Management of multidimensional farming - the perspective of farm enterprises as heterogeneous self-organising systems[1]

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Abstract

The whole modernisation process has led to a tremendous increase in productivity, but also to a lot of unintentional effects on the environment, landscape, and the possibility of livelihoods in the rural areas. The call for sustainability and multifunctionality constitutes a tremendous challenge to the farm management, to handle this whole range of voluntary and/or forced consideration of the agenda of multifunctional agriculture. In this paper this challenge is analysed and discussed from the perspective of the farm enterprise, explored as a self-organising system/network. Including a historical perspective the barriers for the development of multidimensional management are analysed by the concepts of knowledge, complexity, network relation and meaning. It is concluded that multidimensional farming is a challenge, not only to farm management, but also to a co-evolving development of the surrounding actor-networks. Development of multidimensional farming takes three co-evolving processes: - a reconstruction of the values and ideas around which the farms enterprises are organised, - a new way of reduction of complexity, shifting from reductionism to systemic knowledge, and: - a development of network relationships that facilitate network building of multidimensional farming.

Introduction

The history of modernisation of agriculture is the story of exclusive attention to technological efficiency in food production, and in recent decades there has been a strong specialisation into monocultural farms. Changing conditions in terms of technical features and market are normally seen as the major rationale and driving force of this specialisation. However, the growing amount of knowledge and how this knowledge is produced and circulated may be an even stronger factor of explanation for this development and thereby a key to understanding the challenges and obstacles to the development of farming which takes into consideration ecological, social and political factors, hereafter abbreviated as "multidimensional farming".

A century ago, all farms were multidimensional in their way of organising, not for romantic reasons or because of certain values, but because of the rationality of multidimensionality seen from a biological and social as well as from an economic point of view. The majority of people were farmers and the farm was the horizon of their lives. The whole modernisation process has been a clash with the rationality of multidimensionality, as a first step to increase food production to a fast growing population and, as a second step, to increase productivity to release labour to the growing industry. As we know, this focus has led to a tremendous increase in productivity, but also to a lot of unintentional effects on the environment, landscape, and the possibility of livelihoods in the rural areas. In the seventies it raised the debate on sustainability, mainly focusing on the environmental aspect, and in the last decade more focus

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has been put not only on the negative side effect of farming, but also on the necessary, positive effects that we want farming to have in the rural areas.

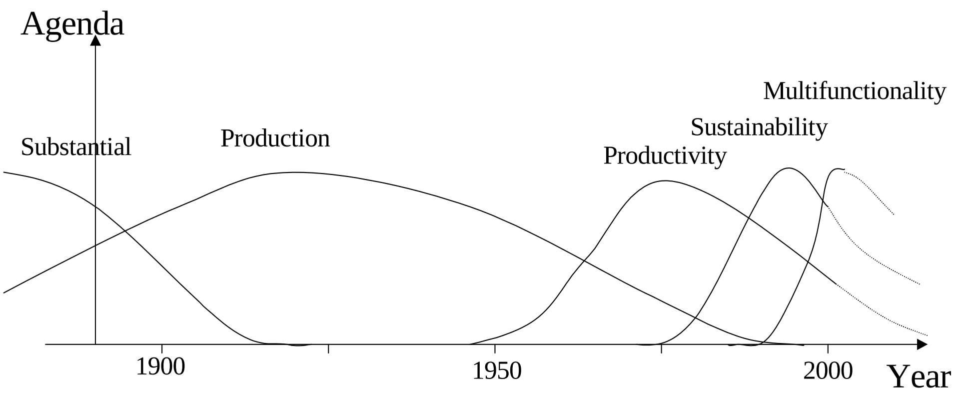

Figure 1: The changes, goals and agendas of agriculture in Denmark

The call for sustainability and multifunctionality constitutes a tremendous challenge to the farm management of profitable farm enterprises, to handle this whole range of voluntary and/or forced consideration of the agenda of multifunctional agriculture. Although one could easily argue that taking a comprehensive view on the different aspects on farm-environment relationship the development of multidimensional farming is much to prefer to a development that focuses on one aspect only, namely the increase of productivity, there is a hegemony of the development of one-dimensional, organised farming. A way to understand the barriers for the development of multidimensional management is to include a historical perspective on the development of one-dimensional management within the theoretical framework presented above, and from here to discuss the challenges to the management of multidimensional farming.

