Assessing learning regimes leading to sustainable intensification at the farm level: a new perspective for management assistance for family farms

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Abstract: To help design advisory approaches tailored to farmers' needs, we propose to highlight the different learning processes that lead to more sustainable farms. To this end, we have defined the concept of 'learning regime' as the set of mechanisms that are triggers for and lead to the acquisition of new knowledge and skills, allowing the head of the farm to improve his production and management methods. This concept has been tested in the cotton-growing basin of Bobo-Dioulasso in 30 farms considered innovative in five technical areas related to environmental sustainability. The results show that there are four different types of regimes (transformer-observer, reactive-networker, optimizer-self-reliant and imitator-dependent). These results call into question the assumption of homogeneity of farmers' capacities to change their routines to acquire new skills and know-how. However, given that the nature of technical changes implemented is heavily influenced by the informational context in which the producer operates, supporting the learning of sustainability calls into question, in particular, the ability to empower farmers' vis-à-vis this context. While this work's contributions are currently mainly conceptual and methodological, it opens up new perspectives to improve processes and tools to support the emergence of a more sustainable agriculture.

Keywords: learning regime, family farm, sustainable intensification, Burkina Faso

Introduction

Facilitating learning by rural actors is increasingly being recognized as a guarantee of sustainable rural development, innovation and adaptation to rapid changes affecting rural territories (Deugd *et al.*, 1998; Darnhofer *et al.*, 2010a). It is no longer a matter of getting farmers to adopt new techniques designed elsewhere but to help them formulate their problems themselves and to seek solutions most appropriate to their situation and to issues of sustainability. Developing such capabilities requires, in particular, a strengthening of the dynamics of learning (World Bank, 2007). Yet, as has already been pointed out by Röling and Van de Fliert (1994), learning processes for famers which would help them design and implement more sustainable forms of agriculture are poorly understood.

Several authors have shown that learning of sustainability requires changes in values, representations (Burton, 2004; Keen *et al.*, 2005; Wals, 2009), goals (Blactstock *et al.*, 2009; Lankester, 2013), or even skills (focused more on management and entrepreneurship, see Seppänen, 2001; Lamine *et al.*, 2009; Weill-Fassina and Pastré, 2004). Each of these changes involves different learning mechanisms. Chantre (2009) shows that it is the combination of self-learning and group learning that seems to make possible changes in evolutionary trajectories to respond to exhortations to reduce pesticide use. Studies on sustainability – Marschke and Sinclair (2009) or

Darnohfer *et al.* (2010b) among others – show the importance of participatory and collaborative learning experiences in developing confidence, encouraging dialogue, and in urging individuals to be critical of their own and others' methods and perceptions of the world.

However, there are few studies that attempt to establish or to generalize causal links between a learning process – or a combination of them – and a type of change leading to greater sustainability. In-depth, context-specific studies based on small samples, such as those of Chantre (2009) and Lankester (2013), are still needed, in order to identify a theoretical model with a more generic scope. In continuation of this work, we try here to formalize the diversity of learning mechanisms on farms which lead to technical or managerial changes. The question is: Are there specific ways to learn to conduct changes which lead to greater sustainability? To answer it, we have chosen to focus on 'learning regimes' which we have defined as the set of mechanisms that are triggers for and lead to the acquisition of new skills to implement new ways of managing farm and producing. In order to define these learning regimes, we proceeded in two steps. First, we explored the literature to identify key variables which help describe these regimes. We built on the existing work on learning in farms, using theories of adult learning, on the one hand, and evolutionary approaches to business innovation, on the other. Second, we refined our analysis model by testing it on 30 farms in the cotton-growing area of Burkina Faso. All these farms are considered innovative in the implementation of their agricultural practices.

We first present our analysis framework for learning regimes that encourage sustainability. We then present the outcomes in two stages: 1) the diversity of learning regimes in connection with the technical and managerial changes implemented, and 2) the factors related to the profile of the learner and to the informational context that can influence these regimes. We then discuss the validity of our analysis model, the perspectives for improvement and for the use of the results to improve approaches and tools to support the dynamics of learning of sustainability in family farms.

