Non material resources mobilized by farmers and flexibility of livestock farming systems: two concepts linked to decision making and sustainability

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Trying to understand the future of farming systems requires more precise knowledge of the ability and properties of the different existing systems to initiate changes and adaptations in face of uncertainties and evolutions of the context. Such properties of farming systems, including sustainability, have to be analysed in the same way as technical and economic productivity, i.e. we have to produce concepts, analysis frameworks and evaluation parameters. The question is: what are the conditions for perennial systems together with their capacity to produce sufficient (i.e. from the farmer's point of view) outputs. Milestad 2003, speaks about a "prerequisite for survival" and proposes transposing the concept of resilience from ecological sciences to farming systems (ecological resilience becoming socio-ecological resilience), "farms being considered as learning systems in constant evolution with their environment". To better understand the mechanisms of adaptations to the market and to variations in the environment, we chose to mobilise the concept of flexibility, taken from management sciences to evaluate the ability of beef cattle systems to adapt to opportunities according to different events (Lémery et al. 2005). We considered flexibility to be the capacity of the livestock system to adjust quickly to a wide range of economic, technical, marketing and climatic constraints, whilst allowing the livestock farmer to cope with the production plan in the medium term, or even the long term. Moreover, we assume that the relational aspects of flexibility are crucial: that is to say, the social frameworks in which farmers are engaged, these frameworks producing non material resources for farmers, meaning the information they look for, they receive (advisors) but also foldouts, source of confidence, basis for comparison, external skills… To develop new management aids, we try then to understand what kind of information farmers mobilize in designing and monitoring their livestock husbandry activity.

In this article, we propose to link the two points of view on livestock farming systems we evoked above: i) a characterisation of flexibility in beef cattle production systems and ii) a formalization of the information system of beef cattle farmers based on the concept of non material resources whose heuristic value we shall specify.

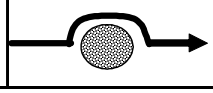
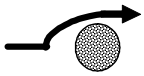
1. Flexibility/resilience of farming systems

The concept of resilience implies some kind of equilibrium for a system and either the ability of the system to face up to a disturbance, i.e. to recover initial characteristics after the disruption, or the amount of disturbance needed to flip the system toward another point of equilibrium (Milestad 2003). In management sciences, the flexibility of a company is measured by the number of stable states it is able to reach and by its ability (cost and delay) to flip from one state to another (Tarondeau 1999). According to the degree of anticipation of the management team, strategic (long term) flexibility can be distinguished from tactical (short term) flexibility, static (over-capacity in order to cope with predictable events) *vs* dynamic (capacity to face unpredictable events) flexibility or proactive (anticipation) *vs* reactive (real time) flexibility. Lopez-Ridaura et al. (2005) made the link with sustainability by defining five scale- and discipline independent properties of sustainable systems. These properties deal with i) the performance of systems: productivity and stability; ii) the ability of the system to cope with changes in the environment or in their own functioning: reliability, resilience and adaptability. They distinguished these three last elements according to the "amount'" of variations in the environment: respectively normal, extreme/abrupt and permanent.

Farming systems, like all systems, can be defined theoretically by their outer limits, and then by what is inside and what is outside. Some major trends or events which have occurred during the past 15 years (EU policy, social demand, health crisis…) no longer make it possible to assess farming systems functioning independently from the context. Chia (2004) proposed distinguishing the internal and the external flexibility of farming systems, i.e. which source is internal or external.
"To recover initial characteristics after the disruption" implies to define what is supposed to be non variable within the system according to the farmer's point of view. This point is critical because it is always more difficult to seek what changes than what is stable (Moulin et al. 2006). It deals also with all the studies trying to define farmers "projects", with a strategic (long-term, global) approach (Commandeur, 2006 with farming styles, Fiorelli, 2005 with partial time farmers…).

1.1. The internal source of flexibility: different control sticks used by farmers
Lémery et al. (2005) focused on the internal flexibility of farming systems, using different disciplines as different points of view (economy, sociology, workforce organisation, management science and animal science, i.e. herd management) on the strategy of farmers to face a crisis or any other unpredicted disturbance (table 1).

