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Combining role-playing games and policy simulation exercises: An experience with Moroccan smallholder farmers

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Moroccan agriculture is currently undergoing major political, socioeconomic, and environmental transitions. Smallholder farmers involved in large-scale irrigation schemes need to modernize their systems to face these challenges. In this study, a participatory process incorporating different simulation and gaming tools was designed and applied to accompany farmer groups in designing joint irrigation projects, generally drip irrigation systems. A role-playing game was used in the first phase of the process to raise awareness among farmers about the scope and contents of a joint irrigation project and list the different knowledge gaps. During the second phase, a policy simulation exercise based on the actual field situation enabled farmer groups to design their own joint drip irrigation project. As a result, several farmer groups produced a feasibility study for their joint drip irrigation system. Our experience highlighted the complementarity of these tools in a process of change. The abstract role-playing game provided valid learning experience while the realistic simulation supported concrete decision making.

KEYWORDS: *irrigation; participatory innovation development; policy simulation exercise; role-playing game; smallholder farmers; Tadla irrigation scheme*

The objectives of this study were to design a participatory process and a set of simulation and gaming tools to accompany groups of Moroccan smallholder farmers in

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the collective modernization of their irrigation system. It aimed to identify farmers interested in changing their system to drip irrigation, to help them understand the scope and content of joint irrigation projects, and to support committed farmers in designing their project. Our work put the emphasis on farmers' choices regarding collective infrastructures, which was the most difficult part of the project. Indeed, such choices are closely related to organizational issues (e.g., irrigation schedules) that require agreement to be reached among the group while respecting the individual projects of farmers.

Here we report our experience in developing and using a role-playing game (RPG) combined with a policy simulation exercise (PSE). We describe the process in which these simulation and gaming tools were used and show the effectiveness of their combined use in this process. Our results support the hypothesis that educational objectives can be most easily reached with abstract games, whereas decision making requires more realistic simulation tools.

Modernizing Moroccan smallholder farmers' irrigation systems

Moroccan agriculture is currently undergoing major political, socioeconomic, and environmental transitions. The different structural adjustment policies that took place in Morocco since the 1980s changed the political context for agriculture. This is particularly true of large-scale irrigation schemes, such as the 109,000 ha Tadla irrigation system, located 200 km southeast of Casablanca. In the past, these schemes were mainly state administered. The state provided water, determined the cropping patterns, provided services such as land preparation, and processed and marketed most industrial crops (sugar, cereals, cotton). The recent state disengagement from agriculture entailed the liberalization of cropping patterns (1994) as well as the privatization of food-processing industries (2005). Industrial crops such as sugar beet are declining, while farmers are looking for alternatives (dairy production, horticulture, etc.). In addition, there are environmental problems with the drop in groundwater tables due to droughts in the early 1980s and late 1990s as well as the increased exploitation of groundwater through more than 10,000 private tube wells.

In this context, in the coming years, small- and medium-scale farmers in the Tadla irrigation scheme—80 % of farmers hold less than 5 hectares of land, accounting for 33% of the total area—will face serious water scarcity, a decrease in services from the irrigation administration, and strong competition in the marketing of their produce. Modernizing the actual gravity irrigation systems should increase the efficiency of water use, improve crop yields through better irrigation and fertilization, and reduce labor costs. However, existing modernization programs, which pay subsidies to farmers to install drip irrigation systems to replace existing gravity irrigation, mainly reach the larger-scale farmers. Small- and medium-scale farmers face several constraints related to financial difficulties to invest (typically only 30% to 40% of the investment cost is subsidized by the state), technical difficulties in installing and managing the system, and uncertain land tenure involving numerous land inheritance problems (Kobry & Eliamani, 2004). The underlying hypothesis of this study is that collective action in the modernization of irrigation systems can help smallholder farmers in overcoming these constraints (Shah, 1995).

