicted. To ensure the monitoring of agricultural production and provide for its evolution, it is therefore essential to have reliable and efficient tools and methods available. By combining modelling, remote sensing and climatology, CIRAD and its partners are contributing to the improvement of an early warning system adapted to the constraints of this region. West Africa is characterised, in fact, by fragmented plots, high variability within plots and a highly variable climate over both space and time. These characteristics make it difficult to evaluate the performance of these tools and methods and, more importantly, their predictive quality. Researchers have therefore developed the crop model Sarra-H, adapted for food

crops such as millet, sorghum and maize, and for local varieties. They have also verified its predictive performance at different scales. Their methodological advances in remote sensing have enabled them to map, at a national level, the area under cultivation and to ascertain the main agroecosystems of which it is composed. Spatial information gathered by processing satellite images will be used to improve the model simulations. This work is part

of an approach which is both operational, with the integration of the Sarra-H model into the early warning system run by AGRHYMET in West Africa, and scientific, with research into the links and coherence between climate scenarios and crop models.

PARTNERS AGRHYMET. Interdisciplinary programme dealing with the West African Monsoon (AMMA). National agricultural research services (Mali, Senegal, Burkina Faso). **France** > Institut de Recherche pour le Développement (IRD), University of Dijon



Preparation of a field before sowing, Mali. © CIRAD



> COCOA TREES AND SWOLLEN SHOOT DISEASE

Progress in West Africa, the world's largest cocoa production area

Cocoa swollen shoot virus (CSSV) [see photo] first appeared in cocoa trees shortly after they were planted in West Africa in the 1920s. The disease was first described in Ghana and then detected in Togo, Nigeria and Ivory Coast. It caused massive damage in Ghana and Togo, but not in the Ivory Coast until 2003; since then outbreaks have raised the question of where their origin lies. The virus is naturally transmitted by several species of mealybugs. To develop a strategy for the diagnosis and control of the disease, the genetic diversity of CSSV has been analysed. This work has allowed six distinct viral species to be identified, having potentially emerged from different plants native to West Africa. The geographical structure of these species has been detailed (Kouakou et al., 2012). In parallel with this, a diagnostic PCR has been developed. The disease control strategy is based on replanting with less sensitive trees

Involving farmers in the design of innovations

In sub-Saharan Africa, the technical options suggested by researchers are not widely adopted by farmers and the performance of farms is little changed. So, how do we ensure that these proposals are more appropriate and therefore better received by their recipients? What steps can be taken to involve farmers in their design? To answer these questions, a CIRAD team has been using modelling: this allows production systems to be better characterised and serves to support discussions between stakeholders on improving farm performance. For four years, researchers have been developing models which have then been used to help farmers in the cotton production zone of western Burkina Faso to develop innovations. Two models have been used: a model built by researchers to determine the capacity of mixed crop/livestock systems to modifications in production conditions, and a decision support model, built with stakeholders, to be used in dialogue between farm managers and technical advisers when analysing the impact of innovations on the functioning of the farm. The first model has shown that the adoption of research proposals can modify the response of farming systems to variability in rainfall and the economic environment. The second has allowed farmers to acquire new knowledge on how to calculate the economic balance of the farm or plan their growing season, thereby facilitating the adoption of new practices, such as the production and use of organic manure or planning crop management.

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Mali > Institut d'Economie Rurale (IER)

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Training technicians using a model.
© N. Andrieu/CIRAD

after the removal of diseased trees and their neighbours in production plots, and the use of sanitary barriers comprising other plant species in cocoa agroforests. Complementary work will help us to better understand the emergence and spread of CSSV (notably in Ghana), the resistance of cocoa trees to the main species involved in the virus and the control of CSSV in agroforestry systems with sanitary barriers.

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Swollen shoots of a sick tree
(left, p.32) and red vein banding
of young leaves (this page).
© E. Muller/CIRAD



Constructing a wood stack.
© D. Louppe/CIRAD

<http://url.cirad.fr/biomass-energy>



BIOMASS ENERGY AND SOCIETIES IN THE SOUTH

The aim is to design sustainable biomass production systems tailored to the situation of rural communities, for whom access to energy is still a problem. This means developing ways of using lignocellulose biomass – wood and crop residues – to generate energy, and looking into the agro-nomic potential of several plants, such as jatropha, cotton, groundnut, soybean, sorghum and sugarcane. There are high hopes for bioenergies. However, devoting agriculture to producing such forms of energy raises risks for developing countries if it is practised at the expense of food production.



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« While the processes for converting biomass into energy have always existed, their scientific study is much more recent.

A platform for green energy

An interview with Eric Martin, head of the Biomass & Energy platform

Inaugurated in June 2012, CIRAD's Biomass & Energy Platform is being used to study the processes involved in the thermochemical conversion of biomass into energy. This booming research area corresponds with some of the major ecological and development challenges facing southern countries.

Can you describe for us the Biomass & Energy Platform?

Eric Martin: Over an area of 500m², it houses the main R&D pilots for biomass conversion into energy. Its specificity is that it combines all the biomass thermochemical conversion processes on a semi-industrial scale: pyrolysis, roasting, gasification, and an engine test bench for biofuel combustion. The platform also houses a centre for the preparation and processing of biomass, a laboratory for physico-chemical analysis and a storage area.

What is the objective of the research you lead?

E. M.: The scientific objective is to improve our knowledge of and to optimise conversion reactors. In particular, we want to improve the processes and expand the range of usable biomass. The specificity of the platform is to host pilots on a semi-industrial scale. Processes

are from the laboratory scale to the pilot. This characteristic is a major advantage sought by our partners. In addition, the facilities are also as flexible as possible to provide the broadest possible scope for experimentation. I should clarify that while the processes for converting biomass into energy have always existed, their scientific study is much more recent.

And these research themes are currently at the heart of global issues?

E. M.: Yes, our experiments address major issues in terms of ecology and development in southern countries. A third of the world's population does not have access to energy services, primarily in rural areas of developing countries, whereas biomass is a locally available resource, in the form of agricultural and forest products and waste. These can

provide the energy required for the development of economic activities and thus help alleviate poverty. Biomass also offers an opportunity to produce energy with no greenhouse gas emissions.

Can you tell us about one of this year's results?

E. M.: Take the BioViVe project, for example. It is seeking to replace fossil fuel with a gas obtained from the pruning residues and uprooting of vines. This gas, produced using a staged gasification process, is adapted to the needs of glass manufacturing and is being tested in Verallia's furnace in Champagne. The CIRAD platform has played a major role in optimising the industrial process

And the knowledge we have gained in this project can be adapted for small to medium energy units suitable for rural areas in developing countries. ○

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<http://url.cirad.fr/energy-platform>

<http://ur-biomasse-energie.cirad.fr/>

> LOCAL BIOENERGY PRODUCTION

What impact on the lives of rural populations?

In southern countries, producing and making local use of biomass for energy is considered a factor in economic development and a way to alleviate poverty. The potential impact of these new local energy systems on the livelihoods of rural populations is likely to influence the innovation trajectory in this sector. To contribute to this synergy, CIRAD launched a multidisciplinary research programme in Madagascar, Burkina Faso, Mali and the Brazilian Amazon. With the evaluation grid they developed, researchers were able to identify some critical elements for determining the success of these systems. First, it appears that the positive effects depend on the ability of local peoples to organise themselves in order to manage their facilities and the biomass supplies required. The first attempts to create forms of community management in Amazonia and Burkina Faso failed. The use

of private operators supported by public funding, as followed in Mali and Madagascar, seems to have a greater structural effect. Second, the prospect of local energy production changes users' perceptions of energy and seems to stimulate demand. Finally, although it is still difficult to generalise, the successful experiences show that using biomass makes it possible to produce energy at a lower cost than conventional systems. Energy and climate crises have led to a rethink on the location and methods of energy production, but many questions still remain about the capacity of local systems to provide sufficient energy at a low enough cost to promote economic development and improve the living conditions of populations in southern countries.

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The multifunction platform in the village of Markacoungo, Mali. Multifunction platforms (PNUD project) are village infrastructures designed to provide energy services at an affordable cost. They operate using crude vegetable oil from *Jatropha curcas*.
© L. Gazull/CIRAD



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Manual shelling of seeds from *Jatropha curcas* in Burkina Faso. The production chains for biomass energy create employment in rural areas. © L. Gazull/CIRAD



In the foreground, the sawing unit, in the background, the electric power station, Andaingo, Madagascar.
© P. Montagne/ CIRAD

> DECENTRALISED RURAL ELECTRIFICATION

The first thermal power station using biomass in Madagascar

In the rural town of Andaingo, on 6 September 2012, CIRAD and its Malagasy and Brazilian partners launched the first electric power station using biomass in Madagascar, as part of the Gesforcom project. This plant, unique in Madagascar, produces electricity at a cost of €0.24/kWh, half the cost of electricity produced by diesel generators, and runs on wood from the town's eucalyptus plantations. The installation comprises a hearth and a boiler, linked to a vertical steam engine which drives an alternator rotor with a power of 75kW to generate electricity. The installation is an excellent example of rational, sustainable eucalyptus plantation management and use, which avoids any risk to the environment or forests. The power station requires 400 tonnes of wood a year, and a total area of between 30 and 60 hectares is reserved to supply this. A wood sawing and drying unit complete the installation, with the co-generation of hot water at 95°C, for drying planks or fruit. This cheap electricity will allow local people to develop economic and craft activities, create jobs and boost incomes among farmers, who will have an outlet for the wood they produce. It will give every single local household a more comfortable life. To assess the impact of the power station, researchers intend to conduct an in-depth socioeconomic analysis of the situation of local households, before and after its installation. A similar survey conducted as part of another rural electricity distribution project in Madagascar put annual income levels at €800 per household.

MEETINGS / EVENTS

The first science days organised by the wood science research group (Groupement de recherche (GDR) Sciences du bois) were held at CIRAD in Montpellier from 26 to 28 November. The aim was to share a common culture between actors from different disciplines and themes in wood science, to promote the work of the laboratories involved, and especially young researchers (PhD students), and discuss the major cross-cutting issues, such as international relations, training and sharing of resources.

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The steam engine and boiler at the Andaingo electric power station, Madagascar.
© P. Montagne/CIRAD





Continuous fixed-bed gasification reactor.
© L. Van de Steene/CIRAD

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> BIOMASS AND ENERGY PRODUCTION

Gasification of char from wood pellets

The staged gasification of biomass produces clean synthetic gas, easily recoverable as electrical or thermal energy. However, this process can be optimised for both conversion efficiency and for the use of diverse sources of biomass. A CIRAD team has studied a key step in the process, the gasification of char in a continuous fixed-bed reactor, using two types of char, one from wood chips and the other from wood pellets. The latter makes it possible to use small-grained and low-density biomass in such a process.

Researchers first performed experiments using a pilot reactor to reproduce this step of the process. They measured temperature profiles, gas composition, density of the bed and velocity of particles to form a database on the reactor behaviour. They thus located, at the top of the bed, a highly reactive zone and significant compaction, causing a drop in the velocity of the particles. These tests showed that the gasification of char pellets had the same characteristics as that of char from wood chips. In a second step, the researchers have developed a model based on the resolution of conservation equations coupled with reaction kinetics. This model has the advantage of taking into account compaction in the bed and the apparent kinetics of heterogeneous reactions at the particle scale. It satisfactorily reproduces the profiles of measured physical quantities for various conditions and for both types of char. This model is already providing new and complementary information to the experimental work and will ultimately help optimise the industrial process.

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> TANNINS, HEXAMINE, BORIC ACID

Protecting wood against fungi, insects and fire

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A wood which is not naturally durable will deteriorate if used outdoors without any protection. Treatments with boron are effective – it is anti-fungal, anti-corrosion, fire-retardant and insecticidal, and has no impact on the environment – but only in the short term as boron is highly soluble in water and is quickly leached out. Hence the idea to combine it with molecules able to fix it in wood. CIRAD and its partners have opted for polymer networks based on mimosa tannins coupled with hexamine. Wood thus treated and dried has shown good retention

of boron, whether it be softwood or hardwood. After standardised leaching, wood shows excellent resistance to white rot and dry rot in both temperate and tropical strains. In fact, resistance is equal to that provided by the conventional products available on the market. Resistance to Saintonge termites, a species widespread in France, is also significantly improved. In addition, the polymer network improves the mechanical properties of the material and acts as a flame retardant. However, treated wood has a dark colour and ageing tests are under way to

assess the evolution of its external appearance. This system is very promising and will be subject to further study and improvements. This will include performing further impregnation tests on other non-durable species, field experiments where wood is in contact with the ground and testing for ecotoxicity.

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PARTNERS Austria > Austrian Science Fund (Lise Meitner programme), Salzburg University of Applied Sciences. France > Languedoc-Roussillon regional council (ARPE programme), University of Lorraine.



A market in Moroni, Comoros.
© V. Porphyre/CIRAD

ACCESSIBLE, QUALITY FOOD

Economic growth, urbanization and changing lifestyles are all making consumers change their dietary habits. These profound changes in the agrifood sector raise questions regarding competitiveness, supply chain organization, and exclusion: the crises seen in the sector recently have not always been linked to shortages but also to the problems certain population groups have in accessing food resources.

<http://url.cirad.fr/quality-food>





Sweet potato and plantain banana stall. © A. Bechoff/CIRAD

> SWEET POTATO AND PLANTAIN

Estimating the bioaccessibility of carotenoids

Orange-fleshed sweet potatoes and plantain bananas are staple foods with high levels of β -carotene, a pigment that is a vitamin A precursor. In sub-Saharan Africa, women and children suffering from deficiencies are advised to eat them. However, does their consumption really help alleviate vitamin A deficiency? And is their carotenoid content the only parameter to be taken into account? A team from CIRAD recently showed that carotenoid bioaccessibility – the fraction that can be absorbed by the body – is a crucial parameter in the elaboration of food nutritional quality, and that that fraction varies substantially depending on how food is prepared. Carotenoid bioaccessibility was better in preparations cooked with fat than in those in which the food was simply boiled or made into porridge. For instance, 100 grams of orange-fleshed sweet potato porridge provides just 6% of the recommended daily allowance (RDA) of vitamin A, whereas two fritters or a single chapatti made using the same ingredient provide 75 to 100%. Furthermore, vitamin A supply levels calculated based on food carotenoid contents are therefore largely overestimated, and only bioaccessibility can provide estimates close to biological reality. The results of this study should foster the consumption of products containing orange-fleshed sweet potato flour and encourage people to add fat to boiled plantain banana preparations.

PARTNERS Bioversity International. **United Kingdom** > Natural Resources Institute (NRI)

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> POLYPHENOLS

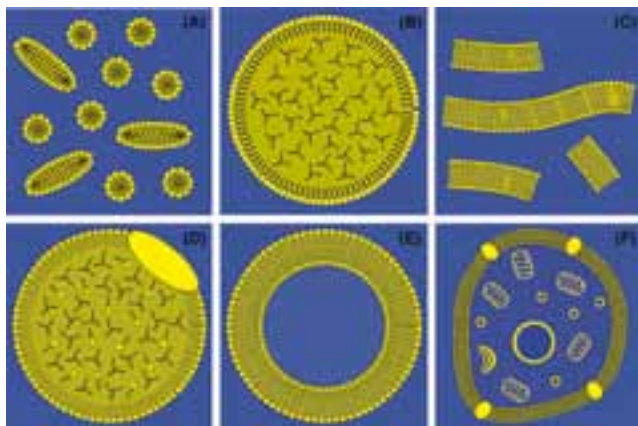
How can we improve their antioxidant properties?

