les dossiers d'AGROPOLIS INTERNATIONAL

Expertise of the scientific community in the Languedoc-Roussillon region (France)

Family farming

AGROPOLIS INTERNATIONAL

agriculture • food • biodiversity • environment

Agropolis International

brings together authorities of research and higher education in Montpellier and Languedoc-Roussillon in partnership with local communities, companies and regional enterprises and in close cooperation with international institutions. This scientific community has one main objectivethe economic and social development of Mediterranean and tropical regions.

Agropolis International

is an international space open to all interested socioeconomic development stakeholders in fields associated with agriculture, food production, biodiversity, environment and rural societies. Agropolis is an international campus devoted to agricultural and environmental sciences. There is significant potential for scientific and technological expertise: more than 2,500 scientists in over 75 research units in Montpellier and Languedoc-Roussillon, including 300 scientists conducting research in 60 countries.

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- Animal production and health
- Biodiversity and Aquatic ecosystems
- Biodiversity and Land ecosystems
- Economics, societies and sustainable development
- Environmental technologies
- Food: nutritional and health concerns
- · Genetic resources and integrative plant biology
- Grapevine and Wine, regional specific supply chain
- · Host-vector-parasite interactions and infectious diseases
- Modelling, spatial information, biostatistics
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Agropolis International promotes the capitalization and enhancement of knowledge, personnel training and technology transfer. It is a hub for visitors and international exchanges, while promoting initiatives based on multilateral and collective expertise and contributing to the scientific and technological knowledge needed for preparing development policies.

Family farming research expertise in Languedoc-Roussillon

World agriculture is overwhelmingly dominated by family farming, which is the leading rural employment source and food provider. The 2014 International Year of Family Farming launched by the United Nations spotlights the importance of this system, providing an opportunity for the Agropolis International scientific community to showcase its high long-standing commitment to research on and for family farming.

The topics covered in this *Dossier* concern 21 research units based in Languedoc-Roussillon Region, involving over 1 000 researchers whose activities are fully or partially focused on addressing—in collaboration with many partners—major family farming challenges in France and worldwide.

The scientists have developed four multidisciplinary approaches to deal with family farming issues—these are designed to:

- study economic, organizational and social dynamics related to family farming
- investigate and develop tailored farming and livestock production systems to enhance sustainable agricultural production without upsetting rural communities and environments
- manage natural resources and biodiversity, with family farms playing a key role
- support farmers regarding innovations, resource management and the analysis of interactions between public policy and local and regional stakeholder dynamics.

This Dossier also underlines the activities of three Montpellier-based foreign and international research institutions that are highly involved in the development of smallholder farming in developing countries, in partnership with regional teams. Finally, it summarizes degree and nondegree training-education programmes offered by Agropolis International member institutions.

This Agropolis International *Dossier* is a contribution to the UN call for commitments to family farming within the framework of:



www.fao.org/family-farming-2014/en

Family farming

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Cover photo: Rice cropping in Madagascar – S. Carrière © IRD The information presented in this Dossier is valid as of 01/01/2014.

Foreword Family farming: *development issues* and research opportunities

The diverse range of farming models and practices that shape world agriculture will inevitably require renewal. The overall picture is now, despite the occasional pessimistic media coverage, quite clear agriculture will have to produce more to feed growing populations living to an increasing extent in urban areas. It is also essential to produce better as current farming systems often have unsustainable environmental impacts, with human health and ecosystem balances also sometimes paying a heavy toll. These quantitative and qualitative revolutions have to be accompanied by efforts to mitigate the growing inequalities and disparities between the world's farmers, while generating (rather than eliminating) jobs in the farming sector.

Visible trajectories of change being promoted in Organisation for Economic Co-operation and Development (OECD) countries tend to be geared towards land concentration, greater production, financialization and intensification through the artificialization and standardization of production systems and, more broadly speaking, food systems. However, by advancing even further along the path of agricultural industrialization and professionalization, could we overcome the limitations of conventional modernization based on fossil fuels and labour productivity gains, derived from agricultural revolutions in developed countries and the green revolution? There is reason for doubt.

Family farming—which relies almost exclusively on family labour and strong interrelationships between farming families and their farms—seems to offer convincing alternatives.

This form of production has proven its resilience despite regular claims that it is on the brink of disappearing: 2.6 billion people live off family farming, which provides jobs for 40% of the global workforce; men and women continue to cultivate and develop areas that are of no interest for other forms of production due to the assumed low productivity potential, and family farming continues to generate food for a significant portion of humanity based on the effective use of natural ecosystems and long-standing and constantly evolving know-how.

> ▲ Growing potatoes in Equador. O. Dangles © IRD

Everywhere family farming is practiced it is clearly resistant. Moreover, family farms are not necessarily small, poor and backward, especially in the light of their performance in response to current challenges and their multidimensional nature. They are potentially capable of creating wealth, ensuring food security, sustainably managing natural resources, providing jobs, reducing certain inequalities, contributing to energy

transition and controlling emerging health risks worldwide.

The intrinsic qualities of family farms do not, however, fully guarantee their sustainability. Their responses to various adverse events may also be detrimental to the ecological and social balance. These smallholdings are also clearly in a vulnerable position due to unregulated competition with agribusiness. Family farming requires technical and organizational innovations, supported by tailored public policies, to be in a suitable position to cope with global challenges and meet the need for renewed agricultural models.

Agricultural research must document the current state of family farming in support of discussions on possible farming systems of the future. This means characterizing the strengths and weaknesses of the farms, measuring and comparing their demographic significance, their economic, agricultural, environmental and social performances, as well as their replicability. Public policies that could enhance family farming performance or even facilitate the emergence of new support approaches and methods should also be assessed.

Many research units of the Agropolis scientific community have been directly or indirectly involved in studying this vast and complex situation through multiple partnerships with higher educational institutions in Languedoc-Roussillon Region. Their production and current orientations highlight the renewed long-term interest in multifaceted research on family farming. This Dossier provides a full comprehensive overview of the diversity, originality and promise of this research, which is mostly conducted in partnership with developing countries. Some of these research initiatives are focused specifically on family farming, while others develop innovations in collaboration with and for family farmers, promoting joint knowledge building through participatory activities. This research community is hence devoted to working with farmers and their representative organizations on and for family farming and its efforts will be highlighted and synergized in 2014—the year the United Nations has dedicated to family farming.

> Jean-Michel Sourisseau (UMR ART-Dev), Pierre-Marie Bosc (UMR MOISA) & Michel Dulcire (UMR INNOVATION)

Topics covered by the research teams

(January 2014)

esearch units and teams are mentioned on the following chart in order of appearance in this document.

- 1. Economic, organizational and social dynamics
- 2. Farming and livestock production systems
- 3. Wild and cultivated biodiversity and natural resource management
- 4. Support and public policy

The 'page' column indicates where the unit is presented. Red dots (•) indicate the main topics focused on by the research teams, while black dots (•) indicate secondary topics in which the teams are also involved.

Research teams and units	Page	I	2	3	4
UMR ART-Dev – Actors, Resources and Territories in Development (CNRS/UM3/CIRAD/UPVD/UM1) Director: Geneviève Cortes, <u>artdev@univ-montp3.fr</u> http://art-dev.cnrs.fr	10	•		•	•
UMR MOISA – Markets, Organisations, Institutions and Stakeholders Strategies (CIRAD/INRA/Montpellier SupAgro/CIHEAM-IAMM) Director: Étienne Montaigne, <u>montaigne@supagro.inra.fr</u> http://umr-moisa.cirad.fr	12	•	٠		•
UMR GRED – Governance, Risk, Environment, Development (IRD/UM3) Director: Francis Laloë, <u>francis.laloe@ird.fr</u> www.gred.ird.fr	14	•		•	
UPR HortSys – Agro-ecological Functioning and Performances of Horticultural Cropping Systems (CIRAD) Director: Éric Malézieux, <u>eric.malezieux@cirad.fr</u> http://ur-hortsys.cirad.fr	22	•	•		•
UPR AIDA – Agroecology and Sustainable Intensification of Annual Crops (CIRAD) Director: Éric Scopel, <u>ursca@cirad.fr</u> www.cirad.fr/nos-recherches/unites-de-recherche/agroecologie-et-intensification-durable-des-cultures-annuelles (temporary website)	23		•	•	•
UPR Performance of Tree Crop-Based Systems (CIRAD) Director: Éric Gohet, <u>eric.gohet@cirad.fr</u> www.cirad.fr/ur/systemes_de_perennes	24		•		
UMR LSTM – Laboratory of Tropical and Mediterranean Symbioses (CIRAD/INRA/IRD/Montpellier SupAgro/UM2) Director: Michel Lebrun, <u>lebrun@univ-montp2.fr</u> http://umr-lstm.cirad.fr	26		•		
UMR SELMET – Mediterranean and Tropical Livestock Systems (CIRAD/INRA/Montpellier SupAgro) Director: Philippe Lecomte, <u>philippe.lecomte@cirad.fr</u> http://umr-selmet.cirad.fr	28		•		
UMR INTREPID – Integrated and Ecological Intensification for Sustainable Fish Farming (CIRAD/IFREMER) Director: Béatrice Chatain, <u>beatrice.chatain@ifremer.fr</u> Deputy Director: Jean-François Baroiller, <u>jean-françois.baroiller@cirad.fr</u> http://umr-intrepid.cirad.fr	29	•	•		
UMR QUALISUD – Integrated Approach to Food Quality (CIRAD/Montpellier SupAgro/UM1/UM2) Director: Antoine Collignan, <u>antoine.collignan@supagro.inra.fr</u> http://umr-qualisud.cirad.fr	30		•	•	

▲ An exchange between an INTA technician and a farming family, Rio Negro province, Argentina. P. Oliveri © INTA

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UMR AGAP – Genetic Improvement and Adaptation of Mediterranean and Tropical Plants (CIRAD/INRA/Montpellier SupAgro) Director: Jean-Christophe Glaszmann, <u>diragap@cirad.fr</u> http://umr-agap.cirad.fr	36	•		•	
UMR DIADE – Crop Diversity, Adaptation and Development (IRD/UM2/CIRAD) Director: Serge Hamon, <u>Serge.Hamon@ird.fr</u> www.diade-research.fr	38			•	
UMR Eco&Sols – Functional Ecology & Bio-geochemistry of Soils & Agro-ecosystems (Montpellier SupAgro/INRA/CIRAD/IRD) Director: Jean-Luc Chotte, jean-luc.chotte@ird.fr www.montpellier.inra.fr/ecosols	39		•	•	
UMR SYSTEM – Tropical and Mediterranean Cropping System Functioning and Management (CIRAD/INRA/Montpellier SupAgro) Director: Christian Gary, <u>dirsystem@supagro.inra.fr</u> http://umr-system.cirad.fr	40			•	
UMR G-EAU – Water Resource Management, Actors and Uses (AgroParisTech/CIHEAM-IAMM/CIRAD/IRSTEA/Montpellier SupAgro) Director: Olivier Barreteau, <u>olivier.barreteau@irstea.fr</u> http://g-eau.net	42		•	•	•
UPR GREEN – Management of Renewable Resources and Environment (CIRAD) Director: Martine Antona, <u>martine.antona@cirad.fr</u> http://ur-green.cirad.fr/	43	•	•	•	•
UMR ESPACE-DEV (IRD/UM2/UR/UAG) Director:Thérèse Libourel, <u>therese.libourel@univ-montp2.fr</u> www.espace-dev.fr	44			•	
UMR Innovation – Innovation and Development in Agriculture and the Agrifood Sector (CIRAD/INRA/Montpellier SupAgro) Director: Christophe Soulard, <u>christophe.soulard@supagro.inra.fr</u> http://umr-innovation.cirad.fr	50	•			•
UPR B&SEF – Goods and Services of Tropical Forest Ecosystems (<i>CIRAD</i>) Director: Alain Billand, <u>alain.billand@cirad.fr</u> http://ur-bsef.cirad.fr	52	•	•	•	•
UPR AGIRs – Animal and Integrated Risk Management (CIRAD) Director: François Roger, <u>francois.roger@cirad.fr</u> http://ur-agirs.cirad.fr	54		•		•
UMR TETIS – Spatial Information and Analysis for Territories and Ecosystems (AgroParisTech/CIRAD/IRSTEA) Director: Jean-Philippe Tonneau, <u>tonneau@cirad.fr</u> http://tetis.teledetection.fr	55	•			•

Family farming

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Economic, organizational *and social dynamics*

amily farming still overwhelmingly dominates global agriculture. Capital-intensive agribusiness only accounts for the main market supply of some agricultural products—such as soybean and palm oil—but family farming massively contributes to global production (cereals, tubers, fats, stimulants, fibres, animal products). Family farms are intimately linked to the agricultural landscapes and *terroirs* shaped by their practices and thus play a critical role in natural resource, biodiversity and land management, as well as in preservation of cultural diversity and local development. They contribute directly to generating income and employment for a large segment of the world population.

Family farms therefore have a pivotal role in the evolution of societies and environments upon which they are highly dependent. Their centuries-old transformation has accompanied the slow process of transition from predominantly agricultural to more diversified economies where secondary and tertiary sectors provide the bulk of the wealth and employment. As a consequence of world demographics, around 75% of agricultural workers are located in Asia, 20% in Sub-Saharan Africa and 5% in the rest of the world. Urbanization is under way on all continents, but most of the population in Africa and South Asia will remain rural for several decades.

Despite these reconfigurations and the growth of urban areas, farmers and their families occupy the largest part of the ekumene^{*} on all continents, including those where agriculture is no longer peoples' main activity. Rural areas, even in the most ecologically marginal zones, have been shaped by remarkably diversified agricultural development, thus demonstrating the high flexibility and adaptation capacity of family farming. This adaptability is both spatial and historical. Farmers have been able to adapt under heavy constraints, while concomitantly being technically and organizationally innovative when the setting is favourable, particularly when benefitting from public support via agricultural policies (credit, training, extension, market regulations). This diverse range of social and environmental contexts, scales and timeframes is being documented and analysed by Agropolis member institutions in Montpellier (CIRAD, CNRS, IAMM, INRA, IRD, etc.). Nine research teams directly or indirectly devote research to these dynamics, often in partnership with research organizations in developing countries throughout much of Sub-Saharan Africa, North Africa, Latin America, South and Southeast Asia. Studies are carried out on the dynamics of farms hampered by land pressure, on the resilience of farming systems and their contribution to sustainable development, on the effect of changing family strategies on production systems and natural resources, on new opportunities for the adoption of agroecological practices arising from urban growth, on the social management of seeds and on revitalizing local economies, to name but a few.

Various theoretical and empirical approaches are implemented, involving a range of disciplines related to earth and life sciences, and especially social sciences. Innovative designs of new research frameworks provide effective responses to new challenging issues (e.g. the World Agriculture Watch). As illustrated in this chapter, specific approaches, sometimes comparative and often interdisciplinary, are needed to deal with the diversity of situations and questions to be addressed. The expertise of Montpellier researchers in this area is well established, as they are regularly called upon by policymakers and various stakeholders. One of the greatest challenges is to continue, delve deeper and pool research and data in order to gain further insight into the complexity of past and current dynamics, to anticipate change and effectively support the future of family farming worldwide.

> Bruno Losch (UMR ART-Dev) & Stéphanie Carrière (UMR GRED)

^{*} The inhabited part of the world



New patterns in family farming and territorial development

The joint research unit Actors, Resources and Territories in Development (UMR ART-Dev, CNRS/ UM3/CIRAD/UPVD/UM1) conducts research on regional/territorial development from economic, political and social perspectives by connecting globalization and local dynamics. These situations are analysed with a focus on the construction and mobilization of a set of tangible and intangible resources by stakeholders.

Main teams

UMR ART-Dev Actors, Resources and Territories in Development (CNRS/UM3/CIRAD/UPVD/UMI) 70 scientists UMR GRED Governance, Risk, Environment

and Development (IRD/UM3) 45 scientists

UMR MOISA Markets, Organisations, Institutions and Stakeholders Strategies (CIRAD/INRA/Montpellier SupAgro/ CIHEAM-IAMM) Around 60 scientists

...continued on p. 14

These major research themes concern rural and urban development trajectories and their interactions, the issue of natural resource governance and questions related to mobility and circulation processes in the globalization setting. Topics are studied at different geographical scales with a specific focus on governance and public policies.

The unit works on several continents, in many geographical and political contexts that may differ markedly in terms of types and stages of development. The objective is to make effective use of this diversity through explanatory comparative approaches. At international, national and regional levels, it aims to play a dual knowledge-generation and -dissemination role for the scientific community. It also develops expertise to address the high social demand regarding regional planning and development issues (appraisals, surveys, operational research, cooperation).

Family farmers are very active in research carried out by the UMR, being major stakeholders in the spatial dynamics which have a heavy impact on them.

The unit works on conceptualization and generation of typologies of family farms and forms of production, especially via its involvement in the World Agriculture Watch hosted at the Food and Agriculture Organization of the United Nations (FAO, see *below*). Family farms, most of which are pluriactive and fulfil many functions in territorial development, are thus one of the major research focuses of the ART-Dev's analyses. Besides research on the characterization of family farming, the unit's researchers investigate the evolution of thinking and the diversity of development models related to agriculture, the specific treatment of family farms by public policies, and how the latter are contributing to the related debates.

The unit aims to meet its partners' social demand and is therefore also involved in enhancing the capacities of development stakeholders. Family farmers and their organizations are directly involved through ongoing and targeted training modules. The training programmes in which the researchers are involved are also geared towards local governments (and their future leaders) which can play a significant role in supporting family farming.

Territorial dynamics and new rural development patterns in Africa

In the coming decades, the African continent will experience major restructuring resulting from the doubling of its population—an additional billion people by 2050—in a context already subject to high tension due to pressure on natural resources, persistent poverty and the impact of international competition on local economies. In this novel situation, territorial dynamics must be taken into account relative to population densification, migration and urban growth, so as to better address the employment demand, with the pending arrival of 330 million young people in the labour market over the next 15 years—60% in rural areas.

This is a major challenge for rural development policies, which must be based on a renewed strategic vision in order to promote sustainable growth to benefit as many as possible. This growth should be in the agricultural sector and based on greater rural diversification so as to accelerate structural change throughout the continent.



Family farming—the largest source of employment in Africa is and will remain a major contributor in the change process.

UMR ART-Dev and the French Agricultural Research Centre for International Development (CIRAD) are collaborating with the New Partnership for Africa's Development (NEPAD) to gain greater insight into ongoing and expected territorial restructuring processes. This collaboration, which benefits from ties already forged in the RuralStruc programme^{*} (2006-

2010), has led to the publication of an atlas on 'a new emerging rural world' in Africa (with the participation of UMR MOISA, UMR TETIS and UPR B&SEF). The collaboration will continue under NEPAD's new Rural Futures Programme, supported by the French Development Agency (AFD) and the International Fund for Agricultural Development (IFAD), which will be implemented from pilot regions representative of the diversity of African situations, as defined in association with the Regional Economic Communities and the African Union.

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For further information: www.cirad.fr/en/news/all-news-items/pressreleases/2013/new-rural-world

 * Agropolis International Dossier n°7 (2008). Societies and sustainable development. Contribution of the social sciences. p. 41.

▲ A New Emerging Rural World – An Overview of Rural Change in Africa. Atlas for the NEPAD Rural Futures programme. B. Losch, G. Magrin, J. Imbernon (eds.). CIRAD, 2013.

