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CO-CONSTRUCTION OF KNOWLEDGE BETWEEN RESEARCHERS AND FARMERS IN TECHNICAL INNOVATION PROCESSES: LEARNING FROM DIRECT SEEDING IN THE BRAZILIAN CERRADOS

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Abstract — The Unai Project (Brazilian Cerrados) uses a participatory approach inspired by the principles of Action-research to strengthen innovation processes within the context of the Agrarian Reform Sector. It associates as partners scientists, farmers, trainers and development agents and focuses both on the socio-technical and organisational dimensions of innovation. This paper presents the results of a sociological assessment of the encounter between farmers and scientists in connection with the development of knowledge related to direct seeding cropping systems within the framework of the Unai project. The objective was to analyse the complementarities and difficulties in terms of knowledge exchange and production. There was convergence of representations between farmers and researchers about the practical issues related to direct seeding. But there were differences about the overall role of direct-seeding and specifically of cover crops in the production process. Farmers and researchers did not share the same perception of the value of participation, with the former placing a premium on affective and social factors. Farmers' participation in the conception of innovations has several methodological implications, including the necessary formalization of roles and responsibilities of each actor and the development of intermediary actors.

Key words : action-research, innovation, co-conception of knowledge, experimentation, Brazil

Résumé — Le dispositif de recherche-expérimentation-formation du projet Unai (Minas Gerais-Brésil) s'inspire du corpus méthodologique de la Recherche-Action. Il associe agriculteurs, chercheurs et agents de développement au processus de construction de l'innovation, dans sa double dimension sociotechnique et organisationnelle. L'article présente les résultats d'une analyse sociologique des confrontations de connaissances entre chercheurs et agriculteurs lors de la mise au point de systèmes de Semis direct dans le cadre de ce projet. L'étude analyse les interfaces entre ces différentes catégories d'acteurs et questionne les modalités de production et de compréhension mutuelle des connaissances. Il y a convergence entre les représentations des chercheurs et des agriculteurs concernant les aspects pratiques autour du semis direct et de son introduction. Par contre, on observe des différences de perception du rôle du semis direct et des plantes de couverture dans le système de production. Agriculteurs et chercheurs n'accordent pas la même valeur à la participation, les premiers priorisant les relations affectives et sociales. L'association des agriculteurs au dispositif de conception et d'expérimentation de l'innovation pose divers problèmes méthodologiques, en particulier la formalisation des rôles et des responsabilités ainsi que la mise en place d'acteurs intermédiaires.

Mots clés : Recherche-Action, innovation; co-construction de connaissances, expérimentation, Brésil

INTRODUCTION

Within the framework of the Unaí Project (Brazilian *Cerrados*), an alternative approach inspired by the principles of Action-Research (A-R) (Liu, 1997), is being used to strengthen innovation processes in response to demands and needs of local actors within the context of the Agrarian Reform sector. The Unaí Project aims to contribute to the sustainability of production systems in the Unaí district (Minas Gerais State in the *Cerrados* region of Brazil). Conducted by the Brazilian Cerrado Agropastoral Research enterprise (EMBRAPA-CPAC) and the University of Brasília (UnB) in partnership with the *Centre International de Recherche Agronomique pour le Développement* (CIRAD), it focuses among others on the introduction of mulch-based direct seeding (DS) for the production of maize.

The corresponding innovation process was initially launched by researchers but, because of the complexity of production situations, the lack of local references and the need to strengthen local innovation capacity, farmers are now being increasingly involved in the project as active partners. These two groups of actors visualize, build and apply differentially the knowledge necessary for effective action. Creating the necessary conditions for a constructive dialogue between these actors would contribute to improving the tools and mechanisms for co-constructing knowledge and, *in fine*, innovation.

A sociological assessment of production processes and knowledge exchange related to direct seeding cropping systems was carried out in 2006 in order to analyze the complementarities and difficulties in terms of pooling knowledge, learning and mutual perceptions.