Non-enzymatic antioxidants are molecules subject to much research because of their ability to neutralise free radicals and protect biological systems from oxidation. However, as they are, for the most part, relatively hydrophilic phenolic compounds,

they are difficult to implement in lipid matrices, which greatly limits their applications. To get around this problem, researchers from CIRAD and its partners have been interested over the past decade in the grafting of lipids on phenolic antioxidants. Conducted chemically or enzymatically via lipases, this modification produces lipophilized molecules which exhibit new self-assembly properties and affinities with lipids. But what about their anti-radical properties?

erful than the starting molecules. More surprisingly, the grafting of longer chains is accompanied by a drastic fall, or even total loss, of activity. For any given antioxidant, the most effective lipophilization strategy is to determine the critical chain length that will confer the optimal activity.

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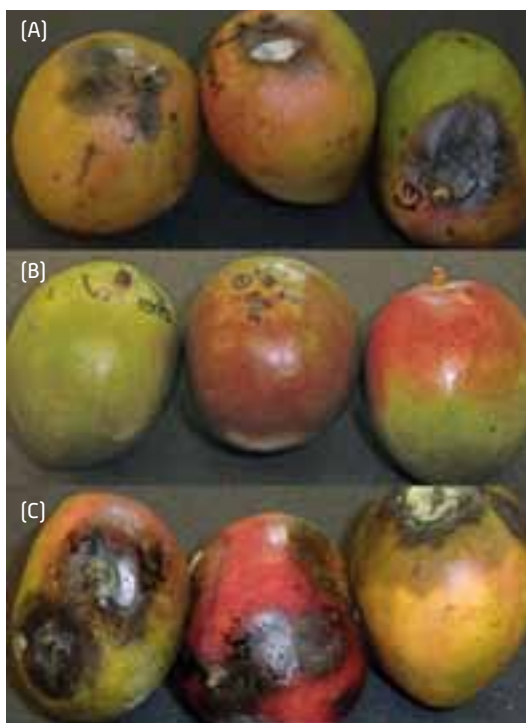
The lipid-water interface as a structural element of micellar systems (A), emulsified (B), lamellar (C), lipoprotein (D), liposomal (E) and cellular (F). In blue: the aqueous phase, in yellow: hydrophobic phases of various compositions (surfactants, triglycerides, phospholipids, galactolipids, cholesterol esters, cardiolipins, lipoproteins etc.).

After the synthesis stage, researchers have evaluated the antioxidant activity of molecules or their modified extracts in systems of increasing complexity. They have worked on chlorogenic and rosmarinic acids and their lipophilic derivatives. Whatever system is studied, grafting of an average carbon chain provides antioxidants which are some two to five times more pow-

PARTNERS **Benin** > University of Cotonou. **France** > Institut National de la Recherche Agronomique (INRA). **Germany** > University of Hohenheim. **Mexico** > Veracruz Institute of Technology, University of Chihuahua. **United States of America** > University of Massachusetts.

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Effect of coating on the development of a post-harvest pathogen artificially inoculated on mangoes: coating with 0.5% chitosan (A), coating with 0.5% chitosan and LPOS (B) and control without coating (C).
© M.N. Ducamp/CIRAD



> POST-HARVEST PROTECTION

An antimicrobial film to protect mangoes

After harvesting, mangoes are subject to a range of diseases that cause substantial losses and are difficult to control using pesticides due to the residues left on the fruit. This prompted the idea of using natural molecules with a broad antimicrobial spectrum. A CIRAD team has successfully tested coating mangoes with an antimicrobial film containing chitosan, combined with the lactoperoxidase system (LPOS), which boosts its efficacy. The lactoperoxidase enzyme system has a broad antimicrobial spectrum and is particularly effective against pathogenic micro-organisms. It can be fixed onto chitosan, a natural polyglucosamine, which has antimicrobial properties capable of protecting fruit against fungal deterioration.

This type of coating has been tested on mangoes to prevent the proliferation of diseases such as bacterial canker, stem end rot and fruit anthracnose. Coatings based on 1% chitosan plus the lactoperoxidase system prevented microbe proliferation and delayed fruit ripening without causing any physiological disorders. They did not alter any of the ripening parameters: firmness, respiratory intensity, weight loss or fruit colour. They can therefore be recommended to protect mangoes post-harvest.

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PARTNERS **France** > Institut des Régions Chaudes, Montpellier SupAgro.
Ivory Coast > University of Abobo-Adjamé. **Venezuela** > Central University of Venezuela.

PUBLICATIONS

La sécurisation alimentaire en Afrique : enjeux, controverses et modalités. Sandrine Dury. A special issue of *Cahiers Agricultures* takes a critical look at the concept of food security and its operatinality. Using original data obtained through field research and various disciplinary studies (political sociology, agricultural economics, techno-economic modelling), it suggests rethinking our viewpoints as regards the ways of improving the daily diet of vulnerable populations. *Cahiers Agricultures*, Volume 21, Issue 5, 285-92.

La protection des indications géographiques. France, Europe, Inde. D. Marie-Vivien [Ed. Quae]. The WTO has a duty to protect the geographical indications that identify a product where the quality, reputation or other set characteristic can basically be attributed to its geographical origin. Champagne, Roquefort, Darjeeling and Basmati are all examples of this. Through a comparative analysis, this book shows how India protects the craft products and ancient varieties that reflect its cultural identity from the threats of globalisation and how the Indian experience throws French and European law into question.

Price spikes and world food security. The need for change. Benoît Daviron, *Perspective* No. 15, April 2012. This edition of *Perspective* places food price spikes within the context of an upward trend and opens new avenues for action that depart from the predominant vision today.

CONFERENCES

The inaugural conference of the **UNESCO World Food Chair** was organised on 27 January by Montpellier SupAgro, with the support of Agropolis International, CIRAD, Montpellier's Maison des Sciences humaines and the Languedoc-Roussillon regional council. The issue of food as a common good was at the heart of the programme.

Co-organized by Pt. Smart Tbk, WWF-Indonesia and CIRAD, the **third International Conference on Oil Palm and the Environment**, 'Conserving Forests, Expanding Sustainable Palm Oil Production', took place between 22 and 24 February in Bali, Indonesia. The conference benefitted from the support of the European project SEA-EU-NET (7th PCRD).

PATENT

CIRAD in Montpellier and the University of Costa Rica's CITA (National Research Centre on Food Science) have been granted a patent (FR.29668171) for **a process that extracts juice from noni** (*Morinda citrifolia*) by pressing (without adding water), combined with the use of membrane technology. The new process produces a clearer juice and, above all, it smells much better. The anti-inflammatory properties of noni juice have now been proved by its effect on the enzymes involved in inflammation processes.

Cissé M., Kouakou Amenan C., Montet D., Loiseau G., Ducamp-Collin M.N., 2013. Antimicrobial and physical properties of edible chitosan films enhanced by lactoperoxidase system. *Food Hydrocolloids*, 30: 576-580. Doi: 10.1016/j.foodhyd.2012.07.018

Cissé M., Montet D., Loiseau G., Ducamp-Collin M.N., 2012. Influence of the concentrations of chitosan and glycerol on edible film properties showed by response surface methodology. *Journal of Polymers and the Environment*, 20 : 830-837. Doi: 10.1007/s10924-012-0437-2

Cissé M., Montet D., Tapia M.S., Loiseau G., Ducamp-Collin M.N., 2012. Influence of temperature and relative humidity on the immobilized lactoperoxidase system in a functional chitosan film. *Food Hydrocolloids*, 28 : 361-366. Doi: 10.1016/j.foodhyd.2012.01.012



Élodie Maître d'Hôtel, an economist at CIRAD

« Despite the opportunity an increase in agricultural prices may represent, its volatility may discourage farmers from investing.

Four conditions for an effective management of agricultural price volatility

What are the impacts of volatility and rising agricultural prices on developing countries?

Élodie Maître d'Hôtel: From the farmers' perspective, an increase in agricultural prices is, theoretically, an opportunity. But in practice, price volatility may discourage farmers from investing in their production systems, as they do not know at what prices they will be able to sell their production. From the consumers' perspective, higher prices directly affect the ability of poor households to feed themselves, as shown by the food crises of 2007-2008 and 2010-2011.

You have studied and compared the management policies for agricultural price volatility in Zambia, Mali and Madagascar...

E. M.-D.: These three African countries share some similarities. Notably, they are poor and very rural countries, where food is mainly based on cereals. Further, they recently implemented policies to limit price volatility in their domestic markets, combining trade measures and measures in their domestic markets. But the results of these policies have not always been conclusive. Our analysis sought to understand the reasons for these failures. We have shown that beyond the choice of policy

What policy measures can be taken to limit agricultural price volatility? A group of experts* has analysed the decisions taken by several developing countries. We get the feedback from Élodie Maître d'Hôtel, economist at CIRAD.

measures, their effectiveness depends on the conditions of their definition and implementation. Four specific conditions were identified.

What are they?

E. M.-D.: The first condition is that the use of a policy measure must be based on in-depth knowledge of the food needs and availability in the country. This expertise underpins decisions and guides choices. At what level should tariffs be set? What stock volumes should be built up? At what moment, etc.? The second condition is that State intervention should be announced and predictable enough so that private operators can anticipate it and make informed strategy decisions. The third condition is that the funding of implemented measures should be secured. In Mali, in 2005 and 2008, the budget allocated to buffer stocks was insufficient to acquire sufficient volumes and therefore contain soaring grain prices. The fourth condition is that the State must be able to guarantee that its intervention has been effectively implemented and monitored.

Measures such as 'a ban on exports' can be extremely difficult and costly to implement in a country with vast land borders.

Are States the only organisations with the power to act on agricultural prices?

E. M.-D.: No. Although the State has a key role to play, alone it will be unable to contain agricultural price volatility on domestic markets. Cooperation between public and private actors is essential. In this respect, consultation platforms have demonstrated their efficiency in Madagascar. These collaborations are still in their infancy in developing countries and should be further investigated. ○

CONTACT

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* GREMA, the group of researchers focused on the regulation of agricultural markets, brings together experts from France's Académie d'Agriculture, CIRAD, GRET and IRAM.



Sheep for sale in Morocco.
© P. Dugué/CIRAD

ANIMAL HEALTH AND EMERGING DISEASES

Increased global trade, climate change, urbanization, the weakness of many public health systems, and increasingly intensified animal production are all factors in the emergence of animal and zoonotic diseases. Such diseases have major economic and sanitary consequences. They affect farmers' incomes and may have serious repercussions on human health.

<http://url.cirad.fr/animal-health>



« One of GREASE's primary objectives is to strengthen interactions between different sectors such as agriculture, health, land use, etc.

GREASE: a network to manage emerging epidemiological risks in Southeast Asia

GREASE is officially up and running. Through an interdisciplinary and innovative approach, this research network aims to improve the interactions between different sectors of society in order to better manage emerging diseases in Southeast Asia. GREASE is one of CIRAD's platforms for research and training in partnership.



Aurélie Binot-Herder

The GREASE network has been officially operational since 2012. What lies behind its creation?

Aurélie Binot-Herder: CIRAD's epidemiologists were approached during the health crises in Asia in the mid-2000s. The implementation of measures for surveillance and control of epidemics in the region revealed a strong need for training. In parallel, interdisciplinary research projects started in Cambodia, Thailand and Vietnam, involving different research institutes, OIE and FAO. It was against this background that GREASE was informally launched in 2009, bringing together researchers from the region around the common issues of managing health risks. We wanted to wait until we had a consolidated network before making it official. This was done in May 2012 with the signing of a Memorandum of Understanding.

How is GREASE organised?

A. B.-H.: The six core partners* behind the network work together in an ethos of research and scientific cooperation. Within the network, other scientific partners

but also government and international stakeholders contribute to our research and training projects as associated partners. Four working groups have been established, examining the interdependence of epidemiological and social systems, biodiversity and health, animal and human health and, finally, the impacts and means of controlling zoonotic diseases. These groups are a good reflection of our interdisciplinary and cross-sectoral approach, which reflects in particular one of GREASE's primary objectives: strengthening interactions between different sectors such as agriculture, health, land use, etc. to improve public health.

The network takes a 'One Health' approach?

A. B.-H.: Yes, this approach acknowledges the fundamental interdependence between human health, animal health and the environment in the management of health risks. Many diseases are zoonotic, in other words they can be transmitted between humans and animals. As such, the close links with Institut Pasteur's network

in Southeast Asia is essential for integrating human health issues in GREASE. But ecological and socio-economic environments also play an important role. It is important to take into account different perceptions of the same health problem to identify solutions which are acceptable for everyone. The participatory approaches to managing health risks that we are developing in epidemiology (with ILRI) and modelling (ComMod network) reflect this approach.

How can we expect the GREASE network to evolve?

A. B.-H.: It seems crucial to us that we reach both governmental authorities as well as local populations. The network tends towards the EcoHealth approach, which aims to strengthen the capacity of local communities to protect their own health through improvements in their environment and production practices. ○

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www.grease-network.com/

* Central Mindanao University in the Philippines, University of Kasetsart in Thailand, National Institute of Veterinary Research in Vietnam, National Veterinary Research Institute in Cambodia, Nabong Agricultural College and National University of Laos.

> RIFT VALLEY FEVER

Rift Valley fever (RVF) is an arboviral zoonosis which threatens both human and animal health. The virus, which can be transmitted by several species of mosquito, mainly affects ruminants (abortions, death) but humans can become infected by direct contact with infected tissues during slaughter including animal manipulations. In humans, feverish symptoms are sometimes accompanied by complications including haemorrhagic fever and encephalitis. The emergence of the disease depends on the presence of mosquitoes, which are its vector, and an environment favourable to their development and multiplication. However, other factors, including social and economic ones, can contribute to this emergence.

Rift Valley fever: epizootics of multi-factorial origin

It's in order to identify these factors and understand the mechanisms that lead to the appearance of the disease that researchers from CIRAD and its partners have conducted extensive investigations in several countries. In the Sahel region of West Africa, researchers have used modelling to better understand the role of rainfall in the dynamics of temporary ponds, which are the main egg-laying sites for mosquitoes. Simulation revealed that episodes of Rift Valley fever occurred in years in which the main two vector mosquito species were present simultaneously and at

high densities. In Yemen and Saudi Arabia, where an epizootic was observed for the first time in 2000, researchers have shown that the occurrence of the disease was due to a combination of two phenomena: two consecutive rainy seasons with higher than usual rainfall levels and the celebration of Eid al-Adha in March, hence massive imports of sheep. On the High Plateaux of Madagascar, the virus is transmitted by vectors, but also spread through animal movements. Cattle trading is responsible for disease circulation between villages, and traditional trade may be behind its



Temporary pond and zebu in Ferlo, Senegal. © V. Chevalier/CIRAD

introduction into the region from other parts of the island, where the disease is endemic.