World Agriculture Watch

UMRs MOISA, ART-Dev, SELMET and TETIS and the internal research unit (UPR) Performance of Tree Crop-Based Systems are contributing to the World Agriculture Watch (WAW, or OAM in French, Observatoire des agricultures du monde). The main objective is to place the dynamics and performances of different types of agriculture (family farming, family business farms run with permanent hired labour, and corporations) back on the public policy agenda, while taking production and economic, social and environmental sustainability into account on local and global levels and anticipating future change.

This initiative provides a platform for knowledge creation, exchange and discussion. It is based on a network of observatories located in representative areas where significant structural changes are under way (e.g. high-risk agricultural production systems). The initiative aims to:

- document farm diversity, structural change, resilience to current constraints and sustainable development contributions
- conduct comparative spatiotemporal analyses
- raise awareness on potential crises and specific vulnerabilities, and propose potential policy options
- strengthen the capacity of observatories and local, national and regional stakeholders for collecting and analysing relevant information that could be used to fuel the policy orientation debate.

This global initiative based in Rome (supported by FAO/ IFAD/France^{*}) operates on the principle of pooling methods and tools implemented by national observatories within the network. These observatories address national concerns on agricultural change, especially related to family farming.

Globally, the key issue concerns changes in forms of agricultural activity organization regarding, on one hand, agribusinesses or hired labour-based firms and, on the other, family farms run solely with family members or with external hired labour but where the families play a key role, as illustrated by the close link between the general and working capital.

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For further information: www.observatoire-des-agricultures-du-monde.org

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 UMR SELMET (Guillaume Duteurtre, Pascal Bonnet)
- UPR Performance of Tree Crop-Based Systems (Cécile Bess
- And a scientific contribution from the French National Institute for Agricultural Research (INRA Céline Bignebat, Magali Aubert, Philippe Perrier-Cornet and Isabelle Piot-Lepetit (UMR MOISA)

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Behaviours and coordination strategies of agricultural, food and rural system stakeholders

The joint research unit Markets, Organisations, Institutions and Stakeholders Strategies (UMR MOISA, CIRAD/INRA/Montpellier SupAgro/CIHEAM-IAMM) is a multidisciplinary research unit. Its research programme is grounded on theoretical precepts in institutional economics, industrial economics and markets, development economics, management science and humanities and social science disciplines sociology, anthropology, political science—and is closely focused on interactions between stakeholders.

UMR MOISA deals with issues related to stakeholder strategies, i.e. public or private, individual (farmers, consumers) or collective (social groups farmers' organizations), and their modes of internal or external organization (vertical and horizontal coordination), as well as to institutional functioning patterns (markets, regulations) concerning agricultural, agrifood and rural systems in Mediterranean and tropical areas.

The unit's research team Agricultures en mutations, stratégies des ménages et gestion des ressources (ASG) analyses changes in farming systems and rural household activities in the trade globalization setting. It is equally interested in the formation of large-scale capitalistic production units and the analysis of coping strategies of the smallest production units through a range of approaches, including the diversification of agricultural and nonagricultural activities to ensure their food security, income and sustainability. This research is mainly focused on developing and emerging countries. Comparisons with industrialized

countries and the analysis of North/South interfaces provide opportunities to gain insight into the specific economic trajectories involved. The research issues concern the coexistence of small- and largescale farms, understanding rural household strategies regarding choices of activities in the presence of major market imperfections, and analysis of the impacts of agricultural change on rural economies.

This research has a number of specific features based on the importance of: (i) taking the actual behaviours of stakeholders (individuals, farms, organizations and institutions) into account, (ii) conducting multidisciplinary social science studies in interaction with technical sciences, and (iii) building analytical materials (factual surveys and derivative data bases) and tools. •••

Small family farms in France

The specificity and future of small farms are at issue due to the increased concentration of agricultural production and land. In 2000, more than four out of ten small family farms in France had an SGM of less than 40 ESU^{*}. These latter farms, which declare that at least one active family member is a head farmer, are on the decline and only accounted for a third of all farms in 2007. Very small farms, with an SGM of less than 16 ESU, represented 20% of all small family farms in 2000, a quarter of which had disappeared in 2005. These farms are mainly located in the area from the Pyrenees to the northern Alps (see *map*). A descriptive analysis conducted by UMR MOISA characterized these farms and their trajectories on the basis of the findings of the agricultural census carried out in 2000 and the 2005 structural survey.

Very small farms have specific production features. They are overrepresented in sheep, goat and beef cattle production systems. Over the 2000/2005 period, their output rate was lower than that of other farms, with a growth rate among the lowest recorded.

Small farm trajectories and the growth rate of sustainable farms vary according to the production orientation. Farms specialized in market gardening thus have very high outputs and growth levels. These trajectories are related especially to the production orientations and the extent of commodity development. Quality labels (*'Label Rouge'*, etc.) are often utilized by small farms. These labels are a growth factor for this farm category, contrary to other labels such as the 'organic farming' label, which is a marginal category in France and seems to have had very little impact on small farm growth rates.



▲ Weight in the departmental SGM and number of small family farms of less than 40 ESU.

Source: IGN map, Agreste Enquêre Structure 2005

Although income source diversification could boost growth, small farms diversify less than other farm categories. Data from the 2010 agricultural census could now be analysed to update these results and focus on aspects such as farm marketing strategies.

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*The European size unit (ESU) is a standard gross margin (SGM) measurement unit and is the equivalent of 1.5 ha of wheat.

Is urban family farming useful for urban development? A case study in Meknès, Morocco

Urban farming patterns in developing countries depend on the urban development dynamics. In Meknès (Morocco), the presence of urban farming could be explained by the low spatial coverage of production activities—intensive indoor dairy farming, market gardening—limited to interstitial areas such as valley bottoms and steep hillsides. Small family production units run the farming activities, providing employment for one urban household member, sometimes in addition to a full-time or seasonal employee. Hundreds of Meknès households derive most of their income and part of their food from these activities. Urban agriculture supplies consumers with fresh milk and various vegetables through short informal distribution channels. Despite its socioeconomic impact, this farming system is overlooked by agricultural support services since it is run outside of the framework of agricultural development standards and plans. Milk, for instance, should normally be sold via agroindustrial milk collection services to ensure the product quality.



Market garden crops are irrigated with surface water (wadis and springs) mixed to various extents with waste water, a source of microbial contamination that could be dangerous to consumers. This family farming is still tolerated since its social function is recognized by public authorities. The functions of this farming system and associated ecosystem services should be taken into account to initiate a programme of interventions geared towards improving its contribution to the sustainable development of agriurban systems: quality production, soil protection, maintenance of emblematic landscapes combining gardens, trees and housing, boosting urban dwellers' environmental awareness, provision of jobs and acceptable income for families. This however requires political involvement in urban development schemes and the same extent of support (financial, advice) as that provided to farmers in other types of farming system in Morocco.

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Urban and periurban farming provides an opportunity to adopt agroecological practices—the compost issue



Are urbanization and rural outmigration really a threat to family farming? There is no really clearcut answer. The presence of reliable markets and consumers in the vicinity of urban and periurban production sites is a sufficiently high incentive to promote local family farming. The production and marketing of high added-value crops such as vegetables is suitable for small agricultural areas when farmers' homes, plots and markets are not far apart. There is of course a high pollution risk, but this could likely be mitigated by adopting and implementing innovative agroecological practices in the light of the growing demand of urban communities, which are better informed and aware of health and even environmental issues.

Regarding composting in Africa, much municipal solid waste is composed of organic matter. Raw material is thus available for the production of compost and organic amendments that could be used to enhance the soil composition and fertility. Studies under way by the internal research unit (UPR) HortSys are thus focused on determining the best institutional, logistic and social strategies that could be implemented to promote green sectors devoted to supplying family farms with alternative inputs or to complement conventional inputs. Urbanization, agglomeration and urban density processes provide a basis for viable alternative or complementary sectors to transform what was previously considered a constraint into opportunities.

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A research and training platform on rural land tenure in developing countries

The Pôle foncier de Montpellier—a rural land tenure research platform based in Montpellier—aims to revitalize and structure collaborations between different teams from Agropolis institutions conducting research and offering training on rural land issues in developing countries. This platform was set up as a scientific interest group (CIRAD/CIHEAM-IAMM/IRD/ Montpellier SupAgro). Although it is based in Montpellier, it promotes close collaborations with external researchers, particularly from developing countries. The scientific activities include three annual 'thematic seminars' and an annual 'doctoral seminar' that provide a forum for discussion and scientific exchange between PhD candidates and experienced researchers from different social science fields specialized on land issues. These seminars are organized by the platform, in partnership with the Maison des Sciences de l'Homme de Montpellier and the Comité Technique Foncier et Développement (AFD/French Ministry of Foreign Affairs). The talks presented at the thematic seminars and doctoral seminar conferences are broadcast live^{*} and can also be viewed later in video^{**}. Les Cahiers du Pôle Foncier is a working paper collection that showcases the research of members of the platform, their partners and associated students.

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* www.livestream.com/lamshm ** http://msh-m.tv

Other teams focused on this topic

UMRAGAP

Genetic Improvement and Adaptation of Mediterranean and Tropical Plants (CIRAD/INRA/Montpellier SupAgro) 176 scientists

UMR Innovation Innovation and Development in Agriculture and the Agrifood Sector (CIRAD/INRA/Montpellier SupAgro) 50 scientists

UMR INTREPID Integrated and Ecological Intensification for Sustainable Fish Farming (CIRAD/IFREMER) 14 scientists

UMRTETIS

Spatial Information and Analysis for Territories and Ecosystems (AgroParisTech/CIRAD/IRSTEA) 73 scientists

UPR B&SEF Goods and Services of Tropical Forest Ecosystems

(CIRAD) 45 scientists

UPR GREEN Management of Renewable Resources and Environment (CIRAD) 20 scientists

UPR HortSys Agro-ecological Functioning and Performances of Horticultural Cropping Systems (CIRAD) 28 scientists

Family farming relationships with biodiversity, conservation policies, territories and governance mechanisms

Research conducted by the joint research unit Governance, Risk, Environment and Development (UMR GRED, IRD/UM3) is focused on two main topics-interrelationships between societies and the environment and relationships between members of these societies in their approaches to the environment. These topics concern the 'socioenvironmental issue', hinged on governance and the environment. As this is a constantly evolving issue, it is essential to understand how new constraints and vulnerabilities, which are now an integral part of sustainable development, modify governance and land and resource management. The unit is structured around three priority lines of research:

- biodiversity conservation and the dynamics of rural areas
- governance and management of territories and resources
- risk and vulnerability of societies and territories.

The unit's scientists are specialized in different fields: geography, economy, anthropology, ethnoscience, agronomy, ecology, etc. Research on family farming relative to the environment, conservation policies, governance systems and territories essentially fall under research lines 1 and 2.

One of the aims of researchers working on line 1 is to gain insight into interactions between biodiversity conservation strategies, the dynamics of rural areasincluding family farming-and ecosystems. Under the assumption that humans are an integral part of ecosystems, biodiversity conservation therefore cannot be understood independently of development processes and rural areas. Family farming and environmental objectives are reconciled within the framework of this new sustainable development requirement, and this can have an impact on local living conditions. Rural societies seldom consider territories and resources solely in terms of agricultural production, but also from an ecological and social standpoint. Their combined agricultural, pastoral, forestry, hunting and fishing activities take the natural dynamics into account, while contributing to cultural identity and social cohesion. The diverse and complex relationship between family farming and the environment also concerns the globalization of environmental issues and the conservation movement, and is affected by the weakening of ecosystems and practices. Finally, family farming is based on various types of land access, which depend on land-use practices, social standards and the history of state interventions in rural areas.

Research conducted under line 2 analyses the governance of access to land and natural resources in situations that are often marked by a broad range of competing standards, spatial competition, competition with agribusiness and political-land conflicts. This may lead to the restructuring of production dynamics, and often exclusion processes.



▲ An association of Cameroonian women opening cocoa pods in Talba region, central Cameroon.

Influence of family strategies and practices on the spatiotemporal dynamics of agroforesry systems in southern Cameroon

SAFSE (Search for trade-offs between production and other ecosystem services provided by tropical agroforestry systems) is a project of the French Agence Inter-établissements de Recherche pour le Développement (AIRD). One of its teams includes researchers from CIRAD (UMR Innovation), the French Institut de recherche pour le développement (IRD – UMR GRED), Université de Yaoundé 1 (Cameroon) and Montpellier SupAgro (Institute for Higher Education in Tropical Agri-food Industries & Rural Development – IRC).

Since 2013, this interdisciplinary team (agronomy, socioeconomics, ecology, ethnobotany) has been gaining insight into the effects of family practices and strategies on cocoa agroforests in different ecological and socioeconomic areas in southern Cameroon. These constantly evolving family strategies are subject to different pressures in different regions. The research under way is focused on a diverse range of constraints and opportunities, based on the hypothesis that they have an impact on and induce changes in cocoa agroforests.

These agroforests, which date back to the early 20th century, were traditionally complex, multilayered and included many associated and useful tree species. These family managed

agroforests were composed of hardy cocoa varieties introduced by the Germans. Biodiversity was high in these agroecosystems, thus ensuring substantial resilience to change (ecological, economic). Successive introductions of new varieties, advice provided by agricultural extension services, spatial and professional mobility, elite investment in villages or in newly cleared lands are all factors which, among others, contribute to expanding the planting of these agroforests beyond the original areas and also to shaping new types of agroforest. These factors sometimes just simplify the cocoa cropping system, thus reducing the ecosystem services provided.

The above-mentioned team combines ecological, agronomic and socioeconomic approaches to characterize the effects of these changes on the structure, species composition and spatial dynamics of cocoa agroforests via their impacts on family strategies in three contrasting forest zones in southern Cameroon.

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For further information: http://safse.cirad.fr/le-projet/programme-scientifique/ wpl-caracterisation-de-la-composition-structure-dynamique-du-systeme

Role of public-private partnerships—a case study on the development of fish farming in Brazilian family farming systems



Since 2001, CIRAD (UMR INTREPID) and its partners have been conducting research on innovation processes regarding fish farming on family farms in two Brazilian regions, i.e. Ribeira Valley (São Paulo) and Upper Itajaí Valley (Santa Catarina).

The theoretical frameworks are based on public policy assessment, studies on the local innovation system and sociological aspects of translation, with sociotechnical networks (and their construction) and associated controversies also taken into account.

Brazilian fish farming has developed differently in the two regions. In the first region, the fish farms have not been able to innovate in order to overcome the economic crisis they face. In contrast, in the second region, fish farms have been enhanced via technical and organizational innovations in response to several economic and climatic crises. Public policies should go much further than technical monitoring, and include organization, technical support, training, funding and the presence of a translator (required because of the joint involvement of different research platforms in the local innovation system).

These initiatives began through a CIRAD thematic research project (2001-2004) aimed at determining the relative importance of various factors driving the adoption or rejection of fish farming by family farmers in four countries with representative tropical situations (Brazil, Philippines, Nigeria and Cameroon)*. These research issues were then further pursued and developed in two other research projects:

- a project (2008-2011) conducted by the Coordenadoria de assistência técnica integral which involved the construction of a new fish farming system (based on Deuterodon iguape) in Ribeira Valley and the Litoral Sud region
- the INRA/CIRAD Ecologically Intensive Fish Farming (PISCEnLIT) project (2011-2013), with one site located in Upper Itajaí Valley.

Finally, a three-party cooperation between Brazil, France and Cameroon is planned based on the conceptual frameworks already developed.

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A.A.

For further information: www.piscenlit.org

* Several end-of-study dissertations have been completed at French and Brazilian universities and graduate schools. With the support of the Comité François d'Évaluation de la Coopération Universitaire et Scientifique and Brazil, a PhD thesis (joint supervision CAUNESP de Jaboticabal and Agrocampus Ouest) was defended on the role of public policies on fish farming development dynamics.



Alto Vale de Itajahi Integrated Fish Farming Model

(MAVIPI). Pig-fish farming combination (80-100 pigs/ha of pond, tilapia-carp polyculture, 8-12 t/ha/year of fish, use of aerators and fish feeding at the end of the rearing cycle).

Interrelationships between agribusinesses and family farms in Madagascar

Large-scale land appropriations are still under way in Madagascar. UMR TETIS is working with the *Observatoire du Foncier*^{*} to monitor the impacts of these dynamics, promote transparency and public debate on these land contracts involving the State, and support the formulation of tailored land policies.

Most investors have halted their projects due to a lack of experience and capital, while others have planted their first crops on a few hundred hectares of land. Competition and complementarities with respect to the family farms differ depending on the setting, but some agrarian dynamics are similar.

The legal transfer of thousands of hectares of land to investors has transformed local land rights holders into squatters, despite the 2005 land reform that recognizes local land rights. Households that accept to surrender their land do so in exchange for compensation promises (rent, employment, infrastructures) or they pretend to be the owners although they are not the real landowners and land users. The losers are mostly cattle farmers who, for the richest of them, may react and violently oppose the companies or villages with which they have negotiated. Conflicts can flare up if the company does not keep its promises.

Only the poorest farmers work regularly with companies, while the others prefer to cultivate their own land for subsistence purposes. Income generated by these jobs thus benefits the poorest (often migrant) workers, but this does not offer a viable pathway out of poverty. Low land rent and low wages are attractive conditions for investors but they substantially increase



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the gap between the return on capital and on labour, and the differential between the added value that remains domestic and that is exported. In terms of social and spatial equity, these results should prompt a comparison with other development alternatives and business models (independent family farming, contract farming, large scale plantations, etc.).

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* www.observatoire-foncier.mg

Forest management in family farming systems in Latin America





▲ Small-scale logging by family farmers in the Brazilian Amazon (using a portable saw).

In the Brazilian Amazon, it is estimated that family farmers hold 12 million ha of forest on their properties. The forest code requires that a 50-80% share of their properties be preserved as forest reserves. Farmers are allowed to tap these forest resources within the framework of State-approved forest management plans. Unfortunately, due to the lack of adoption of appropriate techniques, cleared plots quickly become infertile, and after a few years the properties are completely bare and the remaining pastures are not very productive. The farmers then often abandon their properties and move to other frontier areas where they apply the same land clearing strategy. Preserving forests on smallholdings while improving farmers' living standards is a huge challenge necessitating a radical change of practices.

Research conducted by CIRAD (UPR B&SEF) and partners in the Brazilian Amazon as part of the *FLoresta e AGRIcultura* (FLOAGRI, European Union [EU]) and *Floresta em Pé* (FEP, International Fund for Agricultural Development [IFAD]) projects between 2005-2010 showed that logging, especially in the framework of a farmerforest business partnership, can play a vital role in the development of sustainable

farming systems because timber sales generate primary income that may be invested in sustainable, environmentally intensive farming systems. However, these models could not be widely used without public policies to support the implementation of enhanced technical interventions and the development of sustainable farm forestry. In close relationship with logging, payments for environmental services and offset markets offer an alternative financial source for the development of sustainable farming systems while also combating poverty. The INVALUABLE and PESMIX[®] projects of the French National Research Agency (ANR) assess the impact of these instruments in family farming systems in Brazil, Costa Rica, Guatemala and Mexico. These payments may be provided in cash, as in Mexico, or be in the form of an agricultural and forestry investment plan, as in Guatemala, Costa Rica and Brazil.

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* INVALUABLE project (2012-2015): Integrating assessments, markets and policies for biodiversity and ecosystem services PESMIX project (2011-2014): Payments for environmental services: new panacea or auxiliary for environmental management?

Economic, organizational and social dynamics

Intergenerational seed management in Kenya

Insight into factors that structure the diversity of genetic resources *in situ* is essential to optimize sampling and conservation strategies. Very little is currently known, for instance, on the anthropological factors involved. The diversity of species and varieties cultivated by Meru farmers on Mount Kenya was studied through a combined social anthropology/population genetics analysis.

