Agricultures
et défis du monde
Collection Cirad-AFD

Living territories to transform the world

P. Caron, E. Valette,
T. Wassenaar,
G. Coppens d'Eeckenbrugge,
V. Papazian,
Coordinators

éditions Quæ

Living territories to transform the world

Patrick Caron, Élodie Valette, Tom Wassenaar,
Geo Coppens d'Eeckenbrugge, Vatché Papazian,
coordinators

Éditions Quæ

The *Agricultures et défis du monde* (Agriculture and Global Challenges) collection publishes a book every year that showcases Cirad's research into the sustainable development of tropical agricultural systems. It is co-published by Éditions Quæ, AFD and Cirad. The collection is coordinated by Cirad's Patrick Caron.

Cirad (Centre for International Cooperation in Agricultural Research for Development) is a French research centre which, in association with countries of the Global South, tackles international issues of agriculture and development. In partnership with these countries, it generates and disseminates new knowledge to support agricultural development and to inform the debates on the major global issues concerning agriculture, food and rural territories. Cirad has a global network of partners and regional offices from which it conducts joint operations with stakeholders in more than 90 countries.

Cirad
42 rue Scheffer, 75116 Paris
www.cirad.fr

AFD, the French Development Agency, is a public institution that has been working for 70 years to fight poverty and promote development in countries of the Global South and in French overseas departments and territories. AFD implements the French government's development aid policies.

With a presence in more than 50 countries and nine French overseas departments and territories, AFD funds and supports projects that improve the living conditions of local populations, promote economic growth and protect the planet. These projects concern education, maternal health, support for farmers and small businesses, water supply, preservation of tropical forests, the fight against global warming, etc.

Agence française de développement
5 rue Roland Barthes, 75598 Paris Cedex 12, France
www.afd.fr

Éditions Quæ
RD 10, 78026 Versailles Cedex
www.quae.com

 ISBN: 978-2-7592-2731-0

Version française : « Des territoires vivants pour transformer le monde »

 ISBN : 978-2-7592-2654-2

Chapter 11

Co-designing cropping systems and territorial planning

Oumarou Balarabé and Olivier Gilard

The process of co-designing cropping systems consists of participatory development of crop combinations or their successions on the plot, or of technical itineraries optimized for sustainable productivity. Actors participate in the design process through:
– developing and taking into account a participatory diagnosis that will help formulate new technical proposals;
– the involvement of farms in the adaptation phase of technical innovation, in keeping with their own constraints of access to resources and production factors;
– the involvement of all actors in defining new institutional mechanisms to facilitate the dissemination of innovative cropping systems.

From managing fertility to co-designing cropping systems within village territories

Historically, the design of cropping systems has represented a path of innovation that involved technical modifications at the level of the cultivated plot. It was progressively subjected to adaptations at first the farm level and then at the village territory level, in order to accommodate the diversity of situations and constraints at these two complementary scales (Le Gal *et al.*, 2011).

The introduction of agricultural mechanization in sub-Saharan Africa in the 1970s and 1980s led to problems of erosion and lowered fertility of soils. Sustainable soil management initiatives adopted to address these problems initially focused on managing village terroirs[1], with particular emphasis on the need to integrate farming and livestock activities. Subsequently, innovative cropping systems were developed – technical packages tailored to the size of the cultivated plot – resulting in profound changes in the organization of village territories (Balarabé *et al.*, 2012).

1. Concept that corresponds to a village community and its space, and where production of livestock and other natural resources predominate.

The co-designing of cropping systems as a lever for territorial transformation

The co-designing of cropping systems is based on a preliminary analysis of physical and human environments. The characterization of the physical environment (climate, soil types, water regime, etc.) aims to identify, with the actors concerned, transferable technical solutions (cropping systems) capable of addressing the environment's constraints. A diagnosis of the human environment (socio-cultural organization, typologies of farms, sectors and markets, etc.) is necessary to understand collective constraints in relation to the context. This diagnosis is a prerequisite for setting up a concertation framework (or arenas for innovation) in which local actors can discuss institutional arrangements that complement the adoption of innovative cropping systems. It thus appears that if we start with a process of co-designing of cropping systems, the territory can be modified by new institutional arrangements between actors.

