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*Research*, part of a Special Feature on [Implementing Participatory Water Management: Recent Advances in Theory, Practice and Evaluation](#)

## **Supporting the Shift from State Water to Community Water: Lessons from a Social Learning Approach to Designing Joint Irrigation Projects in Morocco**

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**ABSTRACT.** This paper focuses on the evaluation of a participatory approach aimed at supporting groups of small-scale farmers in the design of joint drip irrigation projects. Our idea was to create a sustainable social learning environment in which they could acquire adaptive knowledge about new irrigation technology and about designing and managing a joint irrigation project while at the same time improving their negotiation capacities. We developed a framework to evaluate the process as well as the outputs and outcomes of the use of our approach with four groups of smallholder farmers in the Tadla irrigation scheme in Morocco. Our findings showed that the learning environment made it possible to compensate for the knowledge differential among stakeholders and to co-produce knowledge that can be mobilized by small-scale farmers to help them make better informed decisions when choosing whether or not to engage in a joint irrigation project and when developing and implementing such a project. We expect that this will ultimately contribute to supporting the shift from state water to community water through a shared understanding of the technical, economic, and social issues and options related to the management of irrigation water.

**Key Words:** *social learning, drip irrigation, irrigation projects; project management, Morocco; farmers; water supply*

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### **INTRODUCTION**

In large-scale irrigation systems around the world, farmers traditionally have limited involvement in the management of water beyond the farm gate. Morocco is no exception. However, the construction of dams and large-scale irrigation schemes from the 1960s onwards changed the perception of water ownership. Water “from heaven,” i.e., rainfall, was transformed into “state water” (Pascon 1978). The irrigation bureaucracy was not only responsible for water allocation and distribution but also fixed cropping patterns, provided services such as land preparation, and processed and marketed most industrial crops, including sugar, cereals, and cotton. This integrated planned development model was greatly affected by state disengagement and structural adjustment programs in the 1980s (van

Vuren et al. 2005). Following the international debate on irrigation management transfer (Coward 1980), large-scale irrigation systems had to face a transition from a hierarchical to more complex coordination modes. These new modes had to include water users in their management (Johnson et al. 1995), and apply market mechanisms after cropping systems and agricultural markets were liberalized and integrated supply chains were dismantled with the privatization of agro-industries.

In Morocco, there are encouraging signs that farmers are becoming more involved in the management of agricultural supply chains, notably the emergence of local and regional cooperatives, particularly for milk. However, despite attempts to transfer responsibilities to associations of water users, surface water management in large-scale

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irrigation schemes remains in the hands of the state. Like elsewhere, irrigation management transfer was not effective, underlining the difficulty in creating the conditions for successful transfer (Mollinga and Bolding 2004).

In addition, large-scale irrigation schemes in Morocco are facing an increasing scarcity of surface water, prompting farmers to use groundwater extracted from individual tubewells. The Tadla irrigation scheme, located 200 km southeast of Casablanca, is an excellent example, with more than 8400 unlicensed tubewells within a 100,000-ha perimeter (Hammani et al. 2007). Farmers mostly pump water from the phreatic aquifer, which is recharged by infiltration of rainfall and water losses from surface irrigation, which are estimated at 50% of the total surface water delivered. Because access is relatively unrestricted, the occurrence of a “tragedy of the commons” (Hardin 1968) cannot be excluded, because groundwater levels are going down.

To relieve water scarcity, the government has focused on giving farmers access to efficient irrigation technology, mainly drip irrigation, through various subsidy programs. The Ministry of Agriculture considers the results unsatisfactory in the approximately 142,000 ha already implemented, and wants to increase the pace and equip another 550,000 ha with drip irrigation by 2020 (PNEEI 2007). So far, larger farms have received most of the subsidies (Bekkar et al. 2007). These farmers have the financial resources and knowledge to prefinance their equipment so that they can take advantage of retroactive subsidies and to intensify cropping systems to ensure a sufficient return on their investment. They are also informed and sophisticated enough to (1) successfully negotiate a complex subsidy procedure that requires dealing with a state agency to obtain an adequate water supply, (2) choose appropriate irrigation infrastructures for their farms and work with private contractors, and (3) penetrate new agricultural markets, often through private traders. In a few drought-stricken areas, small-scale farmers have developed joint drip irrigation projects (Bekkar et al. 2007). In doing so, they decrease the cost per hectare and share the different risks associated with the implementation of the project. However, joint irrigation projects add another layer of complexity, because rules have to be elaborated for designing, implementing, and managing these projects, and few joint projects exist at present.

This paper focuses on the evaluation of a participatory approach aimed at supporting groups of small-scale farmers in the design of joint farmer-managed drip irrigation projects within the framework of large-scale agency-managed irrigation schemes. Our idea was to create a sustainable social learning environment to enable farmers to acquire adaptive knowledge about new irrigation technology and the design and management of a joint irrigation project, while at the same time improving their negotiation capacities. According to Pahl-Wostl et al. (2007), a social learning process includes the capacity to “deal effectively with differences in perspective, to solve conflicts, to make and implement collective decisions, and to learn from experience.” To sustain the learning environment, we contributed to developing a knowledge network. The underlying hypothesis was that the approach would reinforce the capacities of small-scale farmers to both deal with a technological innovation that is likely to create significant change and play an active role in debates on water management beyond the farm gate, including interactions with the irrigation authority and the river basin agency. Ultimately, this relates to shifting the perceptions of farmers, contributing perhaps to transforming state water into community water.

