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SEED-DIV:

AN ABSTRACT ROLE-PLAYING GAME FOR DISCUSSING COLLECTIVE MANAGEMENT OF AGROBIODIVERSITY

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Abstract — This research aims at accompanying farmers in building a collective management of their subsistence cereals varietal diversity. Seed management and its impact on biodiversity 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 new collective management rules to participate to agriculture sustainability coping with a large choice of varieties. Participatory conceptual modelling and Role-Playing Games were used in several workshops gathering researchers, NGOs, farmers' organisations and farmers. A result of this series of workshops is an ABM of an archetypal Malian village that represents the current situation where varietal diversity is managed individually but is freely available for the community. In this model, agents are farmers that make varietal choices and provoke seed exchanges depending on their individual strategies and external factors. All descriptive parameters hold qualitative abstract value so that the model can become the support of generic discussions between farmers from different regions. Through the workshops, this model was built and validated with the active input of local stakeholders and scenarios of collective management were constructed. Then the model will be used as a prospective tool for simulating these scenarios of various forms of collective action.

Key words : Mali, Sorghum, agrobiodiversity, seeds system, companion modelling, role-playing game



Résumé — L'objectif principal de cette recherche est d'accompagner les paysans dans l'élaboration d'un cadre de gestion collective de la diversité de leurs variétés de céréales vivrières. La gestion semencière et son impact sur la dynamique de la biodiversité sont soumis aux choix individuels des paysans, leurs stratégies d'une part, et au fonctionnement général du système semencier d'autre part. Nous postulons que la compréhension partagée des interactions au sein de ce système complexe est un prérequis pour travailler ensemble à la construction de règles de gestion collective qui participent à la durabilité de l'agriculture via un accès à un large choix de semences. La modélisation participative conceptuelle et les jeux de rôles ont été utilisés durant différents ateliers réunissant chercheurs, ONG, organisations paysannes et agriculteurs. Le résultat de cette série d'ateliers coorespond à un modèle, un système multi-agents, représentant un archétype de village malien permettant de simuler la diversité de stratégies individuelles de gestion de semences qui sont ensuite disponibles gratuitement pour la communauté villageoise. Les agents du modèle sont des agriculteurs qui choisissent les variétés à semer ce qui provoque des échanges dans la communauté en fonction de leurs stratégies individuelles ou de facteurs externes. Les paramètres utilisés ont une valeur qualitative c'est pourquoi le modèle sert de support de discussion entre paysans de différentes régions. Le modèle a été construit et validé au travers de ces ateliers avec un impact évident sur les acteurs locaux pour la construction de nouveaux scénarios de gestion de la diversité variétale. Ainsi, le modèle a pu être utilisé en termes de prospective pour simuler des scénarios à partir de nouvelles formes d'action collective.

Mots clés : Mali, Sorgho, agrobiodiversité, système semencier, modélisation d'accompagnement, jeu de rôle

INTRODUCTION

The originality of our general approach is to focus on the biodiversity in agriculture, or agrobiodiversity (Wood and Lenne, 1999). During this study, we only consider the cultivated part of agrobiodiversity to evaluate the impact of farmers' practices in the dynamics of biodiversity at the local or regional scale. The global idea of the research process was to consider the farmers' informal seeds system as a complex and dynamic system where individual decisions interact through evolving networks of relations and result in emerging dynamic patterns of varieties at the scale of the communities. Considering less developed countries as Mali and Niger in west Africa, we ask the next question that positions sociocultural and agrotechnic factors on the two side of a same complex system (Brookfield, 2001; Brookfield & al, 2002; Brush, 2000; Jarvis & al., 2007) : "How the farmers' livelihoods are dependent on the varietal diversity and what are the drivers that impact the maintenance of the varietal diversity in the system? This posture define the general context of our research where the Farmer Seed System is considered as complex and dynamic system (Almekinders and Louwaars, 1999; McGuire 2001; McGuire 2008) focusing on farmers' practices of seeds selection and exchange. Besides other packages focusing on description, characterization or improvement of local varieties and functioning and potential of formal nationwide seeds systems, this research was oriented towards farmers' practices regarding the dynamics of the diversity of varieties within seed selection and exchange.