Collective modernization is defined here as the introduction of modern irrigation techniques such as drip irrigation through a joint irrigation project involving a group of smallholder farmers. A typical joint drip irrigation project is a combination of collective hydraulic structures (storage basin, head station unit, etc.) and individual field equipment (water meter, distribution pipes, etc.). However, such projects require not only a change in technology but also a profound organizational change. If the conditions needed to achieve this organizational change are not met, the modernization of irrigation schemes can lead to disappointing agronomic performances (Vidal, Comeau, Plusquellec, & Gadelle, 2001).

Methods and tools

Realistic simulation versus abstract gaming

The approach used in this study was adapted from experiments in participatory approaches for rural development, in particular, the participatory innovation development (PID) approach (Gonsalves et al., 2005), and also drew on methods and tools developed in the field of companion modeling (Barreteau et al., 2003; Bousquet, Barreteau, Le Page, Mullon, & Weber, 1999). This approach comprised the development and use of simulation and gaming tools to accompany farmers in certain steps of their change process.

Many experiments have been conducted with simulation and gaming tools in the field of irrigation (Burton, 1989; Daré & Barreteau, 2003; Steenhuis, Oaks, Johnson, Sikkens, & Vander Velde, 1989). The relevance of these tools in multiactor processes has been demonstrated (Barnaud, Promburom, Gurung, Le Page, & Trébuil, 2006; Duke & Geurts, 2004; Mayer & De Jong, 2004). However, developing and using simulation and gaming tools in multiactor processes is not obvious. Developing the right tool for the right situation is the subject of permanent discussion, and many questions arise when simulation and gaming tools are being developed. Toth (1988) pointed out that one of the major concerns when designing such tools was to find the correct degree of abstraction. According to this author, the designer often faces two contradictory concerns:

- simulations or games should allow participants to get out of their usual scheme, remove them from their daily life and thus enable them to consider other viewpoints;
- while at the same time they should preserve basic features of reality in order to ensure that what is learnt during the game can be used for making real-life decisions.

In the development of the BUTORSTAR game, Mathevet et al. (2007) faced such a dilemma. On the one hand, they wanted to simplify their game to help players understand cause-and-effect relationships, and on the other hand, they tried to keep a realistic environment so the players could extrapolate their new understanding back to reality. Feinstein and Cannon (2002) relate this dilemma to a question of perspective: some simulation tools being deliberately simplistic to increase their educational effectiveness versus others being necessarily complex to sufficiently represent the real world.

Two simulation and gaming tools illustrate these different perspectives: RPGs and PSEs. Games are usually composed of rules that define all aspects of interactions among the players and between the players and the gaming environment, while fixing the goal of the players (Greenblat, 1975; Lindley, 2003). RPGs call for an additional feature: the "roles" that players have to play in the game (Mucchielli, 1983). Thus, an RPG can be described as a goal-directed activity conducted within a framework of defined rules involving characters who role-play. The play dimension of RPG naturally creates a distance between the game and reality (Daré, 2005). Such tools allow experimental exploration of decision making (Mayer & De Jong, 2004), which enables participants to go beyond their restrictive interpretative frameworks (Tsuchiya, 1998). They are thus particularly appropriate to raise stakeholders' awareness about complex issues, systems, or processes (Barreteau, Le Page, & Perez, 2007). Simulations can be described as the testing (following specific rules) of the choices of one or several participants within a model that reflects reality (Shirts, 1975). In a PSE, several participants develop and analyze scenarios (Toth, 1988). Their history is closely related to the development of a negotiation tool, in particular, for multilateral negotiation between political leaders (Tessmann, 2006). These tools help stakeholders prepare to handle potentially critical situations by testing and evaluating possible solutions (Duke & Geurts, 2004). They are consequently more embedded in reality. In summary, RPGs, being more abstract, are better suited to achieving educational goals, while PSEs, which are more realistic, are better suited for decision-making processes.

We therefore decided to first develop and use an RPG to raise the awareness of farmers about the scope and content of joint irrigation projects. The application of this RPG triggered a demand for a more realistic simulation tool. We consequently developed a PSE to support the farmers in their decision-making process. Our approach also included other information and communication methods and tools, such as farmer-to-farmer visits and open seminars, using different supports (video films, written documents, photos).

