

Cognitive styles and networks patterns; a combined approach of learning processes in sustainable agriculture

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Abstract

Drawing on different traditions in social sciences and sociology in particular, this paper analyses two case studies, about rice organic farming and environment-friendly grape production. It leads to the proposition of a combined approach of learning processes in sustainable agriculture based on a typology of learners and professional networks analysis. Beyond the description of social phenomena, this approach aims at the production of both a renewed articulation in social sciences and of relevant information for researchers of other disciplines to engage in partnership with stakeholders, along an interdisciplinary action-research pattern.

Introduction

Sustainable agriculture may be seen as a collective project, an individual endeavour, a public policy or a normative issue. But above all, it presents itself as a new paradigm to which refers a whole range of innovative farming practices, which are evaluated along different and interdependent dimensions such as environmental impacts, social issues and economical profitability (Godard, Hubert, 2002). Agronomists, input suppliers, farmers, downstream agents and other users of the common goods and space are confronted with a cognitive challenge that routine knowledge cannot match. Management studies propose to look at sustainable agriculture as a problem of conception, for both researchers and stakeholders caught in a new “socio-economic order” (Aggeri, Hatchuel, 2003). Collective action is presented as the condition of cross-linked learning processes and intervention-research is the method that is proposed to favour knowledge production. Both to argue and optimise such participating programmes, the challenge may be first to assess the strategies developed by the different stakeholders and specially the farmers to acquire and produce the relevant knowledge when confronted with sustainable projects. In particular, researchers have to get a clear picture of the role they have or may develop in these strategies. Too many “participating” programmes are still driven in rural settings along diffusionist conceptions of individual or collective development (Chauveau, Lavigne-Delville, 1998). The aim of this paper is to propose a combined approach of farmers’ cognitive strategies, associating sociology and ergonomics, in order both to get a better understanding of learning processes underlying complex innovations and relevant information to implement interdisciplinary action-research patterns.

In a first part, an exploration of sociology, enriched by principles from ergonomics, provides the main theoretical elements that frame the assessment of these strategies. Two hypotheses may be argued about the main source of individual apprenticeship, networking vs. experience. Two contrasted local projects, grape environment-friendly production on one hand, rice organic farming on the other, are presented in the second part as exemplary cases to test and refine one kind of hypothesis and method each. They constitute indeed two examples that show the multiplicity of domains of action and reveal

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the different dimensions of such a new paradigm. Results are presented in the third part. Finally, the paper stresses the shortcomings of the two approaches and calls for a renewed and combined analysis of learners and learning styles with a refined investigation of the components of human and social capital of sustainable agriculture farmers. Conclusively, the potential contribution of sociology to cross-disciplinary programmes is discussed.

1. Learning processes as grounded on specific interactions and practices

Sociology and ergonomics as complementary corpus

From an early sociological viewpoint, learning processes have been implicitly reduced to a mimetic mechanism (Tardé, 1901). Later on, diffusionist studies analysed them through adoption rates and it yielded a typology of actors based on their speed to answer to innovative information and adopt the new technological package (Ryan, Gross, 1943). The very mathematical function of this process¹ hinted at the importance of social phenomena, since the number of adopters at a given moment is directly correlated to the number having already adopted a moment before. But knowledge processes started being explicitly pointed out when researchers took a closer look at dialogues. It enabled them to construe the “convergence process” (Rogers, 1962) as a collective construction of meaning to cope with the environment, which enables actors to design their answer to innovative stimuli. Other studies highlighted the role of opinion leaders, as experts in a specific domain and attractive for a specific portion of the social entity to which they belong (Katz, Lazarsfeld, 1955).

Indeed, for many scholars, “communities” are seen to be the space in which learning processes occur, following a hierarchical pattern of socialisation from primary familial internalisation to secondary professional learning (Berger, Luckman, 1967). Communities are also analysed as places where language flows through interactions, building stable networks. Then, the morphology of these networks, linking clusters of peers, facilitates or impedes continuous knowledge production (Darré *et al.*, 1989) that is objectified in common practices. These communities may be identified within geographic boundaries and professional similarity (*ibid.*) or within organisations and enterprises (Wenger, 1998).

Confronted with situations where community or organisation limits are fuzzy or where actors are mobile, belonging to several communities for the sake of various interests, structural interactionist sociology stresses that the learning processes are outputs of the trajectories of actors (Degenne, 1998) managing forms of social capital through advice-seeking relations notably (Lazega, 2001). For other scholars, the “post-modern” context rather puts in light the basic role, in individual performance, of the human capital, as a product of education, socialisation, experimentation (Becker, 1964), at least because its level determines the relational skills necessary to catch relevant informations from different worlds (Forsé, 1999).

Such contrasted positions open the debate among sociologists about social mechanisms of learning processes. However, few of them consider activities and objects challenged in or by learning processes although they are key elements in the evaluation of the relevance and efficiency of the cognitive investments. In the end, it limits their capacity to assess respective roles of human vs. social capital in diverse contexts of innovation. Eventually, a significant opening has been proposed by sociology of science. By taking into account the objects on which practices are enacted, considering the interaction actor-object, the concept of “socio-technical network” (Callon, 1989) both introduces actions content

¹ Quetelet's function : $F(t) = 1/(1 + e^{-t})$.

and context and replaces the old concept of community as the relevant space for knowledge production. In this approach, objects are laden with information and given different meanings by the stakeholders related to them. Hence, they mediate human relations and facilitate cooperation and production of knowledge, construed as the result of strategies of enlistment of objects, peers and stakeholders, as carried out by researchers (Vinck, 1999).

If sociologists of science are indeed mainly focused on researchers and scientific knowledge, some of them develop their analysis towards innovation operators, in industrial settings especially (Dodier, 1999). Consequently, they are driven to borrow ergonomics principles to build a relevant frame to assess situated learning processes (Conein, Jacopin, 1994). Developments in ergonomics, attuned with experiential theories of learning (Dewey, 1916), and drawing on interactionist and constructivist psychology of development (Bruner, 1991) suggest indeed to consider some stages or situations in the production of knowledge through practices and interactions with environment. Complex innovation projects are assessed as an intricacy of different activities, correlated in a moving pattern, each of them enlisting different sets of actors and objects. In such a frame, different natures of skills may be distinguished as diversely needed according to the project whereas knowledge absorption and integration capacities appear as key issues in individual or collective apprenticeships.

Given these theoretical developments both in sociology and ergonomics, the challenge may be to combine them for a better understanding of learning processes developed by farmers in such a complex innovation process as sustainable agriculture.

First set of hypothesis about the sustainable agriculture case

An ergonomic approach of sustainable agriculture will consider each activity in a system, requiring new skills based on farm specific knowledge and new ecological principles. Observation, diagnosis, risk evaluation become decisive (Pastré, 1997) and proceed from much more complex operations than in conventional agriculture. They involve new indicators that have very often still to be designed. Indeed, the previous maximum artificialisation of production has led to a considerable reduction of the scope of these operations, thus specific skills have to be built (or rebuilt, in case of the elders). In that prospect, people acquire information and build sense by acting on objects and through interactions with their environment (Conein, Jacopin, 1994). Moreover, the marketing of sustainable agriculture products needs new economic behaviours to develop specific value chains. Finally, sustainable agriculture very often associates production of goods as well as services (agrotourism) and producers engage in specific crafts wherein interactions with clients are crucial. All that also calls for both knowledge integration capacities and relational skills that come on the top of operational and computational skills.

Thus, when analysing learning processes in sustainable agriculture through activities, tasks and operations, the ergonomic approach leads to focus on specific practices and/or on the nature of skills that are needed. Nevertheless, the social factors and mechanisms that enable or impede actors to develop relevant practices or interactions in order to cope with a new project, are still questioned. It is up to the sociological approaches to investigate the respective impact of experience and social networks of farmers in individual and collective learning processes about sustainable agriculture. It asks social scientists to take in account a dynamic array of activities systems, partly adopting an ergonomic viewpoint. Eventually, such an investigation may also provide pragmatic answers relative to the general theoretical debate between human and social capital as basic sources of learning and performance (Bourdieu, 1986; Forsé, 1999).

Two different cases oriented towards sustainable agriculture have been used for data production in order to progress in that perspective. As contrasted cases, they illustrate different aspects of the new paradigm whereas both are fieldwork places of INRA research-action programmes, hence allowing to address the role of interactions between farmers and researchers.

2. Two contrasted case studies, two kinds of approach

Environment-friendly grape production (EFGP) is a collective project designed and managed by the board members of a co-operative cellar. Economic efficiency of the whole firm is challenged. Technical packages are designed although they require new skills and are not fit with every kind of individually owned production units. A training programme has been implemented to help a small group in a first batch of volunteers to monitor the agricultural practices along the crucial stages of the vine cycle, on which knowledge is focused. EFGP consists essentially in a set of operations and observations to be performed annually. New prescribed products and delicate formulae, control and precise utilisation of sprayers, insects epidemiology, pathological risks and thresholds evaluation, all this contribute to the performance of environmental sustainability. On the economic side of things, sustainability is not that clear. Indeed, adoption of this innovation is costly, individually and at the cellar level. The return on investment is not guaranteed and, given the world competition for their type of wine, better prices are unlikely. This strategy of the cellar is thus presented as a right to enter the market, the future minimum standard to be noticed by buyers. When it comes to social sustainability, this new set of techniques is much more labour and knowledge intensive. Moreover, it bears possibility to prompt new social relations as a “collective fight” against epidemy. Above all, training sessions create many new opportunities for the volunteers to exchange and the managing team trusts these latter to diffuse what they learn out of their group. Finally, EFGP represents a highlighting case to assess the role of networks in both innovation and learning processes and more precisely, to test the diffusionist model assumed by the co-operative managing team.

Following the network approach, both social and socio-technical, we assessed the co-operative membership through complementary entry points:

- technical and social practices implemented by producers on or about the objects of action challenged by the innovative project (vines, pests...) ; for instance, method of spraying... on the one hand, professional readings, commitment to an environmental association... on the other;
- points of view about “what should be done”, with regard to these objects of innovation;
- relations of professional dialogue between members, as highlighted by Darré or Wenger, formed by daily or regular discussions about general topics, exchange of equipment and joint work;
- relations of advice-seeking and advice-giving developed voluntarily by members in different domains linked to their professional activity, as a social capital stressed by scholars such Lazega.

We developed a longitudinal approach, by a close monitoring of the volunteers group from 1999 to 2003, and regular interviews with people not involved in the project. The combination of systematic network analysis² with participative observation enabled us to register both qualitative and quantitative data about professional exchanges within the membership and between members and people outside the

² Each producer was asked to answer to a set of such kind of questions: “from whom, in this list of colleagues, did you ask an advice in matters of plant pest controls last weeks? From whom else outside the membership? To whom did you give one?, “etc... (technique of “name generator”).

co-operative. The challenge consisted of linking dynamics in social relations and practices to technical changes and learning about specific objects, at both individual and collective levels.

On the opposite, organic rice farming (ORF) in Camargue has been studied to identify the diversity of individual learning strategies and to test the impact of “experience”, both due to innate capacities, education, socialisation, experimentation, observation, readings... Indeed, the context is the following: there is a lack of collective or organised actions in the technical domain ; farmers have no proximity, neither geographic nor organisational, that induces an apparent very low density of social networks ; agronomic knowledge and technical advices about organic farming are too general to be of any use in the very specific Camargue (northern limit for rice cultivation, production plots and wild life protected areas tightly intricate) ; agronomic research results produced in conventional rice production for fifteen years in Camargue are not relevant for such new objectives and constraints. ORF is indeed a long-term process, possibly encompassing the whole production system. The drastic reduction of inputs and the prohibition of weedicide ask for a strong cognitive investment in the farm management. Rotations involve different crops, new interannual mechanisms. Organic farming is environment-friendly but its sustainability is not yet settled. Cases of farmers shifting back to conventional farming occur. Others say explicitly that ORF is a moment in the ongoing adaptation of the farm and they consider the possibility to stop it whenever needed. These farmers refer to the economic aspect that is rather attractive. Organic rice is well paid and half the yield of conventional rice may bring double income. However, average production is very low and some farmers may harvest less than 15% of conventional plots.

In this case, following both an ergonomic approach and learning social theories, the principle was to consider different stages or situations in matters of knowledge production, use and/or integration about organic farming within rice producers, and supposed to be linked to their “experience”. The challenge was then:

- to identify some cognitive situations within producers, from an open question about the story of the “problems” they faced in matters of organic rice production, thus highlighting tasks that have been emerging as problematic issues or evolving to routines, but also the difficulty they possibly faced in matters of co-ordination of tasks ;
- to consider situations with regard to producers’ “experience”, from an open question about their sources of solutions, thus revealing the diverse cognitive strategies developed throughout the trajectory, such as experimentation, professional readings or dialogue, but also likely to point out the importance of their initial training, production system (level, date of conversion) and values.

3. Presentation of results

Environment-Friendly Grape Production: complementary networks come to light

As mentioned before, EFGP has been associated in the co-operative cellar with a technical package and first assumed by a small group of volunteers trained by a technical adviser dedicated to the co-operative. However, this group and, at a wider extent, the co-operative membership evaluated diversely this package, as more or less relevant beyond its technical feasibility. That led to define several “strategic positions” with regard to the Boards’ project, each position being associated with both specific practices and points of view (Chiffolleau, 2003). Positions could even be evaluated as quite hostile or incompatible between each other, in a first evaluation, thus limiting the adaptation capacity of the firm. But the dynamic of the project opened new perspectives for both research and action by revealing, even exacerbating, the social mechanisms of both innovation and learning in the co-operative. Indeed, the

close monitoring, between 1999 and 2003, of the practices and the interactions developed by the volunteers and other producers representing the diverse strategic positions in 1999 led to highlight the contrasted role of two kinds of networks underlying these processes.

The first type of network refers to daily exchanges of dialogue and services (joint work, exchange of equipment) between co-operative members. Relations are based on kinship, friendship of youth or neighbourhood and are quite stable. This network is presented by people themselves as the relevant social space for professional individual and collective identities building, exchanges of individual trials and errors or observations, confirmation of (innovative) past choices and integration in routines, attempts of interpersonal influence from “pioneers”. We call it the “proximity network”. The second type of network is grounded by advice relations, either asked or given, thus assuming the contours of knowledge-based strategies needed by the implementation of new practices requiring more technicality, but also by the development and the management of diverse domains of change. Indeed, advice relations with various interlocutors are asked and/or given by producers around distinct topics, which they link with environment-friendly production, more or less explicitly³. Advice relations dynamics thus confirm the different conceptions and implementations of the Boards’ project we first highlighted through “strategic positions”: some producers are in quest of or in position to give advice in order to go deeper in matter of biological fight against pests and diseases, others look for or give advice to implement new collective forms of work and manpower management in order to surmount the extra work or to engage landscaping in perspective of agrotourism. On the one hand, advice relations are much more developed out of the membership and labile than proximity dialogue relations: proximity and advice networks are thus hardly overlapping. On the other hand, when looking at the whole membership level, the advice networks make emerge thematic or pluri-skilled experts as “prestigious” people respectively in one or several network(s).

Finally, these two kinds of networks assume contrasted and complementary roles regarding the collective innovation and learning project: evolution of norms and stabilisation of more suited ones in the proximity network; new knowledge⁴ acquisition and individual distinct skills acknowledgement in the advice ones. Moreover, whereas the first network makes emerge some proximity clusters very close to peers’ sub-groups highlighted by Darré or Wenger notably, the second one reveals sets of people as linked to the same portfolio of advisers and improving some domains of action or on the contrary, reluctant to change. Crossing these two kinds of results, four sets of people may be then distinguished in the studied case, some of them constituting also “clusters” in that people of the set share proximity relations:

³ We thus may distinguish as many networks as there are relevant advice domains according to the membership which is concerned. In the studied case, five domains have been identified: pests and diseases controls, ultra-qualitative practices, work and manpower management, landscaping, grape quality evaluation.

⁴ An advice is indeed more than an information and may be construed as one form of knowledge (Cross *et al.*, 2001).

Nature of the set	The cluster of vine technicians	The cluster of local development actors	The patrimony guards	The set of marginals
Strategic position	Not really convinced by the Board's project but often volunteer	Active carriers of the project, all volunteer	Reluctant to adopt the project but all the same sometimes volunteer	Mainly not concerned by the project except few volunteer
Advice interlocutors	Estates, public extension services	Technician of the coop, agricultural unions, wine unions, patrimony guards (see next)	Local policy makers, land system managers	Input suppliers technicians and salesmen
Advice networks in which they emerge as prestigious	Pests and diseases controls, very high qualitative practices	Quality grape evaluation compared to cooperative rules, manpower management and recruitment	Landscaping, vine planting	People few solicited as advisers even if sometimes high-skilled in one domain : cases opening perspectives (see below)
Innovative practices implemented	Introduction of auxiliary fauna and organic composts, green harvests	Wine festivities, employers groups, services to tourists, trees and flowers planting, terroir zonage	Digs management, landscape rehabilitation	Many or none
Sociological profile	Ex or current "passionate" part-timers, new rural inhabitants pursuing new "life projects", ex Board members' or extension groups' children just out of agricultural schools	Children of ex Board members or Board members (1 st type), young activists of wine cooperation	Notables rich families anchored in the territory for a long time, Board members (2 nd type) or close to them	"Frustrated" producers projecting an estate, part-timers or young settlers too busy, not really interested by viticulture or simply shy, aged producers without successor

The development of the EFGP project progressively opens new perspectives regarding collective action, in particularly by giving tools to involve in the dynamics some of the usually excluded actors:

- the formation and animation of training sub-groups of volunteers by the technician both strengthen and enlarge the current clusters by allowing the quick integration of previously isolated people (young settlers, aged people) in daily dialogue and exchange networks,
- the diversity and multiplicity of questions raised by this complex project prompt some "socially integrated" producers to contact neighbouring "frustrated members" observed as going deeper or further to prepare their private cellar project ; in the same time, the new dynamics created in the cooperative are likely to get them less frustrated...

Organic Rice Farming: towards a cognitive styles typology

In the Camargue situation, the prescription is not associated with technical recommendations. Research is to be designed as well as practices. Experimental approaches are trying to build adapted protocols to the new paradigm. Practitioners are individually engaged in experiential learning, which raises new questions. They are implementing a cognitive strategy, which serves their own project, framed by their values.

As mentioned before, a first step of the analysis was to identify, from an open question, the tasks integrated in routines or still questioning farmers about organic rice cultivation, in a dynamic perspective. Discourse analysis has been used to assess their different ways to speak about, to order and to grade these problems, to highlight the specific relations they make between problems and potential solutions. Organic farmers were indeed supposed to present different profiles regarding these questions. On one hand, all of them do not face the same problems (Darré, 1996) and are not concerned by the same questions. On the other hand, for some of them, these questions have been temporarily solved.

Knowledge has been routinised and it does not appear in their discourse as a cognitive aim but rather as a settled explanation. Identified issues address the different levels of farming operations from the crop to the production system. But other non-agricultural activities, like hunting, agro-tourism, have been also underlined by some respondents as domains of preoccupation. Moreover, beyond tasks, some producers referred to systemic issues whereas others focused on specific themes. It is interesting enough to notice that the first ones, those referring to systemic issues, have already found satisfactorily answers to the thematic questions they once faced.

A first aggregation has been built, roughly and quantitatively summing up the number of identified questions and the level of routinisation of its solutions⁵, thus contributing to define some “cognitive styles” along two dimensions, content (from thematic to systemic) and intensity (from absence to intense identified learning activity). Farmers’ questions have been then related to their “experience”, first assessed through their initial training, professional trajectory and involvement in organic farming, both practically (production system, date and level of conversion, type of marketing) and ideologically (reasons for converting to organic cultivation). We also sought to correlate questions with their learning strategies, construed as investments in human capital. Different categories of learning practices have been highlighted, however not asked systematically to each interviewee, following the principles of a non-directive interview allowing to highlight his or her priorities (*ibid.*).

Finally, based on a first and rough exploration of data, cognitive styles appear to be strongly correlated to specific learning practices, type of conversion and production system. On the opposite, what may be assessed as “basic” elements of human capital (initial training and professional trajectories) do not explain the diversity. Six types may thus be defined among organic farmers.

	Cognitive style	Main learning practices	Production system	Reasons for conversion
1	Questions focused on one thematic problem (weeds) and one type of solution (rotations) ; no specific learning strategy	Exchange with co-operative technical advisers and/or input suppliers	Cereal or mixed Partial conversion (< 20%)	Opportunity (use of fallows), price oriented
2	Satisfying thematic solutions found in the past, no more or no deeper search	In the past, experience (trial and error processed in routinised knowledge) ; current lack of learning practices	Cereal, ancient and important or total conversion	Price oriented
3	Thematic questions in deepening	Few exchanges with colleagues; many trials and errors ; professional thematic travels	Cereal	Price oriented and moderately ideologically motivated
4	Systemic questions in progression	Exchanges with external organic network, solicitation of INRA, specialised lectures, internet consultation	Cereal Important or total conversion	Strongly ideologically motivated and moderately price oriented
5	Satisfying solutions found in matter of rice production but thematic questions about other activities	Dialogue with colleagues, solicitation of INRA	Extensive bull raising, agro-tourism, important or total conversion	Client oriented (tourists)

The majority of farmers thus appears more focused on quite clearly delineated questions, with a rather intensive cognitive activity. But some stop when satisfying solutions are found whereas others try to go deeper or further. Types 2, 3 and 4, for example, may be illustrated through their specific ways to assess and to manage the problems of weeds, that is confirmed as the main issue in Camargue, alike other organic farming situations (Kopke, 1999): for intensive cereal organic growers (type 2), control consists

⁵ This aggregation proceeds from i) the categorisation of interviewees’ point of view regarding eight thematic domains (fertilisation, rice seedling, weeds control...) in four classes (topical, resolved, not relevant, not mentioned), ii) the number of associations made between different domains or practices.

in a tight monitoring of any possible way in for weed seeds and in the eradication of plants at first sight, with a high labour investment. For the type 3, rotations are preferred and different ones are tried, whereas the type 4 associates a strict limitation of rice, a high quantity of manure and several years of alfa-falfa in the rotation cycle in a more systemic approach. Moreover, as highlighted by organic farming scientists (*ibid.*), soil appears a core element in the building of the systemic thinking, characteristic of this type. Some farmers in this type 4 also mention the question of job creation which seems a positive way to loosen current constraints but which is out of their reach because it raises never-ending labour management problems.

Along a professional trajectory perspective, this first step of research leads to a temporary conclusion about the importance of the seniority in conversion, although it seems to play in two contrasted ways : either people stopped searching or they developed the capacity to integrate different topics. A total conversion seems to contribute to the development of systemic issues. At least, two types appear as not very much involved in cognitive strategies about OF. Explanation may be found in a low technical interest and social consideration for organic farming: opportunity that may be given up if too difficult or not profitable for the type 1; mere marketing argument for the type 5.

4. From contrasted cases to a combined approach

Contributions to learning processes understanding

Beyond the illustration of the “distributed cognition” principle modelled in cognitive sciences regarding social settings (Conein, Jacopin, 1994), both cases allow to disrupt with the still classical way to identify or assess innovation leaders and processes in rural settings: people with a high level of agricultural training, pioneers with regard to the prescribed practices, professional leaders are usually supposed to “diffuse” research advice (Darré, 1996).

Each case thus proposes a specific way to question this perspective. On the one hand, the advice relations pattern highlights the “teachers” rather than the “scientists”, people’s potentials rather than weaknesses or reluctance. Indeed, patrimony guards, for instance, are both Board members and quite reluctant to adopt EFGP (not a priority, too costly). However their expertise is sought by their colleagues to guide terroir zonage and promote territorial assets. Furthermore, ex or current part timers appear as advice experts in matter of pests controls or wine promotion when their previous or actual non agricultural work and networks enable(d) them to practice. Moreover, the network approach leads to distinguish interpersonal relations according to their contrasted impact relative to learning and innovation, thus contributing to refine basic hypotheses about the fundamental role of professional networks proposed by rural sociologists and Darré especially. On the other hand, cognitive styles approach is an attempt to go beyond “pioneers” as first ones to do well defined things. The aim is rather to highlight the dynamics of people deepening, broadening, integrating questions and actions or on the opposite, stopping as soon as satisfying solutions (assessed as a specific and exclusive link between problem and action) are found. Such an approach leads to precise people cognitive activity (what? when? how? about what?) and to enlarge the scope of their cognitive strategies beyond the call to experts, even if it does not pretend to cover all the learning practices that people develop.

Furthermore, beyond their specificity, both cases finally highlight two essential cognitive stages or situations in innovation contexts : acquisition of new knowledge, reasoned by task or theme, through advice-seeking relations and/or personal search (experiments, travels, readings...), that may be assessed as investments in human capital contributing to the building of individual “experience”; translation and

integration of new knowledge in individual and/or collective systems of norms and routines through proximity relations and/or possibly call to “systemic” experts, whose role is to confront and confirm individual assessments. In Camargue, where social exchanges are particularly scarce, relations with “peers” seem indeed to distinguish people translating domains of search in new routines, from others still questioning. According to the “peers” considered, routines appear as more or less advanced and/or systemic. The 4th cognitive style producers thus differ from the 5th in that they exchange with other well-advanced organic farmers (even not producing rice) in external networks, whereas the 5th ones exchange locally with people sharing the same project (agrotourism from rice and bull raising). Camargue and viticulture cases thus seem to both confirm how the proximity network, where (innovative) norms are discussed and stabilised, is linked to common values or project. In the co-operative case, where social exchanges are supposed to be frequent and multiplex, only specific relations are indeed presented as those where systems of norms are stabilised: the regular relations with people in the same or a close “strategic position”.

Refining the sociological approach

These two approaches thus present strengths, but also weaknesses, that may be linked to their different focus: collective action vs. technical performance. Nevertheless, their combined mobilisation in the perspective of a new form of agriculture, that has to cross these two types of objectives to become “sustainable” (Godard, Hubert, 2002), may then be relevant. However, partly due to the early stage of the work (specially in Camargue), some points have to be developed in each approach.

The network approach has been indeed driven in perspective of collective innovative project management and finally gives tools to facilitate the coordination. But it does not allow to precise the cognitive steps and integrative processes of people when faced with a problem or a project and sometimes with several opposite advice. Proximity clusters, relations with people in the same strategic position, have been mentioned as the social space for the integration of new knowledge, thus confirming Wenger or Darré’s theory, but we have to go deeper. Moreover, this approach privileges relational skills for technical learning. But where do come relational skills from? How do people acquire them? The type and level of human capital seems to play a crucial role : part-timers are often the most prompt to ask technical advice outside, that they justify by their low initial professional background but also by their habit then facility to discuss with diverse people, “*contrary to full-time farmers, more closed on themselves*”. Producers thus appear as specific and dynamic combination of human and social capitals, that may constitute interdependent factors, partly substituting to each other. Network approach hides however other cognitive strategies developed (voluntarily or not) by isolated people (reading, travelling...) and it does not look at the hierarchical array of topics and learning sources. In addition to that, systematic network analysis is a heavy way of data production that supposes to delineate quite early in the research process both the domains and the set of people concerned by dialogue or advice relations. In that sense, results risk to be biased because researchers may privilege domains of investigation and actors that make sense for them and not for people.

The approach through cognitive styles, more focused on individual technical progression through diverse learning practices constituting investments in human capital, may strengthen both the analytic and intervention capacity, by its specific corpus and posture searching to highlight integration and order aspects in matter of cognition. Still, the analysis has to be carried further. Indeed, even if spontaneous discourse reveals some of the priorities, its superficial analysis falls short from solving the question of the hierarchical aspects of decisions in an innovation process and regarding learning sources. The role of “peers networks” is evoked, as the social space where meanings (then, efficiency? relevance?) are given to individual investments in human capital. The identification of values attached to key objects of action

(soil, manpower...) also appear as a key element in the capacity or willingness of people in matter of articulation of action domains, of hierarchy of topics and of integration of different forms or sources of knowledge.

A further articulation of the two approaches, through the lenses of the social / human capital movement, has then to be done to understand more precisely the decision rules of sustainable agriculture farmers. Sustainable agriculture unsettled technical message asks indeed for new and important cognitive investments in different domains which finally appear as competitive when resource is scarce (e.g. time). Investment in human capital, seen as acquisition of individual knowledge, covers various learning practices the output of which is interdependent. The use of printed or internet material is supposed to make the participation in training activities more efficient and finally enables the development of social capital. At least, the social capital is likely to give the meanings, the necessary opportunities or the unavoidable constraints that frame the multiple choices of a learning trajectory that increase human capital. It may finally require thorough discourse analysis but also tools borrowed from ergonomics, to identify and evaluate these elements that characterise the movement between the two forms of capital.

Towards interdisciplinary action-research models

Beyond disciplinary issues raised in sociology by the specificity of sustainable action, the challenge also consists in articulating these two approaches in a pragmatic way that may be useful for different stakeholders, among whom are agronomists or development facilitators. Indeed, sustainable agriculture addresses directly experimental sciences inasmuch as their approach is based on the selection / extraction of what is relevant for them in the real world to test hypotheses about functioning patterns (Stengers, 1998), whereas knowledge about this new paradigm of agriculture has to be integrated. Disciplines traditionally related to some aspects of farming like agronomy, economy, soil sciences or ecophysiology have to develop and tighten their interactions. Other disciplines have to be called in, like ergonomics, sociology, geography (Riba *et al.*, 2000).

To build such an interdisciplinarity, the different disciplines have to select cases and situations including the specific research objects of each of them. Actors engaged in these situations carry pieces of an integrative knowledge built in action and may contribute strongly to the dialogue between disciplines by pointing out relations and possible intermediary objects, common to several scientists. In that first respect, actors are key partners in the design of a scientific body of knowledge aiming at the sustainability of agriculture. Sustainability is indeed directed towards an unknown future and presents itself as a project more than as a given state of things and arts. It is a project for a heterogeneous set of actors and therefore, researchers, farmers and other stakeholders have to collectively and permanently imagine the relevant questions to be investigated (Röling, 1994).

Crossing grape environment-friendly and rice organic farming notably, new advanced equipment and local rustic varieties appear for instance as interesting intermediary objects for both learning and innovating, collective and individual performances. A focus on geographically and socially anchored objects around which both advice networking and dynamics of questions are developed may be one of the most relevant ways to organise new interdisciplinary collaborations about sustainable agriculture.

Conclusion

To carry out the analysis of the production of knowledge in any socio-economic order but sustainable agriculture especially, management sciences points out the need for intervention-research. At least cross-disciplinary practices are required to investigate the different objects. We thus propose in this paper a combination of two approaches, drawing on two different traditions in sociology and associated with some framing elements borrowed from ergonomics, to highlight the conditions of production of different kinds of knowledge by farmers and to identify influential individuals. We also design ideotypes of learners or clusters of learners, construed as combination of social and human capital, in a given agronomic innovation process. Therefore, we identify limits of individual rationalities and provide an analytical framework of farmer's decision rules.

Beyond a contribution to learning processes analysis, sociological approaches also provide a picture that helps scientists to assess their own relations with farmers and stakeholders and to build an array of relevant interactions relative to the sustainability of the research outcomes (Chiffolleau *et al.*, 2001). Indeed, partnership between researchers and stakeholders may produce a new body of knowledge, promote new types of actors or new roles. However, it may also create new dominating relations or strengthen the exclusion of already outcast categories. Sociologists may also act as loudspeaker for mute entities (Callon, 1999) and push in the game individuals usually discarded or unnoticed. Hence, they enable the facilitation of dialogue between researchers and stakeholders and among stakeholders. Such a combined sociological approach finally contributes to the four research topics delimited in the LEARN NoE programme proposal: capacity building for collective action, cross-scaling in knowing and policy-making, practice of reflexivity and role of knowing in social cohesion.

Bibliography

- Aggeri F., Hatchuel A.** (2003). "Ordres socio-économiques et polarisation de la recherche en agriculture. Pour une critique des rapports science-société". *Sociologie du Travail*, 45, 1, 113-133.
- Becker G.** (1964). *Human Capital : a Theoretical and Empirical Analysis with special reference to education*. Chicago, The University of Chicago Press
- Berger P, Luckmann T.** (1967). *The social construction of reality*. Harmondsworth, Penguin.
- Bourdieu P.** (1986). "The Forms of Capital". In J. G. Richardson (ed.) *Handbook of Theory and Research for the Sociology of Education*, New York-Westport, Londres, Greenwood Press.
- Bruner J.S.** (1991). *Car la culture donne forme à l'esprit : de la révolution cognitive à la psychologie culturelle*. Paris, Eshel
- Callon M.,** dir. (1989). *La science et ses réseaux*. Paris, La Découverte.
- Callon M.** (1999). "Ni intellectuel engagé, ni intellectuel dégage : la double stratégie de l'attachement et du détachement. *Sociologie du Travail*, 41, 65-78.
- Chauveau J.-P., Lavigne-Delville P.** (1998). "Communiquer dans l'affrontement : la participation cachée dans les projets participatifs ciblés sur les groupes ruraux défavorisés". In Deler *et al.* (dir.), *ONG et développement : du nord aux suds*, Paris, Karthala, 193-214.
- Chiffolleau Y.** (2003). "Learning about innovation through networks : the development of environment-friendly viticulture". *XXth Congress of the European Society for Rural Sociology*, 08/18-22/2003, Sligo, Ireland.
- Chiffolleau Y., Dreyfus F., Touzard J.M.** (2001). "Chercheurs et viticulteurs partenaires pour l'innovation : interactions, institutions et apprentissages". *Natures, Sciences et Sociétés*, 3, 29-36.
- Conein B., Jacopin B.** (1994). "Action située et cognition : le savoir en place". *Sociologie du Travail*, 4, 475-500.

- Cross R., Borgatti S.P., Parker A.** (2001). "Beyond answers : the different dimensions of advice networks". *Social Networks*, 23, 3, 115-135.
- Darré J.-P.** (1996). *L'invention des pratiques*. Paris, Karthala.
- Darré J.-P., Le Guen Y., Lemery B.** (1989). "Changement technique et structure professionnelle locale". *Economie Rurale*, 192-193, 115-122.
- Degenne A.** (1998). "Dimensions d'analyse de la segmentation du marché du travail". *Communication à l'Ecole Thématique Marchés et organisations*, Paris, Maison Suger, 20-24 juillet 1998, 12 p.
- Dodier N.** (1995). *Les hommes et les machines*. Paris, Métailié.
- Dewey J.** (1916). *Democracy and Education*. New York, McMillan Company.
- Forsé M.** (1999). "Role and rise of social capital". *Scale conference*, Amsterdam, December 1999.
- Godard O., Hubert B.** (2002) *Le développement durable et la recherche scientifique à l'INRA* Rapport Intermédiaire de mission, Paris, INRA
- Joly P.-B., Paradeise C.** (2003). "Agriculture et alimentation : nouveaux problèmes, nouvelles questions". *Sociologie du Travail*, 45, 1, 1-8.
- Katz E., Lazarsfeld P.F.** (1955). *Personal influence*. New York, Free Press.
- Kopke U.**, (1999). Review of crop production and weed control : state of arts and outlook. In ENOF White Book "Organic Farming Research in the E.U., towards 21th Century". Barcelona.
- Lazega E.** (2001). *The collegial phenomenon : the social mechanisms of cooperation among peers in a corporate law partnership*. Oxford, Oxford University Press.
- Pastré P.** 1997. "Didactique professionnelle et développement". *Psychologie Française*, 42-1, 89-100.
- Riba G., Bellon S., Gautronneau Y., Savini I., Sylvander B.** (2000). *L'agriculture biologique et l'INRA ; vers un programme de recherche*. Paris, INRA
- Rogers E.** (1962). *Diffusion of innovations*, New York, Free Press.
- Röling N.G.** (1994). "Platforms for decision-making about ecosystems". In: L.O. Fresco, L. Stroosnijder, J. Bouma, H.van Keulen (Eds), *The future of the Land : Mobilising and Integrating Knowledge for Land Use Options*, Chichester, U.K., John Wiley & Sons, 385-393.
- Ryan B., Gross N.C.** (1943). "The diffusion of hybrid seed corn in two Iowa communities". *Rural Sociology*, 8, 15-24.
- Stengers I.** (1998). "Prendre au sérieux le développement durable ?". *Cahiers du CDD*, IGEAT, ULB, Bruxelles, 3.
- Tarde G.** (1901). *L'opinion et la foule*. Paris, Librairie Felix Alcan.
- Vinck D.** (1999). "Les objets intermédiaires dans les réseaux de coopération scientifique. Contribution à la prise en compte des objets dans les dynamiques sociales". *Revue Française de Sociologie*, XL (2), 385-414.
- Wenger E.** (1998). *Communities of practice : Learning, meaning and identity*. New York, Cambridge University Press.