The result that we present here is a Role Playing Game (RPG) called SEED-Div. It's the final product from a research project on farmers management of agrobiodiversity in Mali (West Africa) during the period 2005-2007. The paper only presents the final product of this participative research project (Bazile&Weltzein, 2008), without all the steps of its development, tackling farmers' individual and collective management of the varietal diversity of subsistence cereals in Mali and Niger (Pearl millet and Sorghum).

The various RPG developed in this research have allowed to show many scientific and social interests of this kind of methodology that we can summarize within theses shorts sentences:

- to increase the understanding of farmers practices;
- to consider the sustainability of seed system for in situ conservation of agrobiodiversity
- to support the dialogue of many stakeholders for prospective and new scenarios within contradictory point of views

Outside the research line, we can explore other ways where the RPG could be used that comfort the participatory methods for teaching environment:

- learning during practise with students and professionals;
- exchanges between various actors who can explore with this tool;
- co-construction of scenarios.

1. MATERIAL AND METHOD

1.1. General Methodological context and material

1.1.1. Context and Tools : the companion modelling approach

This research was based on a companion modelling process where successive models of the system hold the trace of the perspectives and knowledge gathered, shared and discussed all along the process, iteratively with complementary field studies based on

observation and interviews (Barreteau et al, 2003; Bousquet et al, 1999). While conceptual specification of the models were formalized through UML diagrams and implemented in an Agent-Based Model, several Role-Playing Games were designed to share and discuss different aspects of the models. These Role-Playing Games were used in 4 workshops gathering researchers, NGOs, farmers' organisations and farmers. (Bazile and Abrami, 2008; Abrami et al, 2007)

1.1.2. Material: previous results of the project that did support SEED-Div conception

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. 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' behaviour was not relying on actual strategies, but on statistical values and the model structure was too complex to be shared with farmers. 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.

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.

1.2. RPG design context

1.2.1. Specific constraints on the RPG design

SEED-Div was designed to be used in the last workshop of the research project, where Niger and Mali farmers from 9 different regions were to meet and share insights and outputs of the project in their respective communities. Then, this specific RPG activity had a double objective of being a media of exchange between these farmers and bring them on questioning institutional aspects of seeds management.

The idea was then to wrap up our model in an tool that was as simple and abstract as possible as agro-ecological constraints of the different farmers where very different and half of them did not participate in the preceding companion modelling workshops.

We thus decided to design an activity that could structure the 2 days workshop, starting with a very simple and abstract game and having the participants modifying it to make it more suitable to their questions and finally testing a seeds diversity management institution.

1.2.2. Mains elements for the design

The previous workshops activities were aimed at informing and discussing our ABM : there was little room for interaction among the players. Here the main objective of the activity was to have farmers from different regions interacting and discussing institutional aspects of varietal diversity management. Hence the RPG had to be : 1. simple enough to be played quickly and leave space for interactions 2. abstract enough to be illustrative for all the participants and hinder discussions on a generic level 3. able to allow upscaling from individual decision level on varieties choice and seeds supply to collective decision level on institution crafting (Ferrand et al, 2009).

For the quality of its simplicity and its exemplarity, we took inspiration from the Chering / ReHab¹ game which is used regularly as an introductory activity in training sessions of our fellow researchers of the companion modelling group. The principle of Chering is to ask each player to choose a cell to harvest in a grid and to provide his the result of its harvest as a feedback depending on a the level of resource in the cell and the number of player who chose this cell. Then the idea is to have quick sessions where player first play individually and then try to coordinate their action in groups of different size. From Chering we wanted to keep the principle of :

- having players interacting on an abstract grid of square cells qualified by a single abstract and simple indicator
- having all players making a single very simple choice at every time step on the use of an abstract resource which dynamic is hidden
- being able to play several time steps in successive sessions where players act individually and then collectively

However our wish was to be able to go a step further and have participants designing a local management institution for the resource represented in the game as an objective of the workshop. This is also a fairly classical approach used in companion modelling where a series of workshop session, and if possible a workshop of several day, is used to have 1) participants interacting around a simple RPG 2) participants modifying the RPG to make it

¹ <http://www.commod.org/pdf/ficheCherIng.pdf>

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more adequate to their constraints 3) participants designing and playing scenarios or institutions within the RPG (d'Aquino et al, 2003; Castella et al, 2005; Gurung et al, 2006).