Studies^{*} carried out by UMR AGAP researchers, in collaboration with French and Kenyan partners, have shown how the social organization of farmers—with their marriage, residence and seed exchange practices—contributes to shaping the genetic diversity of cultivated plants by promoting their adaptability to environmental conditions. The conventional genetic-environment interaction (G×E) was broken down into a triple interaction (G×E) to specify the social component (S) in order to explain the observed variability.

This model revealed the different environmental and cultural effects on the organization of diversity. Among the social organization levels, neighbourhood groups were found to represent an essential sociological unit with respect to heritage and seed exchange practices and were thus a key factor in agrobiodiversity organization. However, clans and age had less of an impact. The mother- to daughter-in-law seed legacy practices, combined with residency rules, promoted variety adaptation to local conditions, especially in response to climatic variations. The community history and differentiation patterns were thus reflected in the cultivated species and varietal patterns.



▲ Groups of patrilocal residence on the slopes of Mount Kenya.

After their marriage, each woman can have her own field on her husband's farm. She inherits seeds from her mother-in-law. Seeds are thus transmitted from mothersto daughters-in-law over the generations. Varieties are preserved at the same elevation, hence favouring their adaptation.

The study of the social factors structuring genetic resource diversity is therefore an important prerequisite for the collection, conservation and improvement of these resources in a participatory framework, while providing a basis for the recognition of farmers' rights.

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- * in the following projects:
- AfriCrop: Étude de l'histoire évolutive des plantes domestiquées africaines (French National Research Agency, ANR)
- ARCAD: Agropolis Resource Center for Crop Conservation, Adaptation and Diversity Subproject 3. Cereals in Africa: from advanced to under-utilized crops. www.arcad-project.org
- PICREVAT: Predictability of climatic information to reduce the vulnerability of tropical agriculture (ANR)
- ATP CIRAD: Reproduire des plantes, reproduire une société

Role of cooperatives in family farming dynamics in Peru





Under the Empowering Smallholder Farmers In Markets (ESFIM) programme, European research agencies (CIRAD, Wageningen University, Natural Resources Institute) are conducting studies in 11 countries in collaboration with marketoriented farmers' organizations. Family farming changes and innovations should be thought out and managed collectively. Cooperatives have a pivotal role in local dynamics as a means of collective action.

In this setting, UMR Innovation collaborated with the *Tallán-Chusis* cooperative (Costach), which has been developing in northern Peru since 2007, with the aim of reviving the Pima cotton sector through economic solidarity. Despite the fact that the cotton grown in this area is of exceptional quality in terms of the fibre length, strength and fineness, the cropping area decreased from 60 000 ha to only I 500 ha (2010) in 30 years. This was due to the fact that the local textile industry benefitted from the reduction in import taxes and replaced this local cotton by a poorer quality imported cotton, while still flaunting their exported

textiles as being made with local cotton. In collaboration with the cooperative, UMR Innovation demonstrated that local Pima cotton is a very attractive niche product, but the market and production systems have to be reconstructed.

Costach must therefore focus on building regional and international relationships and regaining some of the added value by championing different parts of the cotton sector in order to compete with local industries. Costach was finally recognized by different stakeholders (Ministry of Agriculture, investment banks, municipalities) in 2011, and managed to negotiate purchase prices and arrange for its members to benefit from seasonal loans and preharvest advances. In 2012, the cooperative had 5 600 family farmer members (3-5 ha, cotton with a relay food crop) and was able to increase the Pima cotton cropping area to 12 000 ha. On the strength of this experience, Costach will build its own cotton ginning and spinning mill, supervise variety testing, begin a process to register the denomination of origin and thus help to revitalize the local economy.

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For further information: www.esfim.org/collaborative-research/peru

▲ Millet winnowing at Kabururu, Kenya. This process is designed to separate the grain from impurities. ©VLabeyrie

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Farming and livestock *production systems*

amily farming feeds three billion people in developing countries, not through improvised techniques, but rather on the basis of precise technical systems and sophisticated skills. Ninety-five percent of the world's cocoa cannot be produced without advanced expertise. Nineteen billion animals cannot be raised without a sophisticated herd feeding strategy. Tropical farmers have thus developed efficient technical systems founded on gradually enhanced, tested and proven local know-how. An analysis of these farming systems revealed amazing features: Cameroonian and Thai farmers grow cocoa and rubber trees outside of the usual cropping areas delineated by agronomists; Egyptian family farmers produce 80% of the milk supply for the Cairo metropolis; smallholder family rubber plantations in Thailand account for 95% of the country's total rubber cropping area, etc.

These and other examples highlight how researchers of Agropolis member organizations take local technical knowledge and stakeholders' practices into full account in their research. They show that it is possible to co-build and design tailored and enhanced technical systems in collaboration with farmers so as to boost agricultural production without disturbing rural areas. Ongoing research on farming and livestock production systems also take the now essential agroecological dimension into consideration. The latest results show that agricultural production can be achieved using ecological principles and without a heavy environmental impact. Rather than promoting protected areas, agroecology applied to family farming supports efforts to combine production and protection (land sparing vs. land sharing): on modern family farms imagined by these researchers, environmental resources are protected and people are fed. The research units and examples presented in this section illustrate this challenge:

- Who would have imagined that soil from termite mounds could be used as fertilizer? UMR LSTM has. This soil is applied by women in vegetable crop plots to enhance plant growth and reduce attacks of certain pests.
- In Cameroon, UPR Performance of Tree Crop-Based Systems showed that, despite obtaining lower yields than on commercial palm plantations, oil palm is an essential crop for family smallholders. The crop is managed in association with food crops, so as to ensure a long-term source of income.

- Horticulture is a key to achieving global food security and balance. In Guadeloupe, UPR HortSys developed cover crop techniques to reduce herbicide treatments in citrus plantations.
- Conservation agriculture is a promising technique that combines minimum tillage, cover crops and crop rotations. UPR AIDA is investigating ways to integrate soil-enhancing properties.
- Natural rubber is a high quality renewable resource that can reduce nonrenewable fossil fuel consumption. In Thailand, UMR Eco&Sols revealed that on some soils cover crops provide substantial natural fertilization for tree crops. UPR Performance of Tree Crop-Based Systems showed that family rubber plantations are capable of adapting to global warming while producing high quality rubber.
- Urbanization in Central Africa places heavy pressure on fuelwood resources. UPR B&SEF encourages assisted natural regeneration of trees with the aim of enhancing slash-and-burn agriculture practices and reducing deforestation risks.
- Research carried out by UMR SELMET on the traditional buffalo milk sector in the Cairo region highlighted its crucial role in supplying milk to this urban centre.
- Research conducted by UMR INTREPID revealed that traditional fish farming provides a supplementary source of income for family farmers.
- In Morocco, UMR G-EAU supports discussions between irrigators and institutions to explain different irrigation strategies geared towards saving water.
- Through participatory epidemiology studies, UPR AGIRs and UMR MOISA combine disease monitoring and insight into economic factors influencing disease management by family livestock farmers.

The regional scientific community's in-depth knowledge on farming and livestock production systems of family farming is a mark of the respect these systems deserve and contributes to their protection. Not all of those systems will survive, but at least their awareness will be enhanced.

Emmanuel Torquebiau (UPR AIDA)

Co-designing low-input citrus cropping systems in Guadeloupe

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Agricultural and rural development stakeholders must address the sustainable development issue by designing (or redesigning) and assessing cropping systems to ensure their sustainability. Prototyping can be an effective design method, but by this strategy researchers are often the sole designers. However, successful innovation transfer depends highly on the involvement of other stakeholders in the different design and assessment phases regarding these new systems. Participatory approaches are used to an increasing extent to cope with this transfer issue, and multicriteria assessments provide an opportunity to effectively evaluate the sustainability of cropping systems.

UPR HortSys has formalized the re-Design and assessment of Innovative Sustainable Cropping Systems (DISCS) method whereby cropping systems are redesigned through a participatory approach and multicriteria assessment tools specific to each involved stakeholder category are developed. The DISCS method is in line with the prototyping strategy but is distinguished by an iterative approach applied at three study levels (experimental plot, farm and territory) to ensure that the innovations and assessment criteria fulfil stakeholders' expectations. This method was used to study citrus production in Guadeloupe, where family farming systems are common and characterized by highly diversified cropping systems in small areas (less than 3 ha). This study led to the development of weed management prototypes designed to reduce applications of herbicides, the main source of environmental pollution associated with citrus cropping systems. This method also created real momentum for the development of a sustainable cropping system, particularly through the mobilization of all stakeholders in this sector, but

also through the formalization of their local know-how. This redesign process, which began in 2007, is ongoing and takes new constraints (policies and pests) affecting the citrus sector into account, while prioritizing new redesign objectives that the profession is now supporting.

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▲ A recent orange orchard in Guadeloupe. The steep slopes prevent mechanical weed control, which is why herbicide treatments are systematically carried out.

Horticultural systems and agroecological innovations

Horticulture is now considered an essential component in the global food balance and security. Horticultural systems are also a major source of income and employment for the poorest people living in tropical areas.

Main teams

UMR INTREPID Integrated and Ecological Intensification for Sustainable Fish Farming (CIRAD/IFREMER) 14 scientists

UMR LSTM Laboratory of Tropical and Mediterranean Symbioses (CIRAD/INRA/IRD/Montpellier SupAgro/UM2) 24 scientists

UMR QUALISUD Integrated Approach to Food Quality (CIRAD/Montpellier SupAgro/UM1/UM2) 66 scientists

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Horticultural crops are, however, very susceptible to pests and pest control methods usually rely on pesticides, resulting in risks to human health and the environment. The global challenge is to reconcile horticultural production of high enough quality and quantity to meet the growing global demand, while promoting the economic and social development of farmers in developing countries and limiting risks to human health and ecosystems.

The internal research unit Agroecological Functioning and Performances of Horticultural Cropping Systems (UPR HortSys, CIRAD) aims to develop innovative horticultural cropping systems based on agroecologial functioning.

It conducts research at stations based in Montpellier, French overseas departments (Martinique, Réunion) and different African countries (Benin, Kenya, Madagascar, Senegal). Family farming is the focus of agroecological innovations currently being tested and disseminated in horticultural cropping systems to enhance their agricultural, sanitary, environmental, economic and social performances and to design innovative horticultural cropping systems favouring agroecological functioning and regulations. The research unit's scientific investigations are focused in two strategic areas:

- agroecological functioning of horticultural cropping systems
- assessment and design of horticultural cropping systems that address new economic, ecological and health challenges.

Family farming is approached as a space consisting of different compartments and types of biodiversity system (plant, animal and microbial biodiversity; aboveground and soilborne biodiversity; resource biodiversity; destructive biodiversity), as well as cropping techniques used by farmers.

The unit develops active national and international partnerships (international research institutes and organizations) for developing country oriented research. •••

Ecological intensification of annual crops

The internal research unit Agroecology and Sustainable Intensification of Annual Crops (UPR AIDA, CIRAD) focuses on the functioning and conditions underlying the ecological intensification of annual cropping systems on family farms in the tropics. The aim is to analyse and design annual crop based cropping systems that make effective use of resources and ecological processes by assessing, from different spatiotemporal dimensions, their agricultural, technological, environmental, economic and social performances. AIDA aims to ensure the food security of local populations in developing countries by focusing research mainly on the production of staple annual crops, such as upland rice (Madagascar, Southeast Asia), maize (Africa, Latin America, Asia), sorghum and millet (drylands in Sub-Saharan Africa) and cassava, which is often cropped in rotations

with these main crops. The research is also devoted to annual crops, such as cotton (Sub-Saharan Africa) and sugarcane (Indian Ocean and the French West Indies), that are planted to consolidate the income of these people.

UPR AIDA contributes to the intensification and stabilization of production in these different types of tropical family farming agrosystem. It intends to develop an agroecological approach for the intensification of annual crops via two complementary technical pathways: (i) improving the eco-efficiency of resources and inputs used in the production process, and (ii) better management of ecological processes that regulate agroecosystem functioning so as to enhance the growth and production of crop species and ensure ecosystem services (fertility, natural pest control, etc.). UPR AIDA thus focuses on innovative and complex cropping systems that mobilize a more diverse range of biological agents (service plants, mulch, predators,

competitors, etc.) that interact with each other and with crop plants.

The unit strives to conduct effective research along three interacting thematic lines concerning these complex systems: understanding/ design/assessment. It thus develops collaborations with other research units that are more specialized in biology and ecology for the first line, social science of innovation for the second, and economy and political science for the third. It is active mainly on the crop field scale—its status and management. However, in compliance with the agroecology concept, it also takes other scales into account depending on the processes studied, the specific impacts and the involvement of different stakeholders. The farm scale is especially important for analysing the relevance and technical/economic performance of these innovative cropping systems. •••

The ABACO project—Agroecology-based aggradationconservation agriculture





▲ An exchange between farmers on a test plot where Bambara beans were grown in infertile soil using CA practices under the ABACO project, Alaotra Lake region, Madagascar.

Family farming in semiarid Africa is in an increasingly vulnerable position due to the direct and indirect effects of climate change, demographic pressure and resource degradation. Conservation agriculture (CA) is promoted as an alternative to restore soil productivity through increased water and nutrient use efficiency in these regions. However, CA adoption is low for a number of technical reasons, but especially due to the fact that CA has often been promoted as a technical package without enough flexibility for adaptation to the diverse range of tropical family farming conditions. Farmers' involvement in designing and implementing locally tailored CA practices, as part of a long-term soil rehabilitation strategy, is the core approach implemented by the ABACO initiative.

This project brings together scientists and practitioners from western, eastern and southern Africa, coordinated through the African Conservation Tillage Network. It relies on agroecologically intensive soil rehabilitation measures and increased water productivity in semiarid regions—options which are implemented, tested and disseminated through local co-innovation platforms. ABACO proposes to assess approaches tailored to the needs at different sites, rather than applying strict definitions of CA

approaches that might not be suitably applicable at all sites. Simulation models are used as a support for multiscale analyses (field, farm and territory) in order to efficiently inform local stakeholders and policymakers on the trade-offs necessary between the different components (agronomic, environmental, economic and social) regarding the sustainability of rainfed crop production.

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Improving the performance of cocoa, rubber and oil palm smallholdings

The internal research unit Performance of Tree Crop-Based Systems (CIRAD) focuses part of its research on smallholders in the cocoa production sector-who produce 95% of global volumes-and rubber and oil palm sectors, where smallholdings respectively account for 76% and 41% of the area under these crops worldwide. The term 'smallholders' encompasses a highly diversified range of agricultural production units: managerial companies, farming enterprises and family farms, which are the most numerous.

Main teams

UMR SELMET Mediterranean and Tropical Livestock Systems (CIRAD/INRA/Montpellier SupAgro) 34 scientists

UPR AIDA Agroecology and Sustainable Intensification of Annual Crops (CIRAD) 56 scientists

UPR HortSys Agro-ecological Functioning and Performances of Horticultural Cropping Systems (CIRAD) 28 scientists

> UPR Performance of Tree Crop-Based Systems (CIRAD) 20 scientists



For these three sectors, family farm fields have two common related characteristics: very marked yield differences between fields under the same soil-climate conditions, and a highly diverse range of practices. Like all family farms, those in these sectors adapt very quickly to changes by taking advantage of the technical possibilities—they seek technical advice and innovations that take their rationales into consideration. These two unique features of family fields and farms prompted the unit to conduct research on three different scales: (i) long-term technical management of fields planted with tree crops, (ii) the functioning of the farm and farmer as a strategic decisionmaking unit, and (iii) the socioeconomic environment of the farm.

Concerning oil palm, the unit is active in Indonesia, Ecuador and Cameroon. The three scales are integrated, while focusing on the performance of palm stands on family farms, on the impacts on technical aspects of the practices, development initiatives, farmers' strategies in setting up their palm stands, small-scale processing, relationships between smallholders and agroindustries in oil mill supply areas, and forms of land access. The sustainability of smallholder stands is assessed.

For rubber, the plot approach used is aimed especially at characterizing smallholders' practices in Thailand so as to be able to subsequently identify the socioeconomic dynamics that determine these practices and farm changes. The trajectories of family rubber farms are characterized by the roles of land and labour as key determinants of recent farm changes. Concerning the sector patterns, the analyses are focused on public policies and markets.

Research on cocoa farms in Cameroon is focused on the plot and reducing yield gaps, the economic functioning of farms using a simulation tool, and the synergy between food crops and agroforestry systems (AFS). Farmers' AFS are assessed, while innovative AFS are also co-constructed. •••

Different crop histories of village palm plantations in Cameroon

The Edéa region in southern Cameroon is the main oil palm growing area in the country. Commercial palm plantations achieve satisfactory yields under the soil-climate conditions of the region (14-16 t/ha of bunches), whereas very contrasting yields are obtained in smallholdings (2-14 t/ha of bunches). These lower smallholding yields could be explained by the fact that farmers plant unselected planting material. The previous food crop and forest were found to be respectively associated with low and high yields in the smallholders' plantations. This raises the question of the rationale underlying smallholders' choices of land on which to expand their oil palm area.

To address this issue, on the basis of survey findings, UPR Performance of Tree Crop-Based Systems reconstructed farm trajectories, their form of land access and practices in different fields on different types of smallholdings in the region: family farms, farming enterprises and managerial businesses. Family farms were found to follow a typical trajectory for several decades:

- creation of a family farm producing food crops for both selfconsumption and marketing
- development of a palm plantation through food crop sales, sometimes supported by a project
- once the farmer is able to live off income generated by the palm plantation, the food cropping area is reduced to a size sufficient to meet the farmer's self-consumption needs and palms are planted in the former food crop fields



▲ How a family farm develops to become a farming enterprise with a permanent employee.

Palm plantations require two types of expansion: external, taking over off-farm forest land; and internal, taking over on-farm food crop-fallow rotations, thus explaining differences in previous cover.

a permanent employee is hired when the palm plantation is large enough: a 10 ha oil palm area is sufficient for a farmer to 'retire'...

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Family rubber farms in Thailand—diversity, ability to innovate and adapt to global changes



With a third of global production, Thailand is the largest natural rubber producing and exporting country, with smallholdings accounting for 95% of the total planted area. On these farms, rubber is often the main source of income in a diversified farming system. These rubber based family farms are highly diversified, ranging from smallholdings of less than one hectare, exclusively involving family labour, to large-scale farming enterprises of up to a hundred hectares employing several paid workers, but where family members are also involved in the farming activities.

Global and local changes have an impact on rubber-producing countries: demographic changes (increasing and aging populations, migration of workers between regions and sectors), scarcity of arable land, environmental pressure (forest, biodiversity and water conservation) and climate change. Meanwhile, the growing global demand for rubber is an incentive to produce more natural rubber, thus increasing the challenges facing rubber growers.

To address these challenges, in 2008, CIRAD (along with three Thai partners: Kasetsart University, Prince of Songkla University, Department of Agriculture) created a multidisciplinary research platform—the Hevea Research Platform in Partnership. This platform aims to enhance rubber plantation productivity, characterize the environmental impacts of these plantations and identify key factors that determine natural rubber quality. These activities are mainly geared towards:

• characterizing forms of family farms involved in rubber growing

 describing plantation practices to assess their impacts on production, the environment and natural rubber quality

gaining insight into the biophysical and socioeconomic drivers of practices so as to address growers' technical innovation needs

Family farming

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analysing the adaptation strategies of rubber growers to global change.

