Accompanying farmers in the building of collective rules for agrobiodiversity management

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Abstract

This research aims at accompanying farmers in building a durable collective management of their subsidence cereals varietal diversity. Varietal diversity dynamics are driven by farmers' individual choices and strategies on the one hand, and by the seed system functioning on the other hand. We think that the mutual understanding of the interactions arising in this complex system is a prerequisite to work together on the construction of durable collective management rules.

We follow a dynamic research process that uses models building and simulation through Agent-Based Models and Role-Playing Games. We have used these tools to collect, synthesize, formalize and exchange researchers and stakeholders knowledge. As a result, we have a model of the system built with the active input of Malian farmers. This model will next be used in simulations for collective prospecting on management scenarios.

Key words: Agent-Based Models, Agrobiodiversity, Collective Management, Mali, Role-Playing Games.

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1 Introduction

Our food supplies today depend on a dangerously narrow base made up of a limited number of crops with only a few improved, high yield varieties (CIP-UPWARD, 2003). Our research is related to the emerging field of agrobiodiversity, which studies the links between biological, environmental and sociocultural diversity of farming systems. We work more particularly on small farming systems in developing countries. There, farmers use the diversity of their traditional varieties to ensure themselves a stable yield in a risky economic and climatic context. In this context, the genetic erosion of subsistence crops is a real threat to poor farmers' food security.

Farmers' seeds provide the raw material for agricultural production and are a reservoir of genetic adaptability that can withstand economical and environmental change. One of the main objectives of the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture (FAO, 1996) is to reinforce the capacity of farmers and their communities to manage plant genetic resources.

Our research aims at accompanying farmers and other involved parties in the implementation of such a sustainable management. In this perspective, a first and necessary step is to build a shared understanding of the links between functioning and viability of farming systems and the agrobiodiversity of a territory. This means going beyond the farmer's decision process on choosing his varieties. We also have to understand the global functioning of the seed system he relies on. We use particular tools that are Agent-Based Models (ABM) and Role-Playing Games (RPG) to imply from the beginning the stakeholders, and the farmers in particular in the formalisation of their knowledge into a model. This model will next be used in simulations for collective prospecting on management scenarios. This paper aims at presenting and discussing our intervention methodology.

After a brief summing up of the context and objectives of our intervention, we will present the companion modelling methodology that shapes our work, as well as the tools we use, agent-based models and role-playing games, and how we have organized our intervention process. Then we will detail how our understanding of the system has evolved along 3 steps of research were different models and games were developed and used: formalisation of fieldwork hypotheses in data in an initial "expert" ABM; breaking up of the system representation into 4 decision context modules that were addressed with farmers through RPG workshops; recomposition and generalisation of the resulting new representations into a ABM that has been validated by the farmers in a dedicated workshop. As a conclusion, we will discuss the transferability of our methodology and how simulations can be used to work with the various stakeholders on seeds collective management rules.

2 Context and Purpose

This research has been financed by 3 different projects (FFEM, BRG, FIDA) revolving around agrobiodiversity. All these projects aim at giving a central role to farmers' knowledge and practices, and taking systems dynamics into account.

We work on small farming systems of sahelian Africa – Mali in particular – where food security relies mainly on sorghum and millet crops. These farmers frequently use a wide panel of ecotypes as a strategy of dispatching risk in time and space. Improved varieties may be used but in their uncertain agro-climatic environment, only local ecotypes ensure stability in yields. However, changing conditions (agricultural intensification and land saturation; climatic change and short cycle varieties selection) result in varietal diversity erosion. Finally, in these rural areas, the access to varieties relies essentially on farmers seed system (informal exchanges within villages or markets and self production of seeds) (Brookfield 2001).

The companion modelling process we have initiated constitutes a meeting point between farmers from various regions of the country, farmer organizations, researchers and NGOs. It is intended to bring support to the reinforcement of farmers' seeds systems functions: dynamical preservation and improvement of robust traditional varieties; access to the national seed system.

