Just as with other innovations in agriculture, the successful dissemination of CA systems depends on the training of local farmers and the integration of their knowledge, the training of extension agents in agronomy and methodological questions, the organization of local stakholders as well as the technical and economic empowerment of farmers (e.g., systems requiring less use of chemical inputs). The support needs here are therefore enormous, in particular during the first years and are actually amplified by the relative complexity of CA systems and the break with traditional practices of smallholder farmers.

Proactive public policies and adequate funding are therefore indispensable to the large-scale dissemination of the innovative techniques and require the involvement of a broad range of local and international players.

Contacts

- Jean-Luc François, **francoisjl@afd.fr**
- José Tissier, **tissierj@afd.fr**
- Jean-Claude Legoupil, **legoupil@cirad.fr**
- Florent Maraux, **maraux@cirad.fr**

Conclusion

Through collaborative efforts between AFD and CIRAD it was possible to demonstrate the potential of CA systems and their interest in the developing countries who face varying ecological, economic and sociological circumstances: smallholder farmers could take avantage to embrace them.

Today, the diversity of available CA cropping systems should allow us to address the technical issues for many of the bottlenecks encountered in tropical conditions. Obviously, some of these systems will still need to be adapted either through flexible incremental adaptation with the farmers or through more radical modifications designed to respond to emerging challenges (e.g., climate change, emergence of new diseases, development of new markets, etc.). This might require the integration of other agro-ecological mechanisms (e.g., development of repulsive plants based alternatives to chemicals products for pest management).

Obviously these innovative systems will need to undergo a thorough impacts study as this is the only way to obtain critical analysis on the technical solutions proposed, their long term effects, how they can be replicated and the possibility of generalizing them.

In addition, for a larger and more rapid dissemination of CA among smallholder farmers in the developing countries, it will be necessary to work towards a better integration between individual fields scale, farms scale and the territory scale. It is only through this kind of multi-scale integration that we can hope to influence the conditions of adoption and implementation of these innovations. The above are some of the new challenges—and they call for long term commitment, flexibility and, hence, sustained support from research organizations, funding institutions and political leadership. In this regard, CIRAD and AFD continue to work together to support national rural development agencies working on CA by combining experimentation with innovative solutions, their analysis (monitoring, etc.) and promotion of dialogue among actors. The widespread adoption of agro-ecological systems in the developing countries will, in the end, come through a more systematic sharing of relevant findings and experiences among different networks around the world but also through a tighter integration between research and development support institutions.

www.afd.fr **www.cirad.fr**

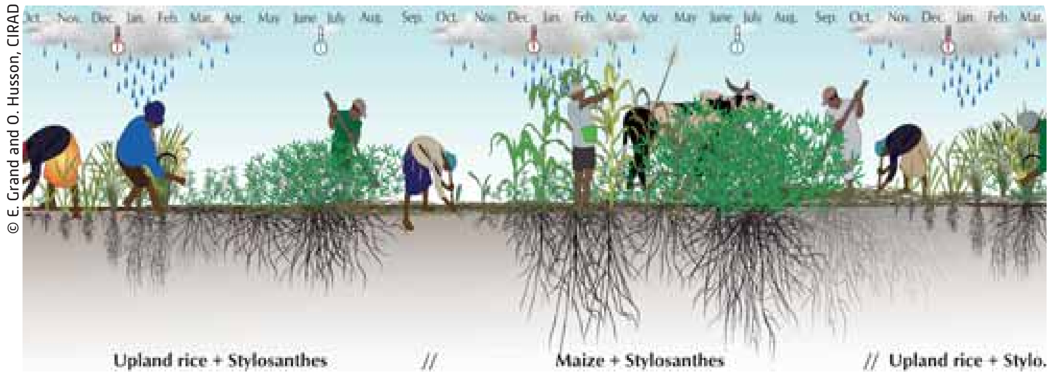
cirad AGRICULTURAL RESEARCH FOR DEVELOPMENT

afd AGENCE FRANÇAISE DE DÉVELOPPEMENT

Conservation agriculture and ecological intensification of small scale farms in the tropics

Opportunities for partnership between research and development

CIRAD, AFD, September 2011



Example of annual cereal cropping system (rice, maize): close management of Stylosanthes guianensis *as cover crop.*

As has been underlined by the UN Right to Food Special Rapporteur, Olivier de Schutter, the principal route to feeding an increasing population and to mitigating climate change, in particular in the developing countries, is assisting smallholder farmers in agricultural development and especially with the promotion of agro-ecological farming practices.

It is with this mindset that AFD (a funding institution) and CIRAD, French Agricultural Research Centre for International Development, have been working together for more than ten years towards the development of Conservation Agriculture (CA) systems, in particular in Madagascar, Laos, Cambodia and Cameroon.

