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FARM ENTERPRISES AS SELF-ORGANIZING SYSTEMS: A NEW TRANSDISCIPLINARY FRAMEWORK FOR STUDYING FARM ENTERPRISES?¹

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INTRODUCTION

Our research group on Farming Systems at the Danish Institute of Agricultural Sciences has been committed to on-farm research for more than 30 years, studying various aspects of farming in practice. At first our focus was more on technical and biological aspects of foddering, strategies for growing fodder beets, production of high quality silage, herd replacement strategies, etc. In the 1970s and 1980s the findings of this research were not well-received within the academic circles as its methodology was regarded as case orientated and unscientific, without the statistical evidence that generalizing projects could provide. However, our findings were in great demand by consultants and farmers because they were readily applicable in practice.

The growing attention to the sustainability and, now, multi-functionalityⁱ of agriculture and food production calls for a multidisciplinary research and development approach. What is needed now is to move from on-farm research to farming system research. Organic farming, nutrient balances, and nature quality are among the new topics. In the early 1990s a cybernetic model of a farming system was adopted (Figure 1) (Sørensen and Kristensen 1992) where the management system was introduced in the theoretical framework as the farm's controlling system (controlling the production system through measurement and adjustment). However the controlling system remained an unexploited black box in this model. It was still not explained how the farms were organized and why they were managed so vastly differently. The farmer was introduced as an observer of the system but not as a part of the system observed. It was realized that the hard system could not be studied independently of the soft system but this problem was still dealt with in a pragmatic way by describing the individual case as a platform for the transverse analyses and interpretations of the cases. From the early 1990s we have worked on developing a theoretical framework for transdisciplinaryⁱⁱ studies (Alrøe and Kristensen 2002) that can treat a farm as a *whole system* i.e., as an entity which includes both the social and the technical aspects of a farm and, more importantly, the connections among the social, biological, and technical elements involved.

Within the fields of Rural Sociology, Agronomy, and Economics, attempts have been made to establish a theoretical framework for observing and analysing a farm as an entity. We have in particular been engaged with three different theoretical frameworks: the farming styles approach, the Bawden approach (also known as the Hawkesbury approach), and the agroecosystem approach. While acknowledging their contributions in this paper we argue that these theories do not offer a truly transdisciplinary theoretical framework for understanding farm enterprises.

Furthermore, we will introduce a new theoretical concept, combining Actor-Network theory and Luhmann's theory of social systems, as a working ontologyⁱⁱⁱ that understands a farm enterprise as a self-organizing system, and thereby as a system independent of an external observer, and argue how the latter can serve as a platform for transdisciplinary studies.

REVIEW OF LITERATURE

Many different attempts have been made to grasp the farm as a whole system in order to explain the dynamics of farming and development. In the following we will discuss three important and widespread approaches: 1) The 'farming styles' (FS) approach developed by van der Ploeg and his colleagues at agricultural university at Wageningen, The Netherlands; 2) The Hawkesbury approach (also known as the Bawden framework), which is a research and education methodology (paradigm) developed by Richard Bawden and his colleagues on the Faculty of Agriculture and Rural Development at the University of Western Sydney at Hawkesbury (Australia);

¹ A draft version of this paper have been presented at the xvth ISA World Congress of sociology, RC40 Sociology of agriculture and food. 7 – 13th July, Brisbane, Australia

3) Conway's 'agroecosystem' approach with a theoretical heritage from cybernetics and general systems theory, with the primary focus on sustainability assessment.

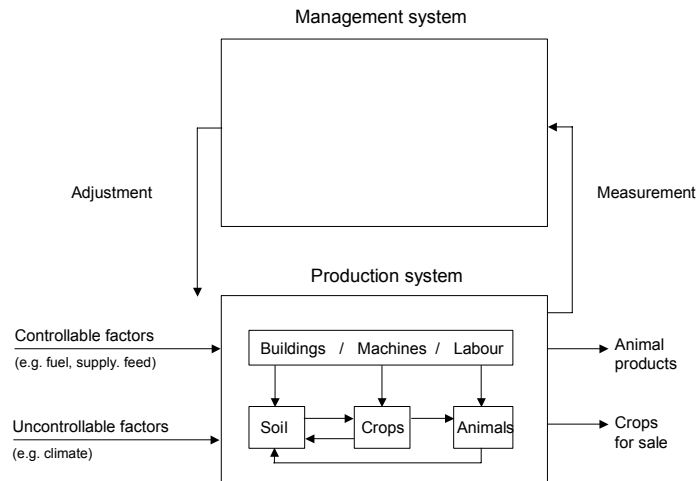


Figure 1: Sørensen and Kristensen's (1992) model of a livestock farm as a cybernetic system

The farming styles (FS) approach

The point of departure of the farming styles theory is to grasp the heterogeneity among farmers. Van der Ploeg defines a farm as:

"...a social (and therefore goal-orientated) co-ordination of the whole range of tasks, which together constitute the totality of the farm labour process, and that such social co-ordination implies the ongoing observation, interpretation, and evaluation of similar and different forms of social co-ordination (i.e. one's own and the farming practice of others)..." (Ploeg 1994:17).