Analysis framework

To propose a concise overview of the different dimensions of learning (what, why, how), we choose to define the concept of 'learning regime'. A learning regime is the complete set of mechanisms that are triggers for and allow the acquisition of skills to implement new ways of conducting one's system of activity.

We align ourselves with cognitive approaches – evolutionary and skills theories – that highlight the crucial role of learning mechanisms to understand the productive trajectories of firms and the foundations of technical change. Learning is seen as an organized and voluntary process. It is based on repetition and experimentation which ensure that tasks are performed with greater ease and speed, and thus allow the identification of new production opportunities (Dosi *et al.*, 1990). This is accompanied by a building up of skills, defined as the expertise and knowledge gained over time (Richardson, 1972). Routines (repetitive model of action, Nelson, Winter, 1982) which are expressions of the firm's skills can be improved and transmitted through the sharing of experiences (Dosi, 1988). The nature of the skills acquired depends on the different institutional, geographic, and relational spaces (Lundvall, 2005) in which the firm is evolving.

This model, when applied to the farm, allows us to define the coherence of a learning regime based on the following three mechanisms:

- Trigger factors: *why* is the farmer learning? We consider learning to be voluntary. It can be initiated either because the farmer is 'alert' (Chantre, 2009) to any problem that may arise and require a solution or because there is a learning opportunity (with availability of information

or knowledge at low cost, as part of a project to support development, for example, or an informal discussion).

- The manner of learning or the *learning style* (Kilpatrick & Johns, 2003): *how* is he learning? The learning style encompasses both the nature of the source of the knowledge and the process's temporality: either it is a matter of through the learner's own experience in a continuous process, whose start and end are difficult to pin down, or it is through a source of exogenous information, one-time, as in a training session, an exchange visit, a discussion with someone, which then requires an appropriation before it can be applied.

- The *outcome* of the learning: the nature of the resulting change in the farm's functioning. We deem three types of changes as relevant. The first is a change in agricultural practices, without impact on the overall functioning of the farm. This normally corresponds to fine-tuning or optimization of the farm's activities. The second is a systemic change corresponding to a change in the farmer's objectives and his routines of organizing his productive activities (stopping cultivation of a particular crop, introduction of new activities, etc.). An analysis of the steps of the trajectory of evolution helps judge whether the change is systemic or not. The third change is of the farmer's 'frame of reference' itself, i.e., of all his representations and assumptions resulting from acquired experience and which orient his perception of experiences to come. This is what Mezirow (1991) calls transformative learning. A farmer's frame of reference may, for example, be his understanding and knowledge of practices for managing his farm, or his ability to interact with others and build learning networks. We consider that such learning leads to a change even of methods of learning and therefore of the learning regime.

Finally, we consider that the learning regime is conditioned by the 'learner profile', which comes close to what Kolb defines as the intrinsic psychological and cognitive characteristics of the individual which determine his preferred way to learn (whether through practical experience or through active conceptualization). To describe this profile, we initially rely on the key variables identified in previous studies on farmers' profile: age, ethnicity, years of experience and capital owned. This last can help the learner's ability to invest in the experiment, both on the physical level as on the psychological. We contend that this profile may vary over time when transformative learning takes place.