Our issue being agrobiodiversity, the principle of the game would be managing a resource diversity instead of managing a resource quantity and then having players choosing and renewing color tokens representing the different varieties of a resource. More specifically, the game should be able to tackle the essential aspects of the design of a local seeds management institution:

- are there some underlying collective management institutions that help in maintaining the varietal diversity at the scale of a local community?

- Would a formal institution be helpful and how should it be crafted : what should be

- its status (conservation or supplying) : what should be the production objectives of the institution ?

- its resources : financial (which money), land, human (who is making the work)

- its governance : which procedural and institutional rules – REF A OSTROM ??

- the scale it should function

1.3. Workshops organisation

The organisation of the workshop(s) is a crucial point of any participative work and it is also the case of RPG where the questions of who are the participants, how they are selected, and which is their status in their community has a string impact on potential insight that will be raised within the workshop and also on the diffusion of the process.

As the workshop was the final event of a 3 years farmers driven process, we choose to invite many farmers from a variety of agricultural conditions in Mali and Niger. Ten (10) farmers came from Mali with the charge to represent this diversity of agrarian situations, cereals, varieties and cropping system en general. Five (5) members of ONG were accompanying theses farmers, one from each region, and participated to the choice of them within two principal criterions: capacity to debate the local conditions of its region and knowledge of the diversity of cropping system that generate. The same distribution was adapted for the Nigerian case with eighth (8) farmers but only two persons from ONG.

All the charges were assumed from the project.

The research staff was composed with 4 researchers from France (1 geographer, 2 modellers and 1 agronomist), 3 researchers from Mali (1 geographer, 1 agronomist and 1 sociologist) and 1 researcher from Niger (a genetist). All of them came with a specific charge in the organisation, animation, debating and modelling.

2. RESULTS

2.1. Description of SEED-Div

2.1.1. General description

In the RPG SEED-Div each player owns a field on which there are 4 plots. All fields are identical in size and represented as squares within a grid that represents the village fields. Each plot may be on 1 of 2 different types of soils (deep / shallow). All players cultivate the same cereal on their field but 8 varieties of this cereal are available. Each variety is

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represented by a different colour and has specific typical characteristics (optimal yield, sensitivity to water stress, length and plasticity of the cycle, photoperiodism, size and colour). Each player is initially given seeds from randomly chosen varieties for his 4 plots (seeds for 1 plot is represented by a disc of the colour of the variety). Then at each round (representing a year), the player must plant cereal on its plots by sticking its seeds disc on a card. He can choose among the 8 varieties as long as he is able to get a disc of the proper colour. New seeds can be obtained through harvesting (0, 1 or 2 discs depending on how the variety was appropriate to the climate), through exchange with other players or through external sources such as markets or NGOs.

The game can be played with different levels of institutions. In a first step, players can be grouped in "families" where the elder is designed as the chief of the family. Then it is possible to craft a seeds management institution at the scale of the village and play it in the game.