The tools used in this study are considered to be complementary in the way they provide information and enable the generation of knowledge in the process of solution development (Bluemling et al., 2006). They facilitate individual learning as an iterative process of action and reflection (Hagmann, 1999) but also promote social learning as the growing capacity of a multiple stakeholders' network to develop and perform collective actions (Craps, 2003). Indeed, these tools are intended to favor exchanges and dialogue on whether or not to engage in the modernization of a joint irrigation project and, if need be, on how to define such a project.

The approach was initially designed on the basis of know-how of irrigation professionals in France and in Morocco who had already dealt with joint and individual modernization projects in irrigated agriculture (Kobry & Eliamani, 2004). By regularly reviewing and evaluating the tools, the process, and the results produced with the stakeholders, the approach was continuously adapted to their needs. By proceeding in this way, the approach aimed to enhance social learning between the facilitation team and the farming communities as well as within the communities. Furthermore, the approach relied on the stakeholders' motivation to work together on the identification and implementation of a solution to their problems (Gonsalves et al., 2005; Thysen, 2002).

Accompanying process

The accompanying process developed in this study is flexible and adapted to individual situations, taking the structure of the Participatory Innovation Development approach:

1. **Diagnosis**
   A discussion is organized with farmer groups who have expressed an interest in the collective modernization of their irrigation system in order to understand their constraints and needs. These are generally farmers who have observed drip irrigation systems on neighboring farms and are interested in implementing these systems on their own farms but who face many difficulties in designing and implementing such projects alone. The typical components of the PID approach are presented by the facilitation team, an if concrete interest is shown, an agreement is reached on the following steps. In parallel, general surveys are made to characterize the situation and to specify farmers' objectives.
2. **Development of solutions**
   At this stage, farmers acquire information about drip irrigation experiments by visiting other individual and joint drip irrigation projects on farms. Joint feedback sessions follow to enable farmers to share observations and to discuss the implications for their projects. An RPG session is then held to further clarify the pros and cons of a joint irrigation project and identify those who want to move forward in developing such a project.
3. **Testing of solutions**
   Once farmers have a clear idea about the scope of a joint irrigation project and about the feasibility of their individual cropping patterns under drip irrigation, they provide information on the structural characteristics of their farm as well as their existing and planned cropping pattern. Using this information, a PSE is held to help farmers test different technical designs of a joint irrigation project and finally decide on the structure of their project.
4. **Evaluation of solutions and decision making**
   Using the results of the PSE, the facilitating team prepares a feasibility study of the project. This first design of the modernization project quantifies the different technical options in terms of investment costs and management implications. This study is presented to the group and amended following discussion on the technical and managerial options. The farmers' groups are finally ready to launch the tender for the design and construction of their joint irrigation project.

The TADLA role-playing game

The first simulation and gaming tool developed in this study was the TADLA RPG. Its objective was to raise awareness about the scope and contents of a joint irrigation project by supporting farmers in sharing and structuring their knowledge (Steps 1 and 2 of the PID approach). More specifically, this RPG intended to

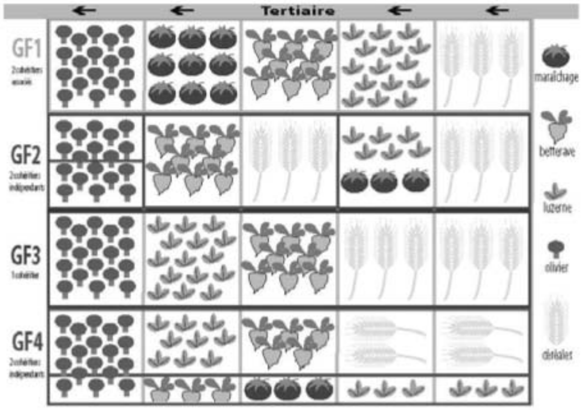

FIGURE 1: Representation of reality in the TADLA role-playing game, showing the existing gravity irrigation system, different groups of farm families (GF1 to 4), and existing cropping patterns on the different plots (horticulture, sugar beet, alfalfa, olive trees, and wheat)

- promote social learning among the farmers and support basic discussions about technical options and management rules;
- raise awareness about the collective dimension of the project along with the ensuing constraints, advantages and compromises; and
- allow the participants to identify knowledge gaps and the support they will need (which questions need to be answered, who can answer).