3 Method and Tools

3.1 Companion modeling: what is it?

A wide range of literacy concerning action-research and environmental management recognizes the inherent complexity of socio-ecological system. Some authors have formalized long-term intervention methodologies using modeling techniques and dedicated to support stakeholders in implementing an adaptive management of their system (Hagmann, Chuma et al. 2002; Walker, Carpenter et al. 2002).

Companion Modeling is a methodology formalized by a group of researchers from various disciplines and concerned by action-research and renewable resources collective management (Bousquet, Barreteau et al. 2002; Bousquet, Barreteau et al. 1999). Its principle is to identify the various points of view and subjective criteria to which the different stakeholders, including researchers, refer implicitly or even unconsciously, and to integrate this knowledge into simulation models to be used within the context of platforms for collective learning (Barnaud, Promburom et al. 2006). These models are built along iterative cycles so that the knowledge and the representations they carry can be contradicted and enriched as often as possible by as many stakeholders as possible. A typical companion modeling cycle is made of three steps:

1. Collecting and synthesizing existing knowledge through surveys and analysis (domain experts input)

2. Formalizing this knowledge into a model (modeler input)

3. Confronting the model through participative simulation workshops (stakeholders input). The observation and analysis of these workshops gives feedbacks to get into a new iterative cycle.

3.2 Agent-Based Models (ABM) and Role-Playing Games (RPG)

The preferential tools of companion modeling are ABM and RPG. In ABM, computer autonomous entities called agents have perception, cognition and action capacities. They evolve in an environment where they interact with resources and other agents. During simulations, overall dynamics emerge from the interactions of the agents within this socially or/and spatially organized environment. ABM are very useful to represent complex systems and have been widely used in the last years in the field of environmental management (Bousquet and Le Page, 2004).

In RPG, players are immerged in an artificial environment where they have to act in conformity with imposed game rules. In companion modeling, elements of reality (natural resources dynamics; spatial and social links between stakeholders; or information and actions available to them) are transferred within the game environment and rules. Participants should be able to "import" their reality into the game and relate their decisions to this reality. However, enough distance should be put between the game and the reality for the participants to be able to step back from their daily schemes and consider others viewpoints more easily (Tooth 1988). In the field of environmental management, RPG have proven very efficient in supporting collective decision through stakeholders' empowerment, sharing of information, or options and organizational innovations testing. (Dionnet, Barreteau et al. 2006)

Formally ABM and RPG have the same architecture: autonomous entities situated in an environment and interacting dynamically. This has led to a large series of joint uses of ABM and RPG in the companion modeling community. Most often, RPG are used to "open the black box" of computer models to stakeholders or ABM are used during RPG to simulate biological or physical dynamics, or to play time steps to make the game faster. (Barreteau, 2003).

3.3 The methodology: overview of the companion process in Mali

The companion modeling process implemented in Mali has occurred along 3 cycles:

- Cycle 1 – formalisation from existing data: initial data gathering, formalisation into an "expert" model, and identification of knowledge gaps on system dynamics.

- Cycle 2 – co-development of a conceptual model: desegregation of the "expert" model into conceptual modules, fieldwork and RPGs involving farmers in the information of these modules.

- Cycle 3 – generalization and simulation: development of a "generic" ABM representing an abstracted system and of an accompanying RPG.

4 Results and discussion

4.1 Analyzing farmers: from field work to an "expert" model

Many on-farm experiments have been conducted during 2001 to 2004 in 12 villages of Mali. They depended on direct field observations, participatory appraisals and farmers' interviews on their crops. They resulted in a large amount of data on the biophysical and socio-economic determinants of farming systems diversity towards sorghum. These data have been structured and spatialised into a database and a GIS (Bazile and Soumare 2004).

A realistic "expert" ABM was developed on this basis. From an archetypal landscape, this model generates a spatial distribution of farms (with their fields, crops and varieties) embedded in a social structure. However the agents' behavior was not relying on actual strategies, but on statistical values and the model structure was too complex to be shared with farmers. (Abrami, Bazile et al. 2005).