In this view a farm is understood as a system of activities or practice, linked to the goals of the actor(s) involved.

The individual practice of a farm is developed within the framework of local social constructed farming styles, which Ploeg defines as follows:

"Farming styles refer to a cultural repertoire, a composite of normative and strategic ideas about how farming should be done. A style involves a specific way of organizing the farm enterprise: farmer practice and development are shaped by cultural repertoire, which in turn are tested, affirmed and, if necessary, adjusted through practice. Therefore, a style of farming is a concrete form of praxis, a particular unity of thinking and doing, of theory and practice." (Ploeg 1993:241).

In 1995 Ploeg adds to this definition of a farming style:

"In general terms, a style of farming can be defined as a particular unity and coherence of the following elements:

1. A set of strategic notions, values, and insights shared by a particular group of farmers concerning the way farming ought to be organized;
2. a specific structuring of the practice of farming that corresponds to the strategic notion or "cultural repertoire" used by these farmers;
3. a specific set of interlinkages between the farm enterprise on one hand and the surrounding markets, marked agencies, government policy, and technological development on the other. These interrelations are structured in such a way that the specific farming practice can be reproduced over time."

At first glance the definition of a farm as a social co-ordination of tasks seems to be a useful way of approaching the farm as a whole as well as understanding some of the differences in dynamics and processes between farms. Values and insight play a central role in the understanding of the goal orientation of the farm,

and Ploeg (1990) uses the notion of calculus to explain how the goals and values are translated into the strategy of a farm.

"The way particular goals are translated into practice is investigated in this study in terms of patterns of farming logic, as a calculus, which defines how work must be done in practice for all relevant tasks and under all conditions." (Ploeg 1990:31).

Both the concepts of values and logic/calculus are useful for understanding the self-organisation of a farm-enterprise. However, when it comes to the development of the theoretical framework of FS, these concepts turn into a structural theory. The calculus or logic does not belong to the individual farm, but to the styles of farming and thereby to the social structures. And how the farm differentiates from the styles of farming is not clear.

"A calculus or farming logic is here conceived of as the practical discourse that farmers follow in the organization of the labour." (Ploeg 1990:31).

Paradoxically, in his efforts to explain the agency of individual farms Ploeg ends up with a structural theory where the individual farm can only be understood through its membership connection with a certain cultural repertoire. Furthermore, the degree to which these cultural repertoires--in terms of discrete styles of farming--are real entities or just heuristic parables has been strongly questioned (Vanclay, Mesiti and Howden 1998).

Another critique of the FS-theoretical framework, relevant in this context, is that FS misses the co-production between nature and culture (Goodman 1999:24) --i.e., how the natural and biological processes are interwoven with, and are mutually influencing, the social and technical processes of farming. Furthermore, the co-evolution with the surrounding world is very poorly understood in the FS-framework. The surrounding world is characterized as 'room to manoeuvre', but how this space is influenced by farmers' strategies and relations is poorly understood. To conclude, although the FS-approach offers a comprehensive theoretical framework of the social construction of farming, and some interesting conceptual tools for studying heterogeneity among farmers (Ploeg 1994), it still remains incomplete as a theoretical framework for understanding the organization and dynamics of a farm in its biological, economic, technical, and social context.

The Bawden framework

Bawden and Wilson took a leading role in their advocacy of Peter Checkland's SSM approach (Wilson and Morren 1990). Checkland (1981) distinguishes between 'hard systems' that are predictable, and 'soft systems' that are unpredictable from the vantage point of an outside observer. Soft systems are internally capable of reflecting, learning and choosing. They are not, therefore, determined by natural laws. Checkland further distinguishes between human activity systems (such as railways and companies) and social systems (social groups that are characterized by particular sets of human activities). As a theory of management Checkland's focus is on the human activity systems.

