How information becomes a resource to act in an uncertain and complex world: sense making and contingency in the knowing process

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Abstract: *One challenge for development in the rural areas is to increase stakeholders' capacity to understand their role and to act in a more uncertain and complex world. This issue is mainly dealt with by supporting collective dynamics and enabling stakeholders to envision their various perspectives before exploring possible futures. But the question is further to support the collective action which will be needed to implement what has been identified as a desirable future. We suggest that this implies a better understanding of the knowing process and its relation to action, e.g. the way each stakeholder understands the situation, builds it as problematic and mobilizes his(her) informational environment to tackle the situation. We carried out a study to better understand the diverse ways by which farmers seek information to develop their farming projects. Our framework of analysis focuses on sense-making: how do farmers seek information and give sense to it in order to cope with a management situation they have identified as problematic? Our conceptual model, abstracted from data, suggests that: 1) sense-making is contingent upon the way the here and now situation is characterized as problematic and depends on the purposes and functions farmers assign to the informational resources mobilized to face this situation; 2) farmers assign purposes according to their own farming project based on a dual perspective: the productive activity, and the farmer's identity and capacity; 3) sense-making is backed up by a capitalization process: farmers keep trace of the informational resources which they assessed to be relevant to deal with a given situation. We will then discuss how such results could change our ways to support collective dynamics and stakeholders' capacities to act in an uncertain and complex world.*

Keywords: *informational resources, informational activity, knowing process, sense-making, farming system*

Introduction

While experience was a main driving force for improving farming systems in the relatively stable context of the past decades, practitioners and researchers must now strive for new farming systems in a dynamic and uncertain working context without a clear idea of how to achieve this goal (Ortiz, 2006). Innovation can no longer be built solely on experience and stabilised forms of scientific knowledge. Therefore, the long term challenge for development in rural areas is to improve the capacity of various professionals (farmers, advisers, natural resource managers…) and of rural communities to understand their various perspectives and to act together in an increasingly complex and unpredictable world.

Collaborative approaches to rural development enable the exploration of the multiple stakeholders' perspectives on possible futures and of the existing and future interdependencies which will contribute to shape collective action. Generally, these approaches rest on participative methodologies which focus on *"interpretation and learning rather than optimization"* (Checkland *et al.,* 1998) and which are used to *"facilitate debate about the social desirability and cultural feasibility for changes in problematic situations that come to be regarded as improvements through the accommodation of the different worldviews of different stakeholders"* (Bawden, 2005). Different theoretical perspectives underpin such participative methodologies. Systems thinking perspective offers a basis for soft system methodology which has been successfully used as a way to promote change in complex situations. Cultural and historical activity theory offers another perspective and the change laboratory® methodology, based on the dual stimulation principle proposed by Vygotski (1978) was also applied successfully in many different situations. Such methodologies focus on the collective dynamics while exploring possible futures, but do not really address implementation issues: how will the collective and the individuals act

then in order to reach the desirable future? Our hypothesis is that, by focusing on collective or social learning such methodologies do not pay enough attention to the knowing process while a better understanding of it and its link to action will be helpful to step from the design phase of the collective action to its implementation phase.

In this paper we present the work we undertook to get deeper insight into the farmers' knowing process as it happens while they manage their farming activity. We will first develop our framework and results. We will then discuss how our modelling of the knowing process at the individual's level could be adapted for supporting a collective action.

The knowing process in a sense making perspective

Samurcay and Rabardel (1995) emphasize the capacity of actors to build their own resources in order to act. They describe it as a process: actors assign some properties to what is available in their environment according to what they intend to do in the here and now situation. Theureau (2004) states that each actor *"has an asymmetric relationship with the environment e.g. he interacts only with what, in this environment, is interesting for him or is a source of disturbance for him"*. So the internal structures of an actor (his personality, his competence, his history) and the structures (obviously external) of the environment (including the social one), co-determinate each other while they interact (enaction). But how do actors transform some part of their environment into resources which they can use to act further in the situation? To answer this question, we chose to take a sense making perspective such as the one developed by Weick (1995) and to focus on the informational dimension of the environment of individuals. This means that we analyzed the knowing process in relation with action. We first looked at the way individuals seek for information in order to assess a situation of management. We secondly analyzed how they transform some of the available information into what we called informational resources. We defined informational resources by three components: the Support, the Origin and the Content (SOC) of information. An informational resource can be viewed as a mediating tool whose underlying support, origin and content are not neutral in the interpretation made by the individuals. Finally, we proposed the notion of informational activity to give account of the whole process of making sense of information and using informational resources in order to act.