Conservation agriculture as one of the options for agro-ecological intensifications (others are agroforestry or organic farming for example), targets mainly the integrated management of soil fertility. It is founded on three principles as defined by FAO: minimal soil disturbance, permanent soil cover and crops rotations. In the tropics, CA is practised for the most part in countries with highly mechanized agriculture (e.g., Argentina, Brazil, Australia, etc.). Indeed, no tillage brings substantial cost savings while the use of specialized equipment (e.g. planting machines) and herbicides facilitate management of crops and mulch without crippling additional costs for such big farms.

The situation is entirely different in the smallholder farms of the developing countries where the implementation of such systems requires profound changes in their organization as well as in theoretical and technical knowledge which is still not easily accessible to local extension workers and farmers. The magnitude of the change implies a risk that is still too important for farmers already living in extremely difficult economic situations.

Promoting CA under these conditions is therefore only possible through a long term partnership between research and development, a thinking that clearly underlies the collaborative efforts between AFD and CIRAD.

Adaptability, flexibility and participation of farmers: **three prerequisits for success**

Maintaining, or restoring soil fertility represents a major challenge in the tropical countries. The intrinsic fragility of these soils, the rate of decomposition of organic matter and a population pressure that has led to a reduction of fallowing periods lead to yield decline.

This has led to low yields very quickly, even after exploiting new agricultural lands.

That's why CIRAD has developed several soil fertility management systems based on Conservation Agriculture in different agro-pedo-climatological zones.

Compared to the Green Revolution that was founded essentially on the intensive use of external inputs, the goal today is to improve the ecological efficiency of agro-ecosystems by optimising natural bio-geochemical processes. This makes it possible to envisage a wide range of technical solutions to address the principal biophysical constraints of each situation. These techniques rely on the rotation of crops cultivated, the use of multipurpose plants and the efficient use of different types and varying quantities of agricultural inputs.

In Madagascar, cropping systems based on the use of *Stylosanthes guianensis* have been developed in all of the agricultural zone below 1200 m of altitude, irrespective of soil type. Stylosanthes happens to combine high nitrogen fixation, soil decomposition and weed control (especially Striga asiatica) capabilities with the capacity to also serve as source of fodder for cattle. It permits, in particular, to rapidly improve soil fertility. Stylosanthes-based cropping systems can be quite flexible and can be applied both to smallholder family manual farming operations involving little or no external inputs and to highly mechanized intensive agricultural operations. They can be initiated on very poor soils in association with cassava or directly with staple grains (e.g., rice, maize, etc.) on richer soils or with an initial application of fertilizers. The simplest systems to implement allow for the production of grains every other year. A higher frequency of grain production is possible with tighter management and the involvement of more inputs.

Rice on a Stylosanthes guianensis *plant cover.*

© O. Husson

However, the efficiency of CA systems depends on the successful activation of underlying ecological functions. The more limited the access to external inputs, the more the performance of CA will depend on the efficiency of biological processes that are sometimes difficult to understand and control by farmers (e.g., atmospheric nitrogen fixation, recycling of nutrients, etc.). The three principles of CA were designed precisely to activate these processes but, unfortunately, farmers have difficulties systematically adhering to all of them, all the time.

Farmers have to deal with numerous technical conflicting choices (e.g., weed management without tillage, maintaining soil cover in common grazing land systems, etc.) and have limited room for manoeuvre. In fact, farmers may be obliged sometimes to opt for suboptimal operational management from the standpoint of the ecological and agricultural efficiency of CA systems.

It is therefore necessary—and that's where research comes in—to measure the consequences of such management, to identify the lower threshold beyond which the effectiveness of the system and its main agroecological functions can no longer be guaranteed and dysfunction risks increase to risky levels dysfunctionning occurs (e.g., the percentage cover necessary for weed or erosion management). Research must finally suggest adaptations keeping undesirable consequences under control (e.g., integrating plants with allopathic effects on weeds or modifying spatial arrangements so that plants cover can make up for shortfalls in mulch).

The collaborative efforts between AFD and CIRAD, as well as interactions with different development projects in this regard have provided opportunities to work under farmers' conditions and to gain efficient interaction with them. The latter are thus increasingly participating in the development of research questions and tools as well as the multi-criteria analysis of the effects of these innovative techniques. They are also contributing actively to the adaptation of the innovative CA techniques which enhances their dissemination.

Flexibility, diversification and adaptability need to be the watch words in the creation of these new CA systems. For example, soil cover plants used in CA can render other services (e.g., integrated disease and pest control) that transcend the question of soil fertility. In a multi-criteria approach, the systematic non-respect of the three CA principles should therefore not necessarily be totally inhibiting provided other services are better covered.

Similarly, a better integration of conservation agriculture and animal husbandry, omnipresent in the tropics, should be the target in order to take advantage of co-benefits offered by such integration to improve the acceptability and sustainability of the CA systems. Some cover crops are also excellent fodder (e.g., *Brachiara* sp. and *Stylosanthes* sp.) and, thus, can bring quick returns on investment and an improvement of the animal production. This is the case with milk production in the Malagasy Highlands. Reciprocally the use of organic manure is also useful to compensate the lack of fertilizers when these are not available and ensure a better functioning of CA systems.