As a framework for multidisciplinary studies, the Bawden framework builds on Checkland's system typology and includes four levels of research: reductionist science (basic science), reductionist technology (applied science), hard system science, and soft system science (see e.g. Bawden 1991). From our point of view, the theoretical platform for the systems/research levels remains pragmatic and the connection between the four levels of research (and how the biological and technical processes of a farm influence the social processes and vice versa) remains unclear. We argue that more theoretical efforts are needed to connect the different levels/modes of reduction (Alrøe and Kristensen 2002).

At the soft system level the Bawden framework operates with the notion of a farm as a system entity and refers to Maturana and Varela's theory of autopoiesis^{iv} and theories of self-organization (Sriskandarajah, Bawden and Packham 1989). This leads to a conceptual understanding of a farm as 'an organism' of human activities (figure 2).

In our view this model has two problems. The first problem is that it views a human activity system as a closed system, visualised by enclosing lines drawn around the farm, open only for input and output. The conceptual model of the farm becomes a physically and structurally closed system with only internal relations or activities. The assumption of a farm being physically closed is add odds with the reality of today's agriculture, where each farm is inextricably involved in numerous relationships as a consequence of specialisation, technologisation, and globalisation (Benvenuti 1975), and where the activities that contribute to the physical

production and reproduction of the farm belong not solely to the farming system, but to numerous other actors and systems.

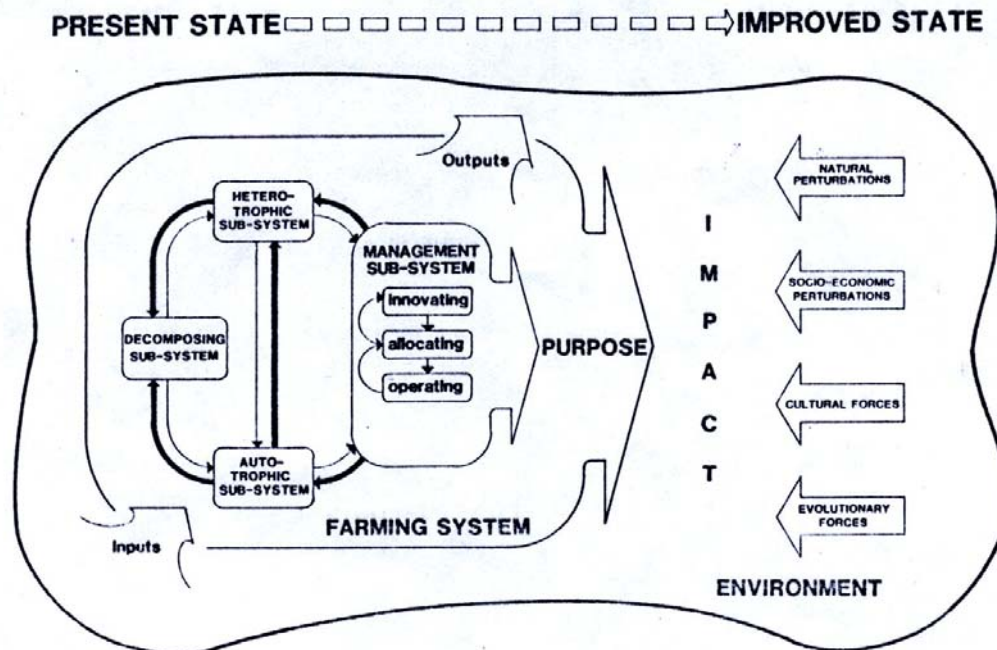


Fig. 1. A model of farming as a human activity system.

Figure 2: A model of farming as a human activity system (Source: Sriskandarajah et al. 1989)

The second problem is that the concept of autopoiesis combined with the concept of soft systems as human activity systems lead the Bawden framework to view the farming system as a mental construction in the mind of the farmer, which it designates as the farmer's worldview^v. And since, in line with Maturana and Varela, the idea of approaching social systems as autopoietic systems is strongly rejected (see e.g. Mingers 1995), the very idea of learning comes to be restricted to the mind of the individual farmer.

The Bawden framework is caught in the opposite position of the farming styles approach. They see a farming system as a mental construction in the mind of the farmer whereas the farming styles approach sees the farm as a social construction. Thus the Bawden framework ends up with a radical constructivist position, and takes a pragmatic view on systems theory as only an epistemological question (Bawden 2002). To conclude, the Hawkesbury model holds a very clear focus on the individual farm as an entity, but fails to include the social and technical environment of the farm.

The agroecosystems approach

Conway defines farm enterprises as agroecosystems and he thus focuses on the connection between the biological and the social-technical dimension of the farm.