The conception of cropping systems, as it relates to crops and technical itineraries, thus appears to be an element of transformation and planning of the village territory. It is as if the planning of village territory – at one time achieved through a concerted management of the territory and its resources (purely organizational innovation) – is triggered by a technical innovation which, through the organizational and material changes produced, results in a modification of landscape elements.

Concerted land planning as a prerequisite for co-designing cropping systems

The adoption of soil conservation practices is confronted by a key problem of divergence between the private interests of actors and the collective interests of society. In developing countries, this divergence is exacerbated because property rights pertaining to the land and its produce are poorly defined. In Sahelian regions, where agricultural lands are common resources, concerted planning of rural spaces and natural resources is a prerequisite for any innovation affecting the organization of agricultural and livestock activities.

Such is the case in pastoral areas in Niger and Burkina Faso, where endogenous rules have defined pastoral areas – including paths to access them – and modalities of transferring fertility between agriculture and livestock breeding activities, thus paving the way for promising technical innovations such as forage production. In general, a concerted planning of agro-pastoral territory necessitates the provision of the following within the common space:

- spaces reserved for feeding herds (agro-pastoral area);
- area for penning livestock (pastoral areas) and cattle tracks;
- agricultural spaces, with defined allocation of residues (*in situ* conservation or for other use).

This organizational innovation has to precede the dissemination of innovative cropping systems that make up the technical innovation component (Ruttan, 2006).

This collective management of the territory, involving the design of innovative cropping systems, has the dual objective of increasing the total productivity of the resources produced (e.g., crop biomass) and of optimizing its use between the different actors in the territory.

Box 11.1. Case study: co-designing direct seeding and mulch-based cropping systems and management of territories in North Cameroon

Conservation agriculture is based, at the same time, on three principles:
- minimal tillage;
- maintenance of a permanent cover;
- appropriate crop associations and rotations.

These principles together contribute to biological soil management, and ensure ample crop productivity and conservation of the soil capital (Séguy *et al.*, 2006).

In the cotton-growing areas of North Cameroon, co-designed cropping systems in conservation agriculture exhibit a wide range of variation depending on the agro-ecological environment, the types of farming and the local collective organization. They include forage mulch-based cropping systems, degraded-soil restoration cropping systems, low-fertilizer cropping systems, and so on.

In the process of co-designing cropping systems in North Cameroon, a specific concertation approach within pilot terroirs, based on agro-pastoral diagnoses, took the diversity of territorial dynamics in the area of intervention into account. Thus, for example, in the agro-pastoralists's terroir in Sirlawé, the fields surrounding the village, traditionally used for continuous cultivation of cereals and for livestock penning, were converted into forage cultivation in association. The other surrounding lands, whose fertility declines as the distance from the village increases, were used for conservation agriculture tailored to restore degraded soils. A concerted planning of the territory enabled space distribution and livestock movement over time.

In the terroir of Laïndé Massa, where sedentary livestock breeders and farmers coexist, the co-design of cropping systems required a continued concertation between the two communities. Supplementary forage cultivation was taken up in association with cereals in the home territory of the livestock breeders. The adjoining plots, used by farmers, were traditionally reserved by the community for agricultural activities in the rainy season, and for range pasturing in the dry season. These plots were divided into pasture lands and clearly defined conservation areas, which helped meet the increased requirements of livestock herds during the dry season, while preserving crop residues for soil cover.

(Based on Naudin *et al.*, 2010).

Perspectives for land use planning using cropping systems

There is considerable flexibility in the design of innovative cropping systems for the purposes of territorial planning. We suggest some possibilities.

Landscape planning

The mechanization of production systems is leading to the gradual disappearance of trees from agricultural landscapes. The renewed interest in ecosystem services provided by various shrub species, as well as the role trees can play in mitigating the effects of climate change, are proving to be major factors in their return. Co-designing specific agroforestry systems to address this need holds great promise and can ultimately lead to the sustainable re-integration of trees into cultivated plots, and thus to a new form of territorial planning. Examples include the *Faidherbia albida* parklands, shaping the village landscape in sub-Saharan Africa, and agroforestry in agricultural systems in Vietnam.