CONTACTS Véronique Chevalier, Annelise Tran, Animal and Integrated Risk Management, veronique.chevalier@cirad.fr, annelise.tran@cirad.fr

PARTNERS Agence Nationale de Sécurité Sanitaire (ANSES). World Health Organization (WHO). World Organisation for Animal Health (OIE). Food and Agriculture Organization of the United Nations (FAO). Institut Pasteur International Network (RIIP). **Madagascar** > Centre National de la Recherche Appliquée au Développement Rural (FOFIFA). **South Africa** > University of Pretoria. **Thailand** > University of Kasetsart. **United Kingdom** > University of London. **Zimbabwe** > University of Zimbabwe.

Soti V., Tran A., Degenne P., Chevalier V., Lo Seen D., Thiongane Y., Diallo M., Guégan J.F., Fontenille D., 2012. Combining hydrology and mosquito population models to identify the drivers of Rift Valley fever emergence in semi-arid regions of West Africa. *PLoS Neglected Tropical Diseases*, 6:e1795. Doi: 10.1371/journal.pntd.0001795

Emergence in the Indian Ocean

RVF has been reported in mainland Africa, the Middle East (Saudi Arabia and Yemen) and the Indian Ocean, where the first human case was notified in the Comoros in 2007.

The Emerging and Exotic Animal Disease Control (CMAEE) research unit is the National Reference Laboratory for RVF in terms of virology. Since 2009, the 'AnimalRisk-OI' programme funded by FEDER POCT (European Union, Regional Council of Réunion and the French government) has established an epidemiological surveillance network for animal health in the Indian Ocean region, in order to better understand the epidemiology of the dis-

ease, assess the risk of introduction and suggest surveillance measures.

Four sero-surveillance surveys on ruminants in Mayotte revealed that, despite the absence of clinical cases, RVF seroprevalence was quite high, reflecting the risk of introduction through uncontrolled animal movements. Viral genomes were detected in Madagascar, Mayotte and the Comoros archipelago. Phylogenetic analyses confirmed the homology of two of the Mayotte human isolates with strains from Madagascar and East Africa. Further work included entomological surveys to identify the mosquito species present in Mayotte and their distribution.

Animal movements, vector abundance and climate forecasts are, among other things, key elements for better prediction and control of RVF.

CONTACTS Catherine Cêtre-Sossah, Eric Cardinale, Emerging and Exotic Animal Disease Control (Joint research unit (UMR) CMAEE), catherine.cetre-sossah@cirad.fr, eric.cardinale@cirad.fr

PARTNERS ARS Réunion-Mayotte, Mayotte and Comoros Hospitals, FEDER-POCT 'AnimalRisk-OI', FOFIFA-DRZV, Institut Pasteur, Veterinary Services of Mayotte, Comoros and Madagascar.

Cêtre-Sossah C., Pédarrieu A., Guis H., Defernez C., Bouloy M., Favre J., Girard S., Cardinale E., Albina E. Prevalence of Rift Valley Fever among ruminants, Mayotte. *Emerging Infectious Diseases*. 2012 June;18(6):972-5.



Goats in Mayotte.
© E. Cardinale/CIRAD



Marie-Noël de Visscher, ecologist at CIRAD



More than 50 scientific publications, 11 PhD theses including six by students from southern countries, 34 Masters level courses and 60 conference papers.

GRIPAVI project, a model of multidisciplinary research for development

The GRIPAVI project* improved our understanding of the circulation and persistence of avian influenza and Newcastle disease in wild and domestic birds in Africa and Vietnam.

Marie-Noël de Visscher, project coordinator (2010-2011) and an ecologist at CIRAD, discusses the project's positive evaluation.

* Led by CIRAD and funded by the French Ministry of Foreign and European Affairs between 2007 and 2011.

PARTNERS

World Organisation for Animal Health (OIE). **Ethiopia** > Ministry of Agriculture and Rural Development, National Animal Health Diagnostic and Investigation Centre. **France** > Agence Nationale de Sécurité Sanitaire de l'Alimentation, de l'Environnement et du Travail, Institut National de Recherche Agronomique (INRA). **Madagascar** > Département de Recherche Zootechniques et Vétérinaires. **Mali** > Laboratoire Central Vétérinaire. **Mauritania** > Centre National de l'Élevage et de Recherche Vétérinaire. **South Africa** > Agricultural Research Council - Onderstepoort Veterinary Institute. **Vietnam** > Hanoi Agricultural University, Institute of Policy and Strategy for Agriculture and Rural Development, National Institute of Animal Husbandry, National Institute of Veterinary Research. **Zimbabwe** > Veterinary Services of Zimbabwe.

In 2012, the project was evaluated and got good reviews...

Marie-Noël de Visscher: Yes, several aspects were appreciated. In particular, the fact that we were quickly operational while the project was launched in an emergency situation. At the time, the detection of the virus in Africa aroused great concern. The project was built around six observatories and their teams were all the more effective because CIRAD already had links with the national scientific structures. Today, these partners have strengthened their skills and gained in autonomy for both diagnosis and health monitoring. In this, GRIPAVI was at the interface between science and development.

Your multidisciplinary approach was also praised...

M.-N. d. V.: GRIPAVI brought together epidemiologists, virologists, sociologists and ecologists. This work has been very positive because everyone has worked in their own discipline but on common research questions. Incidentally,

this multidisciplinary approach is part of the structure in our team's scientific project.

Among the many results of the GRIPAVI project, you advocate targeted surveillance. What does this mean?

M.-N. d. V.: Routine surveillance, especially of wild birds, is expensive and difficult to implement, which makes it even less suitable for developing countries. We identified those determinants for risk situations which should be monitored as a priority. In Africa, for example, more attention should be paid to wetlands with a high concentration of wild birds near farms. Furthermore, to be effective all surveillance strategies must take into account farmers and how they perceive health risks. ○

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

> CATTLE, GENETICS AND ADAPTATION

Taking the Senepol breed as an example

A better understanding of the origins of tropical cattle breeds and of their adaptation to the environment has been made possible by an original approach which combines studying the genetic structure of breeds and detecting footprints of selection in the genome using high-throughput genomic tools. This approach has been applied to the Senepol breed, which is considered as trypanotolerant and thus adapted to endemic areas of trypanosomiasis, even though it lives outside these areas. According to the official history, this breed was obtained in the early twentieth century on the island of St. Croix in the Caribbean by crossing the N'Dama breed (a West African trypanotolerant taurine breed) with the European breed Red Poll (originating from the United Kingdom).

Surprisingly, analysis of the genotypes (54,000 biallelic markers) of 153 Senepol cattle from Venezuela and of 18 other cattle breeds (European and African taurine breeds, zebu) shows that the Senepol breed has no African taurine ancestry (90% European ancestry and 10% zebu). These results refute the official version of the origins of the breed and its supposed trypanotolerance, limiting its export to areas free of trypanosomiasis.

However, the Senepol breed is a very good example of a European taurine breed adapted to tropical conditions. Indeed, one of the four chromosomal regions under selection is located at the *slick* locus that controls the short and shiny hair of this breed, a characteristic which is involved in heat tolerance.



Senepol cattle in Venezuela. © P. M. Aso, Simon Bolivar University

CONTACT Laurence Flori, Host-Vector-Parasite Interactions in Infections by *Trypanosomatidae* (InterTryp), laurence.flori@cirad.fr

PARTNERS France > AgroParisTech, Ecos Nord, Fonacit, Institut National de la Recherche Agronomique (INRA), Institut de Recherche pour le Développement (IRD), SupAgro. Venezuela > Simon Bolivar University

Laurence Flori, Mary Isabel Gonzatti, Sophie Thevenon, Isabelle Chantal, Joar Pinto, David Berthier, Pedro M. Aso and Mathieu Gautier, 2012. A quasi-exclusive European ancestry in the Senepol tropical cattle breed highlights the importance of the *slick* locus in tropical adaptation. *PLoS One*. 2012;7(5):e36133

> EHRLICHIA RUMINANTIIUM, THE AGENT OF COWDRIOSIS

Getting to the heart of pathogenesis through 'Omics' approaches

Ehrlichia ruminantium (ER) is responsible for cowdriosis [also named heartwater], a fatal disease in both domestic and wild ruminants. The disease, transmitted by *Amblyomma* ticks, is found throughout sub-Saharan Africa, the Indian Ocean and the Caribbean (Guadeloupe and Antigua).

For the past five years, studies using genome, transcriptome and proteome approaches have been undertaken to characterise the pathogenesis of ER and develop vaccines against cowdriosis. This integrated approach makes it possible to follow changes in the gene and protein expression of ER.

An innovative method for the selective capture of ER transcripts (without contaminating cells) allows us to study the transcriptome at the

early stage of infection.

In fact, ER is an obligate intracellular bacterium that grows in bovine endothelial cells.

Thanks to dedicated ER microarrays, 54 genes differentially expressed between

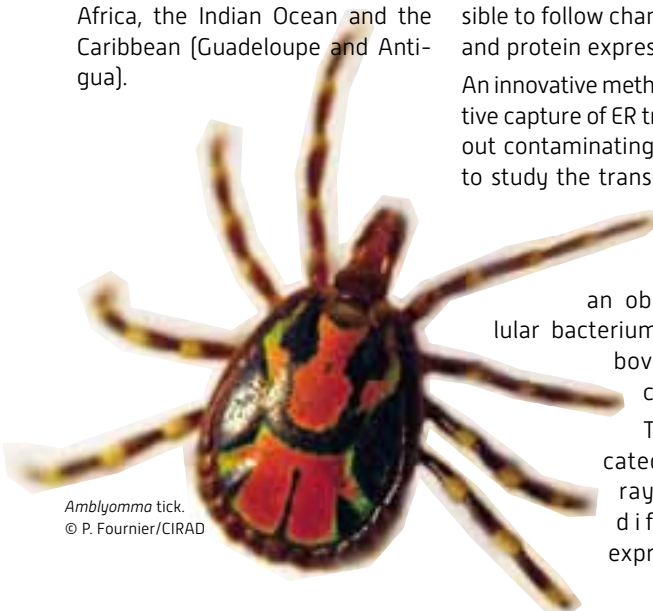
the reticulated body (intracellular vegetative form) and elementary body (free-form infectious) of a virulent strain have been identified. In particular, genes involved in metabolism, nutrient exchange, defence mechanisms and resistance to oxidative stress are over-expressed in reticulated bodies. These results correlate with the oxidative stress experienced and the need for nutrients of reticulated bodies in the vacuoles.

A research project is under way to assess the differential expression of genes and proteins between virulent and attenuated strains. Combined with the analysis of the proteome of the same strains, the results on the transcriptome will make it possible to identify the genes involved in the virulence and attenuation of ER. This research will pave the way for new candidate vaccines

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PARTNERS FEDER project, 2007-2013. Canada > University of Montreal. France > Centre National de la Recherche Scientifique (CNRS), INRIA. Portugal > Fundacao para a Ciencia e Tecnologia (FCT), Instituto de Biologia Experimental e Tecnológica (IBET)

Pruneau L, Emboulé L, Gely P, Marcelino I, Mari B, Pinarello V, Sheikbou-dou C, Martinez D, Daigle F, Lefrançois T, Meyer DF, Vachiéry N. Global gene expression profiling of *Ehrlichia ruminantium* at different stages of development. *FEMS Immunology and Medical Microbiology*, 2012, 64: 66-73.



Amblyomma tick.
© P. Fournier/CIRAD



Door-to-door vaccination of village poultry as part of the mass vaccination campaign in Egypt.
© M. Peyre/CIRAD

> AVIAN INFLUENZA IN VIETNAM AND EGYPT

How can we evaluate vaccination programmes?

In developing countries, national data on animal disease surveillance is often limited. But the evaluation of control programmes for these diseases is based precisely on this data. How, under these conditions, can we evaluate the effectiveness of these programmes? In the case of avian influenza, CIRAD researchers and their partners have used an evaluation of the sensitivity of the animal disease surveillance system, before and after the introduction of vaccination, and taking into account human cases. By following this approach they have been able to analyse the real impact of vaccination campaigns in two countries severely affected by the disease: Egypt and Vietnam. In both countries, impact studies, which combine not only epidemiological and socio-economic but also behavioural data, highlighted the limits of mass vaccination strategies for the avian population. In Egypt, mass vaccination encountered practical difficulties, which failed to provide sufficient coverage and immunity to the avian population to control the epidemic. In Vietnam, the implementation of the vaccination campaign was effective, but the immunity of the avian population sometimes remained too low for some types of production and at certain times. These results were confirmed by the evaluation of surveillance sensitivity. In Vietnam, vaccination led to a reduction in the probability of infection. However, in Egypt, the risk of infection remains stable regardless of the period considered and therefore the vaccination programme in place.

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PARTNERS Food and Agriculture Organisation (FAO). **Egypt** > Animal Health Research Institute (AHRI), General Organisation for Veterinary Services (GOVS). **Vietnam** > International Centre for Research and Rural Development, Department of Animal Health (DAH), National Institute for Veterinary Research (NIVR), Hanoi University of Agriculture

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Delabougli A., Antoine-Moussiaux N., Phan D.T., Nguyen T.T., Dao C.D., Pham T.T.H., Vu D.T., Nguyen V.K., Roger F., Peyre M., 2012. Methodological framework for a participatory approach to evaluate the socio-economic factors impairing the efficacy of animal health surveillance systems. In: *ISVEE 2012*.

PUBLICATIONS

Control of zoonotic diseases in Africa and Asia. The contribution of research to 'One Health'. F. Roger, *Perspective*, No.18, August 2012. Dedicated to the fight against zoonoses, this *Perspective* shows how intersectoral and interdisciplinary research can facilitate the implementation of the 'One Health' approach.

ON-LINE ENCYCLOPEDIA

Feedipedia, an on-line encyclopaedia on animal feeds. The fruit of a joint project by the Association Française de Zootechnie, CIRAD, FAO and INRA, Feedipedia offers worldwide and up-to-date information. Feedipedia inventories the current characteristics of all feeds, from the most traditional, such as wheat, maize, soybean and their co-products, to the least known, often called alternative or non-conventional. Its nutritional recommendations suit many types of animals and correspond to a wide variety of farming systems.

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

EVENTS

AnimalRisk-OI, the Indian Ocean animal health network, run by CIRAD as part of the Centre de Recherche et de Veille sur les maladies émergentes dans l'Océan Indien (CRVOI), held its third Steering Committee meeting from 20 to 22 February 2012 in Saint-Denis de La Réunion. An announcement was made at the meeting of a rapprochement between the networks for animal health (AnimalRisk) and human health (Surveillance Épidémiologique et Gestion des Alertes network - SEGA).

Montpellier's Corum Conference Centre hosted the **18th European Society for Vector Ecology (E-SOVE) Conference** from 8 to 11 October 2012. Organised by CIRAD, EID Méditerranée and IRD and entitled 'From biology to integrated control in a changing world', it examined the most recent findings in the ecology of vectors and measures for controlling them.

RESEARCH AND TRAINING PLATFORMS IN PARTNERSHIP (DP)

The Regional Networks for Animal Health (RéSA-CaribVET) were heavily involved at the **21st Conference of the OIE Regional Commission for the Americas**, held in Barbados from 26 to 29 November, highlighting their promising development. Two technical topics were discussed: the role and preparedness of veterinary services in disaster management (Redesastres, CENSA and IMV, Cuba) and innovative strategies to strengthen regional animal health networks (CaribVET).