These notions were developed to analyze the way some beef cattle farmers seek and use information in order to handle their farm. For this study, we carried out in repeated surveys (three times over one and a half year) among nine beef cattle farmers chosen to explore a large diversity of their ways of performing their informational activity. The semi-directive interviews rested on a loop between the farming practices carried out by the farmer during the period and the information which he mobilized during the same period. Farmer's sense-making is analyzed thanks to his description and explanation of how and why he acquires and selects information (what kind of information in terms of SOC?) as well as how and why he uses information to manage his activity (in which situation and what for?). We developed a conceptual model of the informational activity thanks to a qualitative abstraction procedure which enabled us to give an account of the diversity observed in our data. This model distinguishes: 1) the finalizing sub-activity, which organizes the informational activity in the long term; 2) the monitoring sub-activity which readjusts the informational activity according to the farmer's perception on whether or not the situation needs specific action to be undertaken; 3) the interpretative sub-activity which results in the building of informational resources which are then mobilized to face the situation and assessed for future use; 4) the exploitation sub-activity which integrates informational resources into decision and action of management .

In the following section, we chose not to present the whole conceptual model (for a description see Magne *et al.,* 2007). Our focus is on the finalizing, monitoring and interpretative sub-activities in order to show how our model accounts for the way farmers identify a situation of management, build it as problematic and interpret information while acquiring it to face the situation. We stress how all these processes enable us to explain some of the observed diversity in the farmers' informational activity.

Enaction and building of the situation of management

An individual interacts with his environment by identifying some cues which are meaningful for his action. This is often referred to as situation awareness (Endsley, 1995). Our data show that a farmer quotes a situation according to some events which are regarded as meaningful, e.g. which need to be analyzed further. Events can be characterized by six criteria, whether these events come from the

biophysical processes or from outside the farm (Table A1[1]). Each criterion represents a filter through which the individual interprets an event. By assigning some modalities to these criteria, the individual can then orient his information search according to the way he identifies the situation to be managed. It should be noticed that all the six criteria are not always used to interpret the event and therefore to characterize the situation of management. Instantiation of only one criterion may suffice. But, the six criteria are needed to give an account of the diversity of the farmers' ways of characterizing the here and now context.

Our data suggest that this interpretation of an event and the resulting search of information can also depend on the importance that each farmer attributes to the mastering of what we called a "domain of farming". Actually, during interviews, we identified that farmers segment their activity into different domains of farming and do not attribute the same importance to the mastering and the development of these domains. We also identified that they are differently sensitive to the mastering of a given domain of farming: four criteria (Table A2) underlie the farmers' sensitivity to the mastering of the domains of farming. Each criterion is valued by the farmers along a gradient (high, low and average). Although we have not been able yet to thoroughly identify how farmers articulate their appraisal of an event and their sensitivity to the mastering of different domains of farming, the following example shows how these two dimensions enable us to understand the different information search strategies of two farmers facing an a priori similar event which is scouring in calves (Table 1).

Table 1. Two different information search strategies according to (i) different perceptions of calf scour and (ii) different sensitivities about mastering the domain

		Farmer 1	**Farmer 2**
Farmers' informational activities		Several informational resources especially those from external sources	Only the familiar internal information and the curative treatment prescribed by the veterinarian
Farmers' perception of the event	**Predictability**	/	/
	Delay	No	No
	Familiarity	Yes	Yes
	Frequency	Each campaign	Each campaign
	Intentionality	No	No
	Time-horizon	Long term	Short term
Importance given by the farmers to mastering animal health management		High	High
Farmers' sensitivity about mastering animal health management	**Stake**	High	High
	Pleasure	Low	Low
	Efficiency	Low	Low
	Controllability	High	Average