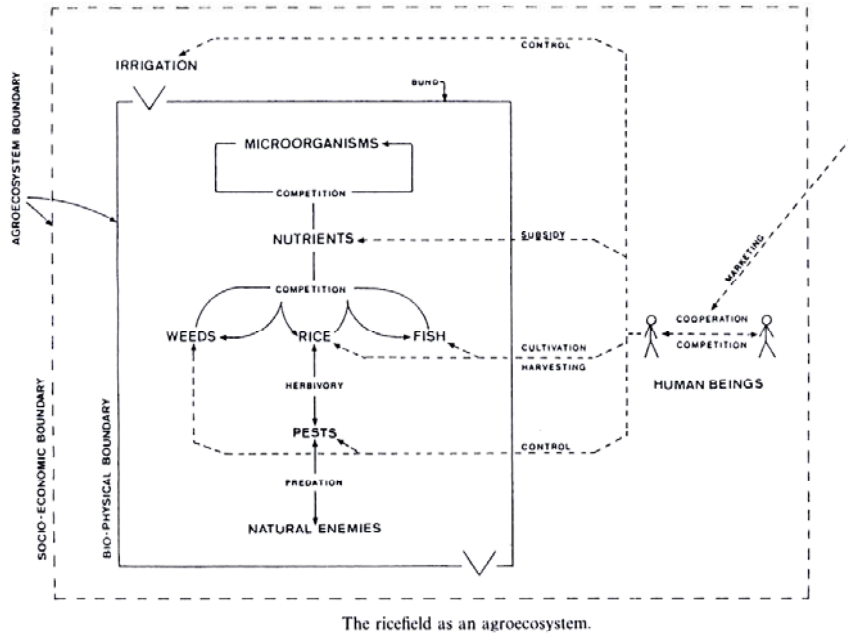
"It is this new complex agro-socio-economic-ecological system, bounded in several dimensions, that I call an agroecosystem." (Conway 1987:96).

The heart of Conway's agroecosystems' approach is to build a multidisciplinary framework for studying, and for facilitating a sustainable development of, primary small farm holders in the developing countries (Conway and McCracken 1990). Conway's platform for multidisciplinary studies build on general systems theory and sees an 'agroecosystem' as a hierarchy of systems, where each level is to be studied in its own right and in relation to the other levels above and below.

Although Conway sees the agroecosystem as a hierarchy of systems, he tries to provide a unitary view of this system via the metaphor of a living organism:

"However, agroecosystem like individual organism are clearly cybernetic. They, too, have recognisable goals and strategies to attain them. I suggest that the primary goal of an agroecosystem is increased social values" (Conway 1991:6).

Conway is here trapped in the same situation as Sørensen and Kristensen (1992) with the management system and the managed system as two separate systems that, as different levels of the hierarchy, should be studied separately (figure 3). From our point of view the farmer is not just an observer of the system, but a part of the system, and the cropping system or the herd system cannot be fully studied and understood without taking into account the values and the logics that the processes are organised around, as it is nicely demonstrated by the farming styles studies (see e.g. the monograph on farming styles ed. by Ploeg and Long (1994)).



The ricefield as an agroecosystem.

Figure 3: The rice field as an agroecosystem (Source: Conway 1987)

The hierarchic systems theory also has problems with boundaries, illustrated in figure 3. In our opinion these physical boundaries will always be contingent, depending on the choices of the observer. As an example to illustrate this problem the tractor applied within the fieldwork will either belong to the system or to the systems environment depending on whether the tractor belongs to the farmers or to machine pool. In physical terms it seems much more fruitful to apply a network metaphor for understanding physical *interactions* of the farm as interactions do not have clear-cut boundaries in time and space (Murdoch 1998).

As an applied systems framework, the agroecosystems' approach does not overcome the problems that multidisciplinary studies have with communication between disciplines. It just adds together different perspectives, epistemologies and ontologies, which belong to the disciplines that are used at each hierarchical level of observation. Conway's suggestion to overcome these problems is a common approach for analysis:

“Each level in the agroecosystems hierarchy has to be analysed and developed both in its own right and in relation to the other levels above and below. To achieve this, with rigor and speed, is a difficult task but is greatly helped by a common approach to analysis and, in particular, a set of well defined common properties for each level in the hierarchy that can be related to each other, within and between levels (Conway and McCracken 1990:222)”

The set of common properties is the four properties of productivity, stability, sustainability and equitability (Conway 1987). Conway's approach is widely applied and valued. An explanation why it works out well in practice could be that the researchers are forced to communicate with each other about their observations, as a result of the RRA-methodology (Conway 1991). But this cannot really be translated into a broader context of agricultural research.