Figure 1: Analysis framework for learning regimes
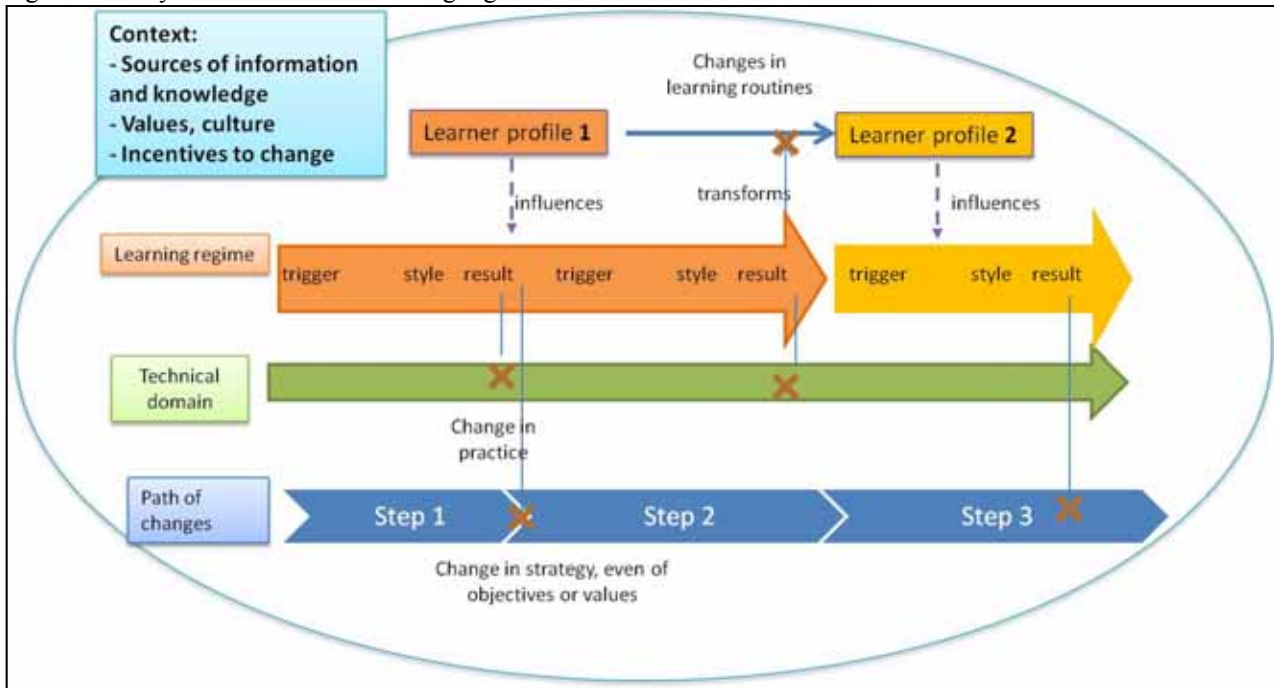
To summarize, a learning regime is constructed by combining two points of view, that of the farmer (emic view) and that of the researcher or the person evaluating the regime (etic view). Triggers, the style and the outcome are described by the farmer. The learner's profile is described by the researcher, through descriptive variables, in order to test the importance of certain factors in the development of different types of learning regimes that will be identified. Figure 1 presents all the concepts, levels and factors mobilized to characterize a learning regime.

Methods

To validate and refine our analysis model, we selected 'case studies', that is to say a set of farms, which are notable in their ability to innovate and to be more sustainable than others. Given the influence of the informational context and of the learning profile on the learning regimes, we chose these farms according to two criteria: 1) their geographical location, in villages with similar agro-ecological contexts, but with differentiated informational contexts; 2) Certain structural characteristics (age and origin of the head of the farm, surface areas, cropping and livestock rearing systems, equipment level).

Three study sites

Three villages were selected in the Koumbia department as a function of their accessibility to information and to new knowledge originating from support which was external to the village (project for development support, presence of advisors and technicians). These villages are distinguished mainly by the intensity of external interventions, the topics promoted being similar throughout the department or even the province. They mainly concern: the use of improved seeds, the introduction of fodder crops for livestock, diversification of food crops (maize, sesame, rice, soybeans), planting of orchards and trees for wood, use of manure, phytosanitary treatments of cotton, and land management (valley bottomlands for vegetable gardening, stone barriers). Occasionally, we may note some contradictions in technical messages (for example, at the same time as the promotion of the 'Operation 100,000 Ploughs', some advisors were recommending minimizing tillage to avoid soil-erosion phenomena). Currently the main convergences between the messages from technicians and advisors (livestock rearing, forests, agriculture, cotton) focus on the need to do more with fewer resources: favouring well-maintained small plots, small healthy herds, rational use of inputs, limited use of pastures and forests, and valorising of crop residues.