For further information: http://hrpp.ku.ac.th

Microorganism-plant symbiosis to improve agricultural and forestry production

The joint research unit Laboratory of Tropical and Mediterranean Symbioses (UMR LSTM, CIRAD/ INRA/IRD/Montpellier SupAgro/ UM2) is a microbiology and plant biology research unit specialized in biodiversity and symbiotic microorganism functioning mechanisms as well as in plant

Other teams focused on this topic

UMR Eco&Sols Functional Ecology & Bio-geochemistry of Soils and Agro-ecosystems (Montpellier SupAgro/INRA/CIRAD/IRD) 68 scientists

UMR G-EAU Water Resource Management, Actors and Uses (AgroParisTech/CIHEAM-IAMM/CIRAD/IRD/ IRSTEA/Montpellier SupAgro) 70 scientists

UMR MOISA

Markets, Organisations, Institutions and Stakeholders Strategies (CIRAD/INRA/Montpellier SupAgro/ CIHEAM-IAMM) Some 60 scientists

...continued on p. 28

🔺 Arbuscular mycorrhizal fungi. Rhizobium nodules.

> responses and adaptation to these microorganisms and to extreme environmental conditions. LSTM's research focuses on rhizobium/ legume and plant/mycorrhizal symbioses. The studies and scope of application are oriented towards Mediterranean and tropical environments where microorganism/plant symbioses could sustainably enhance agricultural and forestry production and restore threatened environments, especially in developing countries.

> In recent years, this unit has developed a series of activities aimed at promoting the transfer of research findings to regional and national socioeconomic spheres, while also targeting family farming by promoting innovative cropping techniques based on local know-how that could be readily adopted by farmers in developing countries. The main goal of development activities conducted at different sites where LSTM is involved in research collaborations (Senegal, Burkina Faso, Madagascar, Morocco) is to make effective use of some overlooked natural resources (termite mound soil, mycorrhizal fungi, edible mushrooms, crop residue, etc.).

The main biological models that have been developed in the research and development (R&D) programme, and the subject of patent applications or innovative company incubation projects concern:

- The role of termite soil as: (i) biofertilizer (stimulating plant growth), (ii) biocatalyst to optimize the controlled mycorrhization process, and (iii) biopesticide against some tropical food or vegetable crop pests such as Striga, parasitic nematodes, etc.
- ² The development of a crop management sequence based on the use of mycorrhizal fungi adapted to polluted soil, described and validated in the field during operations to revegetate mining sites in Morocco.
- The creation of edible mushroom production units in the framework of innovative company incubation projects*.
- The creation of microbial inoculum production units (mycorrhizal fungi, Azospirillum spp.)**. •••

Family farming



^{*} MADAMYCEL Company (in the incubation stage at BOND'INNOV, Bondy, France), MAROMYCEL Company (in the incubation stage at INMA, Marrakech, Morocco) and SENEMYCEL Company (in the incubation stage at INNODEV, Dakar, Senegal). ** INOCULUM+Maroc Company (in the incubation

stage at INMA, Marrakech, Morocco) and STRIGALUT Company.

Use of termite mound soil as a biofertilizer for vegetable crops

Because of the socioeconomic environment in which family farming is practiced and the need to optimize the performance of cropping areas, innovative and inexpensive strategies that can be implemented without high technical expertise are required. Biogenic structures of termite mounds represent a natural resource that could be utilized to enhance the chemical and biological fertility of soils. They contain high amounts of plant nutrients and various microorganisms.

In this setting, an R&D programme was implemented in Komandjari province (Burkina Faso), involving a local womens' association, with the aim of using termite (*Cubitermes* genus) mound soil to improve tomato crop yields. Tomato plants initially grown in mini compost blocks $(4 \times 4 \times 4 \text{ cm})$ amended with termite mound soil (1:10, v:v) were monitored *in situ* after 4 months of cropping. This supplement was found to boost tomato plant development and production while reducing root infestation by parasitic nematodes of the *Meloidogyne* genus (root-knot nematodes), which is the main factor limiting vegetable crop productivity in these regions. This agroecological process was successfully tested with other crops (beans, aubergine, etc.) in other countries (Senegal, Madagascar, etc.).

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▼ Comparison of the growth of tomato plants managed in a traditional way (A), and treated with mini compost blocks amended with Cubitermes termite mound soil (B).





Smallholders supply buffalo milk to the periurban area of Cairo

Two sectors supply milk to the periurban area of Cairo (20 million inhabitants). Around 20% is from industrial sources (imported powdered milk) and large-scale farms with herds of 100 to over 1 000 cattle. The remaining 80% is from the informal milk sector, which the industrial sector refers to as 'loose milk'. The unique aspect of this informal sector is that it mainly supplies buffalo milk. CIRAD (UMR SELMET) and its Egyptian partners are currently conducting research on this informal sector in the DAIRY project* (2012-2014).

CHEVR AVEN SY Family farms in this informal sector are

mainly located around Cairo or in the Nile © C. Corniaux Delta and Valley. In addition to these so-called traditional farms upon which the number of dairy animals managed depends on the size of land—on average 0.25-0.5 acres/animal-there are landless family farms which are heavily market-dependent. These mainly urban units are highly vulnerable because of the unstable sociopolitical situation and high urban growth. They bear the brunt of the increasing prices

of imported concentrates due to the devaluation of the Egyptian pound and the strong speculative pressure on urban land. Over the last 2-3 years, many farmers have left for peripheral areas or newly developed areas in the desert, or they have simply abandoned farming.

> Urban sprawl is one of the key drivers of change in the functioning of livestock production systems around Cairo and the Nile Delta. Since the Revolution, over 20 000 ha/year of farmland north of Cairo is taken over for urban development. The weakness of public authorities in managing land regulations has boosted speculation, thus inducing irreversible changes in these remaining rural patches in urban areas. Moreover, constraints on

periurban family farms are increasing in terms of managing livestock in urban areas (vertical installations, pollution, logistics for inputs and products).

▲ Milk collection and livestock feed distribution in the periurban area of Cairo.

For productive environment-friendly livestock farming in hot regions

The joint research unit Mediterranean and Tropical Livestock Systems (UMR SELMET, CIRAD/INRA/Montpellier SupAgro) focuses on livestock agoecosystems in favourable or harsh hot region environments. Due to the extreme constraints, these systems question the suitability of ecological intensification forms and methods.

Other teams focused on this topic

UPR AGIRs Animal and Integrated Risk Management (CIRAD) 27 scientists

> **UPR B&SEF Goods and Services of Tropical Forest Ecosystems** (CIRAD) 45 scientists

UPR GREEN Management of Renewable **Resources and Environment** (CIRAD) 20 scientists

Livestock production is a major component of the agricultural sector and the economy of many countries. In all categories, there are 19 billion livestock animals in the world, 70% of which are reared by farmers in countries that are not members of the Organisation for Economic Co-operation and Development.

Livestock farming mobilizes around 4 billion ha of grassland, 3.4 billon of which are generally devoted to pastoralism and family farming. It produces a third of all proteins consumed by humans and represents 40% of the gross value of world agricultural production. In developing countries, livestock contributes to the subsistence of 800 million poor people, with 1.3 billion people working in this sector worldwide. Livestock activities are, however, severely affected by global changes. Climate change and trade globalization have an impact on human and animal migration, while increasing pressure on resources. Livestock farming is also highly in question regarding the alleged or actual negative impacts on the environment and human health: water pollution, greenhouse

gas emission, biodiversity and health crises. The challenges for livestock farming systems to address are thus to reduce their negative impacts while demonstrating their ability to produce services (traction, manure, animal products such as meat, milk, eggs, leather, wool, etc.) and income for millions of farmers and their families who depend on them.

UMR SELMET aims to support these changes in order to promote more productive and environmentfriendly farming systems. The unit carries out research in three key areas: livestock farming dynamics, animal-environment interactions, and alternative management strategies to adopt to cope with potential changes. This research is conducted with partner teams in Sub-Saharan Africa, the Mediterranean Basin, Indian Ocean, Southeast Asia and Latin America. Most of the projects involve partnerships with French and European research institutes and universities, and with other international research centres. •••

Intensification of fish farming systems in tropical countries

The joint research unit Integrated and Ecological Intensification for Sustainable Fish Farming (UMR INTREPID, CIRAD/IFREMER) is organized around three key lines of research: innovation, domestication and environment. The 'Innovation processes and systems in aquaculture' line involves development-oriented research and is focused especially on family farming. It is supported by three researchers specialized in agronomy and breeding in aquaculture systems. This research deals with the intensification of aquaculture systems in a sustainable development setting, while incorporating expertise already existing in the unit and that of external partners through a variety of disciplines related to biology, economics and socioanthropology.

Without overlooking other types of fish farming, through the CIRAD research team, UMR INTREPID has for some 15 years been focusing on key factors governing technical and organizational fish-farming innovation in rural agricultural systems in tropical countries, mainly Thailand, the Philippines, Brazil and Cameroon. The concepts applied are derived from an approach involving systemic agronomy, the sociology of translation (actornetwork theory) on a territorial scale and complex system analysis, while using participatory farm survey tools. Scientists' research proposals are validated on the basis of the innovation co-construction model whereby experimental systems are set up within an ethical framework negotiated with development partners.

This participatory action research approach is combined with other research models depending on the issue being investigated (laboratory research or field research where the researcher must make decisions alone).

Research carried out on fish-farming intensification, and more generally on its contribution to family farm intensification, could be ranked in three broad categories: optimizing breeding system functioning; monitoring change dynamics on farm and territory scales; and the role of publicprivate partnerships.

Research on the 'Innovation' line is conducted in partnership with research units in France and other areas worldwide (Africa, Latin America and Asia). •••

Ré-SyPiEx project—a research and development network on extensive family fish farming systems in West and Central Africa



Traditional extensive fish farming contributes to the sustainable development of family farms and the fight against poverty in Benin, Côte d'Ivoire, Cameroon and several other African countries. However, due to its sometimes 'confidential' nature, the socioeconomic impact of these production systems in rural areas currently seems to be overlooked in national development programmes, which are predominantly focused on small and medium enterprise (SME) and industrial fish-farming initiatives. An argued rebalance of this situation would now be warranted, but without questioning the support for these latter types of aquaculture. It would be especially important to show public policymakers that commercial aspects are at the core of traditional or extensive fish farming systems, in addition to other sustainable development aspects.

UMR INTREPID, in collaboration with many African and French partners, has been involved since 2013 in the Ré-SyPiEx project, which perpetuates partnerships initiated since 2011 through the 'Ecological intensification of extensive

family fish farming in West and Central Africa through an analysis of innovation processes – Extensive fish-farming systems' (SyPiEx) project (supported by the West and Central African Council for Agricultural Research and Development). Both of these projects have a dual objective: (i) contribute to the intensification (ecological) of traditional (catfish production in flood ponds or *wedhos*^{*} in Benin) or extensive (polyculture based on tilapia in dam ponds) fish-farming systems integrated in family farms in West and Central Africa, and (ii) strengthen international partnerships between research organizations and universities, and between these organizations and the private sector.

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For further information: www.sarnissa.org / www.apdra.org

*Trenches with an area of up to 5 000 m² or more, which are hand dug in the OUEME River Delta floodplain in Benin. They are used to trap fish when the waters recede.

Small-scale food processing in developing countries

The joint research unit *Integrated* Approach to Food Quality (UMR QUALISUD, CIRAD/Montpellier SupAgro/UM1/UM2) conducts research in the agrifood sectorfrom postharvest or postslaughter food quality development to the assessment of the food's sensory (taste) and nutritional qualities, health benefits and safety. The unit has thus adopted a multidisciplinary approach while also taking the heavy constraints that prevail in developing countries into account-energy costs, water access, manufacturability and equipment maintenance, raw material specificity and variabilityin order to:

 control dynamic food qualitybuilding mechanisms, which requires full knowledge of the food matrix and its interaction with the environment
 eco-design of robust inexpensive processes in compliance with the raw material and end product qualities. UMR QUALISUD is structured in three teams working in three research areas: food quality determinants, controlling food chain contaminants, and processing procedures.

Foods are often manufactured on a small scale in developing countries. QUALISUD thus aims to meet the needs of food processing stakeholders on family, small-scale and small company levels. The unit's main issues on these topics are: how to bring added value to family production units while reducing losses and controlling quality?

Many examples illustrate the research carried out by QUALISUD regarding family food processing:

 supporting small producers in cocoa and coffee sectors in Africa and South America to help them enhance their production so that they will obtain better prices

 improving postharvest technologies for tropical cereals (fonio, millet, sorghum, rice, etc.), roots and tubers (cassava, yam, etc.) promoting small-scale fruit processing technologies to enable families to consolidate their smallscale activities

• improving and developing traditional African products and associated know-how.

UMR QUALISUD is present in developing countries with agents posted in overseas partner institutions (Réunion, French Guiana, Guadeloupe), South America (Costa Rica, Colombia, Mexico) and Asia (Thailand, Vietnam). It has long-standing collaborations in Africa via partnerships with universities and national research centres.

African food tradition revisited by research



The aim of the African Food Tradition Revisited by Research (AFTER) project is to improve traditional African food products and their associated know-how while sharing European and African knowledge and techniques in order to benefit consumers and producers on both continents.

This European Union funded project (FP7/2010-2014) is coordinated by UMR QUALISUD. It involves partners from seven African countries—Benin, Cameroon, Ghana, Egypt, Madagascar, Senegal and South Africa—and four European countries—France, Italy, Portugal and the UK.

By studying traditional food products, the AFTER project intervenes at the interface between know-how (often of families) and food production by small food production companies that aim to market their products on African and European markets.

The project first acquired scientific knowledge on know-how, technologies

and processes regarding the studied products. Based on these data, the team was able to suggest improvements to traditional processes through reengineering^{*} of unit operations with the aim of improving food security and the nutritional quality of traditional products while preserving or controlling their organoleptic characteristics.

Consumer studies were also conducted in Africa and Europe to determine objective criteria regarding the acceptance of traditional products and to ensure that some products could be marketed in the European Union.

Throughout the project, regulatory and ethical aspects and the protection of intellectual property rights of African people were taken into account. The results were presented so as to be ready-to-use by small-scale African food processing stakeholders: families, craftsmen and small food companies.

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For further information: www.after-fp7.eu

* Food process reengineering: redesigning processes to substantially improve the quality of the food product.



▲ A small flock of geese tended by a young boy. Alaotra Lake, Madagascar.

► A Khmer farmer and her buffalo in Svay Rieng province, Cambodia.

Monitoring endemic and epidemic diseases—Newcastle disease (Madagascar) and foot-and-mouth disease (Southeast Asia)

CIRAD (UPR AGIRs and UMR MOISA) and partners are conducting two epidemiological research projects on Newcastle disease and foot-and-mouth disease to gain insight into the risks of disease outbreaks and improve strategies for controlling these diseases.

Newcastle disease is a heavy economic constraint for small family poultry farms in Madagascar. Surveillance and early detection of epizootic diseases is a major challenge to meet in order to reduce morbidity and mortality of poultry due to the disease and thus improve livestock farmers livelihoods. Vaccinations, which are performed only occasionally due to problems of cost and accessibility, do not significantly reduce the disease impact on the household economy. Formal and informal marketing channels are the main mode of Newcastle disease spread between villages, and markets are key sites for disease control and surveillance. Under the GRIPAVI project*, a study (Alaotra Lake region) was carried out that combined an analysis of marketing channels and outbreaks of the disease in order to identify central markets through which most poultry passes on the way to secondary markets. Targeted surveillance of these markets would enable early detection of mortality and/or morbidity due to the disease. Market closure and/or disinfection would quickly stall the spread of the disease along trade routes. A study of the sensitivity of this type of surveillance is under way.



Under the REVASIA programme**, a participatory approach was developed to describe the epidemiological situation regarding foot-and-mouth disease in different Cambodian villages (Svay Rieng Province). In 2010, 138 outbreaks were reported in 19 provinces, with more than 59 000 animals affected. These figures are certainly underestimated since impacts of the disease are spread over time and are not perceived directly by farmers. Regarding these constraints, it is difficult to determine the real situation of the disease and its patterns, thus also limiting the development of control strategies. Participatory epidemiology could overcome these shortcomings. This approach is based on the triangulation principle whereby several data recovery sources are mapped—local knowledge, scientific observations, secondary sources-and allowing quality control of the results. Serological assays performed in parallel to the surveys help to validate farmers' responses and to estimate the sensitivity of the participatory method. This approach was found to be useful for understanding economic factors affecting disease management by farmers. Its widespread use would get farmers more involved by boosting their awareness on the real impact of the disease, while helping managers develop control methods tailored to the disease patterns.

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* Ecology and epidemiology of avian influenza in developing countries: http://gripavi.cirad.fr ** Research for Evaluation of Avian Influenza Surveillance in South East Asia: www.grease-network.org/main-projects/on-going/revasia

Ecological intensification of rubber plantations in marginal areas

Many smallholders in Southeast Asia are currently developing rubber plantations (*Hevea brasiliensis* Muell. Arg.) in regions that are relatively unsuitable for growing this tree due to the soil-climate conditions. This leads to substantial delays before the trees become productive and increased soil erosion risks. The introduction of perennial cover crops between three rows could be an option to minimize these hazards. In northeastern Thailand, two cover crops were studied by UMR



▲ Hevea/Pueraria and Hevea/Vetiveria associations.

Eco&Sols: Hevea/Pueraria phaseolides, a legume, and Hevea/Vetiveria zizanoides, a grass. Cover crops were planted in the inter-rows in a young rubber plantation (3 years old). They were cut every 3 months and the biomass was spread on the soil surface as mulch.

After 4 years, 74% of the nitrogen incorporated in rubber leaves was derived from biological fixation by the legume crop. In deep soil, *Pueraria* also enhanced the water status of the trees via its effect on their root distribution. The growth rate of rubber trees associated with *Pueraria* was twofold higher than that of trees grown without a cover crop in the inter-rows. The introduction of *Vetiveria* did not have significant effects on rubber trees in deep soil. However, in shallow soil, the two cover crops had negative impacts on rubber tree survival in the dry season due to competition for water resources.

These results show that, in shallow soil, farmers have very little leeway for reducing the time before rubber trees begin producing. However, in deeper soils in these regions, the introduction of *Pueraria* helps preserve the soils and improve young rubber tree growth. Direct seeding of food crops under *Pueraria* cover could be considered in order to make better use of the high quantities of nitrogen released by the legume crop in the inter-rows in rubber plantations, thus enabling smallholders to earn additional income.

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Drip irrigation systems of family farmers in Morocco

As water becomes increasingly scarce, Morocco has an international reputation regarding localized irrigation, with farmers and private companies at the forefront of technology. This is supported by an ambitious policy to reduce pressure on water resources by favouring the conversion of surface irrigation into localized systems (especially drip irrigation). According to the national irrigation water-saving plan, 550 000 ha will be converted by 2020 through a highly subsidized investment scheme. In the field, however, another major but less publicized phenomenon is under way—the dissemination of alternative inexpensive drip irrigation systems that are well adapted to Moroccan family farming conditions thanks to the involvement of many often informal intermediaries. This gives family farmers access to technology whereby plants are watered directly at the foot, so it is in line with these farmers' physical, economic and social situations.

In collaboration with its partners (IAV* Hassan II, ENA** Meknès, University of Wageningen), UMR G-EAU studied localized irrigation system innovation processes and their impacts on water resources. Farmers have developed a broad range of different drip irrigation systems to meet their specific agroeconomic (improve their agricultural production, reduce labour requirements, etc.) and socioprofessional (enhance their social status, gain knowledge to integrate new drip irrigation services) needs. It is only the State that explicitly associates this phenomenon with the water-saving dimension.