Despite his efforts, Conway's theoretical framework does not offer a consistent theoretical concept of an agroecosystem. The definition and determination of the system remains a pragmatic decision of the observer and not an ontological attribute of the system. In Conway's methodology the system is not evaluated with respect to its own goals but with respect to the external goals that are derived from discourses of sustainability. Hence Conway's framework cannot help us with conceiving and observing the self-organizing character of a

farm. The 'organism' stays an observer's metaphor and it is up to the observer to draw the system's borders to define the entity.

TOWARDS A THEORETICAL FRAMEWORK OF A FARM AS A SELF-ORGANIZING SYSTEM

The three theoretical frameworks contribute to the studying of various aspects of farming and sustainability. The farming styles approach helps us understand farming as a matter of social interaction. The Bawden framework contributes a clear understanding of a farm as a soft system and of farming development as a matter of learning rather than of linear calculation. Conway shows the need for a multidisciplinary approach to research and development of sustainable agriculture.

But from our point of view, they all fail to establish a comprehensive model of farm enterprises as self-organizing social-technical-biological-economic systems. What all the frameworks have in common is activities as the key element of the system. They conceive the system as processes of activities and use the living organism as a metaphor of the entity for the system. But unlike living organisms which have skin as a physical border to the environment controlling the physical processes underneath the skin, a farming system has no such physical boundaries. A farm is interwoven in linkages with sundry actors and agencies. Hence, if we want to pursue the idea of a farm as a self-organizing system we need a framework capable of explaining the organizational closure of a farm and the relational openness of the farming processes. Our suggestion is to combine Luhmann's theory of social systems, which is almost unknown within the discourses of rural sociology, and the Actor-Network theory of Latour, Callon, and Law, which has become more widespread within rural sociology, mostly within the studies of food networks and organic farming (Goodman 1999; Assouline and Just 2000). Neither of these theories has yet been applied in the understanding of farm enterprises.^{vi}

The Actor-Network Theory (ANT)

A farm enterprise is characterised by a heterogeneous mixture of biological processes, technical operations, geological features and processes, climate, food chains/market, financial market, knowledge, social processes, culture, labour, etc.

If we approach a farm as an actor-network there are many elements that are translated and enrolled^{vii} into the objective of farming. There are the animals, various kinds of machines and technology, the fields, sunshine, rain, computers, various kinds of plants, labour, family labour, experience, skills and knowledge, values, goals, etc. depending on the heterogeneous strategy of the enterprise.

The situation is even more complex, because the heterogeneous network of enrolled entities is not limited to the physical site of the farm. Much of what we would normally call external entities are enrolled as and mobilised as actors into the farming processes: seeds, semen, advisors, capital, magazines, weather forecasts, fodder, food chains, colleagues, scientific knowledge, labour, subsidies, etc. The kind of entities and actors that are enrolled (or not enrolled) into the network and how they are enrolled are characteristics of the enterprise, e.g. whether the commercial consultants or the consultants of the farmers' unions are enrolled and to what kind of performances they are enrolled.

One may easily realize how important it is for the results of the farming processes that all these interactions in the actor-network are balanced in accordance with the strategy of the network.

The perspective we get from understanding farm enterprises from an ANT approach and the ensuing relationality of entities is that the enrolled entities get their forms and performances through the relations in which they are located (Law 1999:4). To illustrate this, a particular cow may on one farm be fed grass from the field and on another farm may be kept in the stable fed feed concentrate. Hypothetically, the same cow may produce 12,000 kg milk in one system and 7,000 kg milk in the other. The same kind of difference can be explored for other enrolled entities such as wheat varieties, computers, consultants, etc.

The notion of contingency is central to the ANT (Biejker and Law 1992). The fact that the realization of a certain actor-network is only one among (infinitely) many possible ones means that actor-networks are initiated on choices that are not open for rational decisions. The network, however, is not necessarily conscious of this matter of contingency. Only through a reflexive process can the state of choice become visible. Therefore, it is often not acknowledged by the actor-network itself that there has ever been any choice - as Mol puts it: "So they displace the decisive moment to places where, seen from here, it seems not a decision, but a fact" (Mol 1999:80).