This paper outlines the context of the project, the methodological frame of the study and the ensuing results. Finally, we draw up selected lessons from this experience.

1. CONTEXT AND METHODOLOGICAL FRAMEWORK OF THE STUDY

Since 2002, EMBRAPA has been conducting participatory diagnostics followed by strategic participative planning in three settlements (*assentamentos*) of the Agrarian Reform: Jiboia, Santa Clara Furadinho and Paraíso. Focus groups (FG) have been set up in relation with the farmers' main concerns. Direct seeding use is widespread in Southern Brazil and among large-scale farmers in the *Cerrados* because of its advantages in terms of fighting against erosion and increasing productivity (Bolliger et al, 2006, Scopel et al., 2007). It could also potentially be very useful for Agrarian Reform small holders confronted with considerable constraints such as access to a tractor, availability of labor and high production costs (Oliveira et al, 2009, Scopel et al., 2007). DS forms a set of complex and dynamic technical systems based on three key principles: undisturbed soil, maintaining vegetational cover at all times, and crop rotation and/or associations. Implementing these systems in practice means adapting them to the specificities of the local agricultural, climatic, social and economic context (Mischler et al. 2008). In the case of Unaí, DS originally introduced for maize production is more and more brought in line with milk production dynamics. Cover crops could in effect provide a strategic fodder source to supplement the feeding of dairy cattle. However, as switching from conventional seeding practices to DS is by no means a straightforward process, farmers need technical and organizational assistance as well as training. It is for this reason that the Unaí project is proposing to adapt DS to the context of family farms in the Agrarian Reform sector agriculture and to develop the specific technical references related to this practice.

Conceptual framework

How does a new technique meet users? How do users appropriate a technique? How can this process be integrated in the design of the technique? The dynamics between design and use are complex, among other things because the actors involved do not share the same forms of knowledge (Darré, 1996; 1999) and action, from which they build their own viewpoints and perceptions. Moreover, misunderstandings between the different actors and the fact that one social group frequently dominates the other often lead to the failure of technical innovation processes. The idea, therefore, was to reconsider the conventional divides between the designers (researchers in this case) and the users of innovations (farmers who according to some would merely be practitioners), as well as the domination of scientific knowledge (Darré, 1999, Faure et al, 2010). Indeed, the innovation process is determined to a large extent in relation with the use and the knowledge mobilized for its implementation. The aim, therefore, according to the sociology of sciences and techniques (Creswell, 2002), is to include the users already during the initial conception phases by establishing an exchange of the different types of knowledge. Because of its social and material dimension, the appropriation process also involves social confrontations between the actors (actor dynamics) related to both material and symbolic elements and creating specific values (Temple, 1998). At the same time, the innovation, as the art of “enrolling” an increasing number of allies (Akrich et al., 1988), is included in the process of building a social-technical network according to the actor-network theory. Being able to identify issues giving rise to controversy, finding ways to get the actors to solve them and understanding the “*translation, interessement and enrolment*” processes (Callon, 1986), as proposed by the sociology of innovation, constitute as many resources for the sociologist in charge of observing these processes. As the appropriation of this type of innovation is equally complex, it is essential for the organizational dimension to be considered as well.

Using these observations as a basis and with the view of giving structure to our analysis of the results, we made a distinction between two types of innovation: a) technical and organizational innovation in connection with DS, comprehended in terms of knowledge confrontation between researchers and farmers; and b) the methodological innovation for establishing an A-R approach in connection with DS and within the context of the Unai project. As regards knowledge confrontation, we also explore two dimensions: objects on one hand and the actors’ dynamics in connection with these objects on the other hand (Vinck, 1999).

