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Productivist or multifunctional: An activity theory approach to the development of organic farming concepts in Sweden

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ABSTRACT

This study proposes a unit of analysis based on cultural historical activity theory for examining the development of organic farming (OF) concepts. The study investigates whether organic farms are becoming more like conventional farms, with related environmental and social problems. The framework is illustrated with a historical analysis of the Swedish case of organic apple farming. The analysis shows that in Sweden, conventionalization is part of the current dominant "intensive organic farming concept", while an emerging concept, the "ecology of food systems", is attempting to break free from this process. The proposed analytical framework can be used for comparing OF concepts and for guiding future development efforts according to the needs of stakeholders.

KEYWORDS

Apple production; concept formation; conventionalization; developmental dimensions

Introduction

Toward the end of the last century, *organic farming* (OF) was proposed as a potential solution for various economic, environmental, and social challenges posed by conventional farming (CF) (Allen and Kovach 2000; Altieri 1995; Rigby and Cáceres. 2001). Despite the quantitative growth in OF, an increasing proportion of organic production seems to be following the old productivist logic of maximizing yields using high inputs. This trend, called conventionalization of OF, is resulting in the activity becoming only a partial solution for challenges created by CF (Darnhofer et al. 2010b; Guthman 2004). This also applies to intensive organic apple production, a relatively new activity in Sweden, which is undergoing intensive development in order to find solutions that meet the need for sustainable livelihoods and for ecologically sound and socially sustainable production.

A review has highlighted the risk of OF losing support among consumers and policy makers if it is perceived as becoming conventionalized (Darnhofer

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et al. 2010b). That review also showed that the indicators used to evaluate whether conventionalization is occurring are often not reliable and that there is a lack of a comprehensive framework to reliably evaluate the type and direction of changes in OF.

OF is commonly defined either formally or discursively (Seppänen and Helenius 2004) by rules, tools, and principles or values (Darnhofer et al. 2010b; Milestad et al. 2008). Previous studies on conventionalization of OF have addressed a variety of different empirical units of analysis, such as the structure and organization of organic food networks, principles making the OF concepts viable, observable physical attributes related to OF or tools at the farm level, ideology, and the developmental driving forces of conventionalization (Allen and Kovach 2000; Best 2008; Glin, Mol, and Oosterveer 2013; Guthman 2004; Klonsky 2000). According to those studies, conventionalization may be manifested either in measurable effects in the natural (or material) world or in structural changes in the social world, or both materially and socially. However, in order to compare and understand the emergence of OF concepts and their possible conventionalization, there is a need for a theoretical unit of analysis that includes on-farm and off-farm material factors[1] and social structures.[2] Such a theory should explain the elements common to different farms and their networks, the function of those elements in the system, and how they are connected.

It has been argued that, in order to understand and prevent the undesired conventionalization of OF, analysis and standards need to use the agri-food commodity chain as the unit of analysis, focusing on its nodes and interactions (Buck, Getz, and Guthman 1997). Michelsen (2001) proposed a framework of an institutional environment involving farmers, their community, agricultural policy, and the food market. However, this unit of analysis and framework are on a general network level and are not associated with theory-based structural elements that take into account both farm production and its network. They do address the empirical historical development and drivers of OF, although not explicitly based on a theory of change.

Recently, Nuutila and Kurppa (2016) proposed the use of the activity system model and its structural elements to compare a current and future organic value chain.[3] Following this approach, in this study we applied *cultural historical activity theory (CHAT)* in empirical testing of the conventionalization theory. The CHAT framework has been used in other areas such as education, health, and industry (Kallio 2010; Launis and Pihlaja 2007; Murphy and Rodriguez-Manzanares 2008). It includes a theoretically based unit of analysis that combines the structural elements of on-farm and off-farm material aspects with elements of the social structure.[4] Additionally, it is related to a theory of change that uses specific analytical tools in order to explain the emergence of those structural elements and the drivers behind their change over time.

The suggested unit of analysis takes into consideration the motivation for, and purpose of, an activity – its *object*. To grasp the structure of an activity, it is necessary to follow its object empirically through time and analyze *whether and why it has changed*. Doing so reveals: (1) the *driving forces* behind the change, (2) *the logic making OF viable*, and (3) whether the *content of the structural elements*[5] of organic farms and their networks is becoming similar to that of the structural elements of conventional farms. Such a historical and structural analysis would gain in strength if guided by analytical tools based on a theory about the structure of human activities, such as farming, and a theory of how and why they change.

The proposed framework was applied in this study to a Swedish context where conventionalization of organic apple production is suspected to be taking place. The aim was to answer the questions: What Swedish OF concepts exist and how have they evolved? What are the key characteristics of their structural elements? What are the developmental dimensions or key principles or logic that make the concepts viable? Does the suggested analytical framework, when applied to the empirical case of Swedish OF, capture both the material on-farm and off-farm aspects and social structural aspects associated with conventionalization of OF? Can this framework contribute to a systematic empirical analysis of the conventionalization theory in different settings?

The paper starts with a brief introduction to the theory, followed by a description of data collection and analysis. We continue by presenting a historical narrative on the emergence and development of OF, exemplified by apple production. Based on this analysis, we elaborate a hypothesis of the key historical developmental dimensions of farming within which different historical farming concepts have solved, or failed to solve, the dilemma of simultaneously achieving short-term and long-term social, ecological, and economic sustainability. The approach and framework are then used for classifying and comparing OF concepts. We conclude by suggesting that the proposed framework may also be used to guide future development efforts according to values pursued by relevant stakeholders.