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The study findings revealed that the introduction of drip irrigation on a farm does not always mean that water is saved on the field (irrigation practices not water-efficient) or farm (production intensification) scale, and it may even increase pressure on water resources, particularly groundwater. It is essential to gain greater insight into farmers' reasons for using drip irrigation so that water savings will be an important issue in discussions between the State and irrigators. Farmers' rationales underlie their choice of irrigation practices and thus the performance of their drip irrigation systems.

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▲ 15 year old Faidherbia albida trees growing in a cotton field in northern Cameroon.

Agroforestry techniques to ensure sustainable fuelwood supplies to urban centres in Central Africa

Domestic fuel and food needs are growing in urban centres in Central Africa, which puts substantial pressure on wood resources. In this setting, the Makala ('embers' in Lingala) project aims to ensure a sustainable supply of fuelwood to these centres while limiting the environmental impact. It also intends to ensure sustainable incomes for smallholders in the Democratic Republic of the Congo (Kinshasa and Kisangani) and the Republic of the Congo (Brazzaville).

Agroforestry techniques have been developed and disseminated by CIRAD (UPR B&SEF) and partners in this project. Assisted natural regeneration (ANR) was used to improve slash-andburn cropping systems implemented by family farmers while contributing to the management of their forest fallows.

Prior to clearing, useful trees were selected by farmers to protect them. Then, during the cropping period, germinated and multiplied stump shoots and suckers of preexisting local forest species were favoured by selective weeding, thinning and pruning practices.



The follow-up to these tests revealed that old trees which had been protected when the crop fields were cleared had a low survival rate due to the difficulties in controlling the burning operations. This limits the applicability of the technique to field edges, through progressive hedgerow enrichment. However, within the fields, stump shoots and suckers of natural forest species that had been protected by ANR during weeding were found to have grown rapidly, indicating that woody fallows could be quickly grown at low cost. Two and a half years after burning, these fallows had greater biodiversity and biomass levels than fallows that had not been managed with ANR. Higher charcoal and agricultural product yields, as well as a reduction in the transition of forest areas into savanna, could be expected. This should help family farmers increase and diversify their incomes (agricultural products, charcoal, honey, etc.), while enabling them to settle their farms, without having to constantly move to new forest lands to practice slash-and-burn agriculture. However, social acceptance, which is a key factor regarding the large-scale dissemination of such innovations, remains to be studied with respect to traditional and modern land rights.

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For further information: http://makala.cirad.fr/le_projet

▲ Cassava leaves are generally carried by women, near Kisangani, Democratic Republic of the Congo.

▲ A lowland where the cropping pattern combines vegetable crops (squash) and grazings after rice and maize crops, northern India. © R. Kahane

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Wild and cultivated biodiversity and natural resource management

amily farming is highly diversified from many standpoints. These farms feature myriad techniques, a broad range of knowledge and know-how and also an intricate combination of species and varieties arranged in a deliberate spatiotemporal pattern depending on the soil, uses and cycles.

Pooling wild and cultivated biodiversity as well as natural resource management in the same chapter underscores the fact that in many family farming systems these constituents are not perceived separately, but rather as a whole in which social, economic, political and cultural factors interact with biological, agricultural and ecological factors. Whereas higher education and research institutions tend to reproduce, respect and comply with expertise specialization, better management of multidisciplinary approaches is the challenge that should be addressed by studies and management of wild and cultivated diversity in the family farming setting.

This chapter highlights several examples of the ingenuity of family farming regarding wild and cultivated biodiversity management. For instance, in Madagascar, plant diversity stems directly from the cropping practices and crop management sequences used. This diversity in turn promotes the diversity of birds from protected forests that take advantage of the agricultural landscape shaped by farmers to nest, feed and breed. Some so-called service plant species are also grown for the purpose of integrated pest management. In central Cameroon, around 100 plant species that have a wide variety of uses-producing fruit, oil, drinks, bark (used for medicinal purposes), timber and fuelwood-have been inventoried in cocoa farms. This multifunctional mosaic also helps preserve soil fertility by providing shade which enhances cocoa tree growth. The many interactions that characterize family farm functioning are promoted and 'plant-microorganism' combinations are proposed to ensure more efficient nitrogen and phosphorus sequestration in Tunisia, Morocco, France and Burkina Faso.

International issues concerning family farming are also showcased via studies on biodiversity and its management. Among some 7 000 known crop species, only a few ensure global food security from a quantitative perspective. Other species that are overlooked on an international scale represent a reservoir of genetic and functional diversity which remains unexploited, despite the demonstrated high potential of these crops. The adaptation capacity of traditional millet varieties to climatic variations is, for instance, being investigated in Niger, while decentralized management systems are tested in Oceania, Africa, South America and Asia. Locally cultivated clones and varieties are distributed in a diverse range of ecological and cultural environments. Each benefits from the adaptation potential of plants originally bred in other areas. Studies on the impact of introducing new varieties have led to the development of a participatory breeding process involving farmers in Mali and other countries to promote the appropriation of resources that best meet farmers' needs.

At a more global level, water resource access and sharing generally represent another crucial international and development issue as it increases the interdependence of local, regional and international stakeholders.

Research is also focused on the inventory, collection and organization of genetic diversity of plants that have been propagated by generations of family farmers until today. As their diversity results from both natural and human-oriented processes, cultivated plants must be considered inherently hybrid entities to be studied by multidisciplinary approaches, as clearly illustrated in this chapter.

Challenges in the study and management of wild and cultivated diversity could not be addressed without the involvement of around 10 Agropolis institutions, bringing together nine laboratories and nearly 550 scientists specialized on over 20 Mediterranean and tropical species and involved in research on five continents.

> Christian Leclerc (UMR AGAP) & Anne-Céline Thuillet (UMR DIADE)

How can the resilience of family farms that crop roots and tubers be facilitated?



Root and tuber crops (cassava, sweet potato, yam, taro) often have a very narrow genetic base in given countries, but the allelic diversity varies significantly between regions. Adaptation to global change could thus be enhanced by longrange distribution of this diversity. However, root and tuber crops do not benefit from seed sectors—smallholders have to manage their own plant material and few of them have access to improved varieties disseminated by research centres. A decentralized system was thus developed whereby farmers are supplied with varietal clones or hybrids with high allelic diversity. The principle is simple—avoid a concentration of resources required for genetic improvement and distribute genes for better preservation, and especially use. The system is complex to implement because sets of varieties with high allelic diversity first have to be assembled and then large-scale screening is required using powerful tools.

In practice, selection of a representative sample (10% of varieties) of useful species diversity avoids duplication and maximizes the possibility of generating high variability. Introduced genotypes are then propagated and distributed directly to farmers, who in turn are responsible for the final selection and redistibution to neighbours. This approach was tested with taro (*Colocasia esculenta*) in Vanuatu, where farmers are widely dispersed and isolated on 80 islands. The material was distributed to many farmers with minimal monitoring and assistance. Field inventories revealed that the introduced varieties were preserved, that the best ones were propagated and distributed via exchange networks and that local varieties were not threatened. If the genotypes

disappear—which is a common phenomenon in these regions—it is essential that the most relevant genes are consciously or unconsciously transmitted via networks. This FFEM-funded approach has now been tested in 19 countries in South America, Asia and Oceania (financed through the EU Food Security Thematic Programme).

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Characterization and development of cultivated biodiversity

The aim of the joint research unit Genetic Improvement and Adaptation of Mediterranean and Tropical Plants (UMR AGAP, CIRAD/ INRA/Montpellier SupAgro) is to contribute to boosting knowledge

Main teams

UMRAGAP

Genetic Improvement and Adaptation of Mediterranean and Tropical Plants (CIRAD/INRA/Montpellier SupAgro) 176 scientists

UMR DIADE

Crop Diversity, Adaptation and Development (IRD/UM2/CIRAD) 50 scientists

UMR Eco&Sols Functional Ecology & Bio-geochemistry of Soils & Agro-ecosystems (Montpellier SupAgro/INRA/CIRAD/IRD) 68 scientists

...continued on p. 38

and breeding varieties adapted to a range of environments and uses, while also participating in training and education in the areas mentioned.

The unit focuses on developing family farming through field initiatives involving the management, characterization and development of cultivated biodiversity. The diverse range of projects under way illustrates the diversity of multidisciplinary and complementary approaches in over 20 countries in South America, Africa, Asia and Oceania.

With its 13 research teams and five technology platforms, UMR AGAP implements quantitative genetics, ecophysiology, developmental biology and biomathematical approaches aimed at gaining insight into the genetic and functional bases of agronomic traits in around 20 Mediterranean and tropical crop species. The team's main activities concern genetic resource analysis and development through studies on diversity structuring and plant adaptation to abiotic and biotic constraints using the latest genomics and functional analysis tools.

This research sheds light on the practices and roles of farming societies in the structuring and management (including conservation) of the genetic resources of major or underutilized food crops. For instance, participatory selection is applied to breed varieties tailored to users' needs and applications, seed systems are improved to adapt them to different settings, and combined analyses of genetic resources and traditional knowledge are conducted.

The unit is based in Montpellier (France) and French overseas departments and regions. Its research is carried out in collaboration with public and private partners in France and abroad—Africa, Latin America, Asia, Europe and Oceania—thus forming a broad global network. •••

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Fonio—a keystone for food security in West Africa

Over 7 000 plants are cropped worldwide but from a quantitative standpoint food security is based on just a few major species. Wheat, maize and rice account for over 50% of the world's food energy intake of plant origin. Underutilized species still represent an unexplored reservoir of diversity and potential despite incentives to foster



sustainable agriculture and consumption via crop diversification. Could these species be tomorrow's crops?

Fonio is promising in this respect. This small-grain cereal is cultivated and consumed in sub-Sahelian regions of West Africa, from Senegal to Lake Chad. Two fonio species are generally cropped, i.e. mainly white fonio (*Digitaria exilis* Stapf), as well as black fonio (*D. iburua* Stapf), which is primarily grown in northern Togo. Fonio is usually only grown on family farms. Farmers tend to differentiate varieties according to the length of their growth cycle. Seeds of short-cycle varieties ripen before the end of the rainy season and therefore serve to fill the hunger gap. Fonio is grown on small plots, often in womens' fields, and harvested every day for daily consumption. Seeds of varieties with a longer cycle, which tend to have higher yields, can generally be consumed and marketed. Fonio cropping thus depends on families' specific needs and uses, and thus on the social organization.

A workshop attended by different stakeholders was held to draw up a concerted list of needs regarding the assessment of available diversity (in a broad sense), improving cultivation procedures, marketing channels and postharvest procedures, including the

development of specific equipment. These aspects are being dealt with through different projects involving multidisciplinary approaches. UMR AGAP, DIADE and QUALISUD and African partners are focusing research on diversity with respect to agrosystems, species, know-how and associated techniques. Comprehensive approaches that do not dissociate the crop from its physical and social environment are applied in these projects. Methods and tools inspired from those used for major crop species are developed, along with new technological and methodological tools, particularly on the basis of preservation, marketing and processing strategies.

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▲ Bundling fonio after sickle harvesting and stacking.

▼ Early fonio harvested in Upper Guinea and stacked in the field before threshing and consumption.

C. Billot © CIRAD and A. Barnaud © IRD

Evolution of millet varieties in Niger in response to climatic variations

Millet is a rainfed crop in Niger, in an economic setting dominated by family farming. The cropping area is bounded in the north by the 350 mm isohyet, while south of this line the climatic gradient extends towards less arid conditions. The flowering dates of the varieties grown in this area are variable and correlated with the rainfall gradient—with millet flowering earlier as the climatic conditions get drier.

A series of heavy droughts occurred in the Sahel between 1970 and 2000. A comparison of millet samples collected in 1976 and 2003 in the same villages in Niger revealed that the varieties, their ranges and neutral



▲ Millet harvesting and storage on a family farm in Niger.

genetic diversity (where diversity has no impact on organisms' adaptation capacity) were similar. Conversely, trials conducted under controlled conditions over a 3-year period indicated a shift towards a more compact morphology and earlier flowering in these varieties.

Genetically, in the 1976 and 2003 samples, UMR DIADE identified polymorphism associated with flowering variation in the PgPHYC gene. The frequency of this gene's earliness allele increased between the two sampling years. These results suggest that there has been selection on this gene over time. These studies are currently being extended within the ARCAD project^{*} under way in a collaboration involving IRD, INRA and CIRAD. These findings demonstrate the adaptation capacity of millet to climatic variations in agricultural systems predominated by family farms in which the crop varieties grown feature high genetic diversity.

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* Agropolis Resource Center for Crop Conservation, Adaptation and Diversity: www.arcad-project.org

Functional and evolutionary biology of plants of agricultural or ecological interest

Research conducted by the **joint** research unit Crop Diversity, Adaptation and Development (UMR DIADE, CIRAD/IRD/UM2) is closely linked with the challenges facing family farming in coping with environmental changes. UMR DIADE pays close attention to processes involved in the adaptation of tropical plants to natural and human-induced changes in the environment. Studies are focused on different biological scales: structural and functional genome diversification mechanisms, and evolution in the genetic diversity of plant populations.

It is currently possible to conduct cutting edge research on a broad range of different crop plants, some of which are little known. This research can benefit from the transfer of advanced knowledge on the biology of so-called model plants (rice, *Arabidopsis*, tomato, poplar). Plant species of agricultural or ecological interest (coffee, casuarinas, yam, maize, palm, millet) are investigated by the unit. These species are generally grown in family farming based systems.

The unit's field studies are often focused on these latter systems. The research activities are carried out with local partners in West and North Africa (Senegal, Niger, Cameroon, Benin, Morocco), South America (Peru, Colombia, Argentina) and Asia (Vietnam).

Many crop plants are native to developing countries. Smallholders have shaped the diversity of these plants and contributed to their adaptation to various environments via their cropping and seed selection practices. Understanding how crop plants evolve and adapt is necessary to identify practices beneficial to this adaptation. In-depth knowledge of the biological mechanisms of adaptation contributes to the development of strategies for the conservation, management and effective use of crop plant biodiversity—a food security pillar for communities in developing countries. •••

Main teams

UMR ESPACE-DEV (IRD/UM2/UR/UAG) 38 scientists

UMR G-EAU Water Resource Management, Actors and Uses (AgroParisTech/CIHEAM-IAMM/CIRAD/IRD/ IRSTEA/Montpellier SupAgro) 70 scientists

UMR SYSTEM

Tropical and Mediterranean Cropping System Functioning and Management (CIRAD/INRA/Montpellier SupAgro) 22 scientists

UPR GREEN

Management of Renewable Resources and Environment (CIRAD) 20 scientists

Soil-plant interactions the basis of production systems

The aim of research conducted by the joint research unit *Functional Ecology & Bio-geochemistry of Soils* & Agro-ecosystems (UMR Eco&Sols, Montpellier SupAgro/INRA/CIRAD/ IRD) is to develop ecological engineering approaches for the management and improvement of the agricultural and environmental functions of Mediterranean and tropical agroecosystems.

Low-input agricultural systems are particularly targeted, which generally involves smallholdings, especially in developing countries. UMR Eco&Sols aims to develop knowledge bases concerning joint changes in plant and soil functioning under the impact of global change and agricultural practices.

The unit conducts research to describe ecological processes involved in primary production and regulation of carbon and nutrient fluxes in agrosystems, particularly: major nutrient cycles (nitrogen, phosphorus), ecosystem regulation

services and, specifically, carbon sequestration—carbon storage and greenhouse gas emissionand the ecological dynamics of biological contaminants. The stability and resilience of these functional communities to climate and land use changes are studied in different Mediterranean and tropical soil-climate conditions in collaborations with national agricultural research centres and universities in developing countries. These experimental approaches are closely associated with a modelling approach dedicated to the formalization of biological and biogeochemical processes that determine soil-plant interactions as well as to the prediction of flows within agroecosystems.

UMR Eco&Sols is located in France (Montpellier) and in several tropical countries of West (Senegal, Burkina Faso) and Central (Congo) Africa, Madagascar, Southeast Asia (Thailand) and Latin America (Brazil, Costa Rica). The main agroecosystems studied range from cereal crop systems to tree crop plantation systems, in association or rotation with legumes. •••

Other teams focused on this topic

UMR ART-Dev Actors, Resources and Territories in Development (CNRS/UM3/CIRAD/UPVD/UMI) 70 scientists

UMR GRED

Governance, Risk, Environment and Development (IRD/UM3) 45 scientists

UMR QUALISUD Integrated Approach to Food Quality (CIRAD/Montpellier SupAgro/UM1/UM2) 66 scientists

UPR AIDA

Agroecology and Sustainable Intensification of Annual Crops (CIRAD) 56 scientists

UPR B&SEF Goods and Services of Tropical Forest Ecosystems (CIRAD) 45 scientists

Legumes in Mediterranean and tropical production systems





The demand for plant protein for food and feed uses has increased considerably in recent decades. As legumes produce high protein seeds, they are prime candidates for meeting the growing demand. However, there is high variability in legume yields due to often limited water and nutrient supplies. It is also now essential to reduce the reliance on chemical inputs in research on new agricultural practices.

The aim of the FABATROPIMED project (2010-2015), entitled 'Ecological services of legumes for nitrogen and phosphorus biogeochemical cycles and carbon sequestration in cereal cropping systems of Africa and the Mediterranean Basin', is to increase the role played by legumes in conventional cropping systems in West and North Africa, and Madagascar. The unique feature of this UMR Eco&Sols coordinated project is that it proposes the co-construction, with farmers, of technological

innovations that influence interactions between soil microorganisms and plants in order to achieve more efficient nitrogen and phosphorus acquisition.

This multilocation participatory research is geared towards organizing selection processes for efficient plant-microorganism combinations adapted to local conditions. These studies are focused on crop plants such as *Phaseolus vulgaris* (green bean), *Vicia faba* (faba bean) and *Vigna unguiculata* (cowpea), grown in rotations or association with cereals such as wheat in Tunisia, Morocco, Algeria and southern France, maize in Algeria and Madagascar, and sorghum in Burkina Faso.

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Agroforestry systems dynamics and management of ecosystem services benefiting rural households

Many global agricultural systems are based on multispecies cropping systems, which provide food and income for millions of rural families. These systems currently seem to offer a credible alternative to fulfil the Millennium Development Goals regarding the eradication of hunger and the fight against poverty worldwide. They could also serve as models for the development of new ecologically intensive and multifunctional cropping systems.

The research plan of the joint research unit Tropical and Mediterranean Cropping System Functioning and Management (UMR SYSTEM, CIRAD/INRA/ Montpellier SupAgro) is aimed at investigating the properties of these systems in temperate and tropical areas, while determining the management leeway for efficient and sustainable production of different ecosystem services that rural households expect from agriculture. Research conducted by UMR SYSTEM is focused on studying the properties of annualperennial and herbaceous-woody species mixtures that smallholders combine in the same area. These species meet different needs of farming families, but compete for light and soil resources. Gaining insight into the terms of this competition could help identify conditions required to achieve greater overall productivity.

The different environmental services offered by these systems have also been characterized: soil protection and water dynamics, biodiversity preservation, regulation of pathogen communities, pests and beneficial organisms. Finally, the evolutionary dynamics of these systems which farmers are instrumental in changing over time—are analysed along with the impact of plant diversity on the stability of their performances and resilience to climate hazards. The many services that rural households expect from multispecies systems also prompted UMR SYSTEM to design new cropping systems by studying evolution scenarios based on crop diversification.

