Farming and livestock production systems

Family 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

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 fulfill 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.

Fabrice Le Bellec, fabrice.le_bellec@cirad.fr

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.

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 agroecological 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; above-ground 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.

© Y. Biard

A recent orange orchard in Guadeloupe.

The steep slopes prevent mechanical weed control, which is why herbicide treatments are systematically carried out.
The ABACO project—Agroecology-based aggradation-conservation agriculture

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.

Éric Scopel, eric.scopel@cirad.fr
For further information: http://abaco.act-africa.org
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.

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. ***
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:

1. creation of a family farm producing food crops for both self-consumption and marketing
2. development of a palm plantation through food crop sales, sometimes supported by a project
3. 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
4. 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’…

Sylvain Rafflegeau, sylvain.rafflegeau@cirad.fr

Different crop histories of village palm plantations in Cameroon

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.

Bénédicte Chambon, benedicte.chambon@cirad.fr

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

Later collection after tapping in a family rubber plantation.

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
- analysing the adaptation strategies of rubber growers to global change.

Bénédicte Chambon, benedicte.chambon@cirad.fr
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 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.

- 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.)**.

* 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.

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/CEAM-IAMM/CIRAD/IRD/IRSTEA/Montpellier SupAgro)
70 scientists

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

...continued on p. 28

---

* Arbuscular mycorrhizal fungi.
> Rhizobium nodules.
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 women’s 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 x 4 x 4 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.).

Robin Duponnois, robin.duponnois@ird.fr

▼ 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).

Family farms in this informal sector are mainly located around Cairo or in the Nile 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—at 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).

Véronique Alary, veronique.alary@cirad.fr

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 agroecosystems in favourable or harsh hot region environments. Due to the extreme constraints, these systems question the suitability of ecological intensification forms and methods.

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 billion 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 environment-friendly 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 (actor-network 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 public-private partnerships.

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

Olivier Mikolasek, olivier.mikolasek@cirad.fr

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

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.

Olivier Mikolasek, olivier.mikolasek@cirad.fr

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

*A 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 sector—from 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 variability—in order to:
- control dynamic food quality-building 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 small-scale 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.

Dominique Pallet, dominique.pallet@cirad.fr
For further information: www.after-fp7.eu

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

Véronique Chevalier, veronique.chevalier@cirad.fr
& Flavie Goutard, flavie.goutard@cirad.fr

** Research for Evaluation of Avian Influenza Surveillance in South East Asia: www.grasse-network.org/main-projects/on-going/revasia

© V. Chevalier

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

A Khmer farmer and her buffalo in Svay Rieng province, Cambodia.
**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 Eco&Sols: *Hevea/Pueraria phaseoloides*, 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.

_Cathy Clermont-Dauphin, cathy.clermont@ird.fr_  
_Nopmanee Suwannang, nopmanee_su@hotmail.com_  
_Claude Hammecker, claude.hammecker@ird.fr_  
_Jean Delarivière, delarivi@gmail.com_  
_Jean-Luc Maeght, jean-luc.maeght@ird.fr_  
&_ Henri Robain, henri.robain.ird@gmail.com_

---

**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™ Melkès, 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.

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.

_Maya Benouniche, maya.benouniche@gmail.com_  
&_ Marcel Kuper, marcel.kuper@cirad.fr_

*Institut Agronomique et Vétérinaire Hassan II, Morocco*  
**École Nationale d’Agriculture de Meknès, Morocco**
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&SE) and partners in this project. Assisted natural regeneration (ANR) was used to improve slash-and-burn 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.

Régis Peltier, regis.peltier@cirad.fr
Émilien Dubiez, emilien.dubiez@cirad.fr
For further information: http://makala.cirad.fr/le_projet

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

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