The key question is: how can the farmer/farm enterprise mobilise and reproduce the necessary knowledge and skills (e.g. in terms of labour and consultants) into the management process of the multidimensional agriculture without losing the internal coherence and strategy of the enterprise, and without loosing all the power of efficiency in food production obtained?

In the following, I will analyse this challenge through the glasses of a theoretical framework of farm enterprise as a self-organising system (Noe and Alrøe 2003 and 2004). The model is based on a combination of some of the core ideas from Latour, Law and Callon's Actor-Network theory (ANT) and Luhmann's theory of social systems.

A farm enterprise explored as a self-organising system/network

The self-organization framework is elaborated and discussed in two papers by Noe and Alrøe (2003 and 2004), and will only be briefly elaborated here to establish a necessary platform from which to discuss the implication of multidimensional farming to the skills knowledge and labour involved in such farming processes. This framework builds on Peircean semiotics and on a combination of ANT and Luhmann's systems theory.

If we approach a farm as an actor-network, there are a lot of dynamic objects[2] that are translated and enrolled as actors/actants into the objective of farming. Those are the cows, 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.

To add to this complexity, the heterogeneous network of entities enrolled is not limited to the physical site of the farm. A lot of what we could call external dynamic objects are enrolled and mobilised as actors into the farming processes: seeds, semen, advisors, capital, magazines, weather forecasts, fodder, food chains, colleagues, knowledge, labour, subsidies, etc. The kind of entities and actors that are enrolled or not enrolled into the network, and how they are enrolled, is characteristic 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 (see figure 2).

One may easily realize how important it is for the economical results of the farming processes that all of these interactions in the actor-network are balanced in accordance with the strategy of the actor-network, no matter whether it is based on a high or a low input strategy. Ewert and Browns's (2003) case description of the quality of labour in the reconstruction of wine-production from low-quality to high-quality wine is a good illustration of the importance of this coherence. Farm enterprises producing grapes for low-quality wine, cannot easily reorganise its network strategy to produce grapes for high-quality wine together with the other changes of the network strategy. It takes training of the workers and reconstruction of how these workers are mobilised into the actor-network from low-salary workers to skilful workers of the farm enterprise.

It is important to notice that the dynamic objects enrolled as actors in the actor-network of the farm enterprise can be actor-networks or artefacts dependent on other actor-networks, e.g. in the shape of consultant offices, dairy companies, wholesalers, etc. organising their own heterogeneous complexity, or artefacts produced and reproduced by other actor-networks like tractors and computer programmes. There will, therefore, be a tension in the interactions between the actor-networks. The mobilisation and implementation interpretation 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. An artefact like a computer programme to optimise pest control is produced from a certain set of ideas of how farming is organised. The company tries to mobilise the farmers to use the programme that they produce, 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 enterprise, which may differ very much form the expectations of the company.

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[2] We use here the notion "dynamic object" in a Peircean sense, as a theoretical understanding of an object with all its different possibilities and attributes independent of an observer or interpreter, vs. the immediate object, which belongs to the environment of an observer. Translated to ANT the dynamic object is equal to the entity of an object and the immediate object is equal to the object mobilised into an actor network as an actant. In Luhmann's terminology the difference between the dynamic object and the immediate object is meaning of the object belonging to the encompassing world and the selections of meaning belonging to the environment of the system. We here apply Luhmann's notion of meaning in a more generalised form referring to all semiotic relations where interactions include an interpretation, while Luhmann restricts his theory to account for communicative (social) systems and psychical systems. Luhmann's notion of system environment is here regarded as the horizon of the system, and the encompassing world is regarded as the idea of the world as it is, independent of a particular observer.

ANT is a strong framework to understand and visualise the heterogeneity and complexity of a farm enterprise, and to stress the importance of coherence in the network–strategy. A farm enterprise can be explained as the coherence of how the dynamic objects (artefact, objects, product companies, people, etc) are involved in the network strategy. Not only in terms of the technical coherence as Barbier and Lémery (2000:385) stress, but as the coherence of the entire socio-technical network including sense-making and social interaction. However, ANT has a very weak theoretical expression of how this cohesion is produced and reproduced. The encompassing world of the actor-networks continuously produces a surplus of possibilities and options, and coherency must be ascribe to network internal operations, and thereby to a process of self-reference and self-organisation (see figure 2).