Table 1: Strategies of livestock breeders faced with a crisis

Sociological type	**"Act upon"**		**"Go with the flow"**	
Farm functioning	High technicity Quality signs Collective initiatives	Herd size increase Not enough grass, high stocking rate	Experience and tradition based autonomy (food, commercial…)	Diversification of the beef cattle production Other productions than beef cattle
Main source of flexibility	Collective support	Farm size	Robustness	Diversity
Properties of the system that farmers want to achieve	A steady system, non sensible to unpredictable events		A system able to change and then return to the initial state	A system able to flip from one state to another
Strategy, behaviour	External frames Technical skills	Internal organisation (size, forage storage)	No change	To grasp opportunities
Scheme: **: Event** **: Farm trajectory**				

Two main strategies were identified according to the farmer's attitude about how to change: "to act upon" and "to go with the flow" (figure 1). These attitudes were confronted with farms trajectories and functioning, i.e. with the different points assessed in the surveys. Four groups were identified (2 for each strategy), differing in the farming systems configuration and revealing four different ways to conceive flexibility, each one corresponding to a specific level of action, used with more or less intensity and combined with the others: i) the feeling to belong to a specific community with a common objective (1a on figure 1), ii) the increase in farm' size, especially the herd's size and the number of calvings(1b), iii) the robustness of the system, evaluated by its ability to check to different changes in the past: traditional pasture-based systems (2a); iv) the outputs' diversity of the system, including non beef products: poultry, vineyard, crops (2b). Flexibility and resilience concepts can lead to indicators allowing stakeholders in farming development to pinpoint and predict necessary actions by taking into account these different points of view. It needs to include farmers who do not consider they belong to the main stream of the agriculture development process. In a contradictory way, this allows them to be well adapted in the face of uncertainty.

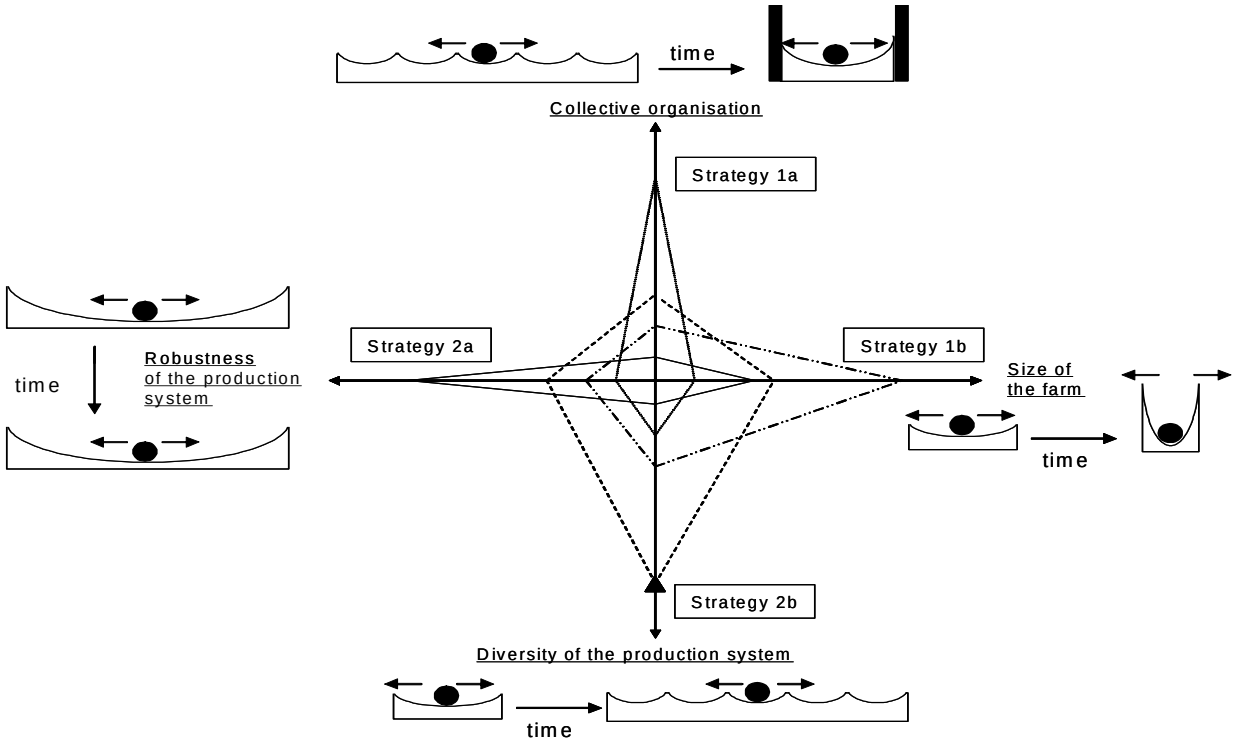


Figure 1: an ecological approach to represent farmers' strategy face to change. The system (black ball) rolls on left or right sides from its equilibrium point (valleys) when a perturbation occurs (arrows). Strategy 1 = "to act upon"; strategy 2 = "to go with the flow"