This shift in perception is important at a time when the state envisages converting 395,000 ha of existing large-scale surface irrigation systems, which involve mostly small-scale farmers, into drip irrigation. These projects will be largely state driven and run the risk of reproducing the interventionist state policies of the past with only limited participation by the farmers. This could lead to marginalizing inputs from farmers and, in addition, reduce their hydraulic independence, because the conversion to drip irrigation will decrease the amount of groundwater reservoir recharge by reducing percolation losses at the field level. To avoid a hierarchical conversion to drip irrigation, different pilot projects financed by international donors are now underway to define and test the terms and methods of such projects.

In the next section, we present the framework we designed to evaluate the process, the outputs, and the outcomes of our social learning approach. In the followed section, we present the results of our evaluation of the implementation of the approach with four farmers’ groups in the Tadla irrigation scheme. In the discussion section, we first explain

why the same process led to different results with different groups before coming back to some of the methodological choices we made when developing and implementing our approach. We also stress the implications of this study and of similar approaches aimed at involving farmers in water management beyond the farm gate. We conclude by listing the implications of our study as well as the outlook for future research and development.

## METHODS

In this section, we briefly present the approach we developed and implemented. We then describe the method we used to evaluate the process, outputs, and outcomes of implementing this approach.

### The participatory approach

There were several design principles underlying our approach: (1) the relatively “light” demand-driven presence of the facilitation team, (2) a focused training program supported by educational tools, and (3) the development of a knowledge network that put farmers’ groups in contact with other farmers who already used drip irrigation, with private service providers such as consultancy firms and engineering companies, and with banks, and government services. Our method was based on earlier experiments with participatory approaches for rural development, in particular the participatory innovation development approach (Gonsalves et al. 2005). We also drew on methods and tools developed in the field of companion modeling (Bousquet et al. 1999, Barreteau et al. 2003).

Our approach comprised the development and use of simulation and gaming tools using a two-phase facilitation method (Dionnet et al. 2008). The first phase, awareness raising, was accomplished through a technical workshop, farmer-to-farmer field visits, and a virtual role-playing game (RPG). The second phase, project simulation, required the farmers to define their individual farm projects, which formed the basis for a contextual policy simulation exercise to enable farmers to design a joint project. Policy simulation exercises were used to help stakeholders prepare to handle potential situations in a number of areas (Duke and Geurts 2004).

Both stages of the approach make use of information and communication methods and tools such as

farmer-to-farmer visits and open seminars supported by different types of media, e.g., video films, written documents, and photographs. These tools are seen as complementary in the way they provide information and enable the generation of knowledge during the process of developing solutions (B. Bluemling, M. Dionnet, M. Kuper, P. Garin, A. Hammani, and A. Eliamani, *unpublished manuscript*). They not only 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” (Maurel et al. 2007). These tools are designed to favor exchange and dialogue on whether or not to engage in a modernization project and, if need be, on how to design such a project.

The approach and the tools were developed through an iterative process of design, testing, and evaluation (Dionnet et al. 2008). The main steps of the approach and the outputs and outcomes are summarized in Table 1.

The identification of farmers’ groups interested in jointly modernizing their irrigation systems was an important step before the process began. The participants were generally small-scale farmers who had already observed drip irrigation systems on neighboring farms and were interested in implementing such systems. However, they faced many difficulties in designing and implementing such projects individually. Once farmers’ groups expressed their interest, we conducted surveys to identify the groups and to better understand their farm projects and background in terms of collective action (Dionnet et al. 2008).

### Evaluation method

As illustrated in Fig. 1, the aim of the framework was to evaluate the process, outputs, and outcomes of the application of our approach. The process refers to the implementation and linking of the different steps of our approach (Table 1). The outputs are the immediate products of the process (Gottret and White 2001), whereas the outcomes relate to the consequences of the outputs, specifically the “amount of change in behavior, attitude, skills, knowledge or condition (situation) of program participants” (Douthwaite et al. 2007). Evaluations using questionnaires with closed and open questions as well as interviews with the farmers involved took place at three different stages

**Table 1.** The approach adopted in this study

	Awareness raising phase			Project simulation phase	
	Technical workshop	Practical workshop	Role-playing game	Individual farm projects	Co-design workshop
Main questions	What is drip irrigation about?	How does it work?	Why a joint project?	What are the farming projects?	What are the collective choices of the project?
Means	Video projected presentation and group discussion	Farmers visit other farmers who use drip irrigation	Role-play scenario: design of a virtual joint project	Survey made by the farmers themselves	Simulation of farmers' project
Outputs	Farmers formalize and share their problems and link them with drip irrigation	Farmers build a consensus on the usefulness of the project	Farmers understand that a joint project has to fit to individual needs	Farmers define their farming project	Farmers make collective choices for the terms of reference of a feasibility study
Outcomes	Farmers gain knowledge on the drip irrigation technique	Farmers gain knowledge on drip irrigation projects, create knowledge network	Farmers gain knowledge on the pros and cons of joint projects	Farmers commit themselves to the execution of the project and envisage the future	Farmers take over the process