Luhmann offers a comprehensive theory on self-organising of social systems (Luhmann, 1995). Where ANT focuses on the heterogeneous openness of relations between the entities of the social, biological, and technical domains of the world, Luhmann takes the opposite position in his theory of social systems and focuses on the operational closure necessary for any system to operate itself.

Food production may be organised in numerous ways according to different goals and purposes, e.g. organic or conventional production. The farm enterprise as a heterogeneous social system must select a meaning in the surplus of possibilities offered by each object that is mobilised into the system/network, in order to be operational. The network or system needs to make or select its own meaning to make a situation of coherence possible, and thereby deselect a whole range of possibilities. According to Luhmann, the production and reproduction of such system meaning must be an internal process of the social system, in this case the farm enterprise. The encompassing world will always offer a surplus of meaning, e.g. of all the ways in which a computer can possibly be mobilised into the farming processes only a few can be actualised in a coherent strategy.

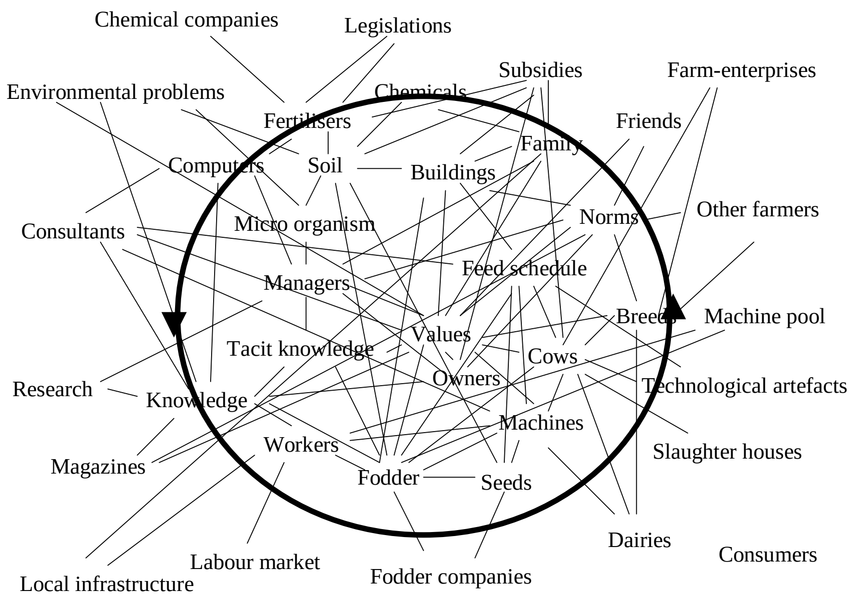

Figure 2: A simplistic illustration of a farm as a network of internal and external relations. In ANT there is no hierarchy of interaction. Knowledge, machines, livestock and chemical products are all at the same level of interaction in the network. This makes the model both very simple and very complex, simultaneously, because it means that no part of the farm can be studied as a matter of only biology, technology, economy or sociology. The circle illustrates the necessary process of self-reference and self-organisation to make the mobilisation and coherence of the farming network possible.

Using Luhmann's theory this way, the notion of selection of meaning is extended to account all semiotic relations generally, where an interpretation is possible, and not communicative relations only. The self-organisation of such heterogeneous social systems, as autopoietic, is then a process of increasing of nonredundant complexity[3]. Every selection of object and of meaning (possibilities) linked (or created by the autopoietic system) to these objects, which are enrolled as actors and intermediates into the actor-network, adds to the complexity of the network/system. And again, this selection/creation of meaning must be a system-internal and self-referential operation, by which the system draws its own operational boundaries. Selection of objects and meaning adds to the system-complexity in terms of what the system can observe in its system environment and in terms of what the system can enrol in its strategy. This implicates that coherence of a farm-enterprises cannot be explored only by studying the objects enrolled into the systems, but that the coherence needs to be studied from the perspective of the system/network – the network-strategy to coherence. The farming styles studies can be used as examples of how these operational boundaries can be studied. Ploeg (1994), Noe (1999), and Chiffoleau (2003) have committed some excellent studies of how different strategies form different clusters of interrelationships. In these studies, farming systems are typologized with respect to the meaning around which they are organised.