In part due to the differential access to these advisory messages, farmers in the three villages are in differentiated informational situations. This should permit the evaluation of the role of projects and the nature of relationships with various advisors in the perception of incentives to change.

Criteria for identifying farms that are innovative and 'more sustainable' than others
In order to identify farms that are innovative and 'more sustainable' than others, we relied on a combination of two information sources:

- Data from surveys conducted in farms in the area provided information on their structural characteristics and the existence of practices and new production systems in the region. This data was compared with the standard farm trajectories in the region provided by the grey literature (Blainville and Dufumier 2009).
- Discussions in each village with key resource persons helped refine the selection with respect to their own perceptions of innovative practices implemented that allow producers to 'do better than others'.

In the cotton-growing basin, there coexist a variety of farms which differ mainly in terms of cotton's place in their production systems (not present, dominant, opportunistic, or in the process of being abandoned), the place of livestock farming in productive activities (dominant or marginal), and the importance of non-farm activities. The reference model we have used is the dominant one in which the farm still remains a cotton farm. In this model, maize is associated with cotton in short rotations without fallow; it follows the recommendations of the cotton producers' group (CPG). The main sustainability issues that arise are environmental and economic ones: lowering of yields and of available surface areas, which result in a more intensive use of synthetic pesticides and therefore in additional costs and even indebtedness. It is the deviations from this model that we sought. Interviews with key resource persons helped identify five areas of technical innovation which lead to greater sustainability: diversification of the cropping system, diversification of the activity system, leveraging livestock rearing for crop farming, management of soil fertility, pesticide use, and management of the environment.

Ten farmers were selected in each village, after making sure that each farmer had implemented technical or managerial innovations and that their learner profiles were varied enough to ensure a broad diversity in our case study.

Data collection
Farm interviews were conducted in two stages:

- A first semi-structured interview used the life-narrative interview technique, allowing the farmer to describe the main stages of evolution of his farm and the major changes he has made. This allowed the reconstruction of the paths of evolution of the farm, and the changes in objectives or strategies that underpinned the transition from one stage to another. For each change made in connection with one of the five pre-identified technical domains, a detailed description regarding the learning process was requested by asking two questions: Why did he make this change? How did he do it? In other words, what had he to relearn in order to implement this change? What were the main sources of learning that he used?

- A second interview, more close-ended, aimed to identify the 'learner profile' (perception of learning, behaviour when confronted by problems and when searching for solutions, assessment of training experiences and participation in projects, difficulties regarding the technical recommendations made to him, preferred information sources). This interview technique is more difficult for the producer since it is more theoretical and it involves the expression of difficult-to-identify tacit knowledge. The ease with which the producer responds is an indication in itself of his ability of conceptualization.