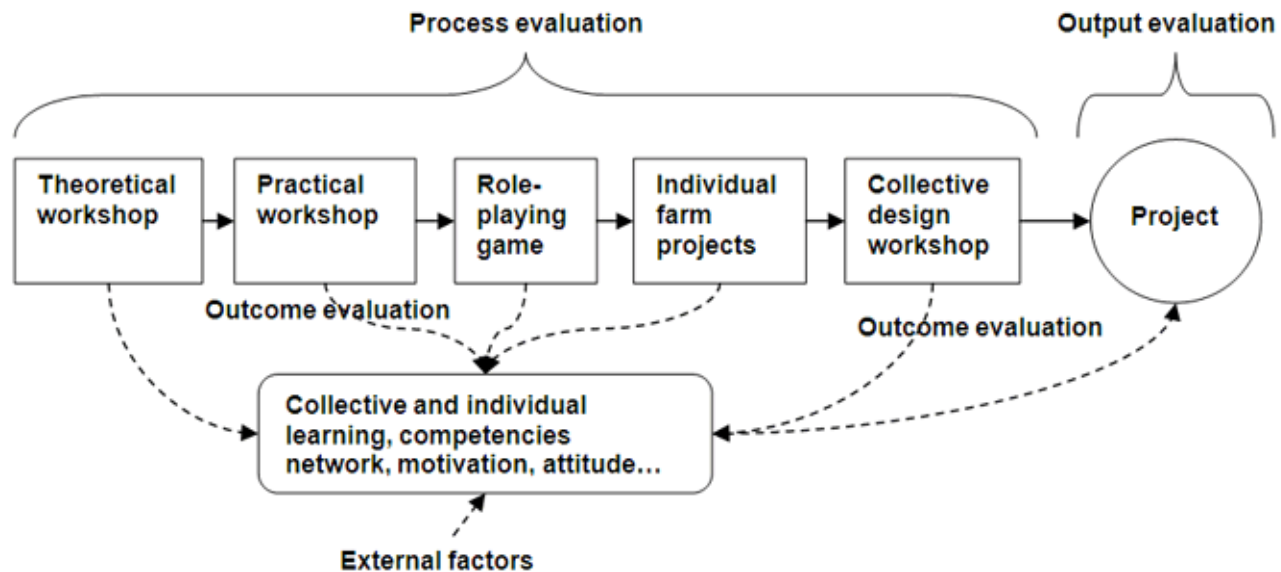
of the process: after the practical workshop, after the RPG session, and after the collective design workshop.

Process evaluation focused mainly on the details related to farmer participation, e.g., number of farmers, the quality of participation, etc. It relied on a log book that described the different participatory activities. Subsequently, we used the evaluation methodology of participation processes developed by Rowe and Frewer (2001). The nine main criteria were: (1) the representativeness of the participants; (2) the independence of the intervention process; (3) early enough involvement to influence on the process; (4) the influence of the participants during the process; (5) the transparency of the process; (6) resource accessibility, particularly with regard to providing farmers enough time and information to take part effectively; (7) clear task definition of, e. g., the nature and scope of the process; (8) structured decision making during the process; and (9) the cost-effectiveness of the process. These criteria were

assessed at the end of the process using nine positive assertions with which the interviewees were asked to strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree, as well as through an interview guide to triangulate the information obtained. Both the questionnaire and the interview guide used Rowe and Frewer's (2001) original questions translated into the local dialect. They were first tested in the local context with two farmers who were not involved in the process, which led to minor changes.

The evaluation of outputs involved the establishment of the terms of reference for a feasibility study for a joint irrigation project and the use the groups made of them. These terms of reference summarized the collective choices made by farmers regarding the technical, financial, and organizational options of their project following several intermediary outputs (Table 1). After that, the group may commission a feasibility study from a private firm and transform it into a real project.

**Fig. 1.** The aim of the evaluation was to judge how the process was led and what outputs and outcomes were produced.



Alternatively, on the basis of knowledge obtained during the process, farmers' groups may decide that they do not wish to implement such a project. Whenever a project was implemented, our evaluation focused on its architecture, e.g., irrigation infrastructure, sophistication of technology, cost, etc., and how the farmers planned to manage the project.

The evaluation of outcomes was more complex because it not only depended on the intervention itself but was also tightly linked to other external factors (Fig. 1). It relied on advances in concepts of social psychology such as Kurt Lewin's change theory (Schein 1995), the self-efficacy concept (Bandura 1997), and concepts proposed by political scientists such as the social learning notion (Maurel et al. 2007). It focused both on the knowledge that the farmers gained about the irrigation technique and how to manage the system and on how they planned to mobilize this knowledge to undertake concrete individual or collective action (Douthwaite et al. 2007). An important outcome was related to the development of a knowledge network that linked experiences, contextual information, and interpretations

(Davenport and Prusak 1998) of different aspects related to the conversion to drip irrigation, e.g., technology, production systems, marketing, subsidy procedures, etc. This network includes the tacit dimension proposed by Roux et al. (2006), which requires intense interactions among the people involved in the process.

To avoid overburdening the process and keep it operational, we decided to evaluate the learning aspects with only a few participants. This was done at three stages of the process using different evaluation tools. First, after the role-playing session, the participants used a questionnaire to assess how the session had improved their understanding of the complexities of a joint irrigation project, including (1) how to implement it, (2) how to choose the infrastructure, (3) how to operate/manage it, and (4) who was to be responsible for creating and managing the project. Second, a survey with open questions was conducted before and after farmer-to-farmer visits to assess (1) participants' expectations, (2) what they had actually learned, (3) to what extent the learning was useful for implementing their project,

and (4) whether they expected to continue sharing their experience. Each farmer could give one or two answers to each of the questions. Third, a final evaluation was made at the end of the process once the terms of reference of the feasibility study had been written. This evaluation, carried out by means of semistructured interviews with farmers' leaders, traced back the main steps of the design of the drip irrigation project. The objective was to understand the farmer's process rather than to focus on our intervention. In doing so, the intervention process was placed in a wider context. During the interview, four questions were discussed:

1. How did the idea come up?
2. What were the different steps leading to the design of the project?
3. Who played a role in the process?
4. What knowledge was obtained and from whom?

The development impacts linked to our approach were directly related to saving water, improving farm revenues, and ensuring the sustainability of joint irrigation projects. We also intended to contribute in the long term to bringing about a change in farmer attitudes toward the management of water resources, which would be the first fruit of decentralized and participative management. Navigating the pathway that relates outputs/outcomes to development impacts is a rather hazardous exercise, because, at the time of writing, it is still too soon to evaluate these impacts, and they are beyond the control of the intervention. However, we present some preliminary conclusions in the speculation section.