1.2. The external source of flexibility: flexibility for some means constraints for others
We focused in a recent study (ingrand et al., 2006) on the external source of flexibility and as a first step, on the commercial links between farmers and the purchasers of animals. The hypothesis was that the number of purchasers (together with the type of contracts), combined with the range of categories of animals sold by each farmer is a major source of flexibility for the farming system (see the analogy with the concepts produced by management sciences in table 2).

Table 2: Analogy between industry and farming systems; flexibility according to the range of products

Specific variable according to the products	**Theorical definition (industry)**	**Adaptation for livestock farming systems**
Diversity	Capacity of the system to manage different kinds of products simultaneously	Large number of animal categories sold
Renewal	Capacity of the system to substitute existing products by other new ones	Adhesion to quality market signs, fattening or not
Modifications of the specifications	Capacity of the system to modify existing products	Quality of feeding, number of heifers kept for breeding, genetics

We defined the range (number and categories of animals sold in a year) as intermediate between internal and external flexibility (Cessieux 2005). It is the result of a combination between the production context within the farm and the commercial context outside the farm. Both of these elements make it possible to define a potential range for the farmer which can

differ from the real range, according to other considerations (farmer preferences, local practices, previous experience or background…). The range is defined by the number of animal categories, the number of animals per category, the fattening status of animals in each category and the inter-annual stability of this pattern.

Commercial structures: flexibility is either quality or quantity
We chose structures that were very different in size (107 to 900 members) to connect different strategies to different points of view about farm flexibility. The smallest structure does not try to increase the numbers of farmers (chosen according to their ability to sell fattened animals all year long), but tries to increase the number of animals sold in quality market chains for each of them (4200 head sold for 107 farms and about half of them sold in quality market chains). The consequences of the crisis were a decrease in steer production and a development of beef from organic farming. In the 2 biggest structures (900 members/1450 "animal suppliers" for one; 286 members, 901 suppliers for the other), the commercial target is to increase their size (animals and farms). There is no specific criterion to become a member.
In the former case, farmer flexibility is seen as the ability to sell fattened animals any time during the year and to respect technical schedules (organic farming or other). For the latter, the proportion of fattened animals is a criterion measuring the farmer's capacity to delay sales when prices are low or when the market is saturated. They consider that stability (of farming systems) is the greatest insurance of their flexibility (but they have few possibilities to influence it and they need many non-member suppliers to regulate flow according to market demand).

Production pattern in farms: flexibility is even unicity or diversity of purchasers
The range of animals sold is mostly diversified (10 out of 15 farmers surveyed). Within the 5 cases with a low range pattern, only one does not produce any fattened animals. This situation (fattening) corresponds to the traditional production system in this area, where crop production is possible to feed and fatten animals, as well as grass quality allowing steers to be fattened at pasture. For example, one farmer has no cows. All animals (cows, steers, heifers) are bought from other farmers to be fattened. Depending on the farmer, the diversity of categories sold is a way of ensuring security for the system. More interesting is that there seems to be no relationship between production pattern and commercial circuits, as the combination between a low range of animal sold and many purchasers exists as well as the combination between a wide range and only one purchaser. In fact, the number of purchasers is not a sufficient criterion to describe the commercial strategy of farmers. The other criterion is the degree of confidence between farmer and purchaser: length of membership, types of contracts, capacity of the purchaser to buy all kinds of animals (i.e. lower quality as well as higher quality) or on the other hand the capacity of the purchaser to valorise the best individuals in a specific market chain. This degree of confidence most often implies for the farmer a rather strict schedule allowing the purchaser to anticipate and plan his activity. Not all farmers are ready to undertake such a process, especially those who sell their animals to several non specialised purchasers.