Establishing the methodological system: the «DS focus groups »

The innovation set-up was mostly based on the focus group approach, which in the case of DS in Unai involved farmers who were interested in DS. These groups constituted a rather recent development by 2006 since the first informal DS groups were formed in 2005. The aim was to co-construct technical and scientific references specifically related to the Agrarian Reform context, as well as to provide a collective structure for the training, appropriation and dissemination of the DS practice, with the prospect of increasing farmers and technicians’ responsabilization and ownership (Triomphe et al, 2008). The fact that a farmer actually attended group meetings or, in some cases, took part in DS experimentation, was enough for him to be deemed a member. Activities were organized on the basis of meetings, exchanges between farmers and training sessions organized by the researchers.

Assessment methodology

The study was carried out within the frame of the Discotech project (*DISpositifs Innovants pour la Conception et l'évaluation des systèmes TECHniques*) – Innovating systems for the conception and the assessment of technical systems – financed by the National Research Agency under the ADD program. It involved establishing and applying an observation grid of “confrontation scenes” between researchers and farmers. These scenes were defined as

situations involving an actual or virtual encounter between the actors taking part in the innovation process. Indeed, it is on the occasion of such encounters that actors exchange their ideas and discuss knowledge at stake. The aim was to discover how a certain type of innovation was set up and how the network of actors allowing such innovation to be adopted in practice was constructed and functioned. Retained scenes for the analysis corresponded to a series of four consecutive meetings conducted by researchers with farmers of the DS focus groups in the three settlements during the summer of 2006 to increase farmers' involvement in the appropriation and construction process of the innovation. Observations and analyses were made on three key aspects.

- *Scene preparation*: context of the scene, invitation (author, support, stated objective), expectations and means given by the actors to participate.
- *Scene description*: venue and actors present, intermediary support objects. How are the exchanges organized (co-ordination, arbitration, sharing of speech time) and what is the content of the exchanges (knowledge at stake)?
- *Scene outcome*: traces (debriefing, reports) and actors' perceptions.

The group of researchers leading the meetings consisted of four agronomists and four trainees. These observations were completed with individual semi-directive interviews with the participants of these scenes (approximately 20 farmers and all the researchers). Questions involved the knowledge at stake, learning, as well as the methods and tools used during these scenes and within the more general context of the Unai project. Eight farmers from the same settlements but not actually members of the DS focus groups were also interviewed. Results from these meetings were presented collectively to all participants in order to validate interpretations.

2. RESULTS OF THE CONFRONTATION AS REGARDS OBJECTS

Analysis of observations made about the scenes focused on agreement and discussion points, as well as different points of view and language.

Points of agreement

Researchers and farmers both seemed to support the objectives, the methodology and the way the project was being implemented, as well as the DS technique and its advantages. Moreover, the practical training sessions and the on-farm experiments and field demonstrations were well received by the farmers, in spite of them being set up and organized by the researchers as they felt they related well with their needs and they met their assessment criteria. In the case of the training sessions for example, farmers fully subscribed to an *in situ* hands-on and practical teaching method that was updated from one year to the next. Farmers who wanted to "see to believe" also requested that the tests be carried out on the scale of the entire field.

Points subject to discussion

The concrete modalities for the switch to DS were subject to discussion, especially with respect to the use of cover crops. The researchers suggested that maize should be grown in association with a secondary, so called cover crop, because of the agronomic advantage the latter brought about and its role as a fodder resource in view of developing dairy farming (Oliveira et al., 2009). They made a distinction between maize crop residues on the one hand used to protect the soil from the sun and erosion; and on the other hand, cover crops which compete with weeds and contribute to enriching the soil with nutrients and organic matter. The farmers for their part mostly saw the DS technique as a way of solving constraints in terms of labour and planting costs, as well as substituting the use of hired tractor by animal traction. Moreover, they did not distinguish between the different types of cover. For many, it

meant breaking away from an established paradigm about how farming is practiced, even if only because the proposed cover crops were unknown to them. In terms of fodder produced by the cover crops, and beyond the sheer lack of experience and skills, farmers' lack of interest was strengthened by the extra labor involved in growing them and by their failure to perceive the economic advantage of such practice in a context where productive fodder production systems already exist (pastures, sugar cane) (Bernard, submitted). Lastly, the farmers' positioning was closely related to the opportunity to confront their traditional practices with new knowledge. Indeed, some of the farmers who had never used the DS system tended to idealize it whereas the farmers who had had the opportunity to test the system in practice were more realistic as to the difficulties involved.