Results
Simple and transformative learning regimes

Figure 2: The four learning regimes
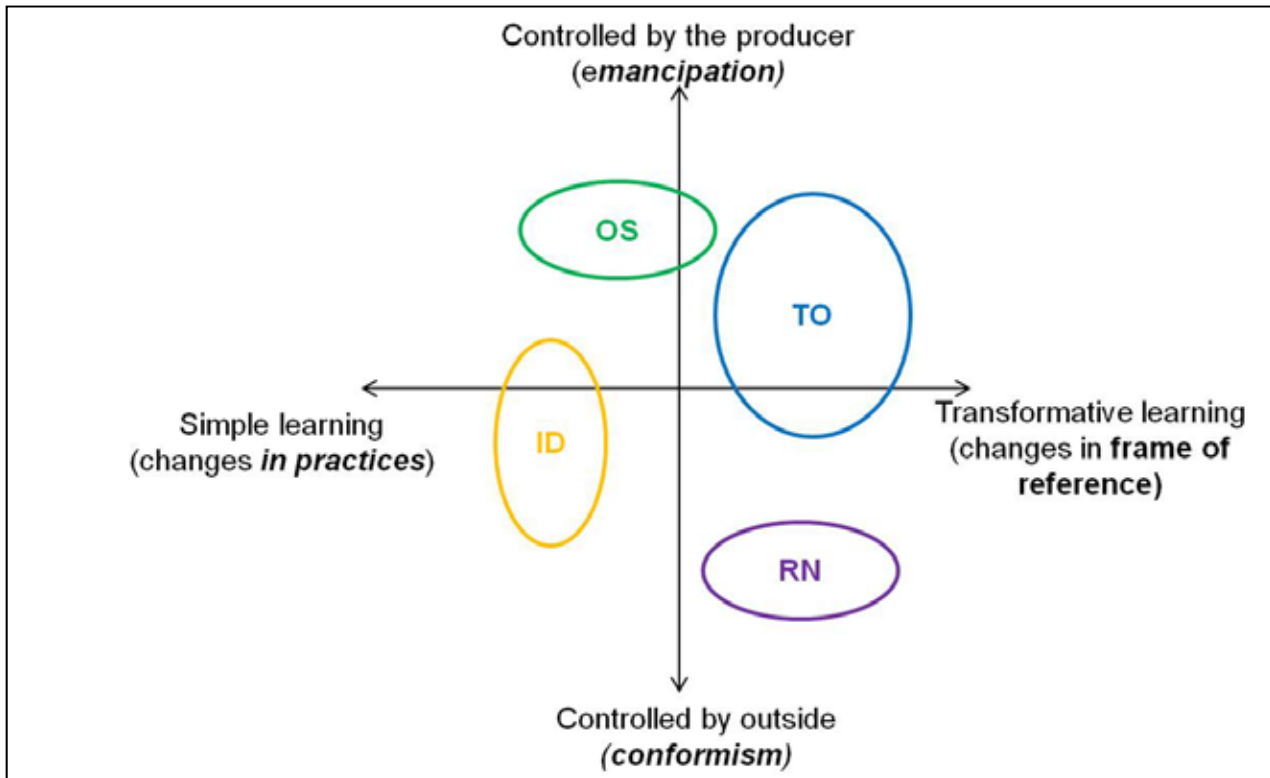
The detailed analysis of the 30 case studies led us to identify recurrences in the links between triggers, styles of learning and nature of the changes. We regrouped these recurrences into four learning regimes (Fig. 2): Transformer-Observer (TO), Reactive-Networker (RN), Optimizer-Self-reliant (OS), and Imitator-Dependent (ID). Strong correlations between triggers and learning styles have led us to retain only two discriminating criteria for these regimes: the control of the learning process (by the producer himself or from the outside) and the nature of learning (simple, transformative).

    o   Transformative regimes: Transformer-Observer (TO) and Reactive-Networker (RN)

These two regimes lead to systemic changes (increasingly integrated production systems) and transformative learning. Producers under these regimes have implemented innovations in several areas such as the integration of livestock rearing into their farming activities and the maintenance of soil fertility and of the activity system.

The reasoning behind adjustments or improvements are based on production and livestock rearing systems (selecting crops that permit the use of stalks for livestock or mulching, cotton or sorghum; valorising poor lands with relatively undemanding crops, retaining the good ones for maize, etc.). These types of producers are able to spell out the rules of decision making that ensure the success of their activities: criteria for choosing the most appropriate fields for a particular crop, the following of cropping calendars, rules for maintaining and feeding herds, choice of crops and rules for adjustments from one year to another (depending on seed availability, market prices, his family's food preferences). They master their production system's routines and the rules for optimization.

For each farmer, transformative learning has had effect in three domains: expansion of the universe of the possible changes, the transition to a more managerial approach to its farm with a full-time commitment, and anticipation of future problems.