2. Non material resources mobilized by farmers

2.1. The analysis frameworks of farming systems: a crude formalization of information

In zootechnics of livestock systems, the formalization of the farmers' information system has not been researched as such and is, therefore, crude. The "object" towards which the system is directed is the herd. Only material resources (principally forage) are taken into account. Nevertheless, in their representation of the dynamic functioning of livestock systems, Osty and Landais (1991, cited in Landais, 1992) considered the information aspect: they distinguished information coming from the subsystem of production elaboration from that which comes from outside. By proposing to distinguish different types of elements that

contribute to the making of technical choices (decision-maker objectives, indicators used to check the way the production process is proceeding, references mobilized to assess the situation, decision rules and social standards of behaviour), Landais (1992) identified different objects of the information system but did not specify their definition, nor their decision-making function, nor how they relate to each other.

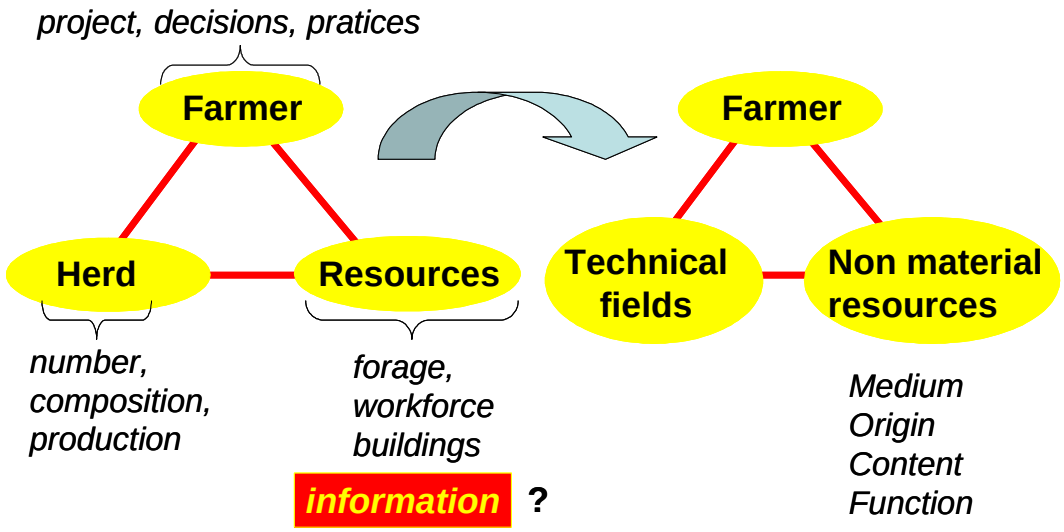


Figure 2: a proposition for a new framework (right side), based on the classical tryptic used in livestock production science (left side), to analyse non material resources in the farmer's decisional process.

Perrot (1991) based his work on formalization of information systems in cattle farming but proceeded from experts' statements, e.g. the statements of farm advisers. Consequently, his study does not make it possible to grasp the meaning farmers assign to information and why it is relevant according to their technical standpoint and their social, economic and historical background. Lasseur (2001) proposed the concept of local farming system to understand farming practices and their transformations as products of social interactions. He showed how interactions between farmers contribute to the social construction of a shared standard of "correct functioning of their system". But this approach does not make it possible to understand the role of "prescriptors" in this construction. In addition, this work provides few elements on information enabling farmers to identify, express and resolve problems. It also remains unclear on the factors motivating farmer integration with networks of actors, whether peers or prescriptors.

Slavick (2004) proposed a preliminary grid to differentiate information according to its origin, content and supports. Havet et al. (2005), who analyzed farmer management writings in farms are more interested in the various functions they fulfil for the farmer. However, none proposes an overview of the farmer's information system and the way in which this system is constructed, mobilized and stabilized.

All these studies contribute partially to the formalization of information systems. A large part relates to a procedural approach to the rationality of the decision-maker as developed by Simon (1956) and overlooks the fact that information is a socio-cultural construct. Others subscribe to this latter viewpoint but leave aside the analysis of the individual appropriation of socially constructed standards. On the whole, they pay little attention to interactions with agricultural prescriptors and the way in which these contribute to shaping livestock practices. Moreover, they do not deal with what we call the decisional activity, i.e. the activity focused

on preparing and controlling the farming activity. This decisional activity integrates both material dimensions (taking samples for analyses, using a computer to store and interpret data, aso.) and immaterial dimensions linked to the socio-cognitive processes at work (understanding of the situation, creation of solutions, choice of a satisfactory solution and evaluation).

For this, we propose to focus on the “human” pole of the “human-herd-resources” triptych and thus recenter the study away from the productive activity (execution of tasks) on the decisional and socio-cognitive activity. To understand this, we propose the concept of immaterial resources (figure 2) and will now explain the epistemological standpoint to which it refers, and how we define it.