## RESULTS

### Evaluation of the process

We implemented our participatory approach with four groups of farmers: an agrarian reform cooperative, a farming equipment cooperative, a milk cooperative, and a family group. All four groups remained involved in the process up to the point of defining the terms of reference for a feasibility study for a joint project. The process was conducted with each group individually, but some activities were conducted jointly to enable interactions between the groups. Farmer-to-farmer

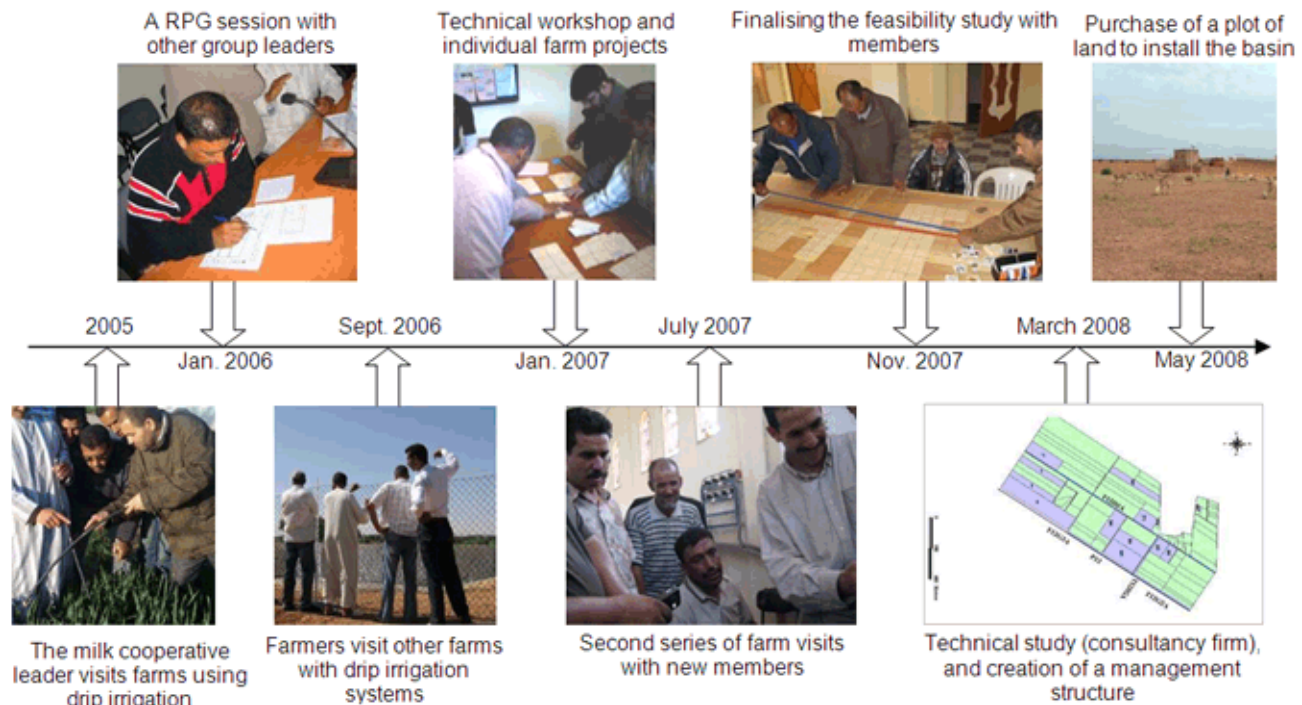
visits were organized at each step of the process, as can be seen in Fig. 2 for the milk cooperative. Farmers were keen to verify different theoretical concepts and what they had learned during the field visits.

The final evaluation, which took place at the end of the process, used the same questionnaire and interview guide with, respectively, four, three, five, and two members of the four groups mentioned above. Detailed results can be found in Appendix 1. Below we present, for each group, how the farmers participated in the process and how they evaluated it.

The agrarian reform cooperative was the first group involved. Their participation was proposed by the state agency because of the positive results of a previous project in the area of irrigation innovation transfer that involved the use of siphons for furrow irrigation. At first, most of these farmers appeared to be enthusiastic about the idea of drip irrigation, but then the cooperative leaders appeared to become more and more reluctant. As they explained later, they had expected the project to be free of charge thanks to their long-standing privileged relationship with the state agency. When they understood that they would have to pay 40% of the investment costs, the leaders declared that surface irrigation was quite efficient and then dropped out. In addition, the president of the cooperative believed that converting to drip irrigation involved risks and did not want to be associated with possible failure. Without the support of these decision makers and despite their genuine interest, the remaining five young farmers did not have the required status to take the lead in implementing the project. During the evaluation session, most interviewees found the process transparent, the task definition clear, and the decision-making process well structured. However, they had reservations about their early involvement and influence in the process as well as its cost-effectiveness. This prompted us to simplify the process, which was seen to be too cumbersome and "scientific." One interviewee had a negative opinion about process independence and resource accessibility. In fact, this reflected the farmers' confusion about the respective roles of the facilitation team and the state agency that had first involved the cooperative in the process.

In the farming equipment cooperative, four older farmers, including the president, were involved in the different steps of the process. They had a positive attitude toward a change in irrigation technology

**Fig. 2.** Different steps in the design of a joint irrigation project with the members of a milk cooperative.



and were interested in planting fruit trees but in the end were reluctant to undertake a joint project. This decision was justified by past problems encountered by their cooperative, which had sold all the collective equipment, as well as their age and the problem of inheritance of the land by their children. They were afraid to leave a complex project with a high investment cost to their children, who would have enough problems in sharing the land and managing individual farms. The interviewees had a positive opinion of the representativeness of the participants and considered that the process was transparent and the decision making was well structured. They were more reserved regarding their early involvement in and influence on the process, as well as how the tasks had been defined. They all thought that the process was not independent, and some thought that access to resources was unsatisfactory, e.g., they asked for more field visits, and that the process was not cost effective. In fact, they were looking for individual rather than collective support.