This model is an integration framework of various disciplinary submodels and data. It has been used to define and validate a reference initial state with our Malian research partners. The modeling process led to the identification of knowledge gaps on farmers' strategies. As a result the objectives of the next step were drawn: simplifying the model by converging to essential descriptive parameters and eliciting missing information about farmers' strategy. (Bazile et al. 2005).

4.2 RPG workshops: building up a conceptual model with farmers

In order to break the complexity of the model, we have identified 4 modules that can describe the system. Our idea was to work separately with the farmers on the specific questions addressed by each module before going back to the whole system. Each of these modules corresponds to a decision context of the farmers. The 2 first modules (crops rotation strategy and varieties association strategy) fix the "static" state of the system. The 2 other modules (varieties changing, supplier selection and seed exchange) fix the dynamics of the system. Three of those modules were addressed within specific RPG workshops, and the last one (varieties adoption and abandonment) was addressed through fieldwork and during the workshops debriefing sessions.

The RPG1 is dealing with varieties association strategies. Farmers have to specify their crops and varieties and their sowing dates in response to climatic variations in order to ensure their food security. Computerized abacus gives farmers a feedback on their harvest. The RPG1 session resulted in identifying archetypal varieties association and varieties changing strategies. It also showed knowledge gaps on crop systems and rotation influence and seeds supplying modalities.

The RPG2 is dealing with crop rotations. Farmers have to specify the spatial organization of their crops in response to climatic variations, and perform group evaluation of their decisions. The RPG2 session resulted in simplifying the representation of farms agro-climatic constraints.

The RPG3 is dealing with seeds suppliers and exchange networks. Farmers have to get appropriate seeds in response to climatic variations and disaster events. Some of them are attributed a special social status and social and spatial proximity relationships are reconstructed through grouping people in different phases of the time step. The RPG3 game session resulted in identifying which specific suppliers' types correspond to which specific rational of seeds research.

The workshops occurred between April and December 2005. They resulted in a rearrangement of our hypotheses and results in a consistent frame built together with the farmers during the collective debriefings. However, each RPG was only be played one time, and the 3 workshops concerned different villages. The objectives of the next step were then to develop a "generic" ABM and design simulations that can be used for supporting collective prospecting on management scenarios.

4.3 Generalization and simulation: gathering information and farmers

The conceptual model built up with the farmers through the RPG workshops has been generalized and implemented into a "generic" ABM. The "generic" ABM dynamics reproduce the evolution of varietal diversity within a village with a yearly time step. For each time step, a climatic year is given and the farmer agents choose their crops and varieties. At the end of the time step, they may change varieties and have to find a supplier to get seeds. The agents' decisions are made up according to strategies identified with the farmers during the RPG workshops. The main parameters of the model have been given qualitative values in order to build a more general representation of the system: farms may be "big" or "small", varieties "early", "medium" or "late", and yields "bad", "medium", or "good". Our hypothesis was that farmers from different regions will interpret these qualitative values relatively to their own context and be able to work together on a more abstract level of representation.

A user-friendly interface allows the main parameters of a simulation to be discussed and modified transparently, and makes the outputs easily readable. This interface allows setting up: the structure of the village (proportion of soils, distribution of size and equipment of the farms); the qualitative characterization of the climate; the parameterization of the strategies and their distribution.

The “generic” ABM has been presented to leading farmers from 5 different regions of Mali during a 4 days workshop in April 2006. For each of the modules, a simple “paper” activity was organized, that used the same formalism and interface as the computer model. Then the computer was used to discuss and calibrate the global and abstract vision of varieties management described in the ABM. The farmers could easily get acquainted with the computer tool. This workshop has proven successful in using an abstract representation of a system to get people from different origin speaking the same language and work together on a same problem. From now on, the ABM tool had completed its duty of helping us formalizing and understanding the system.