2.1.2. Game description and rules

- The roles :
 - All players are farmers who owns 1 field in the same village. All fields are identical: 4 plots on 2 type of soils.
 - Players can be grouped in groups or family where they have to coordinate themselves
 - Specific roles : it is possible to name 1 player per group as the chief of the group. Special roles may also appear when players design the management institution.
- The space and the environment :
 - The village is represented as a grid of fields. The spatial arrangement and ownership of fields and soils is visible on a board representing the territory. (FIG 2)
 - There is a yearly climate characterized by a rain arrival date (early, mean, late) and a rain quantity (low, mean, big).
- The resources and the objects :
 - The varieties: there are 8 varieties in the village. Each variety has a different yield response to agro climatic conditions (soil and climate) and can be characterized by: its resistance to striga, its photoperiodicity (early, mean, late) and its origin (improved or local).
 - The production: depending on the variety chosen, the soil and the climate, a plot may produce 0, 1, 2 or 3 units. A farmer needs 4 units a year to survive
 - The seeds : 1 seed unit is necessary to sow a plot with a variety. A seed unit is represented by a disk of the color of the variety. Farmer sow seeds by sticking the disk on their sheet (FIG 1). Depending on plot production, a farmer may get back 0, 1 or 2 unit of seeds.
- The rules
 - A farmer cannot keep seeds that he does not use the following year.
 - Farmers can ask and give seeds to each other at their own will
 - Farmers can get "white" seeds from the market : the variety is unknown a priori and will be discovered only at harvest
 - Special events can bring seeds from outside
- The organisation : a time step represents a year
 - Initialisation : each farmer is attributed a field and a set of seeds corresponding to the varieties he owns initially.
 - Phase 1 – variety choosing : A rain arrival date is announced. Farmers can try to get seeds if they are not happy with what they have, either from other players or from the market, unless a special event arrives.

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- Phase 2 – sowing : farmers stick 1 seeds disk for each of their plot. When he is over he gives back to the assistant his playing sheet and the seeds he did not use. (FIG 4)
- Phase 3 – harvest : the rain quantity is announced, as well as the occurrence of striga and farmers get their playing sheets back with their production and their new seeds. The production level of each plot is displayed on the board. Farmer can start exchanging seeds for the next step.

2.1.3. Game settings

- Participants : the game needs quite a big number of participants (15 - 30) so that diversity dynamics can be interesting.
- Facilitation team : however there is a bottleneck in the capture of player choices and the allocation and distribution of harvested seeds where a minimal facilitation and assistance team is needed : 1 facilitator, 1 or 2 observers, 1 assistant for the capture, 2 assistants for distributing the seeds and displaying the outputs in case there is no retro projector.
- Material (FIG 1 & 2) : sticking color disks for representing the seeds; playing sheets where players stick the seeds and get results; a lot of cups or glasses to make the color disks easily accessible to the assistant, to put seeds for the market, and possibly to use as a recipient to distribute the seeds to the players; a black or white board and a set of post-its to display outputs, or a retroprojector
- Room and space settings (FIG 3) : there are no big constraint on space and room setting. The essential point is that participants should be able to get up and circulate easily, so it is better not to have tables. Then there is the possibility to arrange spatially the players to reflect their land disposition on the grid, as we did in Bamako, but it is not necessary. It can be useful to use spatial arrangement to design several groups where collective management can be asked.
- Preparation : cutting and sorting the seeds disks, printing the players sheets, arranging the room, briefing the facilitation and assistance team being clear about everybody's role, and if no retroprojector drawing the grid and preparing post-its

2.2. Results from Bamako's Workshops

2.2.1. Elements of improvement

SeedDiv such as it is described in this paper is the result of the improvements proposed by the farmers during the workshop. Three groups spent a few hours working on specific improvements that should be brought to the game : individual constraints, coordination in the village, local management institution. More specifically, the elements improved by the farmers were :

- each farmer owns 4 plots (instead of 1)
- each farmer has 2 plots on 1 type of soil, 2 plots on the other 1
- color and resistance to striga added as characteristic of local varieties
- number of seeds harvested for each level of production
- market and external input of seeds

2.2.2. The institutions played

After playing individually or within family groups, the farmers were asked to work in groups to craft institutions that could manage the seeds of the game. Three examples of institutions practices were designed with rules by the farmers during one day. The implementation of one of them was experimented during the workshop by all of the participants with fairly elaborated rules. The institution that was tested was a cooperative such as one of the village is working on designing. The rules used for simulating the cooperative were the following :

- the cooperative starts with 1 seed of each kind and is able to store seeds for 3 years. Its objective is to have always at least 1 seed of each kind
- 4 multipliers are needed. A multiplier must use one of its plots for multiplication and gets the seed from the cooperative for this plot. A multiplier can get up to 10 seeds on its multiplying plot if its successful and must give 8 of them back to the cooperative
- The seeds produced by the cooperative are of high quality : they give 4 seeds instead of 2 if the plot is successful
- Everybody can ask seeds at the cooperative but it has to give it back. If a farmer borrows seeds produced by the cooperative, it has to give 3 seeds back
- Cooperative members can access cooperative seeds for only 2 seeds back. The cotisation is 1 seed a year.