The representation of the reality in the TADLA RPG is semicontextual. The gaming environment represents a typical tertiary irrigation unit of the Tadla scheme, which covers about 30 to 40 hectares of land, served by a tertiary irrigation outlet (Figure 1). One important question was to know how far such a representation would allow the players—in our case, farmers—to disregard to a certain extent existing problems and conflicts on water management, land tenure, and so forth and focus on the learning process of understanding the scope and content of a joint irrigation project. Our hypothesis was that this abstraction would favor the creativity required for change and enable new forms of interaction between the farmers. In addition, such an environment would enable the use of the tool with farmers who do not share the same project (i.e., to work with several farmer representatives at the same time).

In the TADLA RPG, the players possess virtual farms (described on paper cards) and experiment the different steps of the design of a joint irrigation project. The players' objective is to find an agreement for the dimension and the structure of a virtual project. A simulation spreadsheet is used to quantify the different technical options proposed by the players, to compare these options, and to discuss the financial and managerial implications of these options. During the game session, farmers' choices are projected onto the wall (by video projector). Farmers describe their individual projects (cropping systems) and discuss the joint irrigation facilities.

The game is implemented in three stages: First, a briefing session is held to explain the scope and content of the RPG, then the game itself is played, and finally a joint debriefing session is held. In the last step, participants are asked to analyze the negotiation phases and the decisions that have been taken. Finally, they are asked to draw a link between what happened in the game and their own situation in order to see if they are motivated to continue the process and to expose their needs and constraints. An evaluation is carried out at the end of the session focusing on the relevance of the gaming environment (does the gaming environment reflect the farmers' real situation?) and on the results of the game (understanding the scope and content of joint irrigation project).

The TADLA policy simulation exercise

Once farmers who participated in the TADLA RPG decide to engage in the joint modernization of their irrigation system, they enter Steps 3 and 4 of our PID approach. In these steps, the TADLA policy simulation exercise is used to support farmers in making the necessary choices for the design and implementation of their project.

More specifically, the TADLA PSE aims to

- support the farmers' discussion and choice of their new production systems,
- support the farmers in jointly making the necessary choices regarding the technical and organizational aspects of their project, and
- empower the farmers regarding the implementation of their project and their dealings with private contractors and state administrations.

The TADLA PSE environment is based on the cadastral plans showing the lands of the participants. In this representation, the size of farmers' plots and their geography conform with the plan, whereas their geometry is simplified by the use of square plots. The main question at this stage was to know if such a realistic environment, based on the farmers' own situation, would help them to design their project.

The objective of the TADLA PSE is for farmers to come up with the best possible technical design of their project, combining low investment costs, maximum managerial flexibility in operating the hydraulic infrastructure, and meeting the individual farmers' needs. The participants work with their own data (previously collected by them using a simple questionnaire) and explore realistic scenarios. They express their choices on a scale model using a flip chart, crop cards, and some miniature equipment. An enhanced version of the RPG simulation spreadsheet allows them to make a distinction between investment in joint and individual equipment. It also allows farmers to calculate the expected benefits and costs of their projected cropping systems. In addition, this version of the spreadsheet allows them to compare different technical options in terms of costs, allowing a discussion on the pros and cons of certain technical choices and their implications in terms of management of the future project.