2.2. Information seen as a social, historical and cultural construct meaningful for the actor

We turned to the social sciences to understand information and its processing as the product of social, cultural and technical interactions. We paid greater attention to studies which consider information both as a vector of the meaning constructed through these interactions, and a producer of meaning for the actors who mobilize it. Although these studies may originate from different disciplinary backgrounds and theoretical frameworks, they are all based on the analysis of activity or the activity system (Engeström, 1996), its construction and its control by the actor, who is also culturally and historically constructed as well as being situated in an environment with which he interacts. They consider that: i/ cognition cannot be disembodied from action and goals which are assigned to it by the actor (individual or collective); ii/ the meaning that actors assign to the information they mobilize is the result of complex processes linked to reflexivity and the relationships they have with other actors as well as with the other objects relating to their activity and their environment (Linard, 2001); iii/ the object of the study is not so much the coding, transmission and decoding of information as the use of information, i.e. the information interpreted, embodied in action, situated in a context and integrated into a project (Charlet et al., 2001).

In short, these studies are based on the recognition of a continuity between cognition and action. We focus on those that emphasize the constructive activity of actors, i.e. their capacity to create the resources for their action by attributing properties to the available resources in relation to their intention to act on the situation. The resources are constructed (more or less consciously by the actor) by and for the carrying out of the action, its control, and the processes of learning and appropriation of the environment that are associated with it.

Some studies mainly focused on the construction of meaning in actions and interactions Theureau (2004) defined “the autonomous actor” i.e. who “has an asymmetrical relationship with his environment, in the sense that he interacts only with what, in this environment, interests him or is a source of disruptions for him“. Linard (2001) also showed that the meaning the actors attribute to actions is linked to the meaning they assign to their environment and to their own internal state. Studying the internalizing processes in actors of information stemming from the environment and which have as yet no meaning for them, Linard (ibid) emphasized the motivations that animate the actors, whether their motivation relates to the performances (or the development) of the activity or to their personal development. For Greimas (1966) such motivations are taken into consideration in the actantial model he developed to describe the pursuit of objects by the actor. He defined the attitude of the actor towards the sought object by five verbs: wanting, having to, knowing how to, being able to, thinking – and showed that actors assess their action relatively to the recognition received for it from a moral or social authority.

Other studies focused on the construction of meaning in the processes of appropriation and reconstruction of objects mobilized by the actors to carry out their activity. Rabardel (1995)

thus emphasized the instrumental dimension of the object (the attribution of a use scheme (in the sense of Piaget) to the object), but also underlines the mediating role of the object between the actors and the goals (results and motives for the action) which guide their activity. Far from being neutral, these objects contribute to the performances of the activity. That is what Seifert and Messing (2004) showed about human mediations (the relational feature) in service activities. Leplat (2004) stressed the importance of dissociating the mediating support of the object and its primary function to understand whether lack of mobilization of this object results from support and/or function inadequacy.

As a consequence, should we not consider information as a resource that livestock farmers construct in the course of action and interactions to create and control their farming activity? Should we not question the meaning conveyed by such information, as well as the meaning attributed to it by the farmers? For this we will talk about non material resources. However, this notion is defined and used by us in a different way to that of researchers who focus their study on learning organizations and knowledge management. Indeed, in the latters' approach, non material resources concern the organizational knowledge, competences and knowledge of actors whether internal or external to the firm (Bounfour, 1998), but little is said about the ways of mobilizing and constructing them. We define non material resources as the set of symbolic mediations (observations, human interactions, measurement devices, written supports...) which are relevant for farmers to manage their livestock, develop their farming practices and assess their expertise.

3. The function of information as a link between flexibility and non material resources

We attribute to information a meaning and a relevance that depends on the goal assigned by the farmers to their farming activity (cf previous part). We set information in a utilization perspective: the term resource refers to what is mobilized by farmers to support their decisional activity. The meaning given to the resource can be motivated by and for the development of the biotechnical system or the own development of the farmers. We point out that the information is chosen, used, renewed and developed just as are the material resources more classically studied in livestock farming systems science. We insist on the dimension of the livestock activity we are interested in, i.e. the decisional activity. Non material resources consist of all that goes to support this activity.
We qualify them by four components: their supports, their origin, their content and their function. Two hypotheses underlie this choice: i/ the underlying supports, origin and content of the non material resource are not neutral in the interpretation made by the farmers; ii/ the function of the non material resource accounts for the meaningful relationship the farmers attribute to each of the three previous components and to the development of their farming activity as well as their personal development.