Different points of view on the DS object

On the whole, farmers and researchers perceived DS differently, which may account for their different strategies in the innovation process. The researchers wanted to implement in practice agronomical and ecological management principles by means of a range of concrete options that could be tested *in situ*. DS was also considered as a complex intermediary object (Vinck, 1999) capable of leading local actors towards a more sustainable agriculture. For the farmers on the other hand, in a context with very limited resources and knowledge on cropping systems, introducing DS was perceived as a way to solve two major constraints: break the dependency on the hiring of a tractor DS, and control weeds efficiently, by getting access to animal drawn seeders and herbicides. For some it was also seen as a way to obtain services proposed by the Unai project (fertilizers, seeds and training).

3. CONFRONTATION RESULTS IN TERMS OF ACTOR DYNAMICS

Temporalities of researchers and farmers

Researchers had a hard time mobilizing farmers, the latter either evoking transport constraints, or busy schedules related to milk production. However, differences in temporalities may explain the hiatus. Daily agricultural rhythms determine predominantly farmers' availability for meetings or visits which for their part constitute the central ingredient of researchers' field work. To solve this conundrum, researchers had to adapt their activities to farmers' schedule. Also, they adopted a personalized mode of inviting farmers to meetings to increase their motivation to be present, by playing on the social prestige such as personal invitation conveyed. On the other hand, farmers do not give priority to commitments towards researchers versus other social obligations they may have. Some indeed did not feel concerned, and may even have perceived they were not invited to focus group meetings, due to a misunderstanding of the objectives of meetings and DS focus groups. Formalizing responsibilities and objectives of DS focus groups would need to be done much more clearly from the start to avoid such situations.

Controversy and respective roles in the decision-making

In the short term, the series of meetings with the farmer groups during the summer of 2006 was aimed at planning in a participatory manner the subsequent training and experimentation activities, with farmers assuming a bigger share of the overall responsibilities and tasks. However, the farmers' response was disappointing and not up to the researchers' expectations. One of the reasons for this is perhaps the fact that the farmers were accustomed to the State or to projects dealing with everything. But there were also methodological and conceptual limitations. Indeed, at the time of the meetings, the researchers were hardly aware of any representation differences, since they were under the impression objectives, and objects had been clearly negotiated or explained with the farmers. For instance, at the end of the third meeting, they asked the farmers to think ahead about proposals of activities to implement. But at the following meeting, the farmers showed very

limited initiative and most of the proposals were actually brought about by the researchers themselves. As it turned out, the researchers' request had not been integrated by the farmers because, to them, the request had remained rather vague and unclear. In the end, the researchers had to carry out the theoretical trainings and experimentations related to DS (setting up, loan of seeders, input supply, assessing and organizing the dissemination of results) despite there being no formal discussion concerning the corresponding material and financial modalities. Farmers' participation therefore tended to remain tacit and voluntary.

Recognizing the other's knowledge: who is the expert?

For the farmers, the researcher was considered as the typical ideal expert-adviser. Thanks to the knowledge he acquired "in the laboratory" during his studies, he was the holder of a "*theoretical knowledge*" (these are the exact words used by the farmers), which contrasted with their own knowledge (contrast between a global total technical scientific knowledge and a local practical knowledge). The researcher was also perceived as a source of information. Under such conditions, the farmers expected mostly the researcher to come up with solutions to their problems, or even propose ready-made recipes, as if the researcher were asked to provide some kind of personalized technical assistance they were unable to get access to elsewhere.