These scenarios are the focus of a multicriteria assessment based on experiments and/or simulations of prototypes in collaboration with farmers. In order to support the planned technical changes, greater attention is paid to the evolution of biophysical and technical constituents of systems in transition, while developing strategies to manage these transitions so as to be able to cope with hazards. On the farm scale, the unit studies how strategic choices and the cropping systems involved change and are able to maintain their performances when changes are under way with respect to the climate, regulations, the economy and technical specifications. •••

Cocoa agroforestry systems in Central America—biodiversity management for a better trade-off between ecosystem services

In Central America, UMR SYSTEM is working in partnership with the Tropical Agricultural Research and Higher Education Centre (CATIE) and other members of the 'Tree crop-based agroforestry' Research and Training Platform in Partnership (PP) to quantify ecosystem services provided by cocoa-based agroforestry systems^{*}. These systems, which are managed by farmers and their families on small areas (0.25-4 ha), have long been neglected by agricultural research. Since the 1990s, agroforests have been spotlighted for their extraordinarily high wild and cultivated biodiversity and role in supplying many ecosystem services. The multifunctionality of these systems, their structural similarities with tropical forests, the spatial and functional transition between forests and cropping systems that they facilitate, and their various productions makes them a relevant focus of ecological intensification research.

A network of 229 smallholder cocoa agroforest plots was monitored in Central America (Panama, Costa Rica, Nicaragua, Guatemala, Honduras), to:

- measure the productivity of the main crop (cocoa) and the system (supply services)
- gain insight into the relationships between the botanical composition, the spatial structure of the vegetation and the productivity of cocoa trees and the system

- seek trade-offs between the main crop and system performances
- seek levers to adjust the balance between ecosystem supply services (crop productivity), regulation (pollination, pest regulation, carbon sequestration) and support (primary production, wildlife habitat, etc.) provided by these systems.

By integrating forestry and community ecology concepts and tools with those of agronomy to characterize the composition and structure of complex agroforests and quantify the studied ecosystem services, UMR SYSTEM is firmly positioned in the field of the agroecology of agroforestry cropping systems regarding the ecological intensification of their productivity.

Research conducted by UMR SYSTEM and partners is ongoing in this georeferenced plot network under the PP-PCP 'Central America'.

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* Studies carried out under the 'Cocoa Central America' project in which UMR SYSTEM coordinated the Research component from 2008 to 2012.

Cocoa farms in central Cameroon complex systems that meet farmers' needs



▲ Average use values attributed by Cameroonian farmers to different woody species growing in their cocoa agroforests (study carried out in 2009 on 50 cocoa farms in the central region).

Within the framework of the 'Agroforestry Cameroon' Research and Training Platform in Partnership, UMR SYSTEM is conducting research on cocoa agroforestry systems in collaboration with the Institut de recherche agricole pour le développement (IRAD, Cameroon) and other CIRAD research units (including UPR Performance of Tree Crop-Based Systems). To analyse the performances of these systems—which are hard to assess as a whole—a participatory assessment of 50 cocoa agroforests was carried out based on a use value attributed by farmers for each species in the system. Farmers thus revealed that 80% of the 122 species inventoried in their cocoa stands had between one and seven different uses, thus confirming their multifunctionality. The highest use value was attributed to cocoa trees (24%), but other associated woody species were found to have an explicit value for farmers by meeting the vital needs of farm households, including the sale and consumption of various products (fruits, oil and palm wine), supplies of medicinal products (bark, leaves), timber and fuelwood, preserving soil fertility and generating shade for cocoa trees.

The frequency of these species was also significantly and positively correlated with their use value ($R^2 = 0.914$). This confirms that the

multifunctionality of cocoa agroforestry systems is closely associated with their high agrobiodiversity level and that these complex systems are built and managed by farmers over time. Initiatives to improve cocoa cropping systems should thus take this intentional complexity into account so as to meet farmers' needs and ensure better adoption of proposed technical innovations. Designs of new systems should follow the lead of these agroforestry systems so that cocoa production will hereafter be more in line with farmers' strategies while also providing ecosystem services.

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Large-scale agricultural investment and water resource sharing for irrigated rice cropping in Mali



As pressure on agricultural and food markets increases, vast areas of arable land in Africa are attracting a growing number of international investors in a phenomenon often referred to as 'land grabbing'.

In the irrigation area administered by the Office du Niger (Mali), in addition to competition for land, the arrival of investors has prompted a redefinition of the terms of access to water, an essential resource for irrigated rice production. 600 000 ha of land is currently being allocated to investors, i.e. sixfold the currently developed area, while more than 80% of the Niger River flow is already being used for irrigation purposes during some periods of the dry season. This leaves very little leeway to meet future water needs. Sharing of water supplies between different stakeholders is both a technical and social issue. Family farmers, who have made this rice-growing area a success, see their future becoming increasingly precarious due to the lack of access to information and of leverage in resource allocation negotiations.

In this setting, UMR G-EAU is conducting action research with the following objectives:

- to analyse and compare land management practices of family farmers and investors
- to assist stakeholders in identifying the long-term challenges and foreseeing the impacts of new land allocations on the functioning of the irrigated system.

UMR G-EAU and the *Institut d'Économie Rurale du Mali* conducted a participatory prospective awareness initiative. Different stakeholder groups participated in scenario-building workshops and role playing games. Family farmers, who had until then not been substantially involved in any long-term thinking, were able to exchange information and views on the future. This ultimately enabled them to imagine possible development scenarios for the next 20 years and debate guidelines to move towards the future in the most suitable way, while ensuring the sustainability of the family farming model and preserving the resources.

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Irrigated agriculture adaptation to global changes and impacts on water resources in North and Sub-Saharan Africa

The joint research unit Water Resource Management, Actors and Uses (UMR G-EAU, AgroParisTech/ CIHEAM-IAMM/CIRAD/IRD/ **IRSTEA/Montpellier SupAgro)** conducts research on water resource management arrangements at different scales (catchment basin to irrigated plot). The aim is to test levers to balance water resource preservation and sustainable development. Research carried out at the interface between water resources and uses is multidisciplinary, ranging from earth sciences (hydrology, hydraulics), engineering (automation, fluid mechanics), life sciences (agronomy, hydrobiology), human and social sciences (economics, sociology, political science). The social dimension of agricultural water

use has led the unit to focus on differentiating types of production and their scope for water access and management.

The unit conducts research along three lines, two of which concern the quantitative dynamics of water resources and their strategic and operational management. The third line deals with irrigated agricultural systems, their adaptations to global changes, impacts on water resources and ways to enhance their performances via technical or organizational innovations. Forms of social organization of agricultural production are also taken into account, while focusing on how family farms change to cope with modernization in order to intensify their production, and the increase in more capital-intensive, and potentially competing, production structures.

In irrigated agriculture, as in the entire agricultural sector, 'family farming' structures—based on family control of farm production and management—still prevail worldwide. By mobilizing costly water development projects, irrigated agriculture implies intensification and high added value crops. The current pressure on cereal markets due to growing global demand has questioned the capacity of family farms to modernize in order to make effective use of these development projects. UMR G-EAU addresses these issues of changes in production structures and tension over land and water access in North Africa, Sub-Saharan Africa, and Asia.

The research is focused on agrarian dynamics and associated social and economic challenges, supporting the design and dissemination of innovations in irrigated cropping systems adapted to small family farms, participatory and prospective approaches to integrate smallholders in water resource sharing negotiation and coordination processes. •••

Modelling interactions between ecological and social dynamics

The internal research unit Management of Renewable **Resources and Environment (UPR GREEN, CIRAD**) uses systematic and interdisciplinary approaches to address the issue of the co-viability of ecosystems and the livelihoods they support. Interactions between ecological and social dynamics are the main focus. The aim is to understand how these interactions question collective decisionmaking processes and how nature is appropriated in a sustainable development setting. Studies carried out since its founding in 1994 have highlighted the construction of an interdisciplinary approach to study topics-social, agronomic and ecological sciences, and informatics-where modelling is an intermediation process between different types of knowledge.

With a 'management of common resources and the environment' entry, the unit focuses on a broad range of different resources (water, forests, land, fisheries, etc.) on various scales (village to region, sometimes even country). It conducts cross-sectoral analyses on biodiversity, land-use changes and conservation/usage arbitration, natural and renewable resource access and modes of appropriation. This Montpellierbased research unit is also involved in research in West Africa, the Indian Ocean, Southeast Asia, Central and South America.

UPR GREEN was a pioneer in the development of participatory modelling approaches (ComMod, Companion Modeling) to support local stakeholders (farmers, managers, politicians, etc.) on renewable natural resource management, based on its own modelling platforms^{*}. The researchers are thus highly involved in institutional arrangements that accompany public decisionmaking processes on local, national and even international scales (Madagascar and Senegal on land, Bhutan, Burkina Faso and Ghana on water, Latin America and West Africa on agrobiodiversity).

The unit focuses on the family farming issue via several entries, including agriculture multifunctionality and rural household pluriactivity. It is essential to characterize the heterogeneity of socioecological stakeholders in the modelling process, as well as the differentiation of agricultural systems through an analysis of transitions, crises and agricultural transformations that describe family farming trajectories This analytical framework for family farming applies to individual/collective water management, the management of local varieties in seed systems, the resilience of family farms under the risk of climate shocks or soil degradation, the link between income insecurity and food security, the ecological dynamics of newly cleared land in the Amazonian region regarding the family farming trajectory, etc. •••

* CORMAS platform: Natural resources and multiagent simulations

MIMOSA platform: Computer and Modelling Methods and Simulation Agents



adaptation standpoint. Seed dissemination in Africa is generally managed through farmers' seed systems based on traditional trade, which means that all farmers have access to high varietal diversity that exists *in situ* according to practices that are dependent on the sociocultural context. These open and dynamic systems constantly integrate new cultivated varieties/species and changes in seed trade rules. Currently, 80% of food crop seeds are traded through these systems in Africa, whereas the capacity of improved variety dissemination through formal systems is limited.

The 'Sustainable management of agricultural biodiversity in Mali' (FFEM, 2010-2013) and 'Impact of seed access arrangements on genetic diversity dynamics in agriculture' (ANR, 2008-2012) projects conducted by UPR GREEN and UMR AGAP were aimed

Enhanced production and seed access for family farmers

Access to a variety of high quality seeds for a broad range of species is a major challenge for African family farms, from the food security and climate change at supporting family farming stakeholders in a participatory improved variety selection and seed dissemination process, and at studying the impact of introducing new varieties on the biodiversity dynamics of studied species.

Innovative tools were used to develop a participatory modelling approach applied to seed systems. Multi-agent models incorporate stakeholders' viewpoints and simulate scenarios involving changes in practices to analyse their impacts on biodiversity dynamics, with the ultimate aim of collectively designing new agrobiodiversity management strategies. The characterization of varietal diversity in local cropping systems is discussed to be able to assess system changes according to different scenarios. These scenarios are useful to, for instance, discuss the location of certain minor sorghum varieties (in terms of cropping area and number of farmers that use them) according to the type of farm and risk of genetic diversity loss. Workshops conducted in Mali led to the registration of plant varieties in the national catalogue to enable the extension of sorghum varieties collectively obtained by participatory selection.

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Sociosystem and agrosystem diversification in North African oases—the status of family farming and date palm cropping



Over the centuries, Tunisian oases have adapted to many economic, political and environmental crises. Families were organized around oasis agriculture, with date palms being the traditional core crop. Oasis agrosystems were bio-diversified (three cropping levels, a diverse range of palm varieties), in interaction with livestock farming, often associated with rainfed crops grown outside of irrigated areas. These agrosystems were based on know-how and technical skills passed down from father to son.

In recent decades, political and economic support for Deglet Nour dates (an exported variety) has been underpinned by subsidies for the development of new irrigated areas and the expansion of cropping areas. The oases are open to the public (e.g. tourism). They have, however, been impacted by increased desertification, poverty and outmigration, which is common in dryland regions. All of these globalization-related dynamics have given rise to new patterns regarding society/environment relationships. Agricultural artificialization thus continues through large-scale initiatives (earthworks, deep drilling). Date palm is less bio-diversified and increasingly at risk with respect to diseases and environmental conditions. In some oases, agrosystems are no longer the only economic resources tourism is developing, urban areas are taking over irrigated areas. Palms are sometimes no longer grown to produce dates but rather to be decorative or even recreational (tree climbing). Palm stands are sometimes even replaced by recreational activities (golf, etc.) in irrigation areas. Finally, some other oases are geared towards promoting 'a traditional system'.

A collective^{*} has been set up to update long-standing systemic knowledge and relatively monothematic current research. The aim is to gain insight into the different oasis systems that prevail in Tunisia and other North African areas, the status of date palm and family farming, and the viability of new systems and their environment/society co-viability. This means seeking ways to observe and monitor changes via remote sensing, while also extending the observations to other North African areas (GEOSUD programme). The ultimate goal is to mobilize (in observatories) all knowledge on these systems and their spatial footprints in order to help oasis inhabitants develop more efficient sustainable systems and foresee risks.

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* Collective consisting of UMR ESPACE-DEV in France, the Institut des Régions Arides at Médenine, the Institut Supérieur agronomique de Chott-Marriem at Sousse and the Centre Régional de Recherche en Agriculture Oasienne de Degueche at Tozeur in Tunisia and, internationally, the Réseau de développement durable des oasis (Oases Associations Network).

Environmental monitoring, renewable resource management and complex agrosystems

Founded in 2011, the **joint research unit** *ESPACE-DEV* (**IRD/UM2/ UR/UAG**) conducts baseline, technological and applied research integrating data, knowledge and methods to benefit scientific communities and decisionmakers within the framework of projects for the sustainable development of territories in developing countries on local, regional and global scales.

Based on priority issues concerning environmental monitoring and renewable resource management, the research unit hinges research, training, expertise and services on questions regarding the spatialization of environmental knowledge for decision support in peripheral tropical regions vulnerable to global change.

The research is carried out by three teams in synergy: Spatial observation of the environment (OSE); Integrated approach to environments and societies (AIMS) and Information and knowledge systems (SIC). Studies are conducted in various environments (islands, coastal areas, forests, mountains, drylands, etc.), which all have environments that have been fragilized and/or altered under the constraints of global change. The aim is to provide answers for local people and development managers by boosting awareness on the co-viability of their systems (sociosystems, agrosystems, ecosystems) and the viability of their territories.

The illustrative examples presented by the UMR are in line with the complex systems with an agricultural component theme and are focused on the role that could be played by family farming. In both cases, they involve a native

species (babassu palm in the Amazon region, and date palm in North Africa). The first so-called 'native' species grows in postdeforestation agrosystems managed by local communities, while the second is planted in traditional or changing intensive agrosystems (oasis). These two examples involve system modelling, with fields being monitored by satellite imaging, direct environmental observations and via surveys of stakeholders. Both have basic and targeted research objectives at the society/ environment interface, with the aim of enhancing the sustainability of the monitoring system dynamics.

UMR ESPACE-DEV develops its research activities through a multisite system with headquarters in Montpellier. Secondary stations are located in the French overseas areas (French Guiana, Réunion, Martinique, New Caledonia), Brazil and Gabon.

Ecological intensification adapted to small family farminga case study of babassu palms

Babassu palm (Attalea speciosa Mart. ex Spreng.) is a useful species that is native to dense rainforest areas in the Brazilian Amazon and preserved in agrosystems. In Brazil, babassu palm grows over an area of around 200 000 km² and may be promoted for ecological intensification. It is the focus of extractivism, mainly for its oil-bearing kernels, and is an economic asset in some States. Babassu extractivists are mainly low-income rural workers, often farming or landless women. They belong to an association, i.e. the Movimento Interestadual das Quebradeiras de Coco Babaçu (MIQCB), founded in the 1980s and have been fighting to obtain recognition for their work and associated rights, such as prohibiting the felling of babassu palm trees, and authorization to harvest babassu nuts on large private farms. Moreover, various other stakeholders who use or eliminate this palm could have a swift and irreversible impact on the future of this species.

Knowledge required for setting up management plans for this species is currently being acquired by a multidisciplinary (ecology, remote sensing, socioeconomics, modelling) and interinstitutional (mainly IRD, UMI, UM2, INRA, Federal Rural University of the Amazon, Belem, Brazil) team.

Several projects^{*} are focused on analysing the population dynamics of this palm, its spatial distribution and factors related to the adult population occurrence and density. The impact of babassu nut harvesting (carried out by various categories of stakeholders) on the reproducibility of the resource is being studied so as to be able to perform evolution simulations that could subsequently be used in management plans.

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- Projects:
 CNES/TOSCA_CIC-TOOB project: Remote sensing sensor integration chain for monitoring land-use patterns and automatic extraction of resource objects—a case study of babassu palm

- sustainable management of babassu palms in Brazilian grasslands. Project A IRD-PPR-AMAZ ECOTEL-B: Ecology and remote sensing for local communities-a case study of babassu palms



▼ Manual extraction of kernels from babassu nuts by two generations of quebradeiras de coco (mother and daughter). D. Mitja © IRD





Ecosystem functions of service plants a case study of upland rice crops in highland areas of Madagascar

Biodiversity is pivotal to the ecological intensification concept, to ensure optimal natural resource management and serve as a guarantor of the resilience of family farming production systems. These systems are increasingly hampered

by natural and socioeconomic turbulence.

In Madagascar, in the CIRAD priority research platform 'Highland production systems and sustainability', UPR AIDA conducts research and development activities on different scales—plot to *terroir*—with the aim of enhancing the sustainability of upland rice cropping in highland regions, while providing food security and generating new income to overcome the problem of land saturation in irrigated areas.

An iterative participatory approach, involving analysis, monitoring of reference farms and

controlled experiments under real field conditions, ^{© f} enables innovation in a step-by-step production system design process, combining local know-how and external scientific and technical knowledge to meet current and future needs. In the short term, the main challenge is integrated management of upland rice pests. This crop is hampered by many constraints due to fungal diseases, white grub infestations and parasitism

(Striga asiatica). The genetic diversity of upland rice (selection and breeding) associated with the introduction of service plants in the crop sequence and crop diversification are being studied on a cropping system scale. Innovation adaptation, adoption and dissemination will follow this learning phase.

In the medium and long term, biodiversity generated by the introduction of service plants will provide fodder opportunities for dairy farmers and generate, via soillivestock plant resource sharing, synergies between these two main constituents of production systems.

R. Michellon The genetic biodiversity and multifunctional service plants introduced in upland rice cropping systems are gradually being appropriated in the highland and middle western regions of Madagascar. This has given rise to agrobiological models that could be applicable in other settings.

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Family farming landscapes as guarantors of biodiversity in Madagascar

In Madagascar, a description and analysis of periforest landscapes generated by family farming activities highlighted assets that should be promoted for biodiversity conservation. Land development strategies derived from family farmers' practices, beliefs and strategies have, since ancient times, contributed to shaping heterogeneous landscapes with complex and intricate overlapping of many ecological habitats that are favourable for biodiversity. These agroecosystems, which are the very image of diversity, enable farmers to produce a high variety of crops, fruit trees or timber species, while also enabling local inhabitants to gather a broad range of resources (medicinal plants, fuelwood, fibres, game, etc.). Cropping areas, consisting of a multitude of small plots with different histories and crops, are interspersed with hedgerows, groves and isolated trees (pine, eucalyptus fig, other sacred tree species, etc.), fallows of different ages, grasslands for livestock grazing, patches of natural forest protected by farmers, and fruit tree orchards.