Another characteristic of an autopoietic system is that it has its own internal system rationality or schema at its disposal. Autopoietic systems are operationally closed systems, which means operationally self-sufficient and self-generation systems without input form the outside. This means that the system must produce its own input for operation (Luhmann 1995). E.g. the needle does not produce the feelings of pain whereas the person, who feels the pain, does. The nerve cells are only transmitting impulses, and it is in the mind that this disturbance is 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.

The notion of self-reference thereby leads to a general understanding of observation, namely, that it is the internal complexity of the system that is limiting the capability of the system to observe itself and the capability to observe the encompassing world.

Neither Luhmann nor ANT provides us with a notion of a farm-enterprise as a unity within the heterogeneous nature of a farm enterprise. Here, I would like to draw a parallel to the existentialist physiologist Victor Frankl's (1993) idea of the unity of a human being[4]. Frankl claims that the unity cannot be found in a reduction in multitudes of perspectives, but in the overlaying guidance of meaning. Based on his experience in the concentration caps during World War II Frankl (1984) developed a (logo) theory and therapy that emphasizes the role of "meaning" for survival. Only people who could continuously find and reproduce a meaning of life had a chance to survive. Furthermore, meaning must refer to something in the encompassing world. Self-realisation as a goal cannot substitute this reference to the encompassing world; the more a man strives for self-realisation as the end goal the farer away form self-realisation he moves. Only by referring to meaning in the encompassing world, self-realisation is possible as a by-product spin-off. Selection of meaning becomes a pre-rational condition for any rational operation, just as it is not possible to believe in God as a rational choice, just because we know that it is good for one's psychological well-being to do so. If the belief is an instrumental choice it will not work as a meaning. Frankl (1984) uses a chess metaphor to describe this contextuality of meaning. If you ask a chess player what the best move in the world would be, he will tell you that it depends on the actual position and the person against whom you are playing. A parallel can be drawn to heterogeneous

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3 Maruyama uses the term nonredundant complexity for systems-complexity that cannot be reduced to simpler patterns, see e.g. Maruyama (1995: 225-229).

4 Luhmann refuses the idea of a human being as a unity from an epistemological standpoint, saying that there is no position from where such a unity can be observed (Thyssen, 1997)

social systems. Just as meaning is essential to the unity and survival of a human being, I claim, that meaning is essential to understand the unity and internal coherence of a self-organising social system. Without meaning in Frankl's sense, the selections of objects and meaning in Luhmann's sense will be arbitrary and the systems will fall apart.

The challenges to the management of multidimensional farming

In the following I will base the analysis of the challenges to the management of multidimensional farming on the logical shift in management from subsistence /traditional farming, to one-dimensional organised farming (see table 1).

Table 1

	"Traditional farming"	One-dimensionally organised farming	Multidimensionally organised farming
Knowledge	Endogenous	A-contextual scientific	Contextual (systemic learning)
Handling of complexity	Historical based practice	Reduction of goals and power of calculation	Differentiation of task and increase of internal organisatory complexity
Network relations	Autonomy and local	Few specialised – global Independent	Many specialised – global and local
Meaning	Local embedded norms and culture	Self-interest and maximum food production	Co-evolution and co-operation with the society
Values and goals	Survival of the family Subsistence economy	Maximum food production Profit of enterprise	Increase network quality Plurality of incomes by co-operations

Knowledge and learning

Traditional farming was primarily organised around local indigenous knowledge developed through a long-term practice and interwoven in stories, norms, rituals, etc. (see e.g. Ploeg and Long (eds.) 1994). In a sense, an effective and stable way of organising the management processes as long as the surrounding, social-technical environment is rather stable, and the farming system is interwoven in a larger network of dependent relations with the society in terms of economy, knowledge, supply etc. But when an external or internal wish of a rapid change of goals and reorganising of management processes occurs, such a local, embedded practice shows a lot of inertia and is difficult to change. Norms and rituals become out of context and were seen as major obstacles to modernisation.