From their angle, the researchers wanted to grasp and mobilize the farmers' knowledge to enrich and co-construct both their technical referential and the experimentation set-up, to identify relevant assessment criteria and to strengthen learning processes. Researchers recognized the farmers' expertise to a large extent as it related to their precise knowledge of their production system and of its ecological, biophysical, economic and social-cultural context. They also recognized farmers' practical know-how or their capacity to observe and adapt plants and machines.

The importance of values

For the farmers, attachment of affective values to knowledge and to learning is a key factor for understanding the process: indeed such values seem predominant in decision-making and changes of practice (be they agricultural or linked to participation in meetings). The trust they put into the researchers' expertise had more to do with the latter's behavior and human qualities, in other word, with the quality of the social relation, than with researchers' scientific command or technical efficiency.

For the researchers, dominant values involved the valuation of collective organization of the farmers, and to strengthening their responsibility and autonomy in the innovation process. These can be called values, because the DS innovation may become a simple mean, or in some cases a mere pretext to increase farmers' autonomy. There is a strong a priori faith in collective organization and in participatory approaches to achieve such goal. However, farmers may perceive collective action as a model brought in and supported by the state, by institutions and by researchers (such as when the state obliges farmers to form groups to attribute land and credits to them within the context of the Brazilian Agrarian reform). Farmers for their part tend often to favor a more family-based or individual mode of operating.

Moreover, the A-R approach presupposes a concern with a number of ethical and epistemological issues: respect for the partner, his pace and his language, upfront transparency about the approach being used, willingness to minimize asymmetry, democracy, etc. All of this tends to lead to a certain idealization of systematic participatory approaches, despite the difficulties and challenges such approaches may entail (Sabourin et al., 2010). Adherence of others (eg farmers) to such approaches is furthermore not questioned.

4. DISCUSSION AND LEARNINGS

This study was not intended to draw up a conclusion about co-construction of innovation as such, not least because it was conducted at the start of an innovation process which is still ongoing at the present time. However, it does provide sufficient fruit for thought as regards the synergies between scientific knowledge and practical knowledge (Girard et Navarette, 2005) to be able to highlight a certain number of determining factors.

From the researchers' angle: an insufficient capitalization of generated knowledge

The methodological work of researchers involved in the Unai project has yielded positive results in terms of knowledge sharing, but not necessarily in terms of shared production of new knowledge. By getting together with the farmers, the researchers increase their learning, leading to acquiring a more collective culture (about farmers' context and problems, biophysical environment, language and specific knowledge, etc.), all of which may help in orienting DS work. However, limitations observed were often in connection with the ambiguous line drawn between research and development work. The absence of a formal negotiation as to the respective roles of each group of actors was detrimental to the responsabilization of each actor, particularly in the case of the farmers. This is all the more worrying in a context where support institutions and local extension services are weak or do not exist. The researchers, who do their best to provide assistance to farmers in precarious situations, find themselves intervening as both researchers and technical assistants at the same time, to the point sometimes of behaving as activists. The resulting heavy work-load becomes an obstacle for a scientific capitalization of the generated knowledge. The development and publication of a recent synthesis (Oliveira et al., 2009) has however allowed partly to compensate this lack of capitalization. Also, Ph.D work initiated by Brazilian and French researchers alike over the past few years will allow to valorize over the short and medium-term a considerable part of the research investments made over the past through the Unai project under the form of conventional scientific articles. Hence, the notoriously precarious balance between engaging in research vs. in action (Faure et al, 2010) has shifted lately towards research, in contrast with what happened in the initial phases of the project.

From the farmers' angle: misunderstandings and a tendency to being assisted

The somewhat vague and voluntarily activist attitude of the researchers may lead to confusion among the farmers, whose motivations and expectations are different from the empowerment objectives attributed to the DS focus groups by the researchers. Thus, the farmers would appear not to have understood the logic of the meeting cycle of the summer of 2006, which they claimed were often repetitive. Confusion as regards various actions undertaken within the Unai project has given rise to misunderstandings with the researchers and, in some cases, may have fueled jealousy with other farmers. Farmers of the Agrarian reform sector reproduce a high level of subaltern position and dependency because they are thoroughly used to the authoritarianism of civil servants and the assistance mode of public institutions. This may explain why they tend to consider any external professional first and foremost as a source of short-term help, which can also be mobilized as a privileged social resource leading to a flux of services and favors. The biggest disillusion for researchers was to discover that beyond the human aspects, farmers made hardly any difference between a top-down approach and a participatory one.