The set-up of the PSE is simpler than that of the RPG, as it does not include a debriefing stage. This is due to the length of the simulation, which allocates less time for participants to analyze the decisions they took during the simulation. On the other hand, the different scenarios addressed by the participants are summarized at the end of the session on flip chart. An evaluation is also made at the end of the session focusing on the relevance of the simulation environment and on the results of the PSE (equipment and management choices and responsibilities). A more formal individual evaluation is carried out with the participants some time after the PSE sessions to assess the added value of these sessions for the farmers.

Implementation of the RPG and the PSE

The four steps of the PID approach were implemented with different farmers' groups from the Tadla area. Joint meetings, surveys, and farmer-to-farmer visits preceded the use of the RPG and the PSE.

The implementation of the RPG and the PSE followed an iterative process of design, test, and evaluation (Figure 2). Inquiries were initially carried out in two cooperatives in the area (a total of 41 farmers) to characterize the general situation of Tadla smallholder farmers. A pre-RPG was then developed on the basis of the information collected and on the expert knowledge of irrigation professionals. The pre-RPG was subsequently tested and evaluated with eight Tadla smallholder farmers not concerned by the modernization of their irrigation system (Test Group 1). This prompted the development of the simulation spreadsheet. The more elaborate pre-RPG was in turn tested by a group of researchers and professionals (Test Group 2), providing further scope for improvement. The TADLA RPG was played twice, with Group 1 and Group 2 (heterogeneous group). The head of the milk cooperative from Group 2 involved his cooperative in the process (Group 3) as well as five brothers who were willing to modernize their irrigation system (Group 4). After the test and the evaluation of the TADLA RPG, the TADLA PSE was developed and applied twice with Group 3 and once with Group 4.

The TADLA RPG was played twice. The different steps of this game are illustrated in Figure 3. The first group included seven farmers belonging to a machinery sharing cooperative. The second group was more heterogeneous, as it included five farmers from two different agricultural cooperatives and the head of a milk cooperative.

The two RPG sessions led to the definition of two virtual joint irrigation projects (Figure 4). The projected cropping patterns differed from the initial ones, as more tree plantations (olives and citrus) and horticulture farming were chosen instead of the existing sugar beet and cereals. The discussion about these choices underlined the desire to reduce labor and direct production toward value-added crops. The choice of the irrigation facilities was in both cases a combination of the desire to make the smallest possible initial investment and more personal freedom regarding farm management. Generally, the farmers showed that they had concrete ideas about the technical options of irrigation facilities and, in the case of some, about the management of the new system. The cost assessment obliged the farmers to discuss the advantage of joint projects over individual projects. It also allowed farmers to better assess the amount of subsidies from the different sponsors and their own investment.

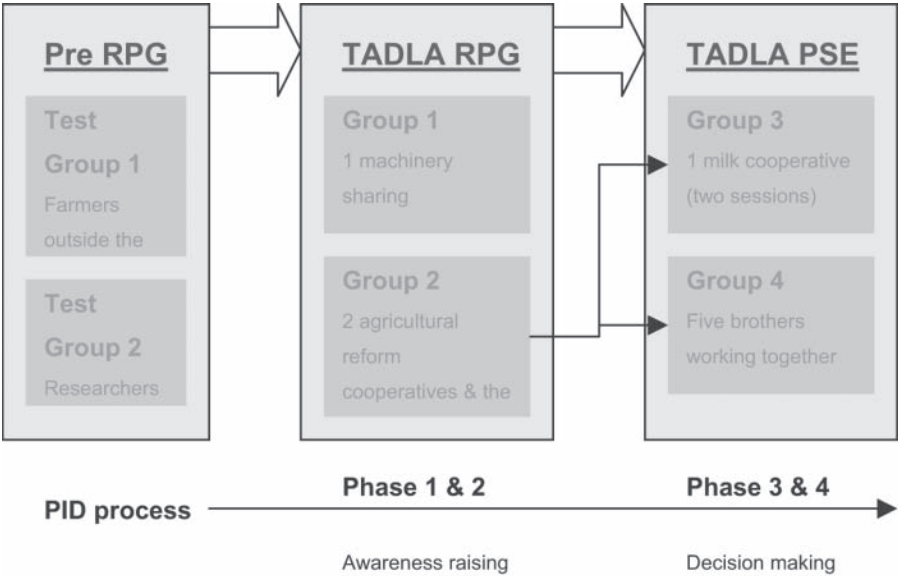

FIGURE 2: Iterative process of design and implementation of the TADLA role-playing game and policy simulation exercise
NOTE: T&E = test and evaluation.