In both regimes, TO and RN, producers mobilize the diversity of information sources available to them in the village (CPG, advisors, peers, projects) as well as outside. However, the information is mobilized differently in managing change at different stages, which leads us to distinguish RN regimes – which tend to be 'controlled by outside' – from TO regimes – which are, in contrast, 'controlled by the producer'. In RN regimes, learning is triggered by incentives to change originating from the farmers' socio-professional environment, especially from their cotton advisors. The changes are numerous and frequent. It is the appropriation of the discourses and messages of technical advisors which guide ongoing experimentation. Mismatches can arise between the goals the farmer sets for himself and the stage of development of his farm. In contrast, in the TO regimes, learning is triggered by a problematization constructed by the producer himself around projects he wants to undertake (such as the introduction of small livestock rearing, introduction of fodder crops) in order to correct deficiencies he has observed in his farm (inadequate income, lack of fodder, etc.). The TO regime consists of an alternation between phases of problematization and experimentation. It is primarily a search for ideas to improve or transform his activities that guides the farmer's search for information, followed by continuous experimentation. He then selects elements that can provide a solution to his problems from the projects and the advice he has received.

- o   Simple regimes: Optimizer-Self-reliant (OS) and Imitator-Dependent (ID)

These regimes encompass producers who do not make systemic changes. These producers mainly seek development and optimization of what they already do, without mastering the rules of adjustment/optimization and without a vision of what the others are doing (i.e., with no clear explanations of their choices with respect to the context in which they operate). Their main motivation is the desire to reduce the drudgery of farming (in particular, of cotton cultivation) and/or the need to cope with farming shocks (loss of livestock, indebtedness). Areas of technical changes involve the development of small-animal rearing, the use of pesticides, environmental management (SDR, stone barriers). Their representations of the environment are less structured or complex than of the previous group. The producers do not demonstrate any changes in their frames of reference.

The OS regime characterizes producers who, for the main part, rely on running their farms based on endogenous learning. It is the need to help the farm survive which triggers the need to learn. Reasoning and the search for information to modify or improve their activities revolve around agricultural practices (how to feed my cattle, how to apply fertilizer, how to make a ditch) without any systemic perspective. Interactions with others are not focused on problems (*why*) but instead on solutions (*how*).

The ID regime, on the other hand, characterizes producers who manage their farms by relying mainly on learning acquired outside the farm. They find it difficult to explain the underlying rationales of changes they have made. They have a desire to accumulate information without necessarily being a connection with a change to be implemented or a problem to be solved. It is 'shocks' that trigger the change (loss of animals, disease, etc.).

Explaining learning regimes: learner profiles and the informational context
Learner profiles: The results show that the learner profiles appear more defined by the attitude of the head of the farm vis-à-vis the informational context (emancipation/conformism) than by the farms' structural characteristics (such as age of head of the farm, date of assuming charge, ethnic-

ity, level of education, capital). Correlations are not significant except for two variables: ethnicity and ownership of non-agriculture capital.

Informational context: Two variables were explored: the role of projects and interventions and the role of advisory services on the type of learning regimes. We observe that it is not the technical content of external projects that most impacts regimes, but the creation of learning situations through interactions (workshops, visits, experiments, etc.) which enhance skills (control, adaptability) and transformative learning (with construction and widening of frames of reference). As far as the technical advice provided to producers is concerned, we find that since technical messages can be contradictory, what ultimately influences the producer's choices is his confidence in the technician.

Discussion and conclusion

Learning sustainability: learning to anticipate points of breaks in routines
We observed that the technical changes which lead to increased environmental sustainability are triggered by different types of factors: the farmer's need to continue in agriculture (either to meet his immediate needs, to keep the farm as an asset, to have an inheritance to pass on to his children), difficulties encountered (insufficient production for his family's requirements, exogenous shocks), interactions with others, either through participation in training programmes or in projects or through exchanges within social networks.