In view of this lack of clearly established frames and rules, the farmers often expect the researchers to take on by themselves the efforts and activities related to the themes they introduced in the meetings. The fact that the farmers make no attempt to make a distinction

between the participants' professional and technical status is logical since, from their viewpoint, the key aim is to establish privileged affective and social relations so that they may hope to benefit from services and favors. Hence, it is up to the researchers to attempt to prevent this form of instrumentalization and ensure through proper negotiation that clear terms and conditions of assistance and mutual responsibilities are defined and possibly drawn up in a contract.

CONCLUSIONS

Results of this study invite to take a critical look at the enthusiasm for participatory approaches and at the way **objects** of researchers are perceived by farmers, and vice versa. Systematized observing of confrontation between the different types of knowledge enlightens this process and highlights the importance of factors that are not strictly cognitive. Distinguishing as we did between objects and the actors' dynamics allowed to establish the importance of value systems and representations of both objects and the actors' roles in the appropriation process of one another's knowledge. It also highlighted the shifts and risks of misunderstanding between the farmers and the researchers, paving the way for further questioning as to the best central themes of research to adapt direct seeding principles and systems to local conditions and needs. While introducing animal drawn seeders and herbicides has been easy since it helps solve major constraints, introducing cover plants and encouraging livestock-agriculture integration has proved far more complicated.

With respect to global frameworks and concepts about innovation, this study shows once more the importance of the selective adoption of new techniques by farmers: they select what interest them in the proposals made by research, even if it only brings them benefits in the short-term. What however is more novel is the fresh outlook on innovation conception and processes that such a study brings to the comparison and linkages between Northern and Southern experiences in the agricultural realm. For one part, there has been a huge multiplication of participatory experiences in Southern countries, probably more so than in Northern ones, with key lessons, approaches and tools making their way from South to North. On the other hand, the once arch-dominant mode of transfer of technology, from North to South, is becoming less of a norm: innovations like direct-seeding as well as others (agroforestry, integrated pest management to name but a few) have also been actively developed in the South and are in the process of being transferred to the North. Finally, advances in the application of learning theories to innovation processes allow to assess with renewed rigor what participatory or action-research approaches have brought. One of the research and action areas identified in this study involves learning related to structured relationships of symmetrical reciprocity both in instrumental terms (competencies) and in symbolic terms (values).

From a methodological viewpoint, this study showed the clear limitations and challenges for each type of actor of a participatory and co-design approach to innovation development. While such an approach, in which researchers take the initiative, can be considered a desirable evolution of their positioning and professional practices, it also entails a risk that in doing so, researchers may overstep their mandate to the detriment of producing knowledge. Moreover, the difficulty for the different actors to understand one another and the fact that the farmers may be inclined to being assisted (a current occurrence not only in Brazil but also elsewhere) are detrimental to a more active involvement on their part. As regards direct-seeding focus groups, a better formalization of roles and responsibilities of each actor appears necessary for such devices to achieve their stated purpose over the medium to long-term. This implies taking into account the risk factor, and the respective responsibilities in conducting field experiments, while also being fully aware of the time constraints and available resources.

To what extent can one expect barely literate farmers to get involved in an action-research approach, in experimentation or in collective organization? When there are virtually no local extension agents as is the case in Unai, it would seem crucial to identify and associate intermediary actors in the process. In this context, the training of development agents from the Agrarian Reform undertaken at the onset of the Unai project and the identification of an effective mechanism by which some of them could be deployed in the region to provide technical assistance to farmers could prove particularly relevant and fruitful.

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