The notion of contingency opens for exploring the heterogeneity of farming strategies among different farm enterprises. If we give up the idea of optimal solutions, the different strategies among the farm enterprises, which are reported in numerous empirical studies (e.g. Ploeg 1994; Whatmore 1994), can be seen as contingency, as actualisation of possibilities. This changes the understanding of the structural surroundings from being prescriptive of the individual farmer to being opportunities for action. This means that the higher the complexity of the surrounding world, the more possibility of heterogeneity in farming strategies.

Entities enrolled in the network of the farm can be actor-networks themselves, e.g. in the case of consultants offices, dairy companies, wholesalers, etc., which organize their own heterogeneous complexity. And each of these is striving to translate the farm enterprises into their own network strategy by selling their products, etc.

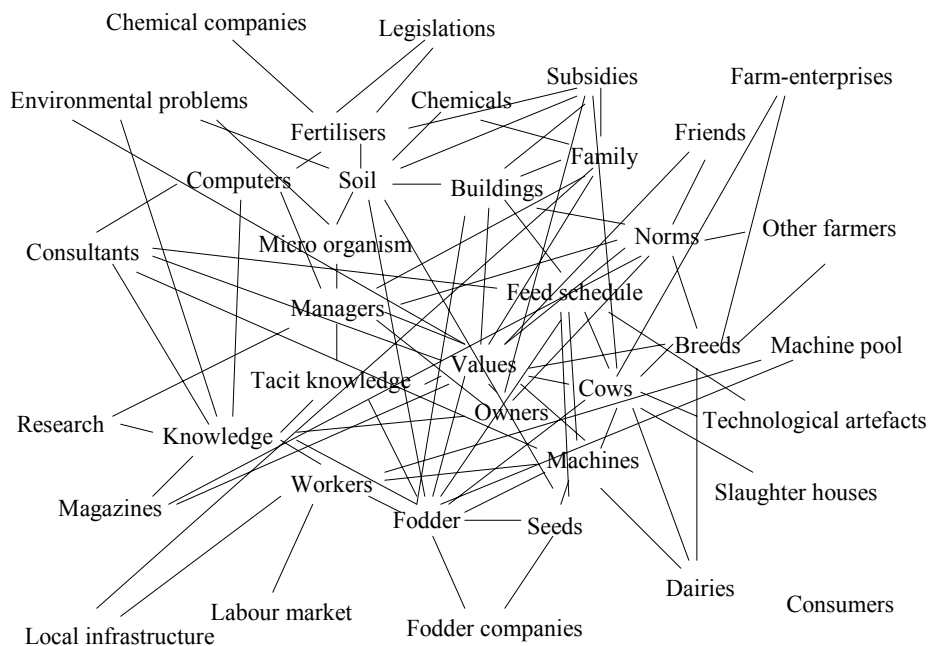


Figure 4: A simplistic illustration of a farm as a network of internal and external relations. It is important to notice that in Actor-Network theory there is no hierarchy of interaction, no macro and micro. Knowledge, machines, livestock and chemical products are all on the same level of interaction in the network. This makes the model both very simple and very complex simultaneously, because it means that no part of the farm can be studied as only a matter of biology, technology, economy or sociology.

In our understanding of ANT, actor-networks are mobilised into each other's heterogeneous strategies, but they are not organized or assembled by one another. An example: the network of the agricultural advisory service is organized in a particular way to provide service to farm enterprises, i.e. the farm enterprises are mobilised into the network of the advisory service, but the network of the individual farm is not organized/assembled by the advisory network. Artefacts of the advisory network are mobilised into the ordering strategy of the farm enterprises. A particular advisor may play a central role in the organizing process of a particular farm, but still the two network building processes may be seen as separated from each other.

The mobilisation and translation processes will always be connected with a negotiation process. A particular farmer's expectations to a certain consultant may differ very much from the consultant's ideas of her own role as an advisor. The same applies to technology, software, and knowledge. A certain artefact like a computer programme to optimize pest control is produced from one set of ideas of how farming is organized. The company producing the programme tries to mobilise the farmers to use their provided tools through advertisements, salesmen, policy, etc. and the farmer tries, if he is persuaded to buy, to translate the programme into the management processes of the farm enterprises, which may differ very much from the expectations of the company.

This analysis indicates that ANT is a useful theoretical framework for grasping the very heterogeneous character and relational openness of a farm enterprise. But a weak point of ANT (who sees an actor-network as an endless web of heterogeneous actor-network relations with local summing ups) is its theoretical

internal and self-referential operation by which the system draws its own operational boundaries, where the encompassing world will always offer a surplus of meaning.