FIGURE 3: Different steps of the TADLA role-playing game: briefing session before the game, individual requests, joint discussion, synthesis of the joint choices, discussion about problematic decision making and list of important questions raised during the debriefing

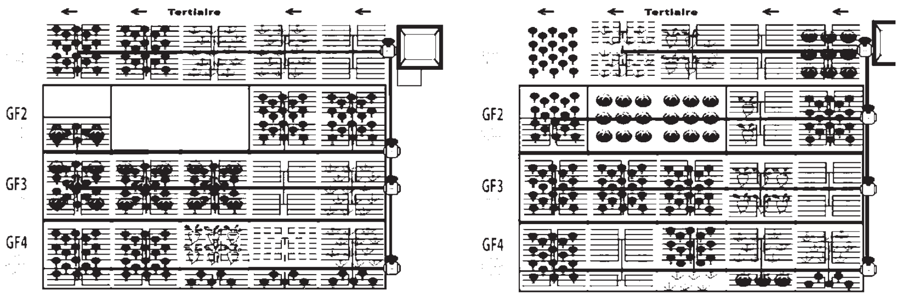

FIGURE 4: Virtual projects with planned cropping pattern and individual and joint facilities (farm equipment, joint reservoir, pumping equipment, pipes, water meters, and gates)

During the debriefing, farmers were asked which decisions were difficult to make and which choices had to be negotiated among the group. Then, to encourage them to link the results with their own situation, farmers were asked to list all the questions that needed to be answered before the next steps of the process. This allowed the facilitating team to identify knowledge gaps. Farmers then put their questions to potential sponsors and local authorities (river basin agency, irrigation administration, social development agency) during the two meetings that followed the two RPG sessions (Figure 5). This allowed farmers to reassure themselves about the commitment of these institutions and to gather further information.

Among the different cooperatives that participated in the RPG sessions, only the head of the milk cooperative showed any real interest in going further in the process. The other cooperatives were lukewarm. Some farmers were finally reluctant to change their irrigation system, and group discord forced those who were motivated to move toward individual projects, despite the higher costs (about 15% more expensive) and the loss of land for the reservoir.

Following a request from the head of the milk cooperative, it was agreed to pursue the process with a group of 11 farmers from his cooperative. The head also brought in a group consisting of five brothers willing to engage in a joint modernization process. There were certain cross-links, as both groups stayed in touch and informed each other of their respective progress. They organized a joint visit to a neighboring farm with a drip irrigation system and were asked to collect crucial information for the PSE (projected cropping pattern, required irrigation facilities).

The TADLA PSE was first implemented twice with six farmers from the milk cooperative (Figure 6). The first session was dedicated to only 17.8 ha of the 36.9 ha of the total area of the project. Although unplanned and due to lack of available data for the remaining area supplied by the participants, the procedure gave the facilitation team the opportunity to meet other members of the milk cooperative and to

FIGURE 5: Roundtable with farmers, river basin agency, and irrigation administration following the first role-playing game session

FIGURE 6: Photos of the TADLA policy simulation exercise session with the milk cooperative
NOTE: Plots are represented by squares, crop choices were written on paper sheets, equipment was drawn on the scale model, and simulations were carried out on the computer.

assess their interest in a joint irrigation project. The different components of a drip irrigation system were discussed by the farmers as well as their location (e.g., the location of the storage basin).