Integration of agriculture and livestock husbandry within the territory

Although the intensification of cropping and livestock systems has often been thought out in a completely compartmentalized manner, a co-designing approach to cropping systems may open up new perspectives of integration, such as the introduction of associated forage plants or of feed-grade plots on degraded lands, coupled with innovative planning of spaces and movement of livestock herds that promotes optimal dispersion of manure. Livestock penning contracts and forage management offer solutions to help integrate agriculture and livestock husbandry, and the optimization of material flows.

Watersheds and water resources management

Constraints resulting from inadequate availability of water for irrigated rice farming have very often been addressed by the construction of expensive water retention infrastructure with its associated maintenance costs. A new approach to the design of alternative cropping systems for irrigated and rainfed rice cultivation led to several proposals: intermittent irrigation rice systems (alternate wetting and drying), minimally irrigated intensive rice irrigation systems, and conservation agricultural systems adapted to inadequately irrigated rice fields. These approaches could eventually generate new practices for water management and irrigated perimeters, and result in new watershed planning methods (Husson *et al.*, 2015).

Optimization in the use of landscape units

Despite the low productivity of agricultural production systems in developing countries, large tracts of land remain poorly utilized or under-used. Examples include the *tanety* or slopes of degraded hills in Madagascar, the *harde* (sterile halomorphic and sodic soils of North Cameroon) and hydromorphic vertisols (dedicated to the off-season cultivation of photoperiodic sorghum in the Lake Chad area). An approach of co-designing innovative and adapted cropping systems can lead to different uses of these soils. For example, bringing the *tanety* and *harde* under cultivation, by applying agroecological techniques based on a combination of more hardy cover crops with adapted root systems, can divert the pressure from livestock herds to such landscape units.

Multifunctionality of rural areas

In the case of Laos, the development and dissemination of these systems has been supported by several successive projects financed by the French Development Agency (AFD): Xayabouri, Pronae, PCADR, Eficas Project, etc. This approach was complemented by taking into account different units of village terroirs, permitting, for example, the cultivation of a cash crop in addition to a rice crop for self-consumption or to a livestock husbandry activity. This functional diversity is part of the villagers' strategy to derive value from spaces available to them.

Thus, the agricultural territory fulfils functions other than its initial function of production. This is especially true when environmental services are integrated, especially those pertaining to the management of water resources, as in case of erosion control upstream of reservoirs.

Finally, the dissemination of co-designed systems also requires that farmers be supported during the transition. The introduction of such a type of innovation represents a real risk that they are often incapable of managing on their own. In Cambodia, for example, there are plans to initiate projects on large territorial units based on the establishment of irrigated perimeters.

References

Balarabé O., Dugué P., Lifran R., 2012. Capital sol et innovation institutionnelle. *Économies et sociétés*, 34, 1927-1944.

Husson O., Hoá T.Q., Boulakia S., Chabanne A., Tivet F., Bouzinac S., Lienhard P., Michellon R., Chabierski S., Boyer J., Enjalric F., Rakotondramanana, Moussa N., Jullien F., Balarabé O., Rattanatray B., Castella J.C., Charpentier H., Séguy L., 2015. Co-Designing Innovative Cropping Systems That Match Biophysical and Socio-Economic Diversity: The DATE Approach to Conservation Agriculture in Madagascar, Lao PDR and Cambodia. *Renewable Agriculture and Food Systems*, 31 (5), 452-470.

Le Gal P.-Y., Dugué P., Faure G., Novak S., 2011. How Does Research Address the Design of Innovative Agricultural Production Systems at the Farm Level? A Review. *Agricultural Systems*, 104 (9), 714-728.

Naudin K., Goze E., Balarabé O., Giller K.E., Scopel E., 2010. Impact of No Tillage and Mulching Practices on Cotton Production in North Cameroon: A Multi-locational On-Farm Assessment. *Soil & Tillage Research*, 68-76.

Ruttan V.W., 2006. Social Science Knowledge and Induced Institutional Innovation: An Institutional Design Perspective. *Journal of Institutional Economics*, 2 (3), 249-272.

Séguy L., Bouzinac S., Husson O., 2006. Direct-seeded Tropical Soil Systems with Permanent Soil Cover: Learning from Brazilian Experience. *In: Biological Approaches to Sustainable Soil Systems* (Uphoff N., Ball A.S., Fernandes E., Herren H., Husson O., Mark M., Palm C., Pretty J., Sanchez P., Sanginga N., Thies J., eds.). Boca Raton (Florida), CRC, 323-342.