The last workshop of the project was gathering researches, farmers and NGOs from various regions of Mali and Niger with the objective of initiating a partnership between all these actors on the definition of seeds management structures. As Niger farmers and NGOs did not participate in the previous workshops and were not acquainted with the ABM, we decided to couple a simplified version of our model with a RPG in order to favor interactions and exchanges between the participants. This was a good way of supporting a collective prospecting on possible reconfigurations of roles and responsibilities of everyone. As fieldwork and technical support will be conducted in Mali, we plan on pursuing some exploration work with the ABM on simulating the scenarios identified during the workshop.

4.4 Process and tools: a short assessment

This paper describes the implementation of a companion modeling process on a problematic concerning agrobiodiversity and seed supply. Modeling activities have imposed a formalization work. This exercise has proven very efficient in supporting interactions among researchers and chasing out implicit hypotheses and knowledge gaps. Even if it looks like we are converging on a « final » model, our models are essentially throwable. The “expert” model has only been used as a catalyser between scientists. The “generic” model content was used as a support for discussing their system with the farmers and as the computer basis of a new RPG, but simulations have only been conducted within lab experiments for now on. A major objective of the first round of RPG sessions was to contribute to the modeling activity. These sessions have proven very efficient in validating and contradicting established data and hypotheses. They also appeared as an original medium to present to farmers results from several years of fieldwork. Farmers and NGOs appreciated this effort to create a more interactive mode of communication. Through all the project workshops, the exercise of staging their practices made the participants feel rewarded and led to build more trust. During debriefings, discussions were more connected to reality than in more classic collective interviews. Finally, the compression of space and time operated by RPG makes coordination issues very salient and allowed initiating discussions about collective management modalities even when it was not the subject of the games

Companion modeling is quite a time consuming process. Building and implementing models, designing, testing and calibrating RPG, organizing workshops take time. In our case, after years of data gathering and system expertise building, we can estimate that it took about one year to get to the “generic” ABM ready to support scenarios simulation. The cost-effectiveness of the process must be seen in a long term perspective of social learning for creating conditions for adaptive management. Finally we would like to stress that a good knowledge of the field and the stakeholders is necessary to have workshops properly organize, be able to make sense from them, and above all prevent eventual manipulations.

Another example of a companion modeling process led on the same thematic for rice in Thailand can be read in (Vejpas et al. 2005). In Thailand, RPG and conceptual modelling was also used to build up a shared representation of varieties management within a village. But in Thailand, the national rice seed system is very strong and the problematic was soon driven towards issues of coordination between the different levels of this national seed system. Companion modelling processes trajectories are in essence very dependant on stakeholders concerns and demand.

5 Conclusion

The companion modelling process developed in Mali has produced a computer model directly stemming from the knowledge sharing work carried on with farmers. This model constitutes an abstract and dynamic vision of agrobiodiversity management in a Malian village. Exchanges and participative workshops carried on for its development have initiated a dynamic of interaction between partners involved in agrobiodiversity management. Through the simulation of simple scenarios, this model is now ready to be used as a tool for supporting prospective discussions between these partners. These scenarios should be discussed and prepared around the following question: how will the current agriculture dynamic, with the emergence of new farmer organizations, permit the traditional system to carry out its functions? Simulations of dynamics in our virtual abstract system will revolve around the following themes: impact of varietal diversity on agricultural production stability; resilience of the traditional seed system towards a massive diffusion of improved variety; response of the traditional seed system to food and seed crises.

A major outcome of this modelling process is to bring together teams working on biodiversity from the North and South to promote new forms of interdisciplinary coordination leading to new channels for the diffusion of research results. In North countries, farming system are more standardized and subjugated to international markets. Most of the time, traditional seed systems have disappeared. It is more difficult to make concrete the rights of farmers to maintain the varietal diversity by free exchange. We could think of a transfer of our method to accompany the organisation of seed management in the organic agriculture networks in the North.

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