UMR GRED researchers, in collaboration with the Université d'Antananarivo, showed that the intra- and inter-plot plant diversity in these fallows is closely linked with the diversity of practices, crop management sequences and strategies implemented by farming families (cropping and fallowing times, land savings, fires, etc.). It was also shown that landscapes resulting from family farming promote movements of birds from protected forests to these agroecosystems to nest, feed and breed. Forest, grassland and ubiquitous bird species all gather in these landscapes, so they have greater avian biodiversity than in the forests. The research findings revealed that these landscapes have protective qualities and serve as buffer zones for forest biodiversity. Current research aims to highlight the extent of their connectivity in order to characterize elements that promote biodiversity.

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▼ Bétisleo women farmers, Androy municipality, Ambendrana, southern highland region of Madagascar.

S. Carrière © IRD



▲ Exchanges between women villagers in southern Benin—traditional know-how, recent knowledge and changes in habits and practices in rural and urban families.

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14

Support and *public policy*

his chapter discusses family farming research activities along two main lines: supporting farmers regarding innovations or resource management, and interactions between public policies and local or regional stakeholders.

Eight research units of the Agropolis International platform are involved in these activities. Four of these units devote substantial research to the development of tools and methods to support family farming and their organizations regarding innovation, resource and territorial management.

A first group of case studies presented in this chapter deal with participatory (or action research) interventions that link farmers and local stakeholders in the research process on a relatively diverse range of topics (acceptance of livestock vaccinations, farm changes and management, market access, taking up farming, and pluriactivity support, etc.). Action research in partnership or support initiatives (e.g. using mapping, simulation or modelling tools) generate scientific knowledge for the academic community of course, but also knowledge that farmers or other stakeholders associated with the studies can directly mobilize and use. The aim is to strengthen their decisionmaking or management capacities (markets, sector globalization, climate change, local development strategies). Interventions specifically regarding action research in partnership also address social and organizational change issues, alongside research on technical changes. Moreover, technical innovations are designed in close to real conditions with the participation of farmers and/or local technicians.

A second series of case studies highlight examples of different research positions regarding public policies focused on family farming. Agricultural and/ or development-oriented research is conventionally mobilized by policymakers to generate technical or economic innovations that could contribute to updating the content of public policies and, more recently, to directly participate in fora for public policy debate and formulation. A second area of research concerns the assessment of impacts—especially economic—of policies on target communities (e.g. economic and social evaluation of animal health programmes).

A third approach concerns the analysis of public policy development and implementation. This is, for instance, the case when programmes include the participation of local communities in decisionmaking on the terms of initiatives and projects on territorial management and development or forest resource management. Finally, another approach regarding interactions between public and private stakeholders is to begin by an analysis of standards. The production, application and processes pertaining to the certification of standards (sanitary, commercial and quality) now have increasingly marked impacts on the production and marketing of fruit and vegetables, animal products, wood, as well as various tropical products faced with sustainable development challenges (palm oil, GM seeds, etc.).

Regardless of whether the issue concerns supporting stakeholders or public policies, the time has come for 'participation' in a broad range of ways, and for the contribution of very diverse stakeholders (public and private, agricultural and nonagricultural, local or not) in defining problems and family farming futures. In this new discussion and action setting, the examples in this chapter show that research has been able to develop positions, methods and tools to renew its status and contributions.

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▲ Business and employment cooperatives (here 'Terracoopa', on the outskirts of Montpellier)—an alternative to overcome difficulties concerning land access and finding funds to get set up in farming.

© P. Gasselin

Supporting stakeholders in their innovation initiatives

Rural societies are currently undergoing major changes due to rapid transformations in their environment, ranging from globalization to the advent of new forms of local governance. Territorial stakeholders innovate

Main teams

UMR Innovation Innovation and Development in Agriculture and the Agrifood Sector (CIRAD/INRA/Montpellier SupAgro) 50 scientists

UMR TETIS Spatial Information and Analysis for Territories and Ecosystems (AgroParisTech/CIRAD/IRSTEA) 73 scientists

UPR AGIRs Animal and Integrated Risk Management (CIRAD) 27 scientists

> UPR B&SEF Goods and Services of Tropical Forest Ecosystems (CIRAD) 45 scientists

to take advantage of development opportunities, manage dwindling resources and cope with crises.

This is a new setting for research intervention on territorial dynamics and changes in agricultural and agrifood production systems.

The joint research unit Innovation and Development in Agriculture and the Agrifood Sector (UMR Innovation, CIRAD/INRA/ Montpellier SupAgro) conducts multidisciplinary research in France and abroad on innovations, which are considered as individual or collective, technical, organizational or institutional processes. It focuses on the entire innovation process, including stakeholders' motives and objectives (farmers, organizations, companies, administrations, politicians, research, etc.), ways that stakeholders actually implement change, methods for supporting innovation and innovation-induced development impacts. The unit conducts joint agronomy-social science research on 'location-specific innovation', with stakeholder involvement in various agricultural development situations and on different topics (agricultural techniques, alternative

farming systems, localized agrifood systems, etc.). Further research is aimed mainly at promoting the development of family farming which, because of its innovation and adaptation capacities, is a sustainable production model. The researchers combine comprehensive, diagnostic and modelling approaches, while also designing tools to support stakeholders in the innovation process. They opt for action research in partnership initiatives with the aim of including stakeholders in the research and supporting innovation processes.

The UMR is organized around three teams:

- On the farm scale, the 'Technical and organizational changes in farming systems' team studies change dynamics involving farmers and rural households.
- On the agrifood system scale, the 'Food markets and territorial development' team studies the dynamics of agrifood products and markets.
- On the project territory scale, the 'Dynamics and governance of urban agriculture' team studies the dynamics and territorial governance of 'urban area-farming' relationships. •••

Supporting mixed crop-livestock family farms in their change dynamics

Family farms often combine mixed crops and livestock for income security and autonomy. These complex production systems require specific tools to support their change dynamics. To this end and in collaboration with partners, several UMR Innovation researchers designed and tested an individual support approach in various settings: predominantly dairy farms in Brazil, Morocco and Peru; diversified farms with suckling cows in southwestern France: and diversified farms with livestock production units of different sizes in Burkina Faso and Madagascar.

This approach is based on a spreadsheet simulation tool (Crop Livestock Farm Simulator, CLIFS) which can be used in ©*R*-Y.Le Gal combination with other tools (e.g. Olympe in Madagascar). CLIFS integrates crop and livestock farm components and their interactions while retaining a general structure, calculation procedures and output variables that can be readily understood by farmers. Farm change scenarios are designed with farmers and assessed on the basis of several resource supply and demand balances (food products, fodder, organic manure) and related economic results.

The support approach is structured in three phases based on the design and simulation of an initial scenario representing the current farm situation, a 'project' scenario based on the farmer's future intentions, and alternative scenarios that open a range of possibilities. The issues addressed concern the choice and sizing of livestock production units to increase milk production, the choice of fodder system with a view to autonomy, the introduction of innovations such as relay crops or partial use of cover crop biomass, and the analysis of farm sensitivity to climate and economic shocks. This approach, which is well rated by farmers since it specifically addresses their situations and questions, should now be transferred to advisory providers to assess its relevance in a professional environment.

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▲ Working session with a farmer in the Lake Alaotra region, Madagascar.

Supporting pluriactive farmers in Languedoc-Roussillon region

The geographical and economic, and to some extent historical and cultural, features of Languedoc-Roussillon region (France) are amenable to pluriactivities. This includes seasonal tourism activities in coastal and inland areas, the wine growing crisis, historically pluriactive settings in the Mediterranean highlands and high-growth periurban areas. Pluriactivity is, however, nowadays as much conducive to the creation and development of activities as it is representative of precarious employment and work. It is a widespread social and technical model that is often misunderstood.

The Insertion territoriale des systèmes d'activités des ménages agricoles (INTERSAMA) project, which combined 10 researchers (UMR Innovation, TETIS and METAFORT^{*}) and six regional development structures, aimed to analyse the functioning and dynamics of farming household activity systems in Languedoc-Roussillon, while also studying their territorial integration and support mechanisms devoted to them. This partnership research involved activities and training in which researchers and stakeholders were joint instigators in the process and

outcomes. Everyone participated in defining the issues, drawing up responses and assessing the process, with the threefold aim of generating knowledge, supporting social transformation and enhancing individual and collective skills and expertise.

The INTERSAMA collective contributed to various theoretical frameworks, especially on the activity system concept, the support relationship, as well as the analysis of work conditions and organization. Pluriactivity projects give rise to fundamental support issues due to their precarious nature, incompatibility with the standard enterprise model and the Fordist labour system. In addition to its scientific output, INTERSAMA designed and tested three complementary tools to support the creation of activities in rural areas (accessible online), while contributing to the debate and formulation of a regional rural pluriactivity support policy.

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* UMR Transformations in Activities, Areas and Forms of Organisation in Rural Territories (AgroParisTech/INRA/IRSTEA/VetAgroSup)

Family farmers major tropical forest management stakeholders

The scientific project of the internal research unit Goods and Services of Tropical Forest Ecosystems (UPR B&SEF, CIRAD) aims to study the ecology of tropical forests, while defining, implementing and assessing policies, instruments, regulations and practices associated with these ecosystems. The overall goal is to facilitate the adaptation of social and ecological systems to constraints and opportunities resulting from global changes and to enhance the sustainability of services provided by tropical forest ecosystems for the benefit of societies at local and global scales.

Other teams focused on this topic

UMR ART-Dev Actors, Resources and Territories in Development (CNRS/UM3/CIRAD/UPVD/UMI) 70 scientists

UMR G-EAU

Water Resource Management, Actors and Uses (AgroParisTech/CIHEAM-IAMM/CIRAD/IRD/ IRSTEA/Montpellier SupAgro) 70 scientists

UMR MOISA

Markets, Organisations, Institutions and Stakeholders Strategies (CIRAD/INRA/Montpellier SupAgro/ CIHEAM-IAMM) Around 60 scientists

UPR AIDA Agroecology and Sustainable Intensification of Annual Crops

(CIRAD) 56 scientists

UPR GREEN

Management of Renewable Resources and Environment (CIRAD) 20 scientists

UPR HortSys

Agro-ecological Functioning and Performances of Horticultural Cropping Systems (CIRAD) 28 scientists The team focuses on three research topics:

- Natural tropical forests: these are a challenge for sustainable development because of their potential to produce essential goods and services for our societies. They are the richest terrestrial biodiversity and carbon pool and the focal point of major global changes.
- Societies that inhabit or depend on them: the unit studies regulations, practices, uses, knowledge and representations regarding forests, as well as cooperation-competition and social capital building dynamics.
- Public policies: policies or instruments that apply to forests can be external to the studied social and ecological system (international conventions, national taxation, national plans for adaptation to climate change, markets and associated financial mechanisms, etc.) or internal to them (domestic markets, local management regulations, practices, organizations and institutions, etc.).

UPR B&SEF focuses on social and ecological systems for which forests and forest resources are key elements. This choice acknowledges the importance of interrelationships between ecological dynamics, stakeholder behaviours and political and collective decisions at different geographical scales. The unit studies these topics and constituents to address a series of social and research issues.

The unit has decided to structure these research issues as well as its entire research team in three general research areas *(see below)*, each with its own specific research hypotheses. It also elicited two major crosssectoral issues that the entire team is addressing.

The unit studies interactions between forests and communities that inhabit or depend on them. Family farmers living in the vicinity of or within dry or humid tropical forests are major stakeholders in the management of these forests which they tap, preserve, transform or destroy. The unit analyses the impact of family farming on goods and services generated by forest ecosystems, while proposing participatory tools to promote sustainable forest resource management. •••





Public policies and sustainable land-use planning

Some research activities of UPR B&SEF are aimed at supporting public policies so as to mainstream family farming activities in sustainable land-use planning and sustainable natural resource management. This has been done, for instance, regarding oil palm in Cameroon, as well as village land management in Indonesia and the Democratic Republic of the Congo.

CIRAD, in partnership with the World Wide Fund for Nature (Central Africa Regional Programme Office, WWF-CARPO), IRD and the Center for International Forestry Research (CIFOR), supports the Cameroonian Ministry of Agriculture in defining a national sustainable development strategy for oil palm. The aim is to promote family and small-scale palm oil production while preserving high conservation value forest cover and ecosystems.

Locally, village communities in Indonesia participate in decisionmaking regarding their lands via land-use plans to integrate family farming and forest activities in a landscape mosaic. A participatory mapping tool is used for this purpose, which shows the scale of land-use plans on a subnational level (districts, 1:50 000). Village communities produce a set of maps showing the current uses of their land and their expectations for the future. These maps are then discussed with decisionmakers (local government).

In the Democratic Republic of the Congo, simple land management plans are drawn up in a participatory manner with village communities. These plans should help stall deforestation induced by the growing demand for fuelwood in large urban centres by organizing sustainable wood and food production on village lands. Village communities located on the periphery of large urban centres are currently living in an environment that is so degraded that forest ecosystems and associated goods and services have almost disappeared.

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Efficiency and acceptance of livestock disease control by family livestock farmers—avian influenza in Vietnam and Egypt



Highly pathogenic H5NI avian influenza is endemic in several countries (China, Bangladesh, Indonesia, Egypt, Vietnam), with significant socioeconomic impacts. Vietnamese and Egyptian governments set up a mandatory mass vaccination programme against this disease implemented through biannual vaccination campaigns for family-reared village poultry (2005-2010 in Vietnam, 2007-2009 in Egypt). Vaccination of commercial poultry (partly from family farms) is handled by the private sector, with varied efficiency depending on the country and type of production.

Studies carried out by UPR AGIRs highlighted the importance of social, cultural and economic factors in the acceptance of community-controlled measures. In Egypt,

family poultry farms (village or commercial) did not vaccinate their flocks, partly because of their limited confidence in government practices, the lack of information, etc. In Vietnam, such vaccinations seemed to be more acceptable, but with marked geographical variations due to the decentralized administration, problems of accessibility and local management of the risk by smallholders, thus reducing the economic benefit they could gain from the vaccinations.

Economic evaluation of health programmes is a major argument in designing control strategies on a national scale. However, the economic priorities of family poultry farmers differ from those at the national level. Moreover, the effectiveness of these programmes depends on the acceptance by farmers to implement the measures and report disease cases. Current evaluation methods do not take these aspects into account and are based on national surveillance data of often questionable quality and reliability. Control programme evaluation methods should involve participatory and interdisciplinary approaches in order to fully understand these constraints, while ensuring that family farmers participate in the decisionmaking process. In Egypt, mass household poultry vaccinations were stopped after these efficiency studies were conducted on family poultry farms.

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Health risks associated with livestock and wild animals in developing countries

The internal research unit Animal and Integrated Risk Management (UPR AGIRs, CIRAD) aims to understand, predict and manage health risks associated with livestock and wild animals in developing countries in a global change setting (habitat simplification, biodiversity loss, urbanization, deforestation, trade globalization, global warming). A broad range of methods-descriptive epidemiology, ecology, geomatics, biostatistics, health geography, anthropology, quantitative epidemiology, modelling of complex systemsare thus implemented under two complementary approaches jointly applied in research programmes

and projects in various geographical areas, including Southeast Asia, Southern Africa, Madagascar and the Mediterranean region:

- The first approach aims to identify factors determining the behaviours and spatiotemporal evolution of animal diseaseszoonotic or not-that are important in terms of health and economic impacts. These diseases are emerging or endemic, vectorborne or directly transmitted (avian influenza, foot and mouth disease, tuberculosis, African swine fever, Rift Valley fever, etc.). Such disorders—by causing mortality, morbidity or decreased milk or meat production-weigh heavily on the economy and subsistence of small family farms.
- The second approach focuses on the functioning of socioecosystems jointly inhabited by hosts (wild

animals and livestock, humans, i.e. farmers and/or consumers) and pathogens. The aims are to assess the animal and public health risks and to propose methods for managing these risks (monitoring and control) that are tailored and optimised for the considered socioecosystems. Efficient control of animal diseases requires rapid responses when an epizootic disease emerges. Addressing this challenge is essential in developing countries where resources (specific expertise, funding, information technology tools, etc.) are limited.

The unit works closely with many partners—research and development institutions—in France and developing countries (Africa and Asia) and is involved in several international networks. •••

Supporting territorial development stakeholders

The joint research unit Spatial Information and Analysis for Territories and Ecosystems (UMR TETIS, AgroParisTech/CIRAD/ IRSTEA) produces methods and knowledge to enhance spatial information management in order to gain insight into environmentsociety interaction dynamics and support stakeholders in sustainable land management.

The development and transmission of useful, usable and used spatial information underlies all of the unit's research. It is structured in four teams spanning the entire 'spatial information chain': acquisition of spatial (especially satellite) data and processing; analysis and spatiotemporal modelling of agroenvironmental and territorial systems; information system management; and conditions for the use of spatial information by territorial stakeholders. This latter team, in particular, conducts research focused on farming: analysis of the effects of the development of agrobusinesses or mining companies on territories and family farms; and the use of spatial information to support small-scale farmers.

The unit's activities—besides producing knowledge and methods on the spatial information chain are also focused on training (initial training, research-based training and ongoing training) and on transfer, especially through public policy support, partnerships in developing countries and expertise or partnerships with private operators.

UMR TETIS operates in various thematic areas—agriculture, environment, territories, resources, health and natural risks—associated with territorial development and sustainable agroenvironmental management. It works closely with territorial managers and stakeholders and develops partnerships with other thematic teams. A crosscutting and unifying component of the unit's scientific project focuses on 'observatories'a unique type of information system-which are taken to be 'sociotechnical information and communication mechanisms'. These downstream mechanisms mobilize and integrate complementary functions (data acquisition and production; analysis and synthesis; management, editing and dissemination), thus enabling unit members to span the spatial information chain and work on common ground.

The unit is also involved, through the EQUIPEX GEOSUD project^{*}, in a strategy geared towards the sharing of satellite information between the scientific community and territorial and public policy management stakeholders.

* http://geosud.teledetection.fr/projet-equipex-geosud.html

Capacity of family farmers to manage the impacts of globalization in the eastern Amazon region

In the eastern Amazon region, in Baixo Tocantins (State of Parà), and in cooperation with the Federal University of Parà (UFPA) and IRD, UMR TETIS is analysing the impact of globalization (models, capital, infrastructures, information, etc.) on local societies, and especially on small-scale farming in a so-called peripheral area. The PERIMARGE project (ANR project 'Peripheral and marginal spaces: interpreting relationships to centres in a global world'), coordinated by IRD, conducts a comparative analysis of data from six countries in Latin America and Africa. The aim is to understand the contemporary sociospatial dynamics, particularly those that affect small-scale farming patterns in areas 'on the margins of development'. The analysed territory—the Mocajuba municipality—is marginal because it is relatively isolated, but also due to the construction of an upstream dam (which has made small-scale fishing almost impossible) and pest and disease problems that have almost annihilated pepper cash crops in this region.

A model was developed to characterize the impacts of globalization influences on the conditions and nature of production systems, on the distribution of value (income) and on governance. This model links the multiplication of centres and the diversification of material and immaterial flows. A trajectory analysis will be conducted to assess the capacities of smallscale farmers and other territorial stakeholders to manage these influences, thus reflecting a differentiated capacity for the activation of current resources (including cocoa and natural rubber, whose qualities are acknowledged) and for organization. A certain degree of autonomy regarding centres is foreseen.



This work is part of a project that the research unit is developing with UFPA, which aims to question the current territorial development model and assess possible future patterns at different organizational levels in collaboration with rural development stakeholders.

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Standards and family farming

The demand for products that meet sustainable production criteria led to marked development in voluntary standards regarding environmental and social 'good practices'. Is family farming able to benefit from these standards?