After the individual surveys were completed, another PSE session was organized with the same farmers belonging to the milk cooperative. In addition, the remaining farmers, who were not present, had officially mandated the six farmers to take the lead for the design of the group's project. Thus, the entire project was discussed and the scenarios explored were based on the total area of the project. Farmers had a clear idea about the changes they wanted to introduce in their farming systems, intensifying their fodder livestock production systems and introducing horticulture. In addition, the technical options became clear and joint decisions were taken about joint and individual equipment, once again allowing individual farmers a large degree of autonomy (individual fertilizer units, for example). The last PSE session was held with all brothers of Group 4 (Figure 7). Before the session, a visit was made to the future location of the project, and some crucial information for the session (location of the storage basin, for instance) was collected. The results of this session

FIGURE 7: The TADLA policy simulation exercise session with the five brothers

were similar to those obtained at the milk cooperative, as the different scenarios they explored supported their decision making regarding the equipment and the introduction of new crops.

At the time of writing, the facilitating team has completed two feasibility studies based on the results of the TADLA PSE sessions. These studies have been returned to the respective groups who contracted private companies, which are currently implementing their projects. Presently, we are using both RPG and PSE tools to accompany other farmers' groups interested in designing a joint irrigation project.

Discussion

In the case at hand, an RPG and a PSE were developed and used in the same process dedicated to supporting a participatory innovation development with Moroccan smallholder farmers. The main characteristics of these tools are summarized in Table 1.

Questionnaires and individual debriefing sessions were used to evaluate the TADLA RPG sessions. These showed that farmers did not really "play" their roles but had no problem in making their own situation match the semicontextual gaming environment. Thus, their choices were taken according to their situation and applied to the virtual environment. At the same time, because the project was virtual, it was easy for the group to avoid long, unconstructive discussions about individual concerns. As a consequence, the evaluation showed that most of the questions regarding the scope and content of the joint irrigation project were clarified. Farmers were able to view an irrigation system and play with its variables. They were thus able to acquire a more comprehensive understanding of how the components of the system work together. The educational purpose of the game was thus achieved even though the farmers did not completely escape their real-life roles. At this point, the leader of Group 3 requested the development of a more realistic simulation tool to support his group in designing their own project.

Following this evaluation, the facilitating team developed the TADLA PSE, which was specifically dedicated to simulate the farmer's real situation. The evaluation of

TABLE 1: Comparison between the TADLA role-playing game (RPG) and the TADLA policy simulation exercise (PSE)

	TADLA RPG	*TADLA PSE*
Context	At the beginning of the process, farmers have limited understanding of a joint irrigation project and how to design one; they need clarification in order to commit themselves or not.	Farmers are committed to implementing a joint irrigation project; they need to make some choices and grasp the consequences of these choices before contacting private contractors.
Data	Previous surveys on Tadla farms are used to design the roles and calibrate the simulation spreadsheet.	Information is provided by farmers before the session.
Representation	Semicontextual environment based on a typical but virtual tertiary unit of the Tadla irrigation scheme	Realistic modular environment based on the cadastral plan of the participants
Roles	Imposed roles; participants play virtual farmers who are described by several characteristics (e.g., family group, total area cultivated, age, cattle, labor availability, capital, etc.).	No specified roles. The constraints of farmers' real-life situations naturally define the choices taken by the participants.
Rules	Participants design a virtual joint irrigation project according to their roles and following predetermined steps.	Participants explore different scenarios and design their own joint irrigation project following a more flexible approach.
Output	Consensus on the contours of a virtual project; identification of knowledge gaps	Consensus on a real project and providing information for the feasibility study
Debriefing	Discussion on the difficult choices and on the negotiation phases and definition of a list of questions	Due to the length of the simulation, no debriefing is carried out. However, the different scenarios are summarized at the end of the session.
Outcomes	Participants have gained insight in the scope and contents of a joint irrigation project.	Participants have designed their project.