It was the success of milk cooperatives as a platform for collective action beyond milk collection, as well as their credibility within these communities, that originally prompted us to include a milk cooperative in the process. At first, only one of the leaders went on a field visit and took part in a role-playing game session. Subsequently, he encouraged a group of fellow farmers to join. The number of members in the group decreased from 15 during the initial discussions to seven when the feasibility study was being designed and the question of investment was discussed. It then increased to 13 farmers, most of whom had been among the original 15 members. These farmers engaged themselves in an 80-ha joint project that is currently under development. The interviewees had a good opinion of their involvement in the process and of the independence of the process. They also found the decision making structured and were satisfied with how requests were taken into account by the facilitation team, i. e., influence, leading to a transparent process. However, some were more reserved about cost-effectiveness. This was mainly related to the use of



the virtual role-playing game, which was thought by the leaders to be useful but not relevant by some other farmers, who preferred to work on their own case. Finally, most interviewees had a negative opinion with regard to task definition and asked for more support than had been provided because they that felt the resources were not sufficient.

The family group was made up of five brothers who jointly manage a medium-sized farm of 33 ha. We were put in touch with them by the leader of the milk cooperative. Their involvement in the process was largely proactive because they were already interested in drip irrigation and had the financial capacity to invest rapidly in a project. They gave a positive evaluation of all nine criteria and emphasized the fact that the terms of reference of the feasibility study matched their needs. Finally, they asked for an extension of the process, focusing on the system operation through more field visits as well as further training sessions.

### **Evaluation of the outputs**

During the process, the terms of reference of the four feasibility studies were defined. On this basis, the agrarian reform and farming equipment cooperatives decided that a joint irrigation project was not appropriate for their situations. The milk cooperative purchased a plot of land of a little less than 1 ha to construct a water storage basin and commissioned two feasibility studies from private enterprises for the implementation of a joint irrigation project.

The family group developed a project that is now operational. Their irrigation system consists of a 13,000-m<sup>3</sup> basin with 18 ha of land equipped for drip irrigation. They chose a high-technology and quite expensive irrigation system with full automation, disc filters, and electrical motors. Their farming systems changed from traditional crops such as cereal and alfalfa to olive trees, of which 1400 have been planted, and field corn silage to recover the investments required for the project. As for revenue and water savings, it is too early to evaluate the gains because the olive trees have not yet reached full maturity. This group has not used its tubewell since the inception of the project, relying entirely on surface water.

### **Evaluation of the outcomes**

After the role-playing game session, an initial evaluation was conducted with seven farmers belonging to the agrarian reform cooperative using a questionnaire. Most interviewees said that they gained a lot of knowledge about how to implement a joint irrigation project in terms of the development process and responsibilities. On the other hand, the game was less useful in helping them to know how to choose the appropriate infrastructure or how to manage a joint irrigation project. In fact, by and large farmers preferred to start working on their own cases straight away. However, these sessions were quite useful in determining the interest of individual farmers in joint drip irrigation projects.

During farmer-to-farmer visits in the Souss area, in which joint irrigation projects are common, another evaluation was conducted with 11 farmer leaders from nine cooperatives and associations of water users. A survey with open questions was used before and after the visits. It showed that a social learning environment that allows farmers to make well-informed decisions needs to integrate knowledge from other farmers as well as “soft skills” for the management of the projects. The survey before the visits showed that a majority of the farmers (eight out of 15 answers) joined to learn from the experience of other farmers and to transfer what they learned to their own groups. A smaller group (five answers) wanted to know how things work, e.g., drip irrigation technique, project management, farming systems, and two mentioned networking. After the visits, when they were asked what they had learned, the majority of farmers (nine out of 13 answers) said that they had gained new insights into the management of joint irrigation projects. This point is especially important because of the absence of such projects in Tadla and the fact that farmers are not involved in water management beyond the farm gate. Most answers (7/9) on the transferability of experience confirmed that the knowledge gained was useful to very useful for their own projects. Two farmers (2/9) stated it was little or not useful because of local particularities. Finally, most farmers (8/11) wanted to keep in touch with other farmers. Five farmers even suggested creating an association to sustain networking activities and social learning.

A final evaluation using semistructured interviews at the end of the process involved two farmers, including the milk cooperative leader. During the interview, he explained that the idea of modernizing

his irrigation system had come up 10 yr previously, when a friend began to use drip irrigation. However, until meeting the facilitation team, he did not feel that drip irrigation was appropriate in his situation because of technical and economic constraints. During the role-playing game, he saw that a joint project decreased the cost per hectare and realized that it would be possible to purchase land to build a storage basin. He then involved neighboring farmers in designing a joint project and organized farmer-to-farmer visits. He said that half the knowledge he had gained during the process was provided by the facilitation team, particularly on technical and financial aspects, and that the experienced farmers he met during field visits provided about a third of the knowledge, especially on how drip irrigation works, how to negotiate with private companies, and how to manage crops under drip irrigation. The remaining knowledge was obtained from a variety of other sources, including institutions, trade fairs, and books.

## DISCUSSION

We will now discuss the conditions that favor the implementation of a joint irrigation project based on the results obtained from the four groups involved. We then come back to the reasons for adopting an approach based on capacity transfer rather than technology transfer. We speculate about some of the implications of this study for the involvement of farmers in water management beyond the farm gate.

### **What conditions favor joint irrigation projects?**

Four groups of smallholder farmers from the Tadla irrigation scheme were involved in the study. Although they followed more or less the same process, in the end two groups decided to undertake a joint project and the other two groups did not. As we saw in the results, this was partly influenced by the way in which the groups entered the process, but their decisions were also affected by more intrinsic factors. We identified five initial conditions that favored or complicated the development of a joint irrigation project.