The content of the non material resources are the fields relating to the technical management of the livestock system (nutrition, genetics, health…) and refer to a set of farming practices. We favour a global view of the livestock farming activity to understand the way in which farmers identify the problems and resolve them. The origin of the non material resources may be: i/ the biotechnical sub-system, farmer experience (stabilized resources); ii/ the different actors (farmers, experts) and organizations that exert an influence on the farmers' technical management. We need to go beyond a simple internal versus external characterization in order to understand how the information's origin contributes to their meaning for the farmer. The type of support of non material resources enables us to take into account the fact: i/ that the relational aspect (human support) contributes to constructing the contents of the actors' interventions with the farmers; ii/ that there are different kinds of mediation that stabilize the non material resources mobilized by farmers (written supports, computers, human supports).

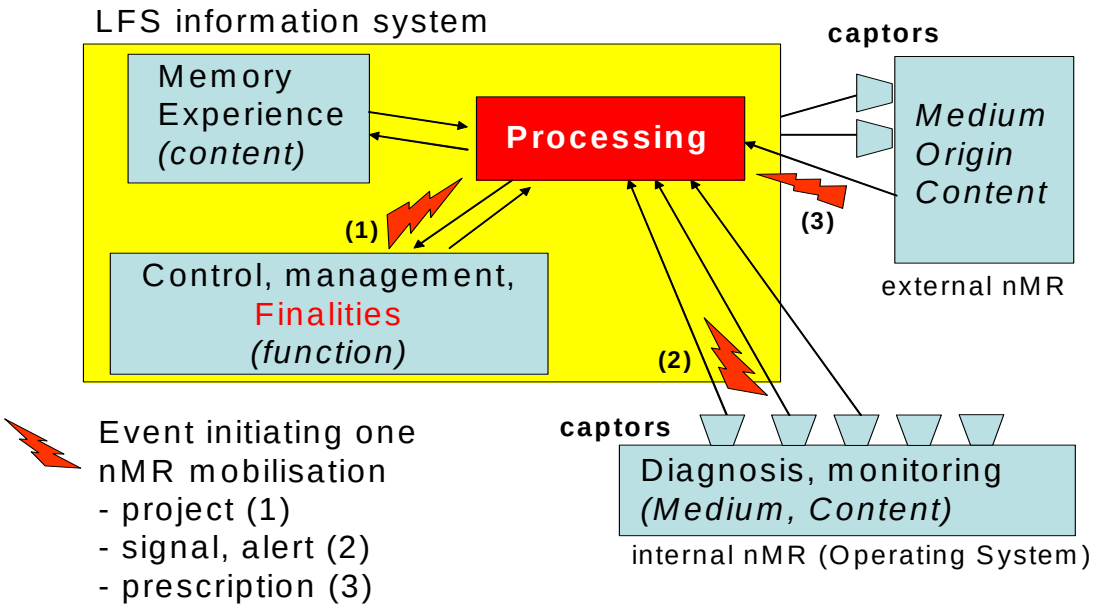


Figure 3: a schematic proposition for modelling the information system of farmers. Three sources of non material resources (nMR) are identified, each corresponding to specific events initiating their mobilisation.

Identifying the functions of the non material resources aims at understanding how farmers mobilize them to control their livestock farming activity ex-ante and ex-post. The ex-ante control makes it possible to identify the non material resources which define for the farmers the correct functioning of their system. The ex-post control makes it possible to identify the immaterial resources, to question the non material resources stabilized until then or to stabilize those newly mobilized.

The framework we propose introduces a new approach to decisional processes. It is inspired from features borrowed from the activity theory. This is why we bring in the decisional activity of farmers to understand the socially, historically and culturally situated work of preparing and assessing production action. This analytical framework can help researchers in the zootechnics of livestock systems:
i/ to formalize farmer information systems (figure 3);
ii/ to gain reflexivity about the knowledge produced so far, as this can help define new research topics. This approach helps highlight the scientific knowledge internalized by the farmers, the way it occurred, to what ends and with which results;
iii/ to identify relevant partnerships to be developed for the design of support tools for the technical management of livestock farms through better understanding of the origins and supporting media of immaterial resources.

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