The example highlights a difference in the two farmers' sensitivity to the mastering of animal health management (which is the domain of farming the event refers to). They both say it is important to master it. They agree on the fact that mastering this domain ensures the sustainability of their activity (high stake), avoids them loosing time to cure sick animals which is very boring (low pleasure). They both are unsatisfied with the results they currently achieve (low efficiency). But they differ on the level of control they feel able to have over this domain of farming (controllability). Farmer 1 thinks that he is able to master animal health and that he can find means for that. Farmer 2 thinks that his room for manoeuvre to master this domain is limited because of the uncontrollability of the biophysical process which is directly exposed to health risks. While the event induces a problematic management situation because the disease is frequent and recurs yearly despite preventive health treatments, farmers differ in their way of interpreting it, though they both consider the domain as important to master. The two farmers interpret differently the event according to the time-horizon of its management. Farmer 1 considers that the problem has to be overcome in the long term whereas Farmer 2 decides it needs to be handled in the short term. This can be linked to the differences in their respective ways of

[1]All the criteria and variables we created are defined in the tables presented in the appendix. We indexed each table of the appendix in the following format: table Ai. Other tables inserted in the paper are indexed Table j.

assessing the controllability of the animal health domain. This also results in different information search strategies. Farmer 1 seeks a lot of information especially those from external sources in order to step back from the origin of the problem and from the way to resolve it. He looks for means which will enable him to keep the animal health domain under control. On the contrary, Farmer 2 goes on mobilizing internal information sources and the veterinarian as he thinks it is the only way to overcome the situation.

Interpretation of information: building informational resources

The informational environment of farmers can be rather complex and fuzzy. How do farmers orient themselves in such an environment and choose relevant information to cope with a situation of management? Our results show that farmers appraise the usefulness and usability of information (Table A3). This concerns the three dimensions we used to characterize an informational resource: support, origin and content. Usefulness and usability appear as filters which result in transforming information into informational resources which can be then further mobilized to cope with the situation.

Defining the scope of information search

Farmers carry out the assessment of usefulness and usability of information according to their appraisal of the here and now context. Our data shows that this is done by activating some *functions* and *purposes* which the farmers attribute to information while thinking of using them in the situation. We identified five functions assigned by the farmers to information (Table A4), and nine purposes (Table A5). The latter were organized into two categories: purposes linked to the development of the particular production and those linked to the development of the farmer. In fact, after assessing the event and the need to face a given situation, farmers still have to develop a strategy to search for and use information. This is not only triggered by the situation as such, but also by the way farmers wish to use information according to their own farming objectives. Identification of the functions and purposes the farmer assigns to information is a way of accounting for the orientation of information search by the farmer's project.

Attributing some value to the information which the farmer seeks does not only depend on the here and now context. The farmer may have already met a similar event and may have already sought information to deal with it. So he values information according also to his former appraisal of some already used informational resources. That is what we called a capitalization process. This process is carried out while assessing the results of an action: were the informational resources useful and usable to act in the management situation? Did they allow him to meet his expectations to control the situation and fulfil his farming objective? This capitalization process is therefore linked to the *functions* and the *purposes* that the farmer has assigned to the use of information in situations encountered earlier. This process leads to an update of the farmer's capital of informational resources. A positive or a negative appraisal of informational resources induces respectively a stabilization or destabilization of the capital. When the farmer meets a similar situation, he can recall informational resources he has already used according to the appraisal he made of them. If the appraisal was negative the farmer can also mobilize other informational resources to test their usefulness and usability.

Let us come back to our example and look at the functions and purposes that each farmer assigns to informational resources (Table 2). Some differences throw some light on the way each farmer assesses the usefulness and the usability of information. Farmer 1 wishes to achieve security in the animal health domain. He considers that he does not need to save money in this domain and prefers to look for the information sources which are the most competent irrespective of costs. To achieve this, he also prefers to combine various sources which can offer the same content (information about preventive or curative treatments). As he wishes to develop his understanding of his own health management practices, he seeks information which is intelligible, but which can also enable him to learn new procedures that will support the development of his own practices, or at least to stand back from his current ones which he assessed as insufficiently efficient. He thinks he may need to better identify the origin of repeated scouring in his calves. Although he wishes to reduce his work load, he feels that this can only be achieved by applying successfully some preventive treatments which he does not apply yet. For him, reducing the work load not only means reducing the time spent in caring animals, but also his own stress (loosing ill animals). On the other hand, Farmer 2 does not share these functions and purposes. He wishes to reduce costs in the animal health domain to improve its

profitability. Therefore he only turns to the veterinarian when he has to dose the calves, and does not really try to improve his preventive actions. He mobilizes information in order to solve the current problem and to choose the action to be carried out. He does not want to think further about the origin of the problem as he considers this will make him loose time and get stressed.