Theoretical framework

Complex concepts in today's world, such as OF, human genome studies, terrorism, and globalization, are multifaceted and poorly delineated objects, ideas, and practices which people try to understand and manage by conceptualizing them (Engeström 2005). Such conceptualization requires theories that reveal the logic of development of a concept, its genetic roots, and the system of functional relationships determined in its occurrence and development (Davydov 1990). Here we propose three components for analyzing the emergence and development of organic concepts: (1) an activity system as a basic unit of analysis that still encompasses the whole (Figure 1),

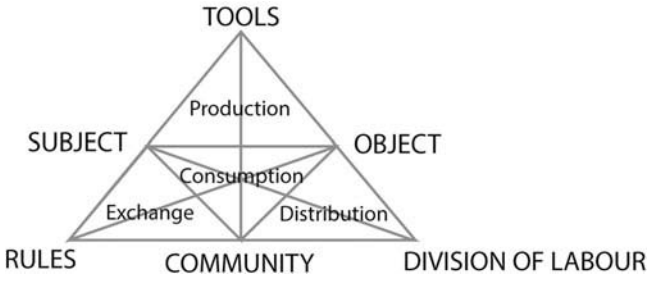

Figure 1. Activity system triangle (Engeström 2015).

(2) the main principles making the concept viable, and (3) its development path explaining why and how the concept emerged and developed.

Taking a human activity as a unit of analysis involves seeing a phenomenon as a process of constant production and reproduction. An activity may be understood as a set of actions directed toward the transformation of an object (Virkkunen and Newnham, 2013). Miettinen (2005) explains that an object of an activity is not simply a material thing (e.g., a farm), but includes a culturally and socially defined collective motive and meaning. We suggest that in the context of OF, it can, for example, be understood not only as the end product, but also as the social needs it aims at satisfying, that is, environmental conservation, healthy food, job and income generation, food sovereignty, and so on.

The actions that compose a human activity are mediated by social and technical elements. In order to understand these elements, Engeström (2015) proposes a general model of human activity called "activity system" (Figure 1). According to this model, a subjects' relation with the environment (object) is mediated by tools, a community, rules, and the division of labor. An activity system is always interacting with other activity systems in a network by feeding inputs into each other (Figure 2) or by collaborating toward a common object and motive. Virkkunen (2006) explains that when a new production concept emerges, all the elements of the production activity (object, outcomes, tools, division of labor, etc.) change qualitatively and are made mutually compatible according to a new logic and principle. In activity theory, a principle is the general strategy that makes the concept viable and the principle is present within all elements of the activity, making them compatible to produce the desired outcomes (Virkkunen and Ristimäki. 2012).

Changes are driven by internal contradictions among elements of an activity system (Engeström 2015). One possibility to overcome such contradictions is to transform the object, the motive and purpose, of an activity in an expansive way. Expansive here means that the new object has new qualitative characteristics that enable it to solve the contradictions within the old activity, widening its scope of possibilities (Engeström 2001). The

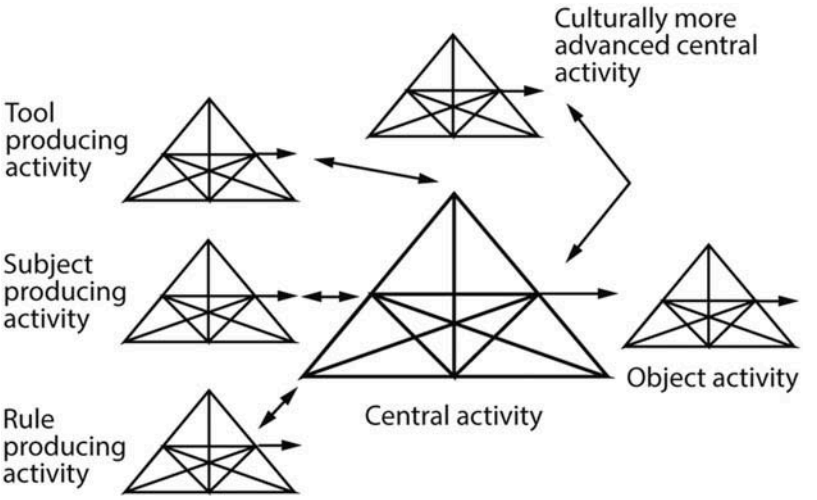

Figure 2. Network of functionally interdependent activities with neighboring activities related to a central activity system (Engeström 2015).

production of the new object usually requires some specific principles to make it viable. Such principles permeate all the elements of the activity system. For example, the production of a standardized, mass-produced product requires different principles than the production of a customized product. In other words, each object requires a specific logic and principle to make the activity viable. The configuration of an activity system with its principle is called a concept of activity. In essence, a concept is not only observable attributes, the object, or the principles, but rather it is the combination of the activity system elements, the principles that make the concept viable and the logic of its development. The suggested analytical framework includes all these aspects (Figure 3). Concepts evolve historically and situationally and they are future-oriented. They are best learnt by investigating, debating, redesigning, and testing them in practice.

Material and methods

In order to grasp the different concepts of Swedish OF activity, we performed a historical analysis. The general development of farming is exemplified by the development of apple production. The historical narrative starts after WWII, with the most influential agricultural development processes of our time, namely industrialization and modernization of agriculture. The negative effects of this farming concept have been empirically described as the main driving force for the development of OF.

The primary data used in this study to chart the narrative consisted of notes, transcripts, and recordings from interviews with owners or managers of five Swedish and five Danish organic farms, four extension workers, 10