Two research projects on voluntary international standards in which UMR MOISA is involved—European NTM Impact project (2009-2011) and the ANR Prigoue project (2011-2014)—have generally highlighted the difficulties family farmers encounter regarding their inclusion in these certified sectors. They benefit little from labelling due to their inability to adapt to the physical and human capital requirements. This situation could also be explained by these farmers' low participation in defining these standards (e.g. multi-stakeholder roundtables for sustainable soybean and palm oil). The hegemony of these standards and differential access to quality assurance generate inequalities between producers (e.g. the exclusion of small Peruvian mango producers from GlobalGap-certified export channels, and the disparity in impacts on different producers of GlobalGapcertified lichis in Madagascar).

The dissemination and adoption of these private standards by smallholders often requires the assistance of non-governmental organizations (NGOs), donors or even industrial operators, indicating that certification sustainability is an issue for family farming. This could be illustrated, for instance, by the fact that many litchi producers in Madagascar lost their certification, especially following the departure of donors, that chocolate manufacturers are pervasively present in the organization of



▲ An increase in the number of voluntary sustainability standards.

the Rainforest Alliance certification of Ivorian cocoa, and that Amazonian communities in the Forest Stewardship Council lost their certification due to the mismatch between NGO support and that of local public institutions.

Finally, family farmers should form collective organizations to gain access to the benefits of certification through the adoption of standards that are tailored to local realities and practices (e.g. organic rice in Laos), and by adopting less expensive certification strategies (e.g. participatory certification in Latin America).

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- For further information:
- NTM Impact project: www.bioeconomy-alcue.org/gg
- Prigoue project: www.prigoue.clusterl.easy-hebergement.net

Strengthening smallholder farmers' capacities for better market access



The access of smallholder farmers in developing countries to agricultural markets is a strategic lever for enhancing their livelihoods and reducing rural poverty. Sustainable market integration of these farmers depends on the implementation of institutional arrangements—contracts, bundled sales, information systems on prices—to reduce asymmetries which constrain them, and on the formulation of public policies to facilitate implementation of these institutional arrangements.

The Empowering Smallholder Farmers Into Markets (ESFIM) project, funded by the International Fund for Agricultural Development (IFAD), supported farmers in 11 countries (Benin, Kenya, Uganda, Malawi, Madagascar, Peru, Bolivia, Uruguay, Costa Rica, India and the Philippines) in their appeal to public authorities and donors to improve their access to markets. With the support of researchers from three AGRINATURA institutions (Wageningen University & Research Centre, CIRAD and Natural Resources

Institute), farmers' organizations identified priority issues and supervised studies conducted by local experts. The findings of these studies have furthered these organizations' reflection on the market access issue, while substantiating their arguments and strengthening their claims in the public debate.

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Participation of family farmers in rural development in Latin America

Research conducted by UMR ART-Dev under the 'Public policy and inequality in Latin America' partnership research platform revealed that the participation of family farms and their organizations in rural development policy negotiations or implementation is linked to a combination of four factors:

- The emergence of national family farmer or peasant organizations in democratic transition settings; which, in the 1990s and especially the 2000s, led to the drawing up of targeted policies on family farming.
- The more or less marked withdrawal, depending on the country, of the State from technical assistance, training, marketing, sectoral regulation, credit, etc.
- Policy decentralization and/or territorialization.
 Finally, the adoption of a crosscutting approach to policies (concerning the environment, health, etc.).

In Brazil, a focus country, this participation is combined with production-oriented support, but with few allocated resources.

> Assessments of federal rural territorial support policies launched in 2004 showed that this participation opened windows of opportunity for family farming representatives regarding training and inclusion in public policies. However, a closer look revealed that this mainly benefitted local leaders and traditional farming community representatives.

Once they were 'transactional leaders', they became professionalized in negotiating rural development projects with technicians, while also being instrumental in overseeing policy implementation. Farmers remain dependent on the expert technical and agricultural system which maintains control over projects. Territorialization is hampered by the federal administrative and financial structure and procedures, and the crosscutting approach is thwarted by corporatism of

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the sectoral ministries (Brazil, Uruguay).

▲ Participation in action...

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Vulnerability of family farming in West Africa to variability and climate change

The aim of the 'Environmental and Social Changes in Africa: Past, Present and Future' project (ANR-ESCAPE, 2011-2015) is to characterize the vulnerability of family farming in West Africa to variability and climate change and to the economic context, while proposing adaptation options for the future. In this project, which involves climatologists, sociologists and micro- and macro-economists, UPR AIDA agronomists contribute to bioeconomic farm modelling in order to determine the extent of farmers' technical flexibility according to their biophysical and economic environment.

The model will help assess the impact of climate change scenarios on farming families' income, food security, farm production and their main environmental impacts. These climate change scenarios will be matched against economic change scenarios: variations in the price ratio between products and inputs and their interannual variability, the development or not of credit and insurance



against climatic hazards. The impacts of farmers gaining access to climate information and meteorological information will also be investigated. The bioeconomic model and simulations will also be compared to farmers' viewpoints so as to identify potential adaptation strategies not taken into account in the modelling process.

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Global partners committed to family farming

MBRAPA (Brazil), INTA (Argentina) and the CGIAR Consortium—three Montpellier-based foreign or international research institutions that are addressing family farming issues in close partnership with the Agropolis scientific community.

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Family farming addressed by EMBRAPA's Labex-Europe (Brazil)

Brazil is a huge megadiverse* country with a range of soil-climate conditions, high ethnic, cultural and economic diversity resulting from the country's history and the large-scale migrations that have impacted it. These migrations had a marked influence on Brazilian agriculture via the adaptation of technologies coming from Europe and Asia, and through knowledge on uses of wild plants and animals passed on by native Indians and Africans. Because of this complexity, different types of small-scale agriculture using this knowledge and these technologies have significantly contributed to the national production of foods, goods and services.

The mission of *Empresa Brasileira de Pesquisa Agropecuária* (EMBRAPA), a Brazilian agricultural research corporation, is to 'provide technological solutions for sustainable agricultural development in Brazil to the benefit of Brazilian society'. EMBRAPA has a network of 47 research centres spread throughout Brazil and covering all of the country's biomes. Technology transfer to developing countries (South-South cooperation) is conducted via projects in Africa (EMBRAPA-Africa—Ghana, Benin, Mali, Mozambique, Angola), South America and the West Indies (EMBRAPA-Americas—Panama). EMBRAPA is thus able to disseminate tropical agriculture technologies and innovations that it develops, and to better fulfil the demands of these countries through its participation in their agricultural development.

EMBRAPA's international cooperation initiatives are mainly conducted under a programme devoted to knowledge exchange, i.e. its 'virtual laboratories abroad' (Labex, see below), which are currently located in the United States, Europe (France), Korea and China. Labex-Europe, hosted by Agropolis International, enables EMBRAPA to establish privileged partnerships with French (CIRAD, IRD, INRA, French National Centre for Scientific Research [CNRS], Montpellier SupAgro, universities), European and international (CGIAR) institutions. UMR TETIS, AGAP and IATE** have hosted researchers under the Labex programme.

After 12 years of Labex operation, substantial knowledge has been gained in the fields of ecological intensification and smallholder farming, such as the breeding of new tropical disease-tolerant fruit varieties by the International Advanced Biology Consortium (CIBA), along with the development of molecular tools used for the selection and genetic improvement of family agroforestry systems. Another example is the development of tools devoted to remote sensing and environmental impact assessments for land-use planning and zoning in the Amazon region. Other specific research programmes conducted in collaboration with Labex-Europe partners have led to the development of technologies and systems that sustainably enhance family farming efficiency, income and smallholders' wellbeing. •••

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For further information: www.embrapa.br/english * Brazil belongs to a group of countries that harbour the majority of the Earth's species and are therefore considered to have the highest levels of biodiversity worldwide.

** Agropolymer Engineering and Emerging Technologies (UMR IATE, INRA/CIRAD/UM2/Montpellier SupAgro)

EMBRAPA's Labex 'laboratories abroad'

Labex is a unique model of international scientific cooperation that was developed by EMBRAPA in the late 1990s. As it is a 'laboratory without walls' or 'virtual laboratory', the infrastructure and administrative costs are low, while being flexible and focused on fulfilling EMBRAPA's strategic objectives.

Senior researchers are posted for a few years in research laboratories abroad in exchange for their research experience and knowledge of networks in Brazil and worldwide. These scientists have a dual research mission—to carry out studies as part of a top-notch research team, and surveying/monitoring, i.e. informing EMBRAPA on new research methods or agricultural technologies, and new avenues for cooperation.

Since 2002, Labex-Europe has been hosted by Agropolis International, which provides technical, scientific and logistic support while also facilitating exchanges with the regional, national and European scientific community.

For further information: www.agropolis.org/project-management/labex-europeexternal-laboratory-embrapa-brazil.php



P Oliveri © INTA

Family farming—a core theme of LabIntex (Argentina)

Family farms account for 75% of all farms in Argentina, but only 17% of the productive area. However, they correspond to around 27% of the gross production value and generate 67% of employment in the agricultural sector. Family farms are also a key factor in sustainable territorial development and food security as they have a pivotal role in domestic market supply.

In this setting, family farming is one of the priority themes of the Instituto Nacional de Tecnología Agropecuaria (INTA, the Argentinian agricultural research institute). INTA's 350 technical support units active throughout the country underpin projects in which family farmers are the main stakeholders. Research carried out by these units is supported by a network of 50 research stations and five regional institutes specialized in the technological development of family farming—an overarching theme of INTA's 'external laboratory without walls' (LabIntex) and of all current research projects aimed at promoting its development.

Moreover, LabIntex will actively participate in scientific events and publications regarding this theme in 2014—the International Year of Family Farming.

The integration of an Argentinian researcher in UMR Innovation has already enabled LabIntex to collaborate in family farming research activities with CIRAD (Environment and Societies department) and INRA (Science for Action and Development department). INTA is therefore sharing its family farming development programmes with the Agropolis scientific community, especially regarding food security*. A research project is under way on territorial dynamics observatories, in which family farms play a major role. It will analyse the role of scientific knowledge production initiatives concerning territories in innovation and development processes, while also conducting a comparative analysis of four situations in France in connection with territorial dynamics observatories that are being set up in Argentina. •••

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For further information: www.agropolis.org/ project-management/labintex-inta-agropolisinternational.php

* http://umr-moisa.cirad.fr/en/seminaires/securite-alimentaire/ programme-2013

An urban farmer t Rio Gallege

LabIntex—an innovative

Presidencia de la Nación

INTA

partnership

In 2012, INTA set up a 'European Montpellier in partnership with Agropolis International, which provides scientific, technical and logistic support. Senior Argentinian researchers are posted for 2-4 years in top-notch European teams to collaborate in projects of joint interest.

The objectives of this partnership are:

- to carry out advanced research with the aim of developing
- to identify and develop scientific cooperations by forming organizations in Argentina, France
- to enhance the competitiveness and sustainability of Argentinian agricultural production.

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CGIAR and the International Year of Family Farming

Family farmers in developing countries cultivate over 80% of all arable land, in turn producing most food consumed worldwide—therefore an important focus for CGIAR research.

CGIAR Research Programs (CRPs) are designed to generate results that benefit small family farmers. Crop, livestock and fish improvement programs offer innovative solutions to enhance and diversify smallholders' activities. New improved varieties and breeds are mainstreamed in so-called 'systems' CRPs, which promote largescale adoption of these varieties using more sustainable natural resource management methods and practices. Farmers' adoption of technology and innovations resulting from CGIAR research is facilitated by an improved understanding of the market and policy environment as a result of the CGIAR program on Policy, Institutions & Markets. System CRPs such as Humidtropics, which is focused on humid ecosystems, tackles the issue of improving the livelihood of small family farmers through increased and stable returns from crops, agroforestry, livestock and fish farms by diversifying crops and farm activities and enhancing market access. In other CRPs, family farmers participate in upstream research activities, as is the case in the CRP Roots, Tubers & Bananas, which promotes the propagation of inexpensive high quality plants for the benefit of family farmers. Food quality and health benefits are also a priority for CGIAR and addressed by research focused on the production



and adoption of biofortified foods (cassava, sweet potato, sorghum, potato) with high vitamin A, iron and zinc contents (CRP Agriculture for Nutrition and Health) and research programs designed to reduce health risks from unsafe or contaminated food and other agriculture related contagious human diseases.

While recognizing the key role that women play on family farms and the extent of their responsibility (field work, herd management, postharvest activities, farm cooperative management, etc.), the 16 CRPs are designed to specifically address the needs of women. The CRPs include a gender component at every level of their programs, foster women's involvement in all activities, and require gender-disaggregated reporting of results as well as clearly indicated research objectives and an associated budget to be able to meet these objectives.

All 16 CRPs had an approved gender strategy by the end of 2013.

The CRPs are designed to have a greater impact on smallholders by creating synergies through ambitious research partnerships with other advanced agricultural research institutes (CIRAD, IRD, INRA, EMBRAPA, USDA^{*}, etc.), national research agencies in developing countries, and with development partners (international and national development agencies, NGOs and private partners) who can help connect the research outputs to the actual impact.

CGIAR—working with a diverse range of partners, in a multidisciplinary approach on activities to generate innovative solutions—is a major global stakeholder in ensuring the development and welfare of family farms.

Philippe Ellul, <u>p.ellul@cgiar.org</u>

* United States Department of Agriculture

CGIAR, a global research partnership for a food secure future

CGIAR is striving to reduce rural poverty, enhance food security, human health and nutrition, and promote sustainable natural resource management.

The 15 member centers of the CGIAR Consortium conduct research in close collaboration with hundreds of partner organizations, including national and regional research institutes, civil society organizations, universities and the private sector. These centers generate and disseminate knowledge, technologies and policies for agricultural development through CGIAR Research Programs (CRPs) involving international multidisciplinary and multipartnership research.



The CGIAR Consortium Office based in Montpellier enjoys a privileged relationship with the Agropolis scientific community, and with other French and European partners.

The CGIAR multi-donor trust fund finances research carried out by the centers via its CRPs. It provides reliable and predictable multi-year funding.

With almost 10 000 scientists and staff, CGIAR is an unparalleled research infrastructure with dynamic networks worldwide.

For further information: www.cgiar.org

Agropolis International *training and education in the area of family farming*

gropolis International proposes a complete training-education programme provided through its member institutions, universities and engineering schools (as well as vocational training institutions). The training-education programme includes more than 80 diploma courses (from Bac +2 to Bac +8: technician, engineering degree, Master's, specialized Master's, PhD), as well as vocational training modules (existing or developed upon request).

The tables below outline trainingeducation courses related to family farming analysis, support and development. They specify the diploma levels, a description of the training and the institutions where the training is provided.

Training-education programmes substantially focused on the family farming theme

Level	Degree	Title	Institution(s)
Bac +6	Ingénieur de spécialisation/ Mastère spécialisé (Specialized Engineering/ Specialized MSc)	Innovations in global agricultural and agrifood systems/Innovations and policies for sustainable food supplies (ISAM/IPAD)	CIRAD, Montpellier SupAgro
	Master of Science (MSc)	Territorial development and projects	CIHEAM-IAMM
Bac +5		Agricultural engineering – 'Sustainable crop production', 'Livestock production in harsh environments', 'Territories and resources: public policies and stakeholders'	Montpellier SupAgro
	Ingénieur (Engineering)	Engineering – 'Sustainable agricultural and agrifood systems in southern countries' (SAADS) – Programme 'Agrifood industries in southern countries' (IAAS), 'Resources, agricultural systems and development' (RESAD), 'Markets, organizations, quality, services in farming systems in southern countries' (MOQUAS), 'Social water management' (GSE)	Montpellier SupAgro
	Master (MSc)	Agrifood agronomy (3A) – Programme 'Livestock production in tropical and subtropical regions' (PARC), 'Resources, agricultural systems and development' (RESAD), 'Markets, organizations, quality, services in farming systems in southern countries' (MOQUAS), 'Agronomy and innovative cropping systems' (ASCI), 'Mediterranean and tropical horticulture' (HortiMet), 'Mediterranean and tropical seeds and plants' (SEPMET)	Montpellier SupAgro, CIRAD,Agrocampus Ouest,AgroParisTech
	Sustainable development of horticultural	Sustainable development of horticultural agroecosystems	CIRAD, Univ. Cheick Anta Diop (Senegal)
		Master Européen Développement agricole durable/European MSc – Sustainable development in agriculture (AGRIS MUNDUS)	Montpellier SupAgro, 5 European universities
	Master professionnel (MSc with	Sustainable development and management – Specialization 'Rural areas and local development'	UM3
	professional scope)	Territorial development and projects	CIHEAM-IAMM

Short training-education programmes

Institution	Title
	Understanding family farming through a systemic approach (4 weeks)
Montpellier SupAgro	Working with agricultural and rural organizations (2 weeks)
	Family farming and development policies (3 weeks)
	Co-constructing support services with/for family farming: agricultural advisory services (3 weeks)
	Co-constructing support services with/for family farming: rural and agricultural funding (3 weeks)
	Constructing agricultural and rural training (I week)
CIRAD	Pastoralism: societies and territories (2 weeks)
	Tropical aquaculture (2 weeks)

5 Family farming

List of acronyms *and abbreviations*

AFD	French Agency for Development / Agence Française de Développement
AIRD	Inter-institutional agency for research and development Agence inter-établissements de recherche pour le développement (France)
ANR	French National Research Agency / Agence Nationale de la Recherche (France)
CGIAR	Global agricultural research partnership for a food secure future
CIHEAM-IAMM	International Centre for Advanced Mediterranean Agronomic Studies – Montpellier Mediterranean Agronomic Institute / <i>Centre International de Hautes Études</i> <i>Agronomiques Méditerranéennes – Institut Agronomique Méditerranéen de</i> <i>Montpellier</i>
CIRAD	Agricultural Research for Development / <i>Centre de coopération internationale en recherche agronomique pour le développement</i> (France)
CNRS	National Center for Scientific Research <i>Centre National de la Recherche Scientifique</i> (France)
EMBRAPA	Brazilian Agricultural Research Corporation Empresa Brasileira de Pesquisa Agropecuária
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FFEM	French Global Environment Facility / Fonds Français pour l'Environnement Mondial
IFAD	International Fund for Agricultural Development
IFREMER	French Research Institute for Exploitation of the Sea Institut Français de Recherche pour l'Exploitation de la Mer
INRA	National Institute for Agricultural Research Institut National de la Recherche Agronomique (France)
INTA	Institute of Agricultural Technology Instituto Nacional de Tecnología Agropecuaria (Argentina)
IRD	Institut de recherche pour le développement (France)
IRSTEA	National Research Institute of Science and Technology for Environment and Agriculture / Institut national de recherche en sciences pour l'environnement et l'agriculture (France)
NEPAD	New Partnership for Africa's Development
PP	Platforms in Partnership for research and training
UAG	University of the French West Indies and Guiana <i>Université des Antilles et de la Guyane</i> (France)
UM1	Université Montpellier 1 (France)
UM2	Université Montpellier 2 (France)
UM3	Université Montpellier 3 (France)
UMR	Joint research unit / Unité mixte de recherche
UPR	Internal research unit / Unité propre de recherche
UPVD	Université de Perpignan Via Domitia (France)
UR	Université de La Réunion (France)



The Dossiers d'Agropolis International series is a deliverable of Agropolis International that is produced within the scope of its mission to promote expertise of the scientific community.

Each Dossier is devoted to a broad scientific theme, and includes a clear overview that is a ready reference for all laboratories and teams associated with Agropolis International that are conducting research on the target theme.

This series is meant to boost the awareness of our different partners on the expertise and potential available within our scientific community, but also to facilitate contacts for the development of scientific and technical cooperation and exchange.

For further information: www.agropolis.org/publications/thematic-files-agropolis.php

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