Table 2. The purposes and the functions assigned to information by the two farmers to cope with scouring in calves

		Farmer 1	Farmer 2
Farmers' informational activities		Several informational resources especially those from external sources	Only the familiar internal information and the curative treatment prescribed by the veterinarian
Purposes assigned to information	**Purposes oriented towards development of productive activity**	Security building	Profit making
	Purposes oriented towards farmer's own development	Cognitive development Reduction of work load	Reduction of work load
Functions assigned to information		Reflexivity Problem finding Problem solving	Decision to act Problem solving

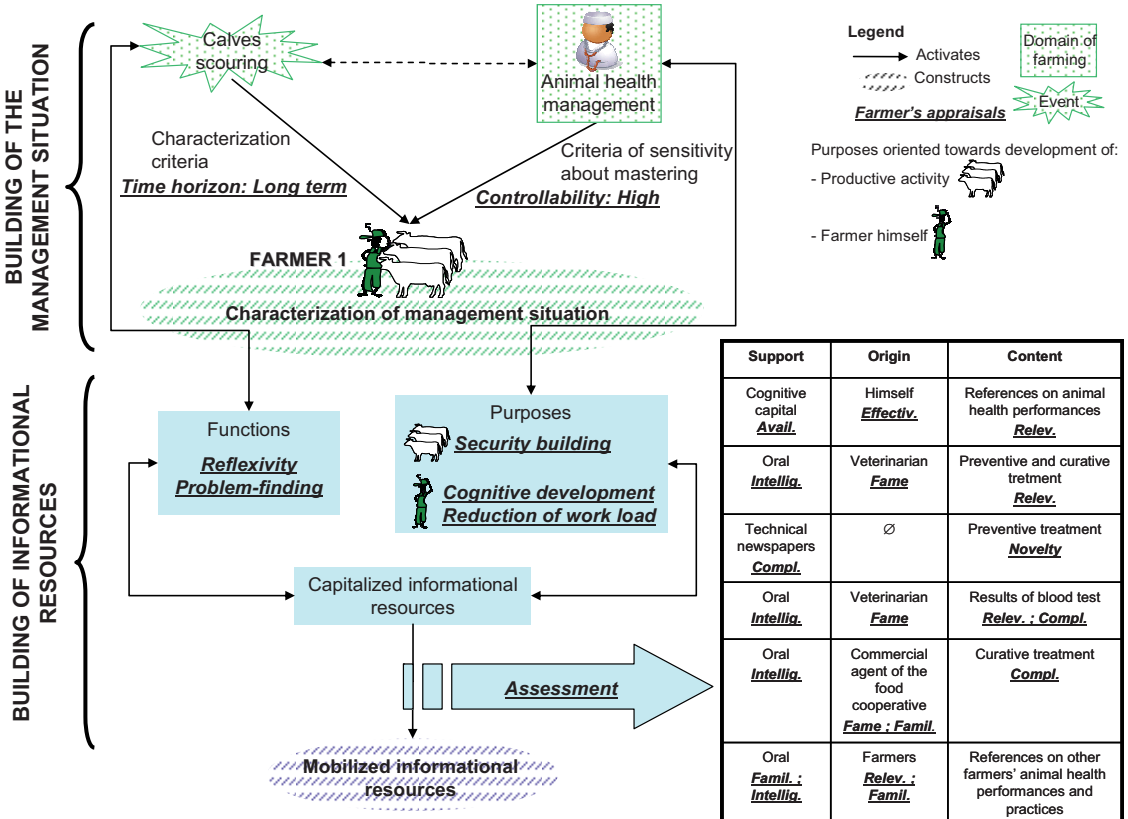
Selecting information

All these criteria allow us to achieve a comprehensive approach to the differences we identified in the informational resources farmers used in order to face a given event (Fig. 1).