(FIG 5 & 6)

Farmers could test and adapt the rules they just crafted and check how it affected the performance of the institution in maintaining the diversity of variety over time and providing seeds for crops. The result was quite spectacular as the stock of varieties of the cooperative vanished within years! This was mainly due to the failures of multipliers and the fact that farmers were not interested in getting seeds from the cooperative they would have to give back.

2.2.3 General elements of feedback

More generally, the participants of the workshop were happy with the possibility of exchanges opened by this evolutive game, and in particular the exchanges they had around the test of a cooperative. The workshop did close on the engagement of partners NGO to keep on supporting farmers with the creation of cooperatives.

The main drawback of the workshop was that it was held in Bamako for logistics simplicity reasons and then was far from any case study site where a field visit could have been organised.

3. DISCUSSION

3.1. Insights from Bamako workshop

The SEED-Div's RPG is actually the result of a long process (3 years) where representative abstractions and key descriptive structural and dynamic elements of local seeds systems were discussed with different groups of farmers during workshops. Despite its very abstract aspects, it actually contains many elements and constraints of the real world and was very easily appropriated and discussed by all the farmers in the workshop.

3.2. How do Seed-Div as a methodology

A more general output of the project is that 3 institutions created during the time of the project have benefited of the support of this process and are still functional.

- Some critical reflections on the ABM in particular on the way the stochasticity of yields is managed
- how do they fit in a wider context / link with current project IMAS
- how does Seed-Div as a methodology fits in a wider RPG research context :

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- an abstract tool to bring participants in stepping back and exchanging ideas on a higher level of abstraction

3.3. Decontextualised description

A resource exists in several varieties. At every time step, Producers can transform this resource, reproduce it and exchange it. In the game, the producers try to meet some production objectives. The idea is to check how the diversity of the resource variety evolves in the system and how it may impact on the producers.

Resource transformation

Different kinds of conditions may affect the yield of the resource / product transformation.

These conditions may be:

- Changing at every time step but identical for the producers (such as climatic conditions or global external events)
- Stable over the time steps but dependant on spatial settings (such as soil types)
- Stable over the time but dependant on producer (such as skill or level or equipment)
- The different varieties may react differently to an identical set of conditions
- An additional random variability might be introduced to represent other kinds of conditions that are not taken in account
- The product of the resource is an important economic or subsistence asset for the producers, and the quality of this product and its potential uses may be different depending on the variety of the resource.

Resource reproduction : Unless its production is null, a Producer is always able to reproduce 1 or 2 unity of the resource.

Resource exchange :

- Producers are free to exchange resource units, although a cost (economic or social) may be attached to those exchanges
- Under special conditions, some producers might get resources from outside the system.

SEED-Div was used successfully during a training session in France and demonstrated its ability for being used as a generic tool for fostering discussions diversity management institutions

3.4. Strengths, limits and potential improvements of the tool

- limits (drawn from decontextualized description and table) :
 - the RPG is valid only for species where there is no genetical drift (autogamous species). This means in particular that it is not possible to use Seed-Div for millet which has an important genetic mixing
 - the RPG as it is is valid only for species where it is possible to master on field seeds selection practices and seeds conservation practices individually
 - on an agronomic point of view, the RPG as it is is valid only for rainfed crops where agronomic conditions are the main drivers of yield response.
 - the RPG such as it is is valid for species where the community is the right scale for local seeds management. However it could be easily adapted to represent a wider territory and other kinds of stakeholders
 - if the focus is on institution crafting it might be interesting and necessary to include more differentiation between the players. Not all members of a community may be able to play the same role in the crafting and functioning of a new institution,n

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- Potential improvements :
 - Introducing “events”
 - Justifying stochasticity
 - Introducing varieties from outside
 - Valuing fallows on bad soils
 - Some contextual rules may need to be specified when the game is played outside its context : farmers did use implicit social and cultural rules when they played Seed-Div that equilibrate the game play. For instance they were not so keen on asking seeds to others as they attach a social cost to it. An affective link to varieties could be recreated by giving qualitative description of the varieties to the players
 - Running simulations over a simplified version where
 - agents type 1 try to minimize the risk : after 3 years, they start to look for the variety with the best worst result among their neighbours
 - agents type 2 try to get the best variety every year : they look for the variety with the best result for the announced climate among their neighbours and go to market if they cannot find it