### *Technology transfer should adapt to farm dynamics and not vice versa*

Without a doubt, the dynamics of the farms involved in the joint projects was the most important reason why some farmers decided to modernize their irrigation systems and others did not. For example, the farmers who belonged to the farming equipment cooperative were old and mainly wanted to secure their future rather than engage in a new farming project that required substantial investments and the mastery of a new technology. On the other hand, the farmers who belonged to the milk cooperative wanted to invest in and intensify their agriculture, and they believed that the introduction of drip irrigation offered an opportunity to do so.

### *Previous collective action is an asset as long as it was not coercive*

The irrigation project of the milk cooperative was built upon the success of previous collective action (Friedberg 1997): collecting milk, providing the village with drinking water, an infirmary, etc. The family project relied on the experience of the five brothers in sharing the responsibility for achieving a common objective: developing the family farm in Morocco with the financial gains from a grocery in Italy that is operated by family members. Some members take care of the farm while the others alternate stays in Italy and Morocco.

On the other hand, the farmers belonging to the agrarian reform and farming equipment cooperatives created by the state had been trying to opt out of collective action and gain their independence in decisions related to crop choice, farming practices, and farm management. These farmers associated collective action with state-driven projects or coercive systems (Schein 1992), and considered the collective dimension of the irrigation project to be a step back in terms of their personal emancipation.

### *Leadership is crucial*

It rapidly became obvious that not all the farmers in the different groups necessarily participated jointly in all the steps of the intervention process, possibly because of the subsidiarity principle but also because of the complexity of a drip irrigation project. Most groups designated leaders for some of

the more technical sessions, e.g., role playing, the simulation exercise, whereas they all participated in the field visits. In fact, as a leader of the milk cooperative put it: “In the beginning we tried to involve everybody in all the events, but we realized that this slowed us down. We then designated four people to represent the group.” These representatives played an important role in transferring information to the others. Later on, they also played an important role in dealing with companies, banks, and the state agency when implementing the project. This was also true for the family group, who clearly shared responsibility in bringing the irrigation project to its term. In both cases, these leaders emerged through a process of attributed leadership (Rosen 1984) and were recognized for qualities such as trustworthiness and competence, their ability to implement a project and influence people, their relational skills, etc.

In the case of the agrarian reform and farming equipment cooperatives, the situation was quite different. Although the leaders were generally respected, they appeared to have little influence and were recognized more for their relations with the administration than for their competence. This reflects the fact that, in both cases, their nomination to the boards of the cooperatives in the past had been partly driven by the state agency. As a result, the farmers belonging to these groups would delegate responsibilities during the process to their families, mainly to their sons, but not to the boards of their cooperatives.

#### *Land tenure represents a considerable constraint for these investment projects*

In all groups, land tenure was a considerable constraint because of complex land inheritance procedures that often involve multiple heirs on a farm that is de facto divided but legally united. This complicated decision making with regard to investments that affected more than just the individual parts of the farm. Furthermore, the presence of tenants who cannot decide on long-term investments and the difficulty of communicating with owners who lived far away did not facilitate matters. All the groups were confronted with these issues, but the degree and nature of the problems differed. The milk cooperative showed how this constraint can be overcome when it purchased for the storage basin a plot that had been lying fallow for the past 10 yr and belonged to 17 different heirs, who had to be contacted one by one to approve the sale.

#### *Uncertain rights to state water make farmers hesitate about investments*

Designing joint farmer-managed drip irrigation projects within an agency-managed irrigation scheme undoubtedly adds a layer of complexity. In Tadla, state or surface water is not only becoming increasingly scarce, but the allocation rules are complex and the procedure is dominated by the irrigation authority despite the consultative role of water users' associations. No annual volume of surface water is guaranteed to farmers, and there is a lot of uncertainty on how much water they will receive and when they will receive it. Growing alfalfa in an extensive manner through gravity irrigation is one thing, but investing in drip irrigation and growing high-value crops in these circumstances is another. Farmers are reluctant to invest in drip irrigation unless the irrigation authority guarantees an annual volume, as was the case for pioneer farmers in earlier drip conversion programs. The irrigation authority is quite reluctant to do this on a large scale. For individual farmers, the presence of an often unlicensed tubewell is generally sufficient guarantee in the event of inadequate supplies of surface water. However, it is more difficult in the case of collective projects, because farmers have to agree to invest in a tubewell and to operate and maintain it with no legal standing. It is not surprising that the family group dealt more easily with this additional risk than the other groups. Many unlicensed tubewells in the Tadla are routinely shared by family members when it comes to installation, operation, and maintenance.

#### *Capacity transfer rather than technology transfer*

Right from the start, we were aware of the potential limitations of our intervention process. According to Argyris (1970), to intervene is “... to enter into an ongoing system of relationship, to come between or among persons, groups or objects for the purpose of helping them.” Our intervention aimed at transferring capacity rather than technology by (1) focusing on creating a learning environment and being more concerned with outcomes such as learning rather than outputs such as joint irrigation projects, (2) making the presence of the facilitation team redundant by developing a knowledge network, and (3) safeguarding the process through regular evaluation.

Our position was inspired by the “Mode 2” research advocated by Gibbons et al. (1994), which

positioned the facilitation team as a knowledge interface (Roux et al. 2006) that provided the setting for the co-evolution of the “values, priorities, intent and action that provide robustness to decision making.” We ourselves learned a lot from the design and implementation of the approach, which was continuously adapted. Because we considered our presence to be transitory, we favored the development of multiple knowledge interfaces within groups as well as with outside resource people. These were not only skilled farmers who had long-term experience with drip irrigation but also representatives of the administration who could advise on subsidy procedures, research institutes that could offer technical advice, and private-sector sources of expertise, equipment, marketing, etc. In addition, by jointly preparing, facilitating, and debriefing with different resource people who sometimes displayed a considerable knowledge differential (Roux et al. 2006) when it came to technical issues, we intended to contribute to creating a learning environment for all those involved. For instance, a meeting on standard subsidy procedures taught the state agency just as much about how the farmers perceived the procedure as the farmers learned about the procedure itself.