These factors are more or less combined or more or less important depending on the level of skills already acquired by the producer in the managing of his various activities in an integrated manner. If he is already capable of implementing systemic changes, triggers for new learning will mainly be interactions with others that encourage him to change his frame of reference, have new ideas, and set himself new goals. Farmers who are incapable of understanding the importance of having a holistic farm approach will not be receptive to technical messages and proposals to help them better maintain their animals.

But there exists, however, a common point between the different regimes in the way learning helps the transition from 'one level to another' (changes in practices, systemic, transformative). It is when the farmer is confronted with a situation of disruption or break in his routine, where the functions of the farm are no longer met, and where the principles that guide his actions no longer allow him to achieve his objectives. He is then forced to mobilize a new way of learning, usually involving someone external to the family farm. The sources of information the farmer uses in such a situation are peer exchanges, management advice provided by the cotton advisors in the CPG, experiments conducted in the framework of projects which encourage critical thinking about the activities being tested and their results (exchange workshops, presentation of results to others, etc.).

Fine-tuning the characterization of regimes
It appears necessary to fine-tune the characterization of learning regimes for sustainability, on the one hand, in terms of patterns of action of farmers and changes in these patterns and, on the other, in terms of organizational learning processes within the farm.

- *Revisiting the criteria for decision making, by emphasizing the ecological processes observed by the producers.* We note that producers are guided in their actions more by the natural processes they observe than by their knowledge of a state (such as soil 'fertility', for example, which is a concept widely used by the advisors). It is therefore no surprise that there are mis-

matches between the problems perceived by producers and the solutions proposed to them. Thus, we end up in a situation where the analysis of more sustainable changes in the management of soil fertility boils down to the use of manure, compost and manure pits, recommendations which are ill-suited to peasant realities. To analyze the learning processes in more detail, we will have to move further upstream, to the criteria that guide the technical changes which can bring about improved soil conditions, including parallels with natural processes.

- *Integrating organizational learning.* An important factor in the dynamics of learning for sustainability seems to be the mobilization of the family in decision-making, sharing of tasks and reflection. In most of our interviews, the head of the farm no longer considered himself as the sole decision maker. Often, it is the young sons who are sent to projects and training programmes because their father is aware of the importance of learning, for himself and therefore for his family. Young people are considered 'innovators' and valued as such. It therefore seems necessary to consider a number of family farms, those with heads who have a more managerial approach to their families and their farms, as 'learning organizations' (Argyris and Schon, 2002), with dynamics similar to those of entrepreneurship, in order to better understand the learning dynamics underpinning technical change.

Supporting the regimes

Our identification of the different learning regimes can become a basis for rethinking the functions of advisory services and systems, by focusing on the farmers' diverse characteristics, not in terms of literacy as is often done, but in terms of capacities and skills in a given context. The challenge is to supply the farmers with the means to undertake changes on their own. This implies, for example, leveraging the various learning sources currently being used, making them more accessible and making them more equal (contrary to farmer perceptions, recommendations originating from foreign projects are not more 'right' than those from local cotton or technical advisors).

Conclusion

The results of this study are currently mainly conceptual and methodological. Our analysis model should be further refined along three axes: an improved consideration of organizational learning on the family farm; an identification of analytical concepts of sustainability that are closer to the modes of reasoning of producers; and the verification of the effects of certain factors (learner profiles) on the types of regimes. The significance of the informational context seems very high (history and nature of relations with state consultants and agro-industrial firms). We distinguished two opposite types of learning style (emancipation or conformism) that both lead to more sustainable farms Learner profiles too are important (ethnicity, security in the form of non-agricultural capital); they play a significant role in determining the type of technical changes the farmer adopts. In the perspective of mobilizing individuals to facilitate and support learning (innovation brokers), it seems particularly appropriate to identify producers who have transmittable knowledge and skills on how to make changes for increased sustainability. Creating spaces for exchanges between producers who are at common stages of development or have similar problems, leveraging specific know-how of different ethnic groups and inter-cultural exchanges, and facilitating access to existing information in a given territory seem to be some of the many possible ways of strengthening existing dynamics of learning.

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