Finally, researchers have still many things to discover on the biological processes underlying soil fertility. Because CA is less disruptive of soil profile and functioning than conventional agriculture, it should provide the ideal framework for a better mobilization of these processes in the future.

It is with these new orientations that researchers began to modify their approach in order to offer more flexible and productive systems that address the immediate concerns of farmers while at the same time being less risky. In fact, with the exception of a few specific cases (e.g., the Malagasy Midwest with its *Stylosanthes*/uplandrice system), AFD/CIRAD experience shows that the rate of dissemination of proposed CA systems has been in most cases low among smallholder farms in the tropics.

A strong need to support and reassure farmers

For the typical small scale farmer, the adoption of agro-ecological techniques represents a major change, both conceptually and from a practical standpoint. It involves taking significant additional risks in an already risky environment—climate-related, economic, political, etc.

This is why partnerships need to be developed with solid local economic actors to help farmers as they adopt these innovations and thus facilitate the dissemination of the same. For example, credit could be extended to farmers for the purchase of inputs, cover crops seeds or particular pieces of equipment (e.g., planters and sprayers). Access to local technical support and, in particular, to markets for their products based on quality norms negotiated upfront, could be enhanced.

In the Kampong Cham Province, Cambodia, the agricultural support programme (or, PADAC) is based on the development of contractual relations between a farmers' organization (CFFO) and an agro-industrial entity specializing in the fodder conditioning (PROCONCO) for promotion of agro-ecological systems based on cassava, maize or soya beans. PROCONCO, which is desirous to strengthen its supply base, both qualitatively and quantitatively, would be willing to advance the funding (up to US$260 per hectare) for the campaign (the Project has guaranteed 30% of the amount of the credit) and to purchase the output at fixed rates (despite the volatility of the price of cassava), with a premium for quality. In addition to being able to access technical support from the Project, participating farmers are thus able to adopt the proposed innovations under rather favourable conditions. The target for the first year was set at 200 hectares for 200 farmers, with a production of 2000 tonnes of cassava and 250 tonnes of maize. The target for the three-year duration of the Project was a total of 8000 tonnes, comprising 80% of cassava and 20% of maize.

© S.Boulakia, Cirad

Mechanical treatment of the cover crop before sowing.

© K .Naudina, Cirad

Technicians and farmers being trained in CA.

In Northern Cameroon, Project ESA (Eau/Sol/Arbre, or Water/Soil/Trees in English) tries to to find organizational solutions to the frequent problem of biomass conservation in the Sudano-Sahel region caused by long dry periods and common grazing. Due to very complex landed property laws and crop residue management system, the enclosure of individual fields can only be a partial solution. To facilitate the dissemination of CA techniques, the project therefore opted for a "community land management" approach based on the establishment of a village consultative framework for ensuring both quantitative dissemination targets, the involvement of all stakholders of the community, the delimitation of zones for specific activities and the development of collective rules for access to crop residues and their conservation. Further, special support is given to stock breeders in order to promote the development of fodder production in the zones set aside for the purpose and, in this manner, reduce pressure on crop residues.
The biomass conservation rate in community lands is 71% compare to only 21% in fields outside the community lands.

This adoption also represents a technological change intensive in knowledge. To take full advantage of the natural ecosystems functions indeed, one has to first understand and manage them. Unfortunately, in the countries where CIRAD and AFD have joint operations small scale farmers and extension workers do not possess the expertise necessary to come to a correct understanding of these biological and ecological mechanisms and to effectively take into account local knowledge for the development of new CA systems.

Support institution working on CA dissemination have often been characterized by top-down approaches that rely heavily on the use of standardized technical packages, at filed level and one agricultural campaign scale. Unfortunately, such methods are hardly adapted to the dissemination of ecological intensification processes.

These approaches are thankfully evolving. While the controlled experiments and controlled demonstration plots remain the main tool at the disposal of CA dissemination structures, more and more on-farm trials (Cameroon, Madagascar) and "farmer field schools" are springing up (Cambodia, Laos, Madagascar). These structures are still mostly managed by extension agents but the time has come to work towards veritable exchange groups that built on local villager structures. It is important to continue to empower farmers so they can become fully fledged participants in the development of these systems.

The circumstances and particular environment of farmers are starting to be better taken into account and this should help address the limitations of the field scale approach. However, the tools employed (simulations of farms trajectories) are currently mainly available in the training of extension agents. Much remains to be improved in the area of the daily practice of providing advice to farmers. For example, in Cameroon, the problem of biomass conservation at field level is approached with the mindset of agriculture/animal husbandry integration, with the stakeholders at the community level being involved.