By focusing on capacity transfer, we intended to minimize some of the pitfalls of participatory approaches identified by practitioners and researchers (Cooke 2001, Henkel and Stirrat 2001, Mosse 2001). These pitfalls include the shaping of local knowledge by project facilitators, a hidden project agenda that results in a dual logic, group dysfunction, the effects of dominance in public meetings by local elites, and the legitimization of higher policy goals through an apparently participatory approach. It is probably the last problem that is potentially the most difficult to deal with. It was formulated very well by Henkel and Stirrat (2001) when they defined participation as a form of governance that provides possibly even more effective ways of incorporating people into the “modern project” by keeping the same objectives, e.g., modernization, but making those who participate responsible. This is probably what happened with the two first cooperatives. As opposed to the other groups, farmers found that the process was not sufficiently independent and had reservations about how they could influence the process, although their overall evaluation of the process was quite positive (Appendix 1). They had the impression that they had not been involved early

enough. Most likely, there was a gap between the participatory process and farmers’ objectives. However, we can argue that, in the case of these cooperatives, we succeeded in making it clear that a joint drip irrigation project was not what they wanted. In any case, this argues for extending the evaluation system we designed for this study. Our evaluation system was reasonably effective in determining the quality of the process and in measuring outputs and outcomes; it also provided feedback about how to adapt the intervention process as we went along and redesign the tools we used. However, it failed to analyze the “whole process of ‘development,’ its discourses, institutions and practices” (Henkel and Stirrat 2001). The challenge is thus to design an operational and dynamic framework to evaluate the development process and the social learning of all the participants that is compatible with an intervention process.

### **Supporting the shift from state to community water**

Analyzing the implications of our study in supporting a shift from state to community water, as we somewhat boldly put it, is a rather hazardous exercise that we will nevertheless attempt here.

In Morocco, large-scale irrigation schemes originally designed to be managed by the state have developed into more complex and confused systems. In Tadla, a groundwater reservoir, i.e., an artifact continually recharged by surface water supplies, has been appropriated by farmers through individual unlicensed tubewells despite regulations stipulating that aquifers are deemed public domain. Understanding the hydrological functioning of the aquifer, i.e., that what is lost on top is recovered below, farmers affirm that this water belongs to them because they have already paid for it. In a way, by creating a certain hydraulic independence, they have put into practice the development option proposed by Pascon as early as 1978: “It will no longer be the implacable order of an extraordinary authority that is at the origin of the distribution of life.” Even though they have appropriated “state water,” this groundwater reservoir does not yet fully qualify as community water (Ostrom 1990), because there are no functional institutions for self-governance of the aquifer. Our hypothesis is that the sense of ownership expressed by farmers, linked to their hydrological understanding of the aquifer,

provides a tremendous opportunity to support a shift from state water to community water. One would have to support the different actors in defining operational rules for sustainable management that are appropriate for this aquifer. This is a formidable challenge considering the present difficulties farmers face in organizing access to groundwater other than through individual or family-owned tubewells.

The new national water conservation program (PNEEI 2007) aims to convert 395,000 ha of large-scale surface irrigation systems to drip irrigation. In past national water conservation programs, the introduction of drip irrigation was mostly considered in its technological dimension at the field level, whereas it is clear that this conversion will bring about substantial changes at the farm, community, and system levels. This underlines the need to reconsider the focus, i.e., drip irrigation as the main technical option proposed, as well as the scope of the program.

Considered simply as a technology, conversion to drip irrigation will not provide support for small-scale farmers in transforming their farming systems through new irrigation technology, more intensive cropping systems, or new markets, nor will it necessarily improve their livelihoods. It may lead to the design of an irrigation system that does not suit their changing needs, possibly prompting a certain number of individual farmers to convert back to surface irrigation. It will not measure the resulting impacts on development. Indeed, there are no well-described pathways (Gottret and White 2001) linking efforts invested in the program to expected outputs such as the amount of area equipped with drip irrigation, outcomes such as improved irrigation practices, and impacts such as reduced water consumption, increased water productivity, and improved livelihoods. It will not challenge the existing hierarchical mode of coordination in water management, leaving farmers behind the farm gate and potentially reproducing the classical pitfalls of large-scale irrigation schemes, e.g., chronic undermaintenance, anarchy in water distribution, etc. Even worse, the massive introduction of drip irrigation will lead to diminishing degrees of freedom for farmers as the groundwater reservoir shrinks because of less recharge by surface irrigation losses. This means that a large part of the community water may be taken back by the state.

Considered as a system of innovation as defined by Edquist (2006), joint conversion to drip irrigation may provide an opportunity to evolve toward more adaptive forms of joint management and coordination (Olsson et al. 2006). This would require a debate on the terms and conditions of implementing and managing irrigation infrastructure, including system design, water rights, and the sharing of tasks and responsibilities in water allocation and distribution, within the framework of the national water conservation program. Drip irrigation is certainly not the ideal solution in all contexts, for all soils or crops, or for all farmers, who have different financial means and farming objectives, and it would make sense to provide a wider range of technical options. It would also require a “societal search and learning process” (Pahl-Wostl et al. 2008) on how to reinforce the adaptive capacities of small-scale farmers in dealing with contextual changes in the socioeconomic environment, such as water scarcity, not only at the farm level but also at the system level, for the governance of water resources. This includes improving farmers’ capacities for coordination and negotiation with the different actors involved, e.g., irrigation agency, private firms, traders, etc. Pilot projects financed by international donors are currently underway in several large-scale irrigation schemes to test the feasibility of converting entire irrigation networks to drip irrigation. They provide an opportunity to advance in this direction, but this is probably not sufficient to empower local communities of water users to manage water more productively and more efficiently, or to change the scope of the national water conservation program.