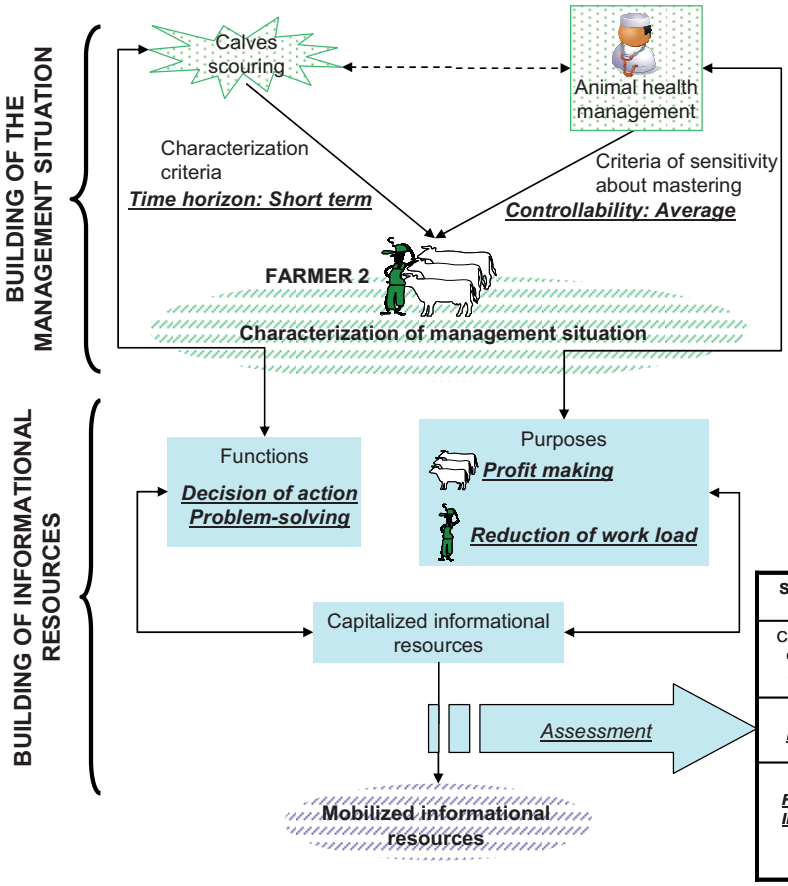
As shown in Figure 1, the event, calf scouring, is differently assessed by the farmers chiefly according to the controllability of the animal health domain and the need to find long or short term solutions. Therefore, even though both farmers try to get information about treatments, they do not really have the same way of assessing the usefulness and usability of the information medium, origin and content. They also view differently the way to balance prevention and cure in order to cope with the situation: the criteria we identified help us understand how these farmers are willing or not to develop more preventive treatments. Their different appraisal of the controllability of the animal health domain, and the specific purposes and functions they assign to information seem consistent with their way of facing the here and now situation through their quest for information.

Farmer 1 seeks information which can help him identify new preventive treatments as he noticed that the preventive treatments he has applied do not enable him to avoid calf scouring. He explores two different sources: the newspapers which enable him to suggest new treatments to the veterinarian, whom he considers as an intelligible expert, and discuss them with him. Farmer 2 on the other hand declares that applying preventive procedures is familiar to him and that he can rely on his own cognitive capital to identify the action to undertake: it is available and less costly. Concerning the curative treatments, they both rely on the veterinarian. Farmer 1 considers the veterinarian as the most competent person and that discussing the treatment with the vet enables him to get a good understanding of the treatment. For Farmer 2, the vet is unavoidable in obtaining a curative treatment and oral discussion is a familiar way to interact with him. It should be noted that Farmer 1 seeks advice from the commercial agent of the feed cooperative in order to identify curative treatments *via* food supplementation. He also carries out blood analyses in his herd and analyzes them later with the veterinarian in order to find out what the real problem is. In brief he seeks far more information than Farmer 2. Besides, both farmers confront their own performances with those of other farmers to self-assess their ability to cope with calf scouring.