From an autopoietic understanding, the self-referential process of selection of meaning, as a first step, will be hidden to the system, because it is not a social system until a selection has been made. This corresponds to Mol's (1999) findings, presented above that the decisive moment of an actor-network will be a place from where there seems to be no choice. Only through reflexive (re-entry) processes these choices can be made visible to the system.

This can be illustrated by an example: if you ask a farmer why she is farming the way she is, you will often get an answer the gist of which is 'because this is the only rational way of doing it'. Farmers who have been through a reflexive process (e.g. most farmers who have converted to organic farming), on the other hand, will often explicitly explain their choice in terms of values (Noe 1999).

Another characteristic of an autopoietic system is that it possesses its own internal rationality or schema. Autopoietic systems are operationally closed systems. This means that the system must produce its own input for operation. For example, a needle does not produce the feelings of pain, the person who feels the pain, does. The nerve cells only transmit the impulses and it is in the mind that these impulses are translated into pain. So it is the internal schema of the system and not the specific quality of the perturbation that defines how a system reacts to a certain perturbation. Translated into the theory of social systems, this means that it is the internal process of the system that defines what can be communicated and how the communication occurs as a reaction to a certain perturbation.

Luhmann's theory of self-reference makes possible a reinterpretation of Ploeg's notion of calculus or farming logic. A calculus belongs not only to a discourse; every self-referential system needs to possess its own system logic to be operational.

Luhmann's system theory makes it possible to observe and understand a farm management system as a self-referential social system that selects its own schema of differences, defends its logic, values, and meaningfulness. This will prevent us from being trapped in an 'actor-position' where farm management, as a process, is linked and limited to the consciousness of the farmer. In most cases many 'actors' are involved in the self-referential communication processes of a management system, but it varies much from one farm enterprise to another (Noe 1999).

In this framework, each farm is understood as a self-organizing node in a complex of heterogeneous socio-technical networks of food, supply, knowledge, technology, etc. This implies that a farm has to be understood in terms of the network relationships and the way in which they are organised by the farm as a self-organizing social system. Among all the different possible ways of interacting with the surrounding world, the system has to select a coherent strategy in order to make the farming processes possible at all.

Methodologically this theoretical framework implies that the self-referential and self-organizing processes of a farm enterprise can only be observed through the communicative processes of the management system. Or, through the outcome of the self-referential processes as different actors and artefact are translated and mobilised into the strategy of the farm enterprise. According to Luhmann, actions do not contain meaning; they are assigned meaning as a cognitive or communicative operation.

SUMMARY AND CONCLUSIONS

In this paper we have argued that the actor-network theory and Luhmann's systems theory in combination provide a better perspective on the ontological understanding of a self-organizing entity such as a farm enterprise. The actor-network theory focuses on the heterogeneous character of a farm enterprise as a social, economic, technical and biological system, and on the entities and actors mobilised and translated into the farming processes as actants. Luhmann's theory, on the other hand, offers an approach for understanding a farm as a self-organizing system (operating in meaning) that must produce and reproduce itself through demarcation from the surrounding world by selection of meaning. The meaning of the system is expressed through the goals, values, and logic of the farming processes. In this working ontology the boundaries of self-organising systems are not dependent on the choices of the external observer, but on the self-reference of the system/network, just as the cell membrane is a construction by the cell and not by the surrounding body.

How can this theory enlighten the sociological understanding and investigation of farm enterprises? Much work still needs to be done in the development of this framework (see Noe and Alroe forthcoming) which, in our view, may offer a new perspective in rural sociology. The notion of a farm as a self-referential

autopoietic system has proved useful for studying farm enterprises as social systems, for observing the rationality and values around which farm enterprises are organized, for exploring what kind of internal and external observations are involved in the process of management, and for observing who and what are involved in the management processes. These advantages are helpful in understanding farm management from the inner system logic (Noe 1999). The self-organization framework can also add to the understanding of why extension systems have failed to develop their extension programmes and target their messages to diverse farmers (Vanclay et al. 1998). Such programmes may have ignored the fact that while the natural sciences in general operate with one logic/ rationality, there are different logics at work in farming. This paper provides the outline of a cohesive theoretical framework to understand such problems. Advising farmers and developing farming practices have to take the system logic (values and rationality) as a starting point, even if the goal is to de- or re-construct agricultural production, whether we are dealing with large commercial farm enterprises or small-scale dairy holders in the third world countries. Indigenous knowledge is transformed into the broader notion of system knowledge.