At a completely different scale, intervention processes like ours provide opportunities to design and test innovative methods that may contribute to designing more adaptive modes of joint management. Whether or not these good intentions are then put into practice remains to be seen, but the farmers and other participants in our approach are likely to mobilize and deploy the knowledge they obtained. However, they will surely reserve some surprises for us in the way they do so.

## CONCLUSION

The main contribution of our study is to have developed a social learning approach on water resources management that (1) taught participants to negotiate knowledge differentials between

stakeholders and (2) enabled the co-production of knowledge. We applied this approach to the design of joint irrigation projects with four groups of small-scale farmers in Morocco. We developed a framework to safeguard the process, to allow us to make adjustments as we went along, and to evaluate the outputs and outcomes of the approach. This study has important implications in three areas.

### **Qualifying the introduction of drip irrigation as a system of innovation**

The approach revealed the most important socioeconomic constraints related to the introduction of innovations, which are often reduced solely to their technological dimension. Considering drip irrigation as a system of innovation (Edquist 2006) implies integrating the dynamics of the farming systems as well as the governance of water resources when designing and implementing joint drip irrigation projects. It also implies focusing on reinforcing the adaptive capacities of the small-scale farmers who manage the projects.

### **The pertinence of a capacity transfer approach**

There is no doubt that, from our point of view, the choice of focusing on a learning transfer rather than a technology transfer process was sound. This approach takes all the dimensions of a drip irrigation innovation system into account and enables learning to continue thanks to the knowledge networks that are created. However, it also takes time: typically about 2 yr for a 50- to 100-ha joint project, and in some cases, leads to rejection of the innovation by well-informed farmers who deem the innovation unsuited to their situation. Probably the process needs to be made more operational and more efficient by more rigorous selection of the groups and clearer conditions for participating groups, allowing groups to leave the process more quickly in the case of incompatibility. For applications at a larger scale, which involve getting in touch with the thousands of small-scale farmers involved, new cost-effective intervention methods need to be developed. Our approach could provide some of the building blocks for such methods, such as a focus on learning, the co-production of knowledge, and networking.

### **Supporting a shift from state to community water**

If, by giving small-scale farmers more keys to the technical, economic, and social aspects of irrigation design and management, we have contributed to a more professional contribution by the farmers to current debates on the conversion of surface irrigation networks to drip irrigation, the underlying objective of this study has surely been achieved. This contribution will need to be qualified in future studies.

Several challenges lie ahead. From a research point of view, the most important challenge is arguably to design a dynamic evaluation framework of social learning that covers the whole process of development, including “its discourses, institutions and practices” (Henkel and Stirrat 2001). Theorizing about the concept of community water, particularly groundwater, in terms of perceptions, practices, and, of course, social learning, is also a considerable challenge. From a development point of view, the contribution of social learning to the introduction of drip irrigation is an issue that will remain important for the next 10 yr both in the north and the south of the Mediterranean.

*Responses to this article can be read online at:*  
<http://www.ecologyandsociety.org/vol14/iss1/art19/responses/>

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**Appendix 1.** Results of process evaluation using the indicators of Rowe and Frewer (2000): 1 = strongly agree, 2 = agree, 3 = neither agree nor disagree, 4 = disagree, 5 = strongly disagree, 0 = not applicable.

		farmer represent- ativeness	indep- endence	early invol- vement	influe- nce	transp- arency	resou- rce acces- sibility	task defini- tion	struct- ured decisi- on making	cost effect- iveness	<b>Average score per group</b>
Agrarian reform cooperative	A	3	4	3	3	2	4	3	2	3	<b>2.6</b>
	B	2	3	3	3	3	3	2	2	2	
	C	2	2	3	3	2	3	2	3	3	
	D	1	3	2	3	2	2	2	2	3	
<b>Average score</b>		<b>2.0</b>	<b>3.0</b>	<b>2.8</b>	<b>3.0</b>	<b>2.3</b>	<b>3.0</b>	<b>2.3</b>	<b>2.3</b>	<b>2.8</b>	
Farming equipment cooperative	E	2	4	3	3	2	4	3	1	4	<b>2.6</b>
	F	1	4	4	3	2	4	3	1	4	
	G	2	4	2	3	2	2	2	1	1	
	<b>Average score</b>		<b>1.7</b>	<b>4.0</b>	<b>3.0</b>	<b>3.0</b>	<b>2.0</b>	<b>3.3</b>	<b>2.7</b>	<b>1.0</b>	
Milk cooperative	H	1	2	2	2	2	3	2	2	3	<b>2.4</b>
	I	2	2	3	3	2	3	2	2	0	
	J	1	1	2	3	4	3	5	2	0	
	K	1	2	2	2	2	5	5	2	2	
<b>Average score</b>		<b>1.4</b>	<b>1.8</b>	<b>2.2</b>	<b>2.4</b>	<b>2.4</b>	<b>3.8</b>	<b>3.8</b>	<b>2.0</b>	<b>1.4</b>	
Family Group	M	2	2	2	2	2	2	2	1	3	<b>2.0</b>
	N	2	2	2	2	2	2	2	2	2	
<b>Average score</b>		<b>2.0</b>	<b>2.0</b>	<b>2.0</b>	<b>2.0</b>	<b>2.0</b>	<b>2.0</b>	<b>2.0</b>	<b>1.5</b>	<b>2.5</b>	