The modernisation process of agriculture in the direction of one-dimensional farming is a change of the idea of ideal knowledge (to base the organising of the farming processes) from local contextual knowledge to global acontextual scientific knowledge. And here we can observe a coevolving and symmetrical process in the way in which agricultural knowledge has been produced and the way in which farming is organised (Norgaard 1994). The ideal scientific research is to focus on one or two factors and to keep all other possible factors stable to isolate the significant effect of input on the output result. The strong and, for the increase of productivity, very successful rationale of one-dimensional farming is the power of reduction and control, combined with a narrowing of goals, but when it comes to multiple goals, the paradigm of reduction shows its shortcomings for handling this explosion in linear complexity of multidimensional farming. The increasing computer power has not solved the problems, so far (McCown 2001). These computer programmes either become very narrow in their perspective or based on very naive assumptions of the effects and relations.

To apply the knowledge generated within the paradigm of reductionism the farmers needed to keep the context as simple as possible, keeping all other variables constant. To illustrate this, the majority of cows in Denmark in the mid 70s were being kept on stable around the year, presumably because of an idea of being in control, of making conditions that match the fodder experiments, although it was detrimental to the welfare of the cows and a more expensive way of feeding them. The main reason for science not producing results from grazing was that it was impossible to make these fodder experiments in a scientifically acceptable way.

Management of multidimensional farming has to cope with multiple goals and aspects in the systems environment. Here I will argue that we need to change our understanding of ideal knowledge from a-contextual, scientific knowledge to a contextual, systemic knowledge. Systemic knowledge is here defined in a in a very broad sense, as the system's expectation of what "happens if" both to the internal network of the system and to the systems environment. Systemic knowledge can be represented within the system in many ways in terms of beliefs, myths, stories, tacit knowledge, intuition, formalised rules and models - what the system knows about itself and its systems environment. There are at least four ways in which a self-referential and self-organising system can develop on and improve its knowledge about the complexity of the farming system and of how the farming system responds to the multiple goals.

1. As a learning process (Bawden 1991) through reflexive processes between outcome expected (involving values and knowledge) and outcome observed
2. Translation of scientific ("a-contextual") knowledge, which means knowledge produced with another context into the context of the farm enterprise
3. Systemic research paradigms that try to focus more on the systems context, in which the interaction studied are embedded, than to isolate the interaction from their embeddedness (Alrøe and Kristensen 2002). Farming systems research is an example of these approaches (see e.g. Conway 1991; Mogensen and Kristensen 1999)
4. Co-learning by identification of similar farming practices (Ploeg 1994) or cooperative learning processes through social or institutional organisations (Barbier and Lémery 2000).

Learning processes may involve more or all of these approaches simultaneously, but with Barbier and Lémery (2000:348) it is important to stress that there is "no learning without change". Systems knowledge is about how the system views its environment, and thereby how it organises itself. Then, knowledge is not necessarily an additive game building more bits to the construction, but may be a game of reconstruction and re-conceptualisation as well, depending on the mindscapes of the people involved in the learning processes (Maruyama 1985).

Ways of handling systems complexity

Referring to Luhmann, the complexity of the systems environment (that the system can cope with) is dependent on the internal complexity of the system. Although we may not understand it as a simple zero-sum game, there will be some kind of trade-off between specialisation and generalisation. The more elements included in the systems environment the less possibility for these elements to be observed and handled by the system in a sophisticated way, unless the systems complexity is increased.

Traditionally, farming was organised around a certain cultural practice, and a range of cultural repertoires developed from generation to generation (Ploeg 1993). Farming organised around a cultural practice contains a great complexity of knowledge based on cultural experience and failures, but like crop rotation, etc., most operations are given, and only few operations are open for decision-making.

The project of modernisation was to depart from practice and tradition to 'rational choice' decision-making. To pursue this strategy, another way to handle and increase systems complexity was needed: reducing the number of elements of systems environment relevant for the system and increasing sophistications of systems by a network of linear calculations applied in a persuasion of strategic rationality. The key elements of this strategy was first of to focus on one goal of maximising only, and secondly, to reduce the complexity of production by reducing the numbers of products and by isolating each product for partial optimisation, keeping all other factors constant. E.g., decision-making in the stable and in the field has become widely independent of each other, which can be seen, for one thing, in the way in which the Danish agricultural research as well as the advisory service has been organised.