The self-organization framework does not reject Bawden's core idea of a farm as a learning system, but it helps to understand learning itself as a social and technological process and not only as mental process of the individual actor involved. Luhmann's theory thereby provides for a theoretical understanding of social systems as learning systems that can overcome some of the radical constructivist problems of the Bawden approach (Alrøe 2000).

The self-organization framework does not deny the social construction of farming practices, which is at the core of the farming styles methodology: It sees farming practices as coevolving rather than just an expression of cultural repertoires. The idea of self-reference could explain why, for example, Vanclay et al. 1998 found it difficult to apply the farming styles methodology to Australian conditions as farm enterprises can relate to different ways of farming without establishing an exclusive membership relationship with a particular social practice. On the other hand, the Actor-Network theory suggests that farming styles are a necessary reduction in the complexity of options making possible interactions and co-evolution between farm enterprises and the surrounding actors. Farming styles can then be understood as discursive environments of the farm enterprises, rather than as a social construction of the latter.

Finally the self-organization framework goes beyond Conway's call for multidisciplinary to call for transdisciplinarity, because our theoretical framework rejects the hierarchical idea of a farm enterprise as consisting of different ontological system levels that can be observed from different angles. Even the microbiological processes in the soil (e.g. crop rotation, or the amount of fertiliser, manure, chemicals etc.) are interdependent as they interact with the system/network that enrolls these processes. At the same time, there is no epistemological position from which the whole system/network can be studied. This calls for not only multidisciplinary studies but for transdisciplinary studies and thereby systemic research (Alrøe and Kristensen 2002).

Self-organizing as a theoretical concept has three important methodological implications for the study of farm enterprises:

1. The organization of a farm enterprise can only be understood and explained from its own system logic. This has implications for sociological, agronomic, and economic research on farming systems
2. A farm enterprise cannot be observed as a whole from one position. This rejects the idea of an epistemological holism.
3. The concept of self-organizing enables one to understand farm enterprises as actors in the co-evolutionary development of agriculture, food chains, knowledge, technology, etc.

While the self-organization framework is far from being fully developed, we hope that this paper would encourage the interested reader to join in the effort of further exploring and developing this framework.

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ⁱ The notion of multifunctional agriculture is mainly used by OECD to focus not only on the negative environmental side effects of agricultural production, but also on the positive contributions of agriculture in terms of local rural development, landscape, etc.

ⁱⁱ The difference between the terms multidisciplinary, interdisciplinary and transdisciplinary can be defined in the following way. “Multidisciplinary: disciplines working on the same problem or issue are autonomous and the work does not lead to changes in the existing disciplinary and theoretical structures. Interdisciplinary: the disciplines work on different themes but with a common framework, or methodology. Transdisciplinary: The interdisciplinary work is accompanied by a mutual interpenetration of disciplinary methodology and theory, and leads to a common theoretical understanding. The transdisciplinary work presumes self-reflection in the different disciplines on their role in the resolution of problematic issues and their relation to other disciplines. And transdisciplinary work thereby transforms the disciplines involved.” (Alrøe and Kristensen 2002, p. 19)

ⁱⁱⁱ We use “working ontology” to stress that we are not using this notion in the context of realism. We mean that every epistemology must have an idea of the world, as it is, that goes beyond epistemology.

^{iv} Autopoiesis means self-producing. Maturana and Varela have developed a theory about all living organisms as autopoietic systems, which are continuously producing themselves and their own input for reproduction. Autopoietic systems are organizationally closed but physically open (for an introduction see Maturana and Varela 1987). Luhmann applies the theory of autopoiesis to social systems as communicative systems, where he sees communication as a self-organising and self-referential system. See Luhmann 1995.

^v Bawden (1991) explains his understanding of the notion of world view like this: “Each of us goes about “seeing” our “reality” through our own little “window on the world”; a *weltanschauung* of value-laden, psycho-cultural, experience-modified knowledge or beliefs or assumptions which shapes the way we handle issues in our world. It reflects the personal disposition which bring to bear as we go about our learning “.

^{vi} For a more comprehensive introduction to the two theories see Noe and Alrøe (forthcoming).

^{vii} In the context of Actor-Network theory enrolling means that an object is mobilised and translated into the actor network as an actor or actant. This means that actants do not exist outside actor networks, but that they, as entities, “achieve their forms as a consequence of the relations in which they are located. But this means that it also tells us that they are performed in, by, and through these relations” (Law 1999, p4).

^{viii} See e.g. Mingers 1995 for a critical review of Luhmann’s use of Maturana and Varela’s theory of autopoiesis.