Try it with

- same conditions lead to same results
- fixed individual variability over the different varieties

4. CONCLUSION

The RPG focuses on the institutional aspects of varietal diversity management. Its specific question was what are the drivers of the diversity at the scale of the village? How to maintain it with a sustainable level of constraint for the community and the individuals? Its aim was to foster discussions between researchers, NGOs, farmers’ organisations and farmers on possible management options of the seeds system at the local scale. Then the idea was to have a tool that could allow easily simulating the consequences of individual actions at the collective level and then discussing implicit collective rules, but also implementing explicit collective rules and testing them. In this way it could be used to facilitate and accompany institution’s emergence. An additional constraint was that this tool had to be generic enough to have farmers from different regions and contrasted agro-ecological constraints being able to play together and exchange ideas.

The result is that SEED-Div has proven able to simulate seeds exchanges and varietal dynamics within a village. Its abstraction has proven efficient in bringing players to confront contrasted situations even though language barriers. Finally it has proven flexible enough to have players designing and implementing an elaborated local management institution.

The outputs of the overall process was that local actors are engaged in local seeds conservation actions reflecting new approaches of management, sharing and redistribution of agrobiodiversity benefits via a decentralised multiplication coordinated with the local actors.

The perspective is to get farmers organisation performing durably in situ managing local genetic material in seeds banks and cooperatives. After a low period, the work is continuing with the recent start of a new ANR project.

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FIG 1 : Assitants table with reserves of seeds at the back and at the front players sheets with their choices for several years and players cups with seeds inside ready for being distributed back



FIG 2 : Display of fields and harvest level on white board

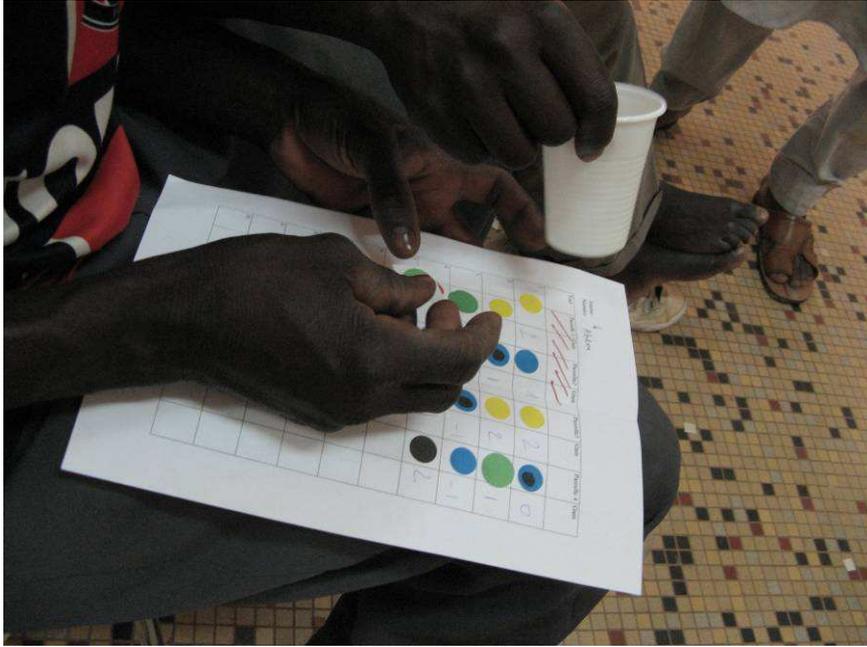


FIG 3 : A farmer sowing the green variety on one of his plots



FIG 4 : Lines of players interacting and discussing



FIG 5 : the cooperative simulated in the game : the cashbox where member put their cotisations and the stocks of the different varieties



FIG 6 : the cooperative manager in action checking how he can answer requests from its members

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