Figure 1. The sense making process: from the event characterization to the building of informational resources for two farmers who are faced with scouring in their calves (Farmer 1, p 5 and Farmer 2, p 6)



Support	Origin	Content
Cognitive capital *Avail.*	Himself *Effectiv.*	References on animal health performances *Relev.*
Oral *Intellig.*	Veterinarian *Fame*	Preventive and curative tretment *Relev.*
Technical newspapers *Compl.*	∅	Preventive treatment *Novelty*
Oral *Intellig.*	Veterinarian *Fame*	Results of blood test *Relev. ; Compl.*
Oral *Intellig.*	Commercial agent of the food cooperative *Fame ; Famil.*	Curative treatment *Compl.*
Oral *Famil. ; Intellig.*	Farmers *Relev. ; Famil.*	References on other farmers' animal health performances and practices *Compl. ; Relev.*



Avail.: Avlailabilty ;
Compl.: Complementarity ;
Effectiv.: Effectiveness ;
Famil.: Familiarity ;
Intellig.: Intelligibility ;
Relev.: Relevance ;
Profit.: Profitability ;
Unavoid.: Unavoidability ;

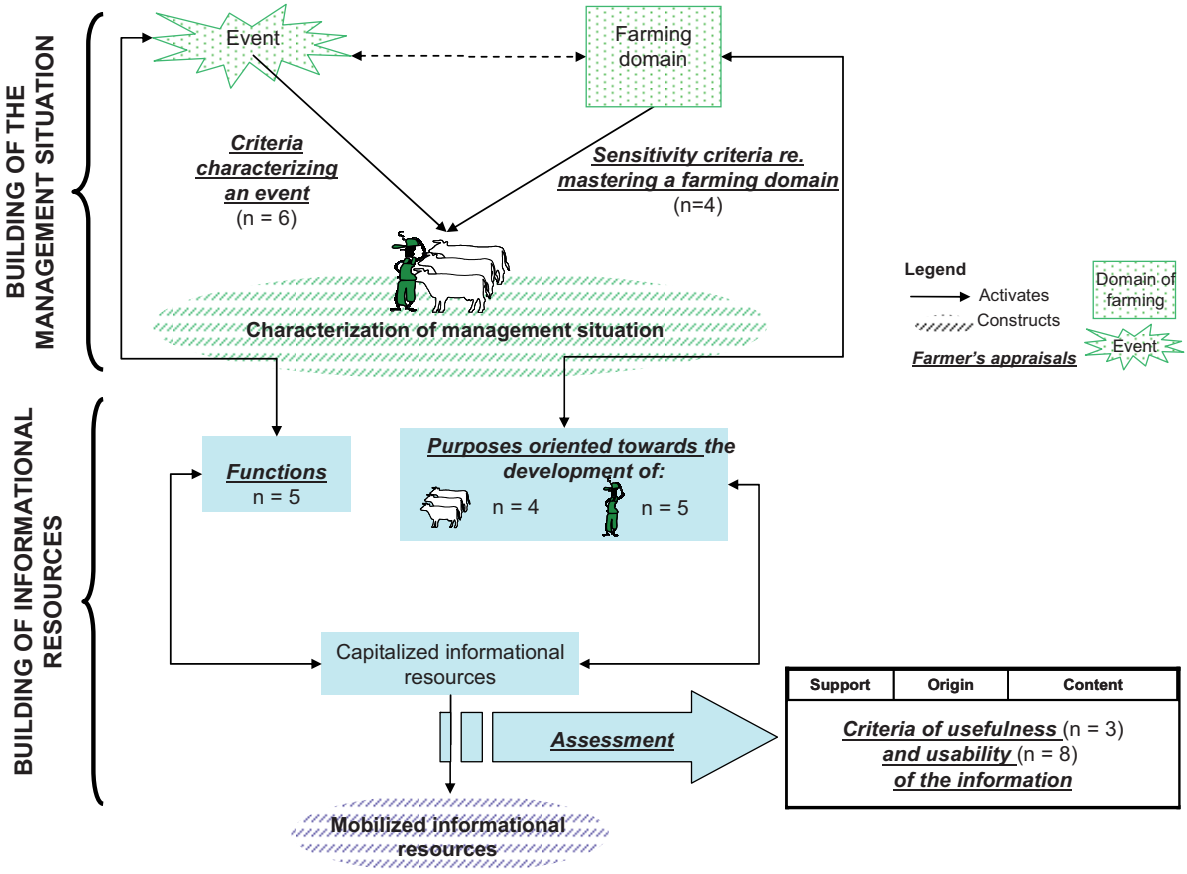
Support	Origin	Content
Cognitive capital *Avail.*	Himself *Profit.*	Preventive treatment *Famil.*
Oral *Famil.*	Veterinarian *Unavoid.*	Curative treatment *Relev.*
Oral *Famil. ; Intellig.*	Farmers *Relev. ; Famil.*	References on other farmers' animal health performances and practices *Compl. ; Relev.*