the first simulation showed that it came too early in the process. Apart from the head of the cooperative who had participated to the TADLA RPG, the other farmers lacked information about drip irrigation systems. In addition, the farmers took a long time to represent their farm using the scale model. Long discussions took place on individual issues and no concrete decision was made at the end of the simulation. It was clear after this session that the scope and contents of a joint irrigation project were not clear for all the farmers. The evaluation of the second session with the same group was much more positive. This session was able to build on the knowledge acquired by the farmers during the previous simulation but above all on the different events that had taken place in the meantime (other field visits, internal discussions, and meetings with the facilitators). The increased participation of the farmers in this session and the discussion of the entire project clearly revealed their commitment to move forward. This time, the PSE helped them to explore scenarios, to make collective and individual choices, and to discuss different issues related to the development of their project. However, the session did not allow responsibilities to be established between members of the group.

The evaluation of the RPG and the PSE support the hypothesis that abstract gaming addresses educational goals better than realistic simulations. Even if farmers did not play the roles they were assigned, the semicontextual environment of the RPG supported valid learning experiences. Similar results were found during an RPG used in irrigated system negotiation in which the social background of players interfered with the roles they played in the game although the educational goal was reached (Daré & Barreteau, 2003). On the other hand, our experience shows that realistic simulation is required to support decision making. The real environment forced farmers to discuss each issue in depth (such as the dispersion of the individual farms), because each choice taken during the PSE would have an impact on their project. Consequently, at the end of the process, agreements were reached between the farmers. The results of the PSE were consequently directly used to prepare a feasibility study for the farmers' project. Moreover, our study underlined the complementarity of these two tools. Farmers who had participated in earlier RPG sessions were much more confident and effective than the other farmers during the PSE session.

Conclusion

The scope of the study—accompanying the modernization of irrigation projects with a collective dimension—was initially defined by researchers and irrigation professionals. This scope was subsequently confirmed during farmer-to-farmer visits to existing joint irrigation projects elsewhere in Morocco. However, our experience with the first farmers' groups from the Tadla produced disappointing results. In fact, during the course of the process, we discovered that these cooperatives were subject to internal conflicts. Once the scope of the project became clear during the first phase of our approach, they showed they were reluctant to implement a joint project.

Our approach did not specifically aim to solve internal conflicts among farmers' groups, and it was assumed that using a semicontextual RPG would help the participants to overcome this constraint in order to focus on the learning process. The results of this study show that it worked quite well. In fact, no conflicts appeared during the RPG sessions. However, we assume that our approach could be improved in order to help farmers address this issue. An explicit work on preexisting conflicts could thus be done prior to the RPG, or during the debriefing, using specific facilitation techniques.

Our approach relies on the participants' motivation to achieve an innovation together. Through continued interactions with farmers, it was possible to continue the approach only with those groups sincerely motivated by a joint irrigation project.

The different simulation and gaming tools served these two phases in the following manner: The RPG was used to work with leaders from different communities who were interested in understanding the scope and content of a joint irrigation project, and once farmer groups were constituted, a PSE was necessary to design their project. In fact, the use of the RPG prompted the development of the PSE.

The hypothesis that collective action in the modernization of irrigation projects helps farmers to face current changes was verified with Groups 3 and 4, who joined the process later on. First, the process allowed farmers to formalize a medium-term plan for their farming systems while listing all the assumptions and uncertainties. Second, decisions on technical options for the joint irrigation equipment clearly took the present and future uncertainty in the water availability into account. The process will result in farmers' groups taking responsibility for the management and maintenance of part of the hitherto state-operated irrigation system. For the time being, this prospect seems to have been accepted by the farmers' groups in the discussions that took place during the different steps in the process. However, it may be necessary to develop specific tools to (a) accompany these groups in the operation and maintenance of their joint irrigation projects on topics such as fixing water tariffs while accounting for maintenance costs and the depreciation of the hydraulic equipment, (b) plan and execute maintenance activities and the replacement of parts of the system, and (c) support farmers in their new cropping and irrigation practices. The development of these tools will be based on existing experience in collective drip irrigation systems elsewhere and might further explore the advantages of simulation and gaming tools.

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