The call for multidimensionality therefore necessitates a dramatic increase in internal complexity of the system to observe and handle the entire different dimension, i.e., a farm-enterprise needs to have a notion and knowledge on nature quality to take up nature quality as a goal in the decision-making. There are different ways to increase system complexity. One is to mobilise complexity that is organised by other systems/networks e.g. to apply a developed practice, which is known or presumed to take different considerations into account, as is the case with organic farming.

Another strategy is to increase the capacity to cope with organisational complexity, e.g. by reflexive learning, training and education as described above, by coordinated division of competences, or by mobilising more resources into the actor-network, e.g. advisors and decisions support systems (Noe & Halberg 2002).

Whatever strategies are applied to increase systems complexity, there is a need for an increasing effort to secure internal coherency of the actor-network strategy. This sense-making convergence[5] processes becomes more and more important with increasing complexity and as a communicative process within the actor-network between humans and organisations enrolled in the network strategy.

Network relations - cooperation with the encompassing actors

From the ANT we know that multidimensional farming involves interaction with many different actors representing the different dimensions. The strategy behind the paradigm of the one-dimensional farming is to reduce the entire dimensions of the project to the dimension of a market, to commoditise all the functions, as the strategy of OECD (OECD 2001).

Development of multidimensional farming is not only an internal process of the farm, but a process of co-evolution (Norgaard 1994) between the different actors and actor networks/systems. Just as traditional farming was interwoven in a complex, local network of interaction, multidimensional farming needs to be interwoven in a network of both local and global actors, e.g. in terms of labour, knowledge, advisors, interest organisations (see e.g. Vanloqueren 2003).

In the paradigm of one-dimensional farming approaches the surrounding actors (the market) are regarded as independent of each partial decision. In the paradigm of multidimensional farming, development necessarily has to be understood as a process of co-evolution, and each decision has possible impact on the surrounding actors and visa versa. In this dynamic perspective, agricultural sciences play a very important role in changing/not changing the scientific paradigm from reductionism to systemic contextual knowledge.

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5 A notion borrowed from Barbier and Lémery 2000:385.

Conclusion and perspectives

Multidimensionally organised farming is a shift in meaning and organising values – a shift in paradigm. In traditional farming, meaning was not an individual task, but was embedded in local norms and cultures. The individual person was not free to choose whether he wanted to be a farmer or not.

The shift to one-dimensional farming was closely connected with an ideological break with norms and culture by an individualisation of interest. The goals of maximizing food production had become the meaning of farming in relation to the society, separated from other interests and meaning that had previously been connoted with agriculture. In a situation of overproduction and regulation of food production, enterprises organised around the meaning of maximizing food production ended up in serious identical vacuums, an existential crises, as we could observe from the farmers' very strong reactions against the environmental debate in the 80s in many countries. The meaning linked to farming has been even further narrowed down to the self-referential meaning of profit.

The meaning was linked to the development of one-dimensional farming as was maximum food production. Multidimensional farming can be seen as a search for a new meaning of farm enterprise in relation to the surrounding society in terms of the many possibilities for actualisation of meaning linked to the surrounding society. Profit becomes thus not a goal on its own but a spin-off of the actualisation of meaning in relation to the surrounding world. Like Frankl's (1984) example with sex and love: a good orgasm is a by-product of forgetting yourself and focusing on the other person.

Multidimensional farming is a challenge, not only to farm management, but also to a co-evolving development of the surrounding actor-networks. The challenge is how to reframe the problem of increase of nonredundant complexity, and to co-evolve a network of multidimensional farming. I argue that development of multidimensional farming takes three co-evolving processes:

- a reconstruction of the values and ideas around which the farm enterprises are organised,
- a new way of reduction of complexity, shifting from reductionism to systemic knowledge,
- a development of network relationships that facilitate network building of multidimensional management,
- and research plays an important role in these processes of co-evolution.

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