Discussion

Our work focuses on the knowing process of individuals while they consider the events which they meet in their work, make sense of them, choose and make sense of the information which can help them cope with the situation created by the event. It highlights the way individuals assess the event, according to the importance they attribute to the mastering of a given domain within their professional activity. It also highlights the way individuals assess the information according to their usefulness and usability and capitalize on informational resources by identifying how they fulfilled the functions and the purposes assigned by the individual to the information in the here and now context.

The knowing process is therefore mainly viewed as a process of sense-making of the here and now context on one hand, of the informational environment on the other hand (Fig. 2).

Figure 2. The sense making process: from the event characterization to the building of informational resources.



We understand the knowing process as a sense-making process by highlighting the way a farmer: (i) makes sense of an event according to the here and now context and to his sensitivity regarding the mastering of the domain to which this event refers to; (ii) qualifies the event according to different criteria (see Table A1); (iii) develops an information search process. This process is oriented by the purposes and functions which the farmer assigns to the information and which enable him to make sense of the information by assessing the usability and usefulness of their medium, origin and content. Usefulness and usability of information are qualified by different criteria (see Table A3). We have still to better qualify the relations between each element of our model. Nevertheless we suggest that a loop exists between the perception of the event and the functions assigned to the information. Also we propose to consider a loop between the purposes assigned to the information and sensitivity about the mastering of a domain. But this needs further investigation.

We did not apply this framework to collective action, and wish to suggest here how it could be used to change our ways of supporting collective dynamics and stakeholders' capacities to act in an uncertain and complex world.

A first avenue consists in checking whether our way of formalizing the knowing process can be applied to the knowing process of a collective involved in a collective action. According to our results, the definition of a possible future is not the only factor which will drive the knowing process to orient action in the given situation. In fact, our analysis suggests that it might be useful to understand how the collective analyze the situation as problematic and mobilize informational resources to manage it. The criteria we identified regarding the assessment of events and of information could be used by an observer to better understand the diverse points of view within the collective. This might then enable the observer to better identify how to reach a compromise between the various stakeholders and which information will be needed by them to achieve such a compromise.

A second avenue would be to analyze how a collective action interferes with individual ones. As the collective work might change the way each stakeholder considers the events and the importance of mastering a given domain of action, our results suggest that it might then be useful to support the various stakeholders in reassessing their informational resources according to their new perspectives on the situation, and even in building new ones. Moreover, if the collective dynamics results in shaping a new identity or in requiring new skills for a given stakeholder, might then be relevant to support this stakeholder in reassessing his informational environment according to the new purposes and functions this environment needs to fulfil.

Our results might also be mobilized in a more normative way. They give some directions to design an intervention in order to support the collective action once a possible future has been identified. For example, a first discussion might be held to identify with the participants the events which occur in the situation they collectively want to act upon and by understanding how each stakeholder characterizes the event according to the criteria we identified at individual level. The discussion might then highlight the differences between the stakeholders' appraisals of the event and put into light how this might be related to the way the various stakeholders envision the need and their ability to master a domain of action which is linked to the situation they wish to act upon. This can be viewed as a way of building the situation to be managed. A second discussion can then be held to firstly identify which information each participant suggests to use in order to act and secondly to try to collectively assess such information as useful and usable according to the criteria we identified at an individual level. This second discussion can be viewed as an information search strategy and as a collective assessment of the collected information in order to sort out those which will become informational resources.