Madagascar.
© V. Porphyre/CIRAD

PUBLIC POLICY, POVERTY AND INEQUALITY

Reducing the structural inequalities that sustain poverty calls for political regulation and action on the part of civil society. Rural development has a major role to play in this, and family farms in developing countries, which are directly affected by trade liberalization, competition between agriculture on different continents and State withdrawal, are one of the cornerstones. Public policy in this field is now the subject of research aimed at understanding the factors of resistance to change and development levers.

<http://url.cirad.fr/public-policy>





25% of transactions are effectively implemented.

Land Matrix, a global observatory on large-scale land transactions

Ward Anseeuw, development economist

Ward Anseeuw, hosted by the University of Pretoria, coordinates in partnership* the innovative Land Matrix monitoring initiative. Inaugurated in April 2012 at the Annual World Bank Conference on Land and Poverty, a new version has already been launched.

What can we find on the Land Matrix web interface?

Ward Anseeuw: It is a collection of all the international land deals since 2000 which meet the following criteria: they cover an area of 200 hectares or more and they initiate a transformation in land use, typically from extensive agriculture to a more intensive and commercial form. This data can be viewed at three levels. The global level shows trends on a worldwide scale. An intermediate level displays transactions by country. Finally, the last level provides for each transaction the date, location and area concerned, investors and the type of contract, etc.

Why do we need a tool like this?

W. A.: Initially, the objective was to quantify these acquisitions, which are usually completed in complete secrecy. Land Matrix has allowed us to have a global view of land transactions across the world. We can now say that 50% of the land concerned was already used for growing crops, 30% of the negotiations are finally signed and only 25% are effectively implemented. Another observation is that inves-

tors are turning increasingly to more stable countries such as the emerging nations, Eastern Europe, Canada and Australia. This is probably due to the large number of failed projects, especially in Africa. Buyers have realised that it is not so easy to grow 'in the middle of nowhere'. And it seems to me that today we can see hints of not only a new geopolitics of agriculture emerging but also of natural resources, brought about by increased commercial pressures. Canada, for example, has the largest freshwater reserves in the world and is presently being targeted by these acquisitions.

The second objective of Land Matrix is transparency...

W. A.: Transparency encourages accountability among the actors involved. Therefore, the Land Matrix data can be used as well as supplied by anyone, it's a crowd-sourcing instrument. The system will go further if we follow a logic of open data, where all data received is published after simple moderation. We hope to encourage more investors and governments of both

investing and host countries to be accountable.

Land Matrix has attracted a lot of attention but also been subject to some controversy...

W. A.: Yes, that's why we have carried out improvements. Transactions pass through several phases [negotiation, signed, under production, etc.] and many transactions were cancelled. Now the interface will take into consideration these different phases and better reflect reality in real-time, because it is being continuously updated. To do this, we are setting up networks of informants in Africa, these are experts and other individuals involved in the African Land Policy Initiative [LPI]. Networks of informants will soon be established in Asia and Latin America. ○

CONTACT

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<http://url.cirad.fr/land-matrix2>

* The Land Matrix Partnership comprises CIRAD, GIGA (German Institute of Global and Area Studies), GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) and ILC (International Land Coalition).



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> TERRITORIAL DEVELOPMENT IN BRAZIL

Evaluating the governance of territories of citizenship

Brazil has become a reference in the field of territorial development. Ten years ago, it committed to a sustainable development programme and established 160 'territories of citizenship' to strengthen the economic vitality of these areas, combat poverty and integrate pressing environmental requirements. Territorial institutional arrangements were also created in order to change the balance of power at the local level. Brazil's Ministry of Agrarian Development recently launched an evaluation of this programme. This assessment is based on a set of indicators that provide an accurate picture of the impact of development policy, with the information required for the indicators being provided by support and information committees in 37 of the territories. CIRAD has participated in the committee for the Borborema territory in the north-east of the country, and on the Ministry's national steering committee for the evaluation. As a first step, the latter has produced a summary of the results and reviewed the quality of the approaches adopted. Thus CIRAD researchers have been able to contribute to the adjustment of these indicators and in the creation of a new indicator, a measure of social management, to provide a better understanding of the performance of territorial institutional arrangements. The preliminary summaries are being used to re-direct territorial policies. CIRAD has also participated in a specific study in the state of Pará, in the Amazon region. Here, a geographical approach was preferred in order to put the evaluations into perspective with the territorial dynamics in each region. This approach is now being adopted for all the territories of Brazil and could be used in other Latin American countries.

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Piraux M., de Assis W.S., da Cruz Rodrigues V., Alves J.W., Monteiro Silva N.N., 2012. Um olhar sobre a diversidade dos Colegiados dos Territórios da Cidadania no Pará. *Novos cadernos NAEA, UFPA, 15, No. 2*. [In press].

Caniello M., Piraux M., de Souza Bastos V.V., 2012. Identidade e participação social na gestão do programa territórios da cidadania: um estudo comparativo. In: *Agricultura e desenvolvimento rural com sustentabilidade: 50º congresso da Sober*, Vitória, Brasil, 22-25 July 2012, 19p.

Caniello M., Piraux M., Rambo A.G., 2012. As políticas públicas territoriais e o desenvolvimento rural sustentável no Brasil contemporâneo. In: *Desenvolvimento, ruralidades e ambientalização: paradigmas e atores em conflito: 5º encontro da rede de estudos rurais*, Belém, Brasil, 3-6 June 2012, 29p.

PUBLICATIONS

Normaliser au nom du développement durable. P. Alphandéry, M. Djama, A. Fortier, É. Fouilleux (Ed. Quae). In the current context of neo-liberal globalisation and the questions raised over its negative effects, the aim of this book is to show through miscellaneous case studies that the standardisation systems are not only new forms of regulation, institutions and social practices, but that in reality they refer to eminently political issues and to the building of a specific balance of power between players.

Organisations et sociétés paysannes. Une lecture par la réciprocité. E. Sabourin (Ed. Quae). This work analyses the transformations of farmer societies and organisations in several continents from a dual socio-economic interpretation that combines the classic logic of mercenary exchange with the viewpoint of the logic of reciprocity.

Appuyer les organisations de producteurs. M. Dugué, D. Pesche, J. Le Coq (Ed. Quae). Producer organisations are very numerous and active in the farming modernisation process in southern developing countries. This didactic work analyses the advantage of the partnership with producer organisations, how they can be strengthened and their relations with the environment. The questions are made extremely accessible and are illustrated by numerous examples in southern countries.

Exploitations agricoles, stratégies paysannes et politiques publiques. Les apports du modèle Olympe. E. Penot (Ed. Quae). This book is the culmination of several years of research by teams of widely differing origins. All the researchers found themselves facing a few common questions: how to design and use a software model to understand farmer strategies? How to quantify a farm's inputs and outputs and, more globally, how to estimate the impact of changes in technical choices on the operation of farms in France and in the developing world?

Structural transformation and rural change revisited: Challenges for late developing countries in a globalizing world. Bruno Losch, Sandrine Fréguin-Gresh, Eric White. Coll. Africa Development Forum, World Bank - AFD. This book addresses the unique situation of countries that remain deeply engaged in agriculture. It explores the reality of their integration into global markets and the nature of their rural non-farm economy, investigates the dynamics of diversification and specialisation, and proposes targeted policies that could facilitate the processes of rural change. Preface: Justin Lin, Chief economist and vice-president of the World Bank.

<http://issuu.com/world.bank.publications/docs/9780821395127>

Evaluation du Code de Développement de la province Nord : 20 ans de développement local en Nouvelle-Calédonie (1989-2008). C. Gaillard, J.F. Béliers, P.M. Bosc, J. M. Sourisseau, M. Passouant, 2012. Païta, Institut agronomique néo-calédonien (IAC), 36 p. The Northern Province of New Caledonia entrusted the IAC and CIRAD with the evaluation of its development code (CODEV), an emblematic instrument of local development since 1989. The work was carried out in 2010 and 2011 with several investigations including one with 353 promoters representing the 3,362 projects funded by the scheme. The results fly in the face of many preconceptions on local development aid. The final report, submitted in 2012 to provincial officials, was used to facilitate discussions for the revision of local development policies.

A brochure for the general public was published by CIRAD for disseminating the key findings.

<http://url.cirad.fr/codev>

PUBLICATIONS

Le temps de la Chine en Afrique. Enjeux et réalités au Sud du Sahara. Overseen by J.-J. Gabas and J.-R. Chaponnière. Karthala-Gemdev co-publication. China has been in Africa for some time, but it has to be said that the figures for the past decade are particularly impressive: trade between Africa and China has multiplied by 12. This book provides useful information on the motivation behind Chinese investments, how they are made, and their impact.

The environmental challenges facing a Chinese oil company in Chad. Edited by G. van Vliet and G. Magrin. *Focales* No. 9 AFD. This book looks at the factors influencing environmental management by the China National Petroleum Corporation [CNPC] when operating abroad, within the confines of the global oil system, particularly in a less developed country [LDC], Chad.

<http://www.afd.fr/home/publications/travaux-de-recherche/publications-scientifiques/focales>

Les forêts du Bassin du Congo – Etat des forêts 2010. Eds. C. de Wasseige, P. de Marcken, N. Bayol, F. Hiol Hiol, Ph. Mayaux, B. Desclée, R. Nasi, A. Billand, P. Defourny, R. Eba'a Atyi, Publications Office of the European Union. As comprehensive an inventory as possible of the Congo Basin forest, its ecosystems, its biodiversity and its socio-economic situation.

<http://www.observatoire-comifac.net/edf2010.php>

Perspective: Food insecurity in Mali – Identifying vulnerable households with precision. I. Bocoum, *Perspective* No. 14, March 2012. Poverty is a major factor in undernourishment. However, poor households may have enough food, while those that are above the poverty line may not. This is the paradox revealed by research in Mali. **Geographical indications for agricultural and handicraft goods: the strength of the link to the origin as a criterion.** D. Marie-Vivien, E. Bienabe. *Perspective*, No. 17, June 2012. Focused on geographical indications, this edition of *Perspective* expands on the idea of creating a legal framework centring on the link to the origin rather than on the type of product. The aim is to ensure better protection of traditional handicraft goods, which are numerous in southern countries.

Bois et forêts des tropiques. Issue No. 310 is dedicated to the management of forest resources, sacred forests and the role of societies in forest conservation. No. 311 emphasises the development of emblematic species: *Tectona grandis*, *Acacia senegal*, *Dipteryx alata* and *Quercus suber*. No. 312 examines traditional knowledge and the dynamics and characteristics of tree species.

<http://bft.cirad.fr/>



Studying rainwater flow in Congo.
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> ECOSYSTEM SERVICES

A useful idea for new policies?

The concept of ecosystem services and its derivative, environmental services, are today internationally acknowledged, which manifests itself in their inclusion not only in environmental policies, but also in sectoral policy reforms. The concept, forged in the 1990s and receiving widespread publicity during the Millennium Ecosystem Assessment, has spread globally through numerous networks, which include scientists, experts, national governments and international organisations. The SERENA programme (Environmental services and use of rural areas), coordinated by CIRAD and IRD, was interested in the genesis and dissemination of the concept in order not only to better understand the issues, but also its limitations and contradictions. The research conducted also examined the transformation of public policies and policy instruments influenced by this concept in three countries: France [Auvergne, Réunion, Guadeloupe], Costa Rica and Madagascar. SERENA was the first French research programme supported by the Agence Nationale de la Recherche (France's national research agency) to deploy social sciences on the theme of ecosystem services. This research has resulted in two major findings. The first emphasises the importance of the linkages of varied professional and scientific networks to support the genesis and spread of a new concept such as ecosystem services. The second finding stresses the fact that innovations in terms of policy instruments are more sustainable when they are rooted in sectors (forestry, agriculture) where policies have for decades helped to build institutions and functional rules.

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www.serena-anr.org



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RuralStruc:

<http://url.cirad.fr/eng-ruralstruc>

Perspective No. 19:

url.cirad.fr/eng-perspective

CIRAD-NEPAD agreement:

<http://url.cirad.fr/eng-nepad>

* A research programme led in partnership by the World Bank, IFAD, AFD, the Ministries of Foreign and European Affairs and Agriculture, Food and Fisheries (France) and CIRAD. It also involved the Ministry of Agriculture and the Facultad Latinoamericana de Ciencias Sociales (Mexico), the Ministry of Agriculture and the Instituto de Investigación y Desarrollo Nitlapán (Nicaragua), the Conseil Général du Développement Agricole and Icon2e (Morocco), the Initiative Prospective Agricole et Rurale and the Association Sénégalaise pour la Promotion du Développement à la Base (Senegal), the Ministry of Agriculture and the Institut d'Economie Rurale (Mali), the Programme d'Action pour le Développement Rural and APB Consulting (Madagascar), and the Ministry of Agriculture and Tegemeo Institute (Kenya).

The viewpoint of Bruno Losch

Sub-Saharan Africa, rising to the challenge of employment to avoid crises

A researcher in political economy, Bruno Losch warns: 330 million young people will enter the labour market in sub-Saharan Africa in the next 15 years. This influx may help development if there is sufficient job creation. If not, there is a strong chance of increasing crises.

"Between now and 2025, the labour market in sub-Saharan African countries will have to absorb some 330 million young people, two-thirds of them in rural areas. To provide perspective, this is the current population of the United States. Without voluntarist measures favouring job creation, there is the fear of major political risks in Africa, with obvious repercussions, which will first be felt in Europe, and then in the rest of the world. These tensions are already at work and the lack of prospects for young people is an essential component of crises in some countries in the Maghreb and Mali.

"This warning is based on the findings of the RuralStruc* programme, which has clearly highlighted the need to reinvest in genuine policies for rural and territorial development. Three key levers for priority action have been identified: strengthening family farms because they represent the greatest potential for employment; developing food production to break the stranglehold of food insecurity - easily convertible locally, it also promotes diversification and employment; and strengthening the functions of small towns in order to increase rural-urban linkages.

"These conclusions, which were intended to stimulate debate on public policies, have really grabbed the attention of NEPAD - the African Union's New Partnership for Africa's Development - including the new initiative, Rural Futures, which relies in part on the results of RuralStruc. CIRAD and NEPAD have also strengthened their cooperation by signing a framework agreement in late 2012 [see page 17]. RuralStruc also clearly raises the question of employment among the preoccupations of development aid and reminds us that agriculture has a much broader role to play than merely being a supplier of agricultural products: increasing farm incomes is the key for rural diversification and a driving force for structural change." . ○

**"The employment potential
of the agricultural sector
is always underestimated."**

EVENTS

The **World Water Forum** was held in Marseilles from 12 to 17 March. CIRAD was there for the whole week on the AllEnvi and AFEID stands in the France area, and contributed to the forum through several events.

The **Research Network on Innovation summer school: The new dimensions of sectoral systems of innovation**. This summer school was co-organised by several CIRAD joint research units and supported by the Languedoc-Roussillon regional council. It brought together more than 120 participants from 40 different universities to analyse the current concept of sectoral innovation systems and their relevance for innovation policy and research.

<http://rrifr.univ-littoral.fr/wp-content/uploads/2012/11/innovation-rri-touzard-temple.pdf>

CIRAD co-organised, along with AFD, FARM and the British consortium Future Agricultures an event on **the role of employment in the agricultural sector for food security**. The event took place on 17 October in Rome, in parallel with the 39th session of the Committee on World Food Security. It provided the opportunity to tackle this topic with stakeholders involved in the international policy debate on food security, including representatives of farmers' organisations, policy makers, technical and financial partners and researchers.

The **third seminar in the 'Le développement en questions' cycle** was held on Tuesday 27 November, at the Institut des Régions Chaudes in Montpellier. This third event examined the new geopolitical context of development, in the presence of an eminent economist: Serge Michailof.

RESEARCH AND TRAINING PLATFORMS IN PARTNERSHIP (DP)

In Asia, **MALICA** launched REVALTER, a multi-scale evaluation of development trajectories in farming in Vietnam [ANR, 2012-2015].



A Mapuche quinoa seller in the Temuco region of southern Chile. © D. Bazile/CIRAD

AGRICULTURE, ENVIRONMENT, NATURE AND SOCIETIES

Extending agriculture generates pressure on the environment and sometimes conflicts of interest. This situation is particularly marked in tropical and Mediterranean environments, which are subject to strong constraints and sensitive to climate change. In order to develop sustainable ways of managing rural areas and ecosystems, it is vital to study their resources and their evolution, and also the interactions between their various components, in terms of their biological and social dimensions. The aim is to develop a new way of managing territories that centres on agricultural production and on restoring the ecological services rendered by ecosystems.

<http://url.cirad.fr/agriculture-and-societies>





Forests can react differently to climatic or anthropogenic disturbance

CoForChange. Increasing our knowledge of Central African forests for better management

Sylvie Gourlet-Fleury, a forest ecology researcher at CIRAD, coordinated CoForChange. The research project, which ended in June 2013, served to provide a diagnosis of the ability of forests in Central Africa to react to human activity and climate change.

* CoForChange is an EU ERA-net BiodivERsA project co-funded by the ANR and the Natural Environment Research Council, which mobilised numerous partners over a four-and-a-half-year period (2009–2013): CNRS, Forest Resources Management, IRD (France); Joint Common Research Centre (Italy); University of Aberdeen, University of Oxford (United Kingdom); University of Bayreuth (Germany); Gembloux Agricultural University (Belgium); Research Institute in Tropical Ecology (Gabon); Ministry of Scientific Research and Technical Innovation, Centre de Recherche sur la Durabilité et la Productivité des Plantations Industrielles, University Marien Ngouabi (Republic of the Congo); University of Bangui (Central African Republic); University of Yaoundé I (Cameroon); Centre for International Forestry Research (Indonesia); Alpi Group; Bois et Placages et Lopola; Danzer; Congolaise Industrielle des Bois (OLAM Group); Industries Forestières de Batalimo; Likouala Timber; Mokabi SA (Rougier Group); Société Centrafricaine d'exploitation et de Déroulage (SCAD); Société Centrafricaine forestière (SCAF); Vicwood Thanry Group.

What was the aim of CoForChange?

Sylvie Gourlet-Fleury: The main aim was to estimate the degree of resilience of the rainforests in the Congo Basin with regard to human activity and climate change. The knowledge acquired is being used to build decision support tools with a view to improving management of these forests against a backdrop of increasing climatic and anthropogenic constraints.

How did you go about this?

S. G.-F.: The project centred on a region of some 20 million hectares straddling the Central African Republic, Cameroon and the Republic of Congo. We compiled, collated and compared large amounts of data on the vegetation, climate, geology, soils, topography, history of disturbance and species performance. Thanks to all this information, we can now go some way towards explaining the distribution of different types of forest. In the region studied, tree species distribution is primarily determined by soil type, and secondly by the intensity of anthropogenic disturbance in the distant and recent past. This is the first time such a study has been conducted on such a large area in Africa.

What recommendations can be made as a result of CoForChange regarding sustainable management of these forests?

S. G.-F.: According to our results, some forests could produce more wood, while others require more stringent protection measures if they are not to be severely degraded or even to disappear altogether. In short, stands with a high proportion of fast-growing trees, which generally grow on fertile soils, could withstand more intense silviculture. Conversely, stands dominated by slow-growing species, which perform better than others on poor soils, seem to be less tolerant of logging but could withstand episodes of severe drought in the event of global warming. These conclusions will serve to draft recommendations for the authorities and land use planning officers who have to decide which zones should be given over to wood production and which should be protected.

Are you going to look further into this?

S. G.-F.: Yes. Two projects were recently launched. DynAfFor, funded by the Fonds Français pour l'Environnement Mondial, was launched in late 2012 and will run for five years. The way in which very different types of forest develop, revealed by CoForChange, is to be monitored. This will allow us to test in the field the resilience hypotheses put forward following CoForChange. The CoForTips project, launched in early 2013, will be looking more closely at the research issues tackled by CoForChange and adding a socioeconomic component. ○

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Fayolle A., Engelbrecht B., Freycon V., Mortier F., Swaine M., Réjou-Méchain M., Doucet J.L., Fauvet N., Cornu G. & Gourlet-Fleury S. (2012). Geological Substrates Shape Tree Species and Trait Distributions in African Moist Forests. *PLoS ONE*, 7, e42381.

PUBLICATIONS

L'adoption de l'agriculture chez les Pygmées baka du Cameroun. Dynamique sociale et continuité structurale. C. Leclerc [Ed. Quae]. This book describes and analyses how the Baka Pygmies changed in Cameroon at the turn of the 1960s with the adoption of agriculture and permanent dwellings. Their move from a hunting and gathering economy to an economy that includes agriculture is an ideal framework for more general reflection on the social dynamics, changes in societies and sustainable development.

L'homme peut-il s'adapter à lui-même ? J. Toussaint, B. Swynghedauw, G. Bœuf, coord. [Ed. Quae]. This work is a compilation of the most recent scientific thinking. It attempts to assess whether man can still adapt to the consequences of his own action on the environment and moderate his thirst for 'always more'. Eminent researchers present results that are sometimes alarming, often puzzling and occasionally reassuring. The work addresses in succession the biological abilities of the human species to adapt and their limits, the consequences of our activity on the environment and the margins for manoeuvre available to us. It develops premises for solutions and the scientific, ethical and philosophical interrogations they generate.

Atlas des bois de Madagascar. G. Rakotovo, A. Rabevohitra, P. Collas de Chatelperron, D. Guibal, J. Gérard [Ed. Quae]. This book describes 187 species of wood in Madagascar that are or can be used for joinery, cabinet-making, timber or packaging: a distribution map, botanical elements, physical and mechanical properties of the wood, natural durability, performance during drying, processing and use, and main uses. This guide is primarily intended for wood sector professionals, but will also be of interest to anyone seeking to find out more about the natural heritage of Madagascar.

Biodiversité au Sahel. Les forêts du Mali. P. Birnbaum [Ed. Quae]. The fruit of 10 years' work in Mali, this book presents an illustrated summary of the ecological functioning of West African arid forests. It uses old climatic episodes, rainfall gradients, the variability in water availability, the action of topography and human action to distinguish the essential factors that explain the organisation of these arid landscapes as a mosaic of habitats.

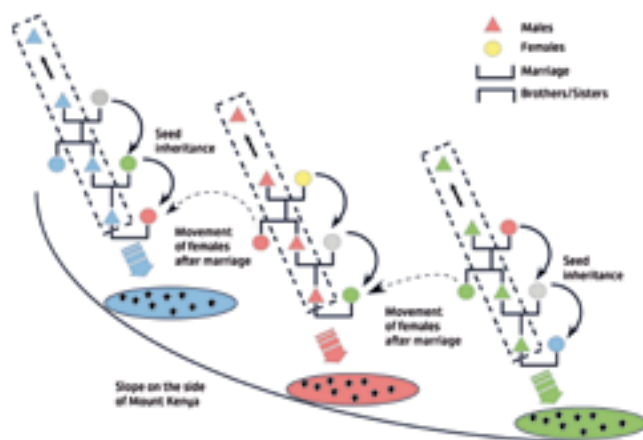
> GENETIC RESOURCES

Social organisation of plants and the triple GxExS interaction

Knowledge of the factors organising the diversity of genetic resources (GR) *in situ* is necessary to optimise sampling and conservation strategies. Among these, anthropological factors are still poorly understood. Our work shows how the social organisation of farmers, with their marriage, residence and seed exchange practices, contributes to the organisation of the genetic diversity of cultivated plants, favouring adaptability in contrasting environments. In this multidisciplinary approach, the classical interaction between genetics and environment (GxE) is replaced by a triple interaction (GxExS), where the social component, S, is explicit.

This model has allowed us to successfully study the agrobiodiversity of Meru communities on Mount Kenya, where environmental and cultural effects can be compared. Among the different levels of social organisation, residential groups constitute an essential sociological unit for seed inheritance and exchange. They represent, therefore, a key factor in the organisation of agrobiodiversity. However, clans and age classes have less effect. The inheritance of seed from mother-in-law to daughter-in-law, combined with residency practices, favours the local adaptation of varieties. This can also be observed in their response to climate variations, especially during droughts. Thus, the history and differentiation of communities are reflected in their GR.

The study of social factors organising the diver-



Patrilocal residential groups on the slopes of Mount Kenya. Once married, women join the group of their husband and begin farming. They inherit seeds from their mother-in-law. Through the generations, seeds are transmitted from mother-in-law to daughter-in-law, which ensures varieties are preserved at the same altitude, thus favouring their adaptation.

sity of genetic resources is an important prerequisite for collection, conservation and improvement, especially within a participatory framework. It is based on a recognition of the rights of peasants.

CONTACTS

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Leclerc C. and G. Coppens d'Eeckenbrugge. 2012. Social organization of crop genetic diversity. The G x E x S interaction model. *Diversity*, 4:1-32.

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Alain Karsenty analyses the finance options in REDD+

In a report commissioned by the European Union on the REDD+ mechanism, Alain Karsenty raised the issues of efficacy and equity related to a performance-based payment scheme. According to the economist, to achieve results, it is first necessary to invest in order to combat the causes of deforestation.

Remind us of the principles of the REDD+ mechanism...

Alain Karsenty: The basic idea rests on the idea of a 'positive incentive': countries receive a compensatory payment if they reduce emissions due to deforestation and forest degradation. This mechanism was well received because it is a payment based on 'performance'. However, to gauge a reduction in deforestation assumes there is a baseline. Basing this on past deforestation is unsatisfactory because some countries have already largely destroyed their forests while others are only just starting. Otherwise, you have to define a baseline scenario of the 'business-as-usual' kind. But who can claim to make such a prediction? And how can we avoid deliberate manipulation, of the type where countries envisage the worst scenario and then could eventually claim to have avoided it?

What are the other difficulties of implementing it?

A. K.: Many of the factors behind deforestation are not under the control of governments, such as the world prices for agricultural and mining products, droughts, conflicts, etc. The international community may have to reward non-virtuous but lucky states, and not those countries which have made real efforts but have been unlucky. Another obstacle is that the majority of countries involved in REDD+ are so-called 'fragile' states which lack effective institutions. If the international community is not working alongside them to invest heavily in addressing the structural causes of deforestation, it is not possible to have a genuine 'performance'.

What recommendations do you make in this report?

A. K.: We need to broaden the concept of performance to the actual implementation of reforms, policies and appropriate measures to control the drivers of deforestation. These fall within the forestry sector, but also – and above all – in governance and land and agricultural policies. In this direction, we call for the close association of the agendas for food security and those for the preservation of forests, biodiversity and climate. Furthermore, we need to find funding other than that from the carbon market, which, in any case, will not pay for the reforms. ○

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WB Executive summary of the report (in French):

http://www.chaireeconomieduclimat.org/wp-content/uploads/2013/01/Resume_executif_options_financement_REDDx.pdf

“Working with governments to combat the drivers of deforestation”

PUBLICATIONS

Environnement, discours et pouvoir. L'approche Political ecology. D. Gautier, T. Benjaminsen. (Ed. Quae). Political ecology, a well-known approach in English-speaking countries, is a method of studying environmental issues and managing natural resources. Based on the study of powers or dominant relationships between players in these fields, it focuses especially on analysing the views and narratives that are the foundation for dominant political debates. This book attempts to broadcast this approach to a French-speaking academic audience.

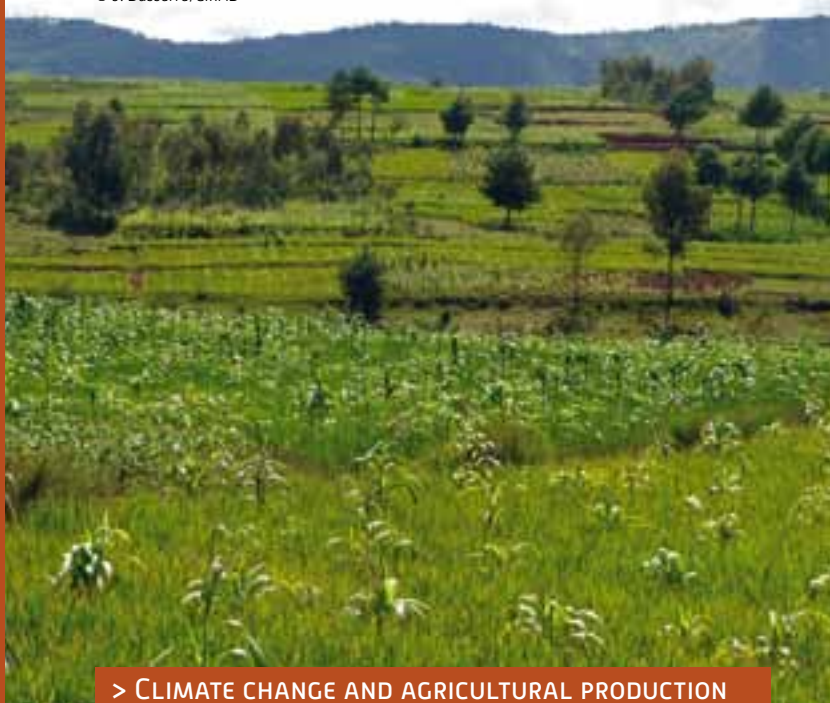
Kajjala, Tattali, Djekabaara – Valoriser les produits pour mieux conserver les forêts.

Scientific coordinators: P. Montagne and A. Bertrand. Ed. Cite 2012. A compilation of experiments with managing various wood and non-wood forest product supply chains in two African countries, Niger and Mali, and Madagascar. It comprises two volumes. Volume 1 covers the results obtained per country: 'Les expériences nationales (Madagascar, Niger, Mali)'. Volume 2 centres on the results obtained in terms of comparisons between the various supply chains or topics studied between the three countries: 'Comparaisons inter-pays (Madagascar, Niger, Mali)'.

Arbres et arbustes introduits dans les îles tropicales. J. Tassin.

Ed. Orphie 2012. A guide presenting almost 240 trees and shrubs introduced into tropical islands, illustrated by more than 500 photographs.

Upland rainfed rice growing in the highlands of Madagascar is spreading to land habitually used to grow maize, beans, sweet potato and cassava.
© J. Dusserre/CIRAD



> CLIMATE CHANGE AND AGRICULTURAL PRODUCTION

Beneficial effects on rice in Madagascar

In the highlands of Madagascar, upland rainfed rice growing has developed in recent years thanks to the availability of varieties suited to the prevailing low temperatures in this mountainous region. However, what repercussions is climate change likely to have on this crop, on which a large proportion of the island's inhabitants depend? By simulating rice production over a century, depending on the extent of climate change and the cropping practices adopted, a team from CIRAD and FOFIFA came up with a surprising result: it was the most pessimistic climate scenario that enabled the best yields. Two scenarios were tested. An optimistic scenario, in which the increase in carbon dioxide levels and the relatively moderate increase in temperature were supposed to foster rice growth, and a pessimistic scenario, in which the combination of a marked rise in temperature and a slight reduction in rainfall could have led to severe water stress in rice. Rice yields were markedly higher in the pessimistic scenario. In this scenario, the increase in temperature speeded up flowering and grain maturity in such a way that the demand for water and nutrients from the plant tallied better with their availability in the soil. Yield variability was lower, and the gap between this scenario and the others continued to grow over the years. Although the initial hypotheses – crops without biotic constraints or marked weather events – limit the import of the results, global warming could have a positive effect on rice productivity in this cold region, where rice is grown at the lower limit of its temperature tolerance.

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Gérardeaux E., Giner M., Ramanantsoanirina A., Dusserre J., 2 012. Positive effects of climate change on rice in Madagascar. *Agronomy for Sustainable Development*, 32: 619–627. Doi: 10.1007/s13593-011-0049-6



Weather station at the top of a flux tower in Paracou.
© P. Darcissac/CIRAD

> CLIMATE CHANGE AND TROPICAL FORESTS

Slow-growing trees are more drought-resi

If the climate in the coming decades conforms to the predictions provided by most climate models, the functioning of terrestrial ecosystems should be significantly altered. In tropical areas, it is likely that deep changes in rainfall regimes will have a greater impact on forest functioning than hypothetical increases in temperatures. In fact, many tropical forests are subject to precise, regular and predictable rainy and dry seasons. This is the case in Amazonia. To study the impact of climate change on tropical forest functioning, a team from CIRAD developed a soil water balance model that estimates the water available in the soil for tropical trees, based on microclimate data. They set up weather stations throughout northern French Guiana to gather the microclimate data required for calibrating the water balance model. The result was that of all the climate variables measured, the relative extractable water, predicted by the model, was the best predictor of the seasonal tree growth variations. And they also realised that the species that

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> TROPICAL FORESTS OF THE AMERICAS

Estimating the age of secondary forests

Tropical forests are the world's largest carbon and biodiversity reservoirs, but they are also its most threatened ecosystems. Deforestation and selective logging have led to the disappearance of primary forests, which are now being replaced by secondary forest zones.

In order to study forest regeneration, a reliable, precise way of dating secondary forests and the disruptions which cause them has been developed. It centres on trees of the genus *Cecropia*, a pioneer species which immediately colonises landscapes opened up by deforestation. Researchers had already shown that the rate at which new leaves are emitted is extraordinarily stable throughout the plant, and that flowering and branching are annual. By observing the scars left on the trunk by their leaves and inflorescences it is thus possible to estimate precisely the age of a tree and, potentially, that of the stand to which it belongs.

The method has been validated by a large-scale study of the species *C. sciadophylla* and *C. obtusa* in French Guiana and Colombia and for three types of disruption: slash-and-burn agriculture, clearing of forest tracks and mining operations. The results confirmed that the estimated age of the trees was indeed correlated to the actual age of the secondary forests. This simple, accessible dating method is a highly promising tool for studies of forest regeneration. Other *Cecropia* species could also act as clocks, making it possible to extend the method to the whole of the tropical region of the Americas.

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PARTNERS **Colombia** > University of the Andes. **France** > Institut de Recherche pour le Développement (IRD), Institut National de la Recherche Agronomique (INRA), Muséum d'histoire naturelle d'Aix-en-Provence, Office National des Forêts (ONF). Ecos-Nord programme.

Zalamea P.C., Heuret P., Sarmiento C., Rodríguez M., Berthouly A., Guitet S., Nicolini E., Delnatte C., Barthélémy D., Stevenson P.R., 2012. The genus *Cecropia*: a biological clock to estimate the age of recently disturbed areas in the neotropics. *PLoS One*, 7: e42643. Doi: 10.1371/journal.pone.0042643

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best resisted to the water stress, and therefore were best able to cope with drought events associated with climate change, were slow-growing ones. Fast-growing trees are much more sensitive to water stress: in an extreme drought event, their growth is slowed to such an extent that these trees are more likely to die. This is a surprising result, since it is generally thought that fast-growing trees are opportunistic species, in other words reactive species able to adapt themselves to their changing environment.

CONTACTS

Bruno Hérault, Fabien Wagner,
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Wagner F., Rossi V., Stahl C., Bonal D., Hérault B., 2012. Water availability is the main climate driver of neotropical tree growth. *PLoS One*, 7: e34074. Doi: 10.1371/journal.pone.0034074

Wagner F., Hérault B., Stahl C., Bonal D., Rossi V., 2011. Modeling water availability for trees in tropical forests. *Agricultural and Forest Meteorology*, 151: 1202-1213. Doi: 10.1016/j.agrformet.2011.04.012



By observing the scars left on the trunk of *C. sciadophylla*, the age of the tree can be estimated accurately. © P. Heuret/CIRAD

PUBLICATIONS

Perspective. Landscape ecosystem services: labelling rural landscapes. E. Torquebiau, C. Garcia, N. Cholet. *Perspective*, No. 16, May 2012. This issue suggests giving multifunctional rural landscapes a label so as to generate added value and reward the people who shape and maintain them. **Control of zoonotic diseases in Africa and Asia. The contribution of research to One Health.** F. Roger. *Perspective*, No. 18, August 2012. Focusing on the control of zoonoses, this Perspective shows how intersectorial and interdisciplinary research can facilitate the implementation of the 'One Health' approach.

PROTA (Plant Resources of Tropical Africa/Ressources végétales de l'Afrique tropicale). Timbers 2. Ed. R.H.M.J. Lemmens, D. Louppe (CIRAD, France), A. Oteng-Amoako (FORIG, Ghana) and M. Brink (Wageningen University, Netherlands). Foundation PROTA/CTA Wageningen, Netherlands, 2012. The second book on timbers in volume 7 of the PROTA encyclopaedia on useful plants originating from tropical Africa. While the first book in this volume described 511 species belonging to a selection of more than twenty botanical families, the second completes the inventory with 693 species whose primary use is also as timber.

EVENTS

The students' association BioTrace, in partnership with CIRAD, INRA, the Pôle Qualiméditerranée and the University of Montpellier 2 and with the support of the Languedoc-Roussillon regional council, organised the **7th BioTrace symposium**, entitled '*Nos aliments : des risques avérés aux bienfaits sécurisés*' from 1 to 3 February, 2012, in Montpellier.

CIRAD participated in the **First European celebration of plants**, called '**Fascination of Plants Day**' on 14 May at Agropolis International in Montpellier. The PI@ntNet collaborative network, associating researchers and amateurs in the field of botany, centring on a software platform devoted to plants, was at the heart of the event.

AWARDS, AGREEMENTS

The **Plant Resistance to Parasites laboratory** (CIRAD-IRD-University of Montpellier 2) has been selected by the *Bill & Melinda Gates Foundation* for a US\$100,000 'Grand Challenges Explorations' award for its project on the development of new resistance genes in rice against emerging bacterial diseases in West Africa.

Hosted by the board of the AllEnvi alliance, CEA, CNES, CIRAD, CNRS, IGN, INRA, IRD, IRSTEA and Météo France signed an agreement to found a **thematic platform on 'continental surfaces' (PTSC)**, pooling their expertise in order to make satellite data available to the environmental research sector.

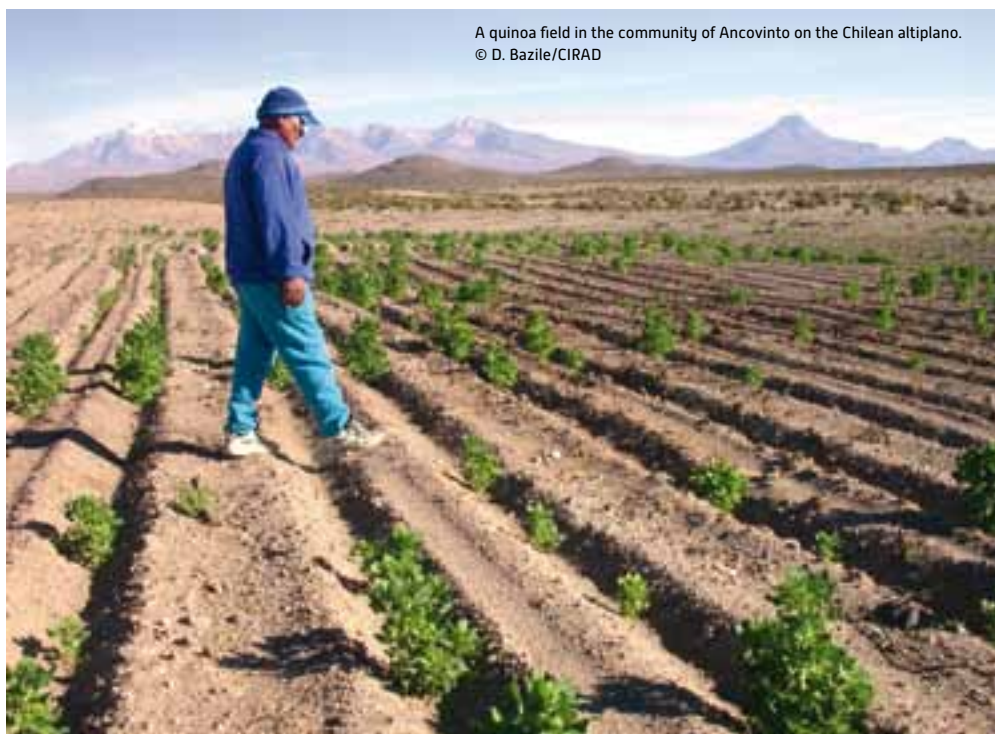
The **Histocytology and Plant Cell Imaging Platform (PHIV)** on the Agropolis-Lavalette campus in Montpellier has been awarded European Regional Development Fund (ERDF) funding for its project to 'design the plants of tomorrow'.

RESEARCH AND TRAINING PLATFORMS IN PARTNERSHIP (DP)

The **Production and Conservation in Partnership Research Platform (RP-PCP)** has launched the SAVARID project on the effects of aridity and drought on biodiversity in savannah socio-ecological systems. (ANR, 2012-2015).

The **Irrigated Systems in Mediterranean network (SIRMA)** has launched the Groundwater Arena project, alongside the Institut National Agronomique de Tunisie (INAT), to study the vulnerability and capacity for adaptation of socio-ecological systems dependent on aquifers. (ANR, 2012-2015).

The **Forests of Central Africa (DPFAC)** platform has launched CoForTips, which succeeds CoForChange, to better understand the resilience of forestry socio-ecosystems in the Congo Basin and build scenarios for decision support. (ERANet Biodiversa, 2013-2015).



A quinoa field in the community of Ancovinto on the Chilean altiplano.
© D. Bazile/CIRAD

> BIODIVERSITY AND THE CONSTRUCTION OF TERRITORIES

Quinoa in Chile

The IMAS project (Impact of Modalities of Access to Seeds on the diversity of genetic resources in agriculture), coordinated by CIRAD, focused on the definition and implementation of management practices adapted to the dynamic *in situ* conservation of genetic resources. It aimed to identify new forms of managing varietal diversity based on interaction at different levels of farmer, commercial and institutional seed systems. Part of the project involved quinoa in Chile. This herbaceous plant, whose protein-rich seed is a staple food in Andean countries, has a high genetic diversity, which allows it to adapt to extremely varied growing conditions and is an asset given the current context of adaptation to climate change. The approach was based on participatory modelling, consulting experts from different disciplines. It has led to the design of a generic model of seed systems and simulation models that have been validated and calibrated with farmers and used to explore scenarios through role playing games. The results of the project include: genetic characterisation of the varietal diversity of quinoa, the determinants of agricultural biodiversity at the farm scale, varietal dynamics in different agricultural contexts, the effects of the connection to the market on cultivated varietal diversity and intellectual property issues in the management of genetic resources. From the point of view of collective action and organisation of the quinoa sector in Chile, an agricultural advisory business and an interprofessional quinoa group, hosted by the Chilean Ministry of Agriculture, have been created to define a quinoa national strategy.

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PARTNERS **Chile** > Centre for Advanced Research in Arid Zones, University of Valparaíso, Catholic University of Maule (UCM), Arturo Pratt University (UNAP) and the NGO CET-SUR of Temuco. **France** > INRA, IRD

Bazile D., 2013. Territorial development. Quinoa: a catalyst for innovation. *Perspective*, n° 20.

At the request of the FAO and following a proposal from French diplomats, the scientific coordinator of the IMAS project is currently a member of the International Coordination Committee (ICC) of the International Year of Quinoa 2013. He is also a member of the ICC Editorial Board with the task of coordinating a FAO-CIRAD book titled 'The state of the world's quinoa' due to be published by the end of 2013.



Quinoa seeds of the Perla variety, sold under the name Quinoa Rea. © D. Bazile/CIRAD



> CONSERVATION AGRICULTURE

What role in family farms in the South?

Over the past 20 years, conservation agriculture has developed considerably in Brazil, where it is now practised on a large scale. It more recently spread to Europe, but is still marginal in Africa. With the benefit of hindsight and experience, we are now in a position to assess its advantages and limitations. This is what scientists from CIRAD and partner institutions that have been involved in conservation agriculture for many years have just done, through a wide-ranging study based on experiences in Brazil and Europe.

Conservation agriculture centres on three main principles: reduced or no tillage, permanent soil protection by organic residues, and diversification of crop rotations. It has real advantages in terms of maintaining soil fertility and cutting production costs, but requires often complex changes in farm management and production organisation strategies. In practice, conservation agriculture is subject to certain limits, and farmers tend to only partly apply its principles and choose systems that allow them to optimise the short-term benefits, even if by doing so, they sacrifice some of the long-term benefits. They therefore sometimes need additional inputs to compensate for resource degradation. These compromises come at a price, and the main problem now is to estimate this cost. This is one of the fields in which research will have to concentrate its efforts in the future, since there are still many unknowns regarding the impact of the choices made by farmers.

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Bernard Triomphe, Innovation and Development in Agriculture and the Agrifood Sector, bernard.triomphe@cirad.fr

PARTNERS **Brazil** > Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA).
France > Agence Nationale pour la Recherche (ANR, Systerra Pepites project), Institut de Recherche pour le Développement (IRD), Institut National de la Recherche Agronomique (INRA), Montpellier SupAgro.

Scopel E., Triomphe B., Affholder F., Macena Da Silva F.A., Corbeels M., Valadares Xavier J.H., Lahmar R., Recous S., Bernoux M., Blanchart E., De Carvalho Mendes I., De Tourdonnet S., 2012. Conservation agriculture cropping systems in temperate and tropical conditions, performances and impacts: A review. *Agronomy for Sustainable Development*. Doi: 10.1007/s13593-012-0106-9

> ARTHROPODS

How many species live in tropical forests?

Tropical rainforests are well known for their rich biodiversity, primarily of terrestrial arthropods. However, the taxon is difficult to inventory, and its overall specific wealth has never been estimated satisfactorily, even on a forest scale. The methodology used is one of the critical points of this type of survey. Therefore structured protocols and a clearly identified site in Panama's San Lorenzo forest were used by a team of a hundred or so scientists from research organisations around the world, including CIRAD, to conduct a vast survey. The researchers collected almost 130,000 samples, which were subsequently identified as belonging to 6,144 species. From this field data and by extrapolation, they came to the conclusion that the 6,000 hectares of forest were likely to be home to some 25,000 arthropod species. The most surprising aspect of this study is that almost two-thirds of the species in the forest were detected over a small area of less than a hectare. The other major result is that there is a close correlation between the diversity of vegetation and that of arthropods, whether or not they are herbivorous. Preserving biodiversity based on our knowledge of the plant formations in a given area, which are much easier to inventory, could thus help preserve arthropod biodiversity.

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PARTNERS

This work brought together around 100 researchers from 30 research organisations worldwide.

Basset Y. et al., 2012. Arthropod diversity in a tropical forest. *Science*, 338 (6113): 1481-1484. Doi: 10.1126/science.1226727

Above: Close-up of the head of an *Oronoqua ibisca* (Hemiptera), one of the species newly discovered during the study. © H.P. Aberlenc/CIRAD

Field samples being sorted before identification. © H.P. Aberlenc/CIRAD



Indicators2012

In June 2012, the CIRAD Board of Trustees unanimously approved the organization's new Strategic Vision, centring on four ambitions:

- Serving as a global reference in terms of our scientific priorities
- Co-constructing strategic agricultural research for development partnerships
- Establishing the conditions for effective innovation
- Changing in order to measure up to our ambitions].

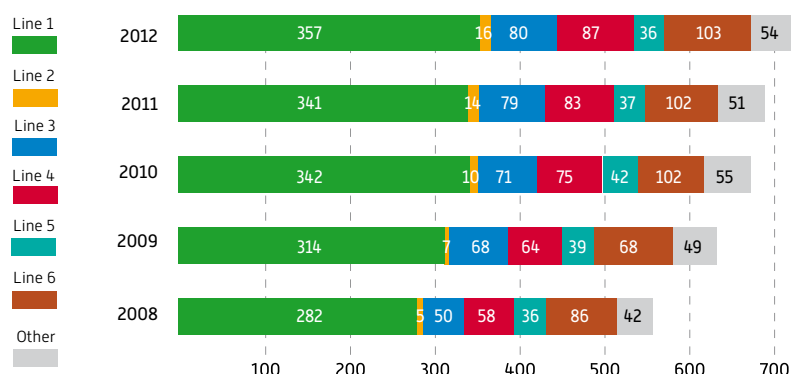
The operational translation of those ambitions into a five-year plan is the object of a new contract of objectives currently being examined. This explains why presentation of the indicators in the annual report is unchanged for this transitional year.

> The ambition of sharing science to meet the challenges facing southern countries

"The ambition of sharing science to meet the challenges facing southern countries" means adapting existing forms of scientific partnerships in order to address research issues that are relevant to development in southern countries. Mobilizing research teams to work on the six priority lines of research set out in CIRAD's strategy and updated in 2012, and building capacity in southern countries, are central to this challenge.

CIRAD has chosen to develop a balanced and sustainable partnership with its scientific partners in southern countries. This is shown by the steady increase in the share of joint publications between 2005 and 2012 (from 41.3% to 50.8%) and of journal articles co-published with researchers in southern countries (more than 50% in 2012, partial figure). The increase in the number of PhD students from southern countries supervised by CIRAD researchers, which slowed in 2009, has progressed since: in 2012, the increase was 21%.

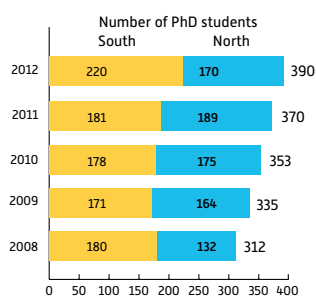
Proportion of CIRAD's publications per priority line of research



Source: Agritrop. DIST. DGDRS. The data for 2012 are partial (as of 28/02/2013)

Line 1: Ecological intensification. Line 2: Biomass energy and societies in southern countries. Line 3: Accessible, quality food. Line 4: Animal health and emerging diseases. Line 5: Public policy, poverty and inequality. Line 6: Agriculture, environment, nature and societies. Other: Outside priority lines of research.

Supervision of PhD students by CIRAD researchers



Source: DGDRS

Co-publications with researchers in developing countries*

Number of journal articles co-published with players in developing countries	2006	2007	2008	2009	2010	2011	2012
Number of co-publications	196	240	307	324	341	364	379
Number of co-publications smoothed over 3 years	n.c.	207	248	290	324	343	361
Total publications analysed	451	524	701	669	720	733	746
Annual share of co-publications	43.5%	45.8%	43.8%	48.4%	47.4%	49.7%	50.8%
Annual average share of co-publications, smoothed over 3 years	n.c.	43.7%	44.3%	46.0%	46.5%	48.5%	49.3%

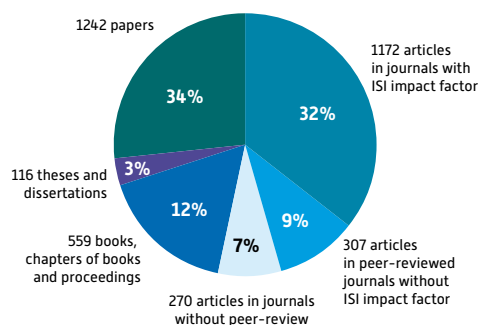
* A country is classified as a developing country if it is on the OECD/DAC list of countries that receive public development aid Source: Agritrop. DIST. DGDRS. The data for 2012 are partial (as of 28/02/2013)

> Diversified, 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, it is ensuring the diversity of its outputs, which are aimed at different audiences.

Scientific output is progressing, with steady growth in the number of articles published between 2007 and 2012, particularly in journals with an impact factor, while CIRAD researchers are continuing to become more qualified [number of directors of research]. The success rate for ANR calls to tender for projects is stable [provisional figure]. CIRAD researchers were considerably more involved in training activities in and through research in 2012 [number of hours of practical work equivalent in Masters courses in southern countries up by 21%], while the number of "consultant professors" is stable. Technology transfer and development output is also stable.

Distribution of publications



Source: Agritrop; DIST; DGDRS.
The data for 2012 are partial (as of 28/02/2013)

CIRAD's participation in ANR competitive calls to tender

	2007	2008	2009	2010	2011	2012
Number of projects submitted	75	72	49	65	81	35
Number of projects funded	23	19	14	12	17	24
Success rate [%]	31	26	29	18	22	23.5

Source: DGDRS, ANR Mission

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

Number of hours [practical work equivalent] of teaching and training development for Masters and PhD courses in developing countries.

	2007	2008	2009	2010	2011	2012
	3.978	4.249	4.439	4.368	4.531	5.515

Source: DGDRS Activity reports

Training for CIRAD's senior scientific staff

	2007	2008	2009	2010	2011	2012
Number of research directors at CIRAD	82	90	99	102	132	137
Number of consultant professors at CIRAD	n.c.	36	52	53	61	60

Source: SIRH [HDR]; DGDRD; DGDRS Activity reports (consultant professors)

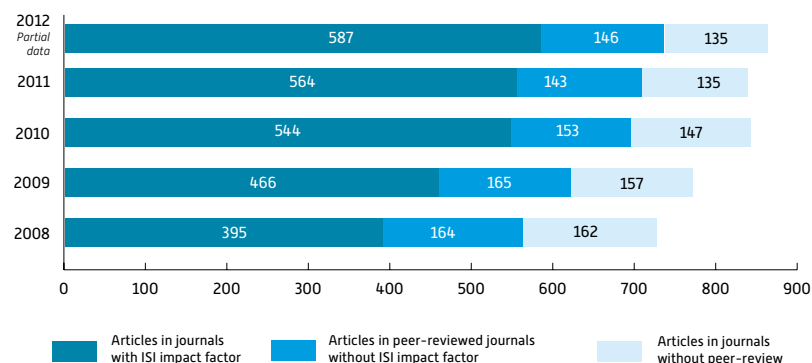
Technology transfer and development: patents, proprietary variety protection certificates and software programmes

Number of applications for patents, proprietary variety protection certificates and software programmes (in brackets: number of patents attributed)

	2007	2008	2009	2010	2011	2012
	8[2]	13 [0]	26 [4]	10[5]	8[2]	8[3]

Source: DelValo, DGDRS

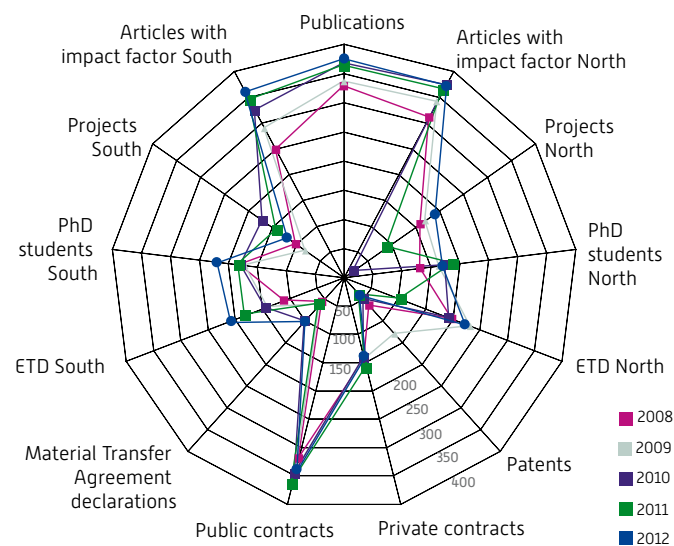
Change in the number of articles published in journals since 2008 smoothed over 3 years



Source: Agritrop. DIST; DGDRS. The data for 2012 are partial (as of 28/02/2013)

Assessing the diversity of CIRAD's scientific outputs

The set of outputs presented below in the form of a star-shaped diagram for the years 2008 to 2012 illustrates the diversity of CIRAD's missions and activities.



Source: DGDRS and UPR SCA

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

CIRAD's activities continued in 2012, on different levels: regionally, within research and training organizations, (PRES in Languedoc Roussillon and the French overseas regions; the sustainable development campus in Nogent-sur-Marne); nationally, in France as part of Agreenium, the national consortium, with other research organizations involved in Programme 187, particularly the IRD, and more actively with research alliances, particularly AllEnvi; in Europe, with reinforced partnerships with the European Commission and Wageningen University; and lastly, internationally, with the renewal of its partnerships in southern countries centring on twenty research platforms in partnership (RPPs) 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 given to southern countries, Europe and international operations. In 2012, overseas postings for CIRAD researchers progressed slightly (particularly in Latin America and the Mediterranean), with greater concentration on platforms in partnership, the number of which increased in 2012, particularly in Africa (21 international RPPs - 11 in Africa, five in Latin America, four in Asia and one in the Mediterranean - and seven in the French overseas regions). The number of overseas assignments was also slightly up, notably in Asia and the Mediterranean. The success rate as regards FP7 calls to tender rose substantially in 2012 (conjunctural effect), while the number of projects coordinated fell slightly.

Co-publications with French, European or international researchers

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)

Number of co-published journal articles, smoothed over 3 years*

	2007	2008	2009	2010	2011	2012
French researchers (including INRA)	210	254	287	306	315	331
European researchers (EU27 excluding France)	52	72	82	101	110	118
International researchers (excluding EU27)	236	286	337	377	392	415
Southern researchers	207	248	290	324	343	361
Researchers from P187	121	153	173	178	179	186
INRA	79	105	115	120	117	120
Total number of publications analysed	473	559	631	697	707	733

Source: Agritrop, DIST. DGDRS

CIRAD co-publications with each organization in LOLF Programme 187

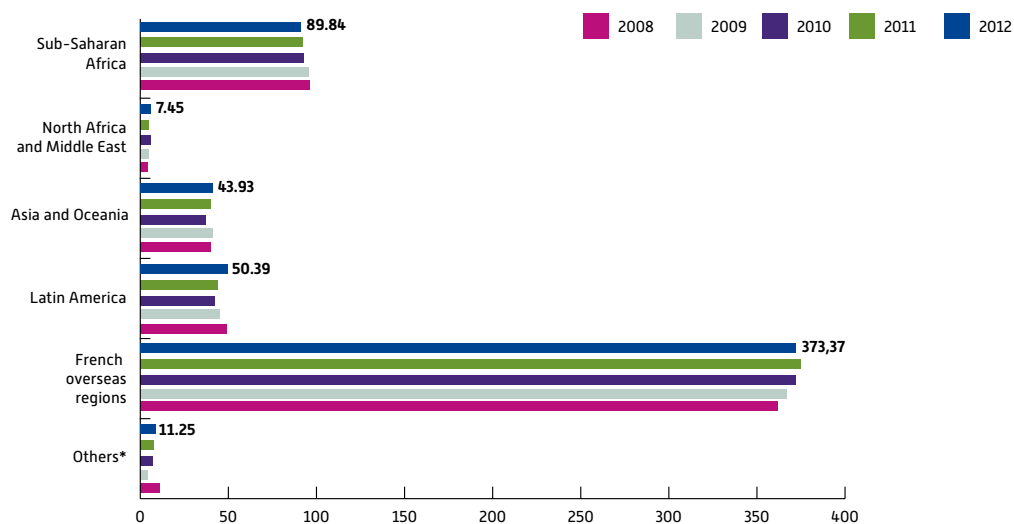
Number of journal articles co-published with organizations in LOLF P187, smoothed over 3 years*

	2007	2008	2009	2010	2011	2012
BRGM	0	0	0	0	0	0
CEMAGREF - IRSTEA	4	8	12	14	13	14
IFREMER	1	1	1	1	1	0
INRA	79	105	115	120	117	120
IRD	46	52	59	57	61	67
Total number of articles in peer-reviewed journals, with or without impact factor	473	559	631	697	707	733

Source: Agritrop, DIST. DGDRS

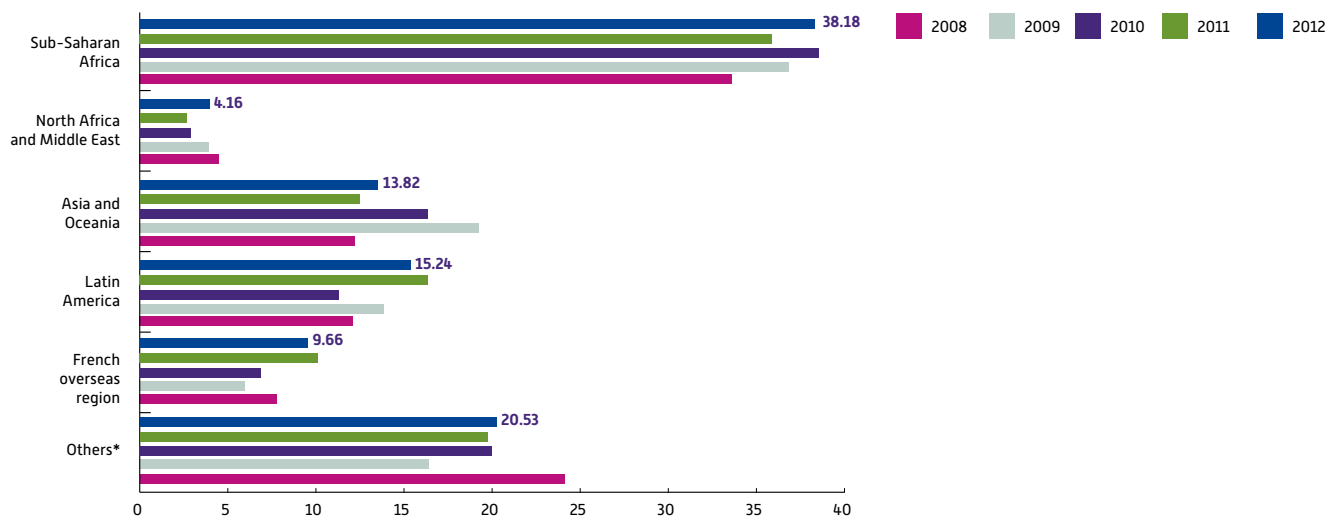
* In order to eliminate annual fluctuations and identify trends more easily, it is common practice to consider certain indicators for publications by smoothing data, or proportions, over three years.

Distribution of overseas postings, according to destination (full-time post equivalent)



Source: SIRH-DGDRD. (*"Others" refers to postings in Europe and North America)

Distribution of missions according to destination (full-time post equivalent)



Source: SIRH-DGDRD. (*"Others" refers to postings in Europe, North America and France)

Number of senior scientific staff members (CS) assigned to research platforms in partnership (RPPs)/Number of senior scientific staff on overseas postings (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 RPPs + 3 RPPs in French overseas departments and territories) out of 267 expatriate scientific staff.

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

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

2012 : 193.8 senior scientific staff at (21 international RPPs + 7 RPPs in French overseas departments and territories) out of 291.5 expatriate scientific staff

Source: SIRH-DGDRD

Table of research platforms in partnership (RPPs) overseas and in the French overseas regions (DOMs)

Region	National RPPs	Regional RPPs	DOM	RPPs in DOMs
Africa				
	PPZS Senegal, lines 1, 5, 6	ASAP, West Africat, line 1	Réunion	3P , line 1
	RP-PCP, Zimbabwe, lines 1, 4, 6	DPFAC, Congo Basin Forests, Central Africa, lines 1, 2, 4, 6,		REAGIR, line 6
	CRDPI Congo, lines 1, 6	SISTO, West Africa, lines 3, 5, 6		KAPPA, line 3
	Forest Biodiversity, Madagascar, lines 2, 6	DIVECOSYS, line 1, West Africa		
	Agroforestry PCP Cameroon, lines 2, 6			
	PP & G South Africa, lines 5, 6			
	SPAD, Madagascar, lines 1, 6			
Asia				
	HRPP, Thailand, line 1	RCP CANSEA (RACASE), Southeast Asia, line 1		
	MALICA, Vietnam, lines 3, 5	GREASE, Animal health and Emerging Diseases, line 4		
Latin America				
	PCP-AFS-PC Agroforestry Systems with Perennial Crops, Central America, lines 1, 2, 5, 6	AMAZONIE, Amazon Basin, line 6	Caribbean French Guiana	Forests
	CIBA, Brazil, line 1	PP&I-A, Latin America (10 countries), lines 5, 6		Agro-ecology and Multi-species Cropping Systems
				Biodiversity and Genetics
		RéSA-CaribVET, line 4 Guadeloupe-Caribbean-Amazonia		Emerging Diseases and Animal Health, line 4
Mediterranean				
	SIRMA, North Africa, lines 1, 3, 5, 6			

Source: Partnerships Office, DGDRS

CIRAD's EU research and development projects (FP) between 2007 and 2012

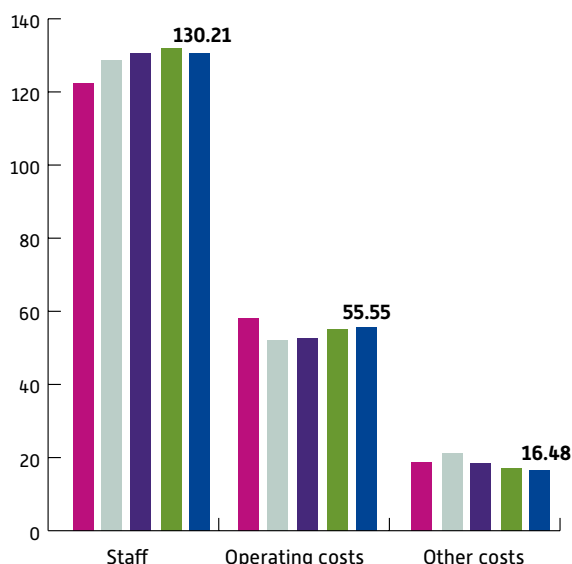
	2007	2008	2009	2010	2011	2012
Number of projects submitted	36	23	23	18	21	20
Number of projects funded	10	7	11	7	5	8
Success rate [%]	28	30	48	39	24	40
Number of projects coordinated by CIRAD	0	4	3	2	3	0

Source: Europe Office, DGDRS

> A structure and resources adapted to meet new challenges

In addition to simplifying and modernizing 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.

Operating costs, excluding internal sub-contracting 2008-2012, in million euros



Source: DCAF, DGDRD (see table 5 of management report)

CIRAD adjusted its operating costs in 2012 as a result of the stagnation in public subsidies, which has had an impact on the change in the number of agents (full-time staff and grant-funded students). Contractual resources are down 10%, linked to the drop in private funding and overseas public funding. The quality approach, which aims to simplify and improve efficiency, has been consolidated, and now concerns 1280 scientific and administrative staff members, 66% of CIRAD's total staff.

Total CIRAD staff (full-time post equivalent)

FTPEs at CIRAD	2007	2008	2009	2010	2011	2012
Number of "classified paid" permanent contracts	1770	1755	1764	1752	1739	1717
Number of grant-funded PhD students	24	48	71	83	81	72.6

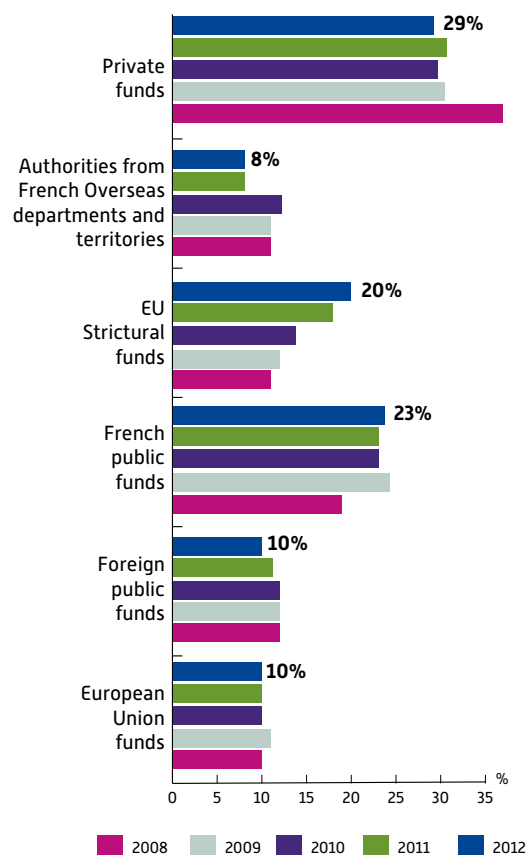
Source: SIRH-DGDRD

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

	2007	2008	2009	2010	2011	2012
Senior staff	59	58.8	59.2	59.6	60.6	62
Grant-funded PhD students	1.3	2.7	3.9	4.6	4.5	4.1
White-collar staff	31.6	31.8	31.4	31.5	31.6	31.5
Ancillary staff	8	6.7	5.5	4.4	3.4	2.4

Source: SIRH-DGDRD

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



Source: DCAF, DGDRD

Number of units (in number of staff members) applying a quality approach (levels 1/2 to 5)

2007	2008	2009	2010	2011	2012
375	444	853	929	1279	1280

Source: Quality Office, DGDRD.

Organisation en April 2013

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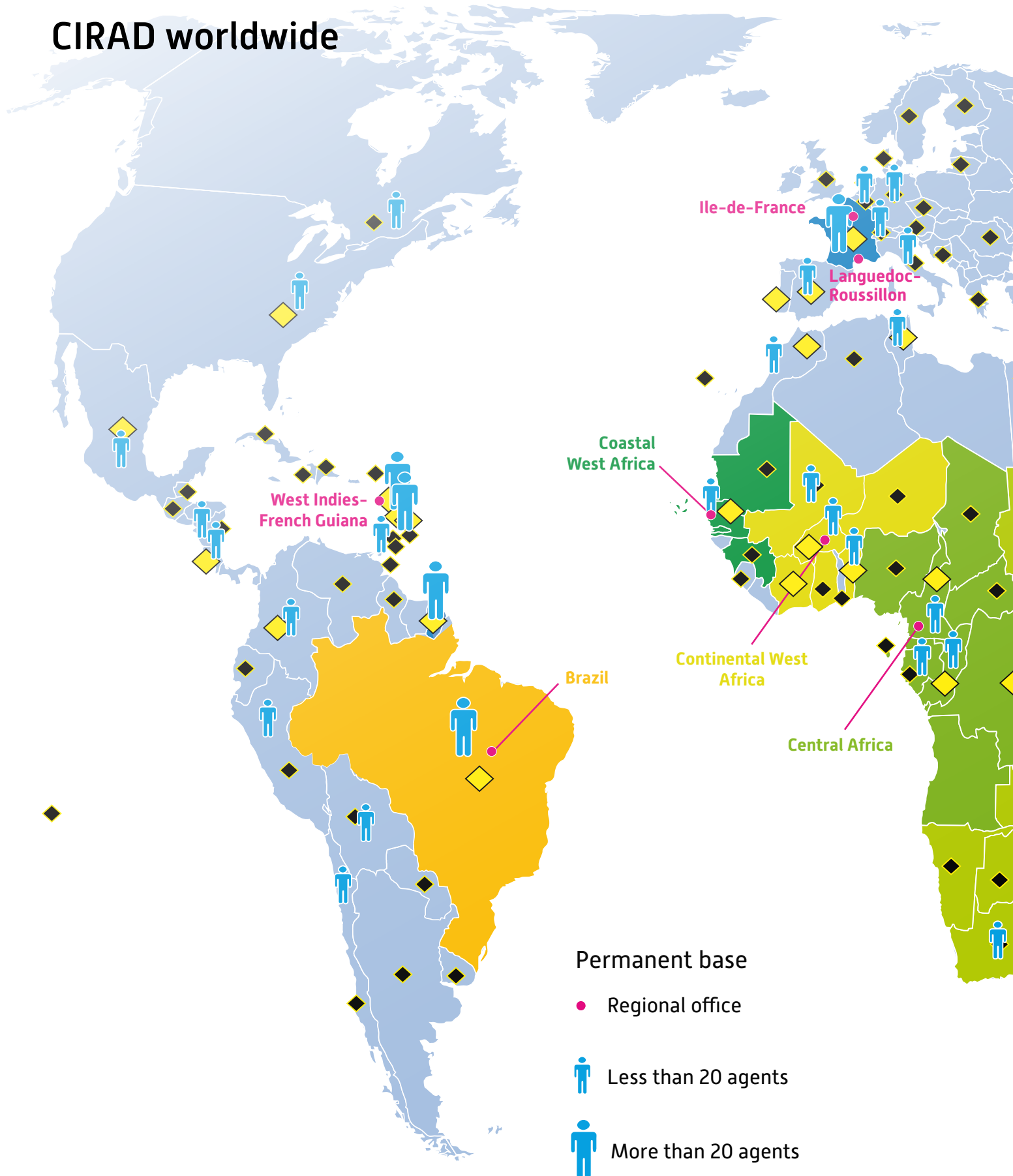
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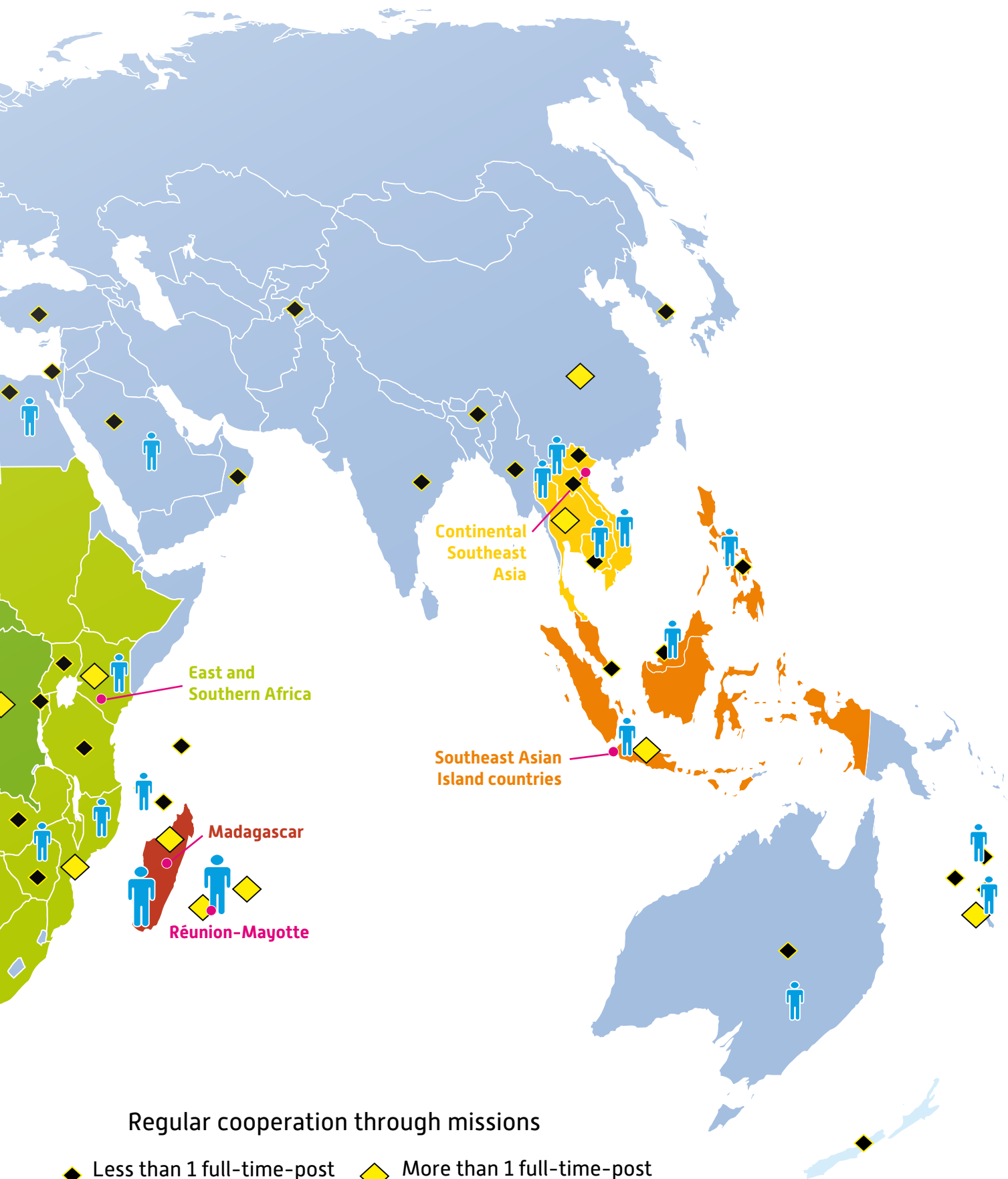
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