Conclusion

Our work is an attempt to formalize the coupling between the knowing process and the action and to give account of the diversity we observed in the sense making process. We consider the latter as essential in the knowing process. According to this, we suggest to pay attention to the way individuals analyze and make use of their informational environment in order to act in a situation. Although our study focused on the individual level, we suggest that our framework may be useful in analyzing the same processes at the level of collective action and can also give some ideas to build an intervention which could support the collective action in its implementation phase. More work is needed firstly to improve our model of the knowing process at individual level and secondly to assess if it could be transferred to the collective level and be used to drive some intervention. It is already clear that the modelling of the knowing process at the collective level will need to include the collective discussion among the stakeholders which will influence their way to interpret and to make sense of events and of information. This collective process of sense making still needs to be formalized.

Acknowledgement

This work was carried out with the financial support of the Institut de l'Elevage and of the ANR-Agence Nationale de la Recherche - The French National Research Agency » under the « Programme Agriculture et Développement Durable », project ANR-05-PADD-0XX-Discotech.

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Appendix: definitions of the criteria and variables created

Table A1. Definitions of the six criteria used to characterize an event in the here and now context.

Criteria	Definitions
Predictability	The probability assigned by the farmer to the occurrence of an event
Delay	The degree of urgency with which the situation needs to be managed
Familiarity	The familiarity of the event for the farmer
Frequency	The frequency of an event according to the farmer
Intentionality	The intention the farmer has regarding the appearance of an event
Time-horizon	The term over which the situation that emerges from an event has to be managed according to the farmer

Table A2. Definitions of the four criteria identified to understand farmers' sensitivity to the mastering of the different domains of farming.

Criteria	Definitions
Stake	What a farmer wishes to gain or not to lose in the mastering of his(her) whole farming system
Pleasure	The pleasure a farmer has in his(her) quest for mastering and developing a domain of farming
Efficiency	The effective degree of satisfaction a farmer has while assessing his(her) personal mastering of the domain of farming regarding the means (s)he invested
Controllability	The potential degree of mastering a farmer estimates being able to have for a domain of farming.

Table A3. Definitions of the eleven criteria of usefulness and usability of information.

Criteria		Definitions
Usefulness	**Relevance**	Adequacy in answering a question or a problem
	Unavoidability	Inevitable character
	Complementary	Value added to other information
Usability	**Familiarity**	Farmer is used to use it
	Fame	Reputation
	Objectivity	Neutral and impartial character
	Intelligibility	Ability to be understood by the farmer
	Availability	The information can be mobilized immediately
	Effectiveness	Ability to achieve the expected results
	Profitability	Ability to achieve a satisfactory result taking into account the cost
	Novelty	Innovative and/or updated nature

Table A4. Definitions of the five functions that farmers assign to information

Functions of the informational resources	Definitions
Reflexivity	Farmer seeks information to stand back from the management situation and thus to better identify the need to question his farming practices and way to manage his farm
Problem finding	Farmer seeks for information to identify the cause of a dysfunction he observes by himself or with someone else
Problem solving	Farmer seeks information to find a solution to deal with the management situation whether or not the cause of the problem is really defined
Decision to act	Farmer seeks information not to think about a problem or a solution but to act at the level of the production process
Design of project	Farmer seeks information to design a project e.g. to build it, plan it, mature it, evaluate its feasibility, monitor its implementation, etc.

Table A5. Definitions of the different purposes that farmers assign to information.

Purposes		Definitions
Purposes oriented towards the development of the production	Profit making	Generate income or profit in a given domain of farming
	Security building	Set up preventive measures at production level to avoid and/or anticipate the disruptions which the farmer is likely to meet
	Value enhancing	Create value or more value regarding the farm products and farm services
	Organizing	Design a strategy of actions to carry out the work, either in spatial or time dimensions.
Purposes oriented to the farmer's personal development	Social recognition building	Compare his way of mastering and developing his farming activity with those of other farmers in order to position himself in a social environment
	Cognitive development	Enrich or strengthen his informational capital. This can include: better understanding of an event or a situation; recall of an experience (memorizing); development of new conceptual frameworks of his farming activity
	Decision support	Be more self-confident to be more assured in decision-making
	Reduction of work load	Physically or mentally reduce the complexity of his farming situation
	Legitimacy building	Provide evidence and justify his compliance to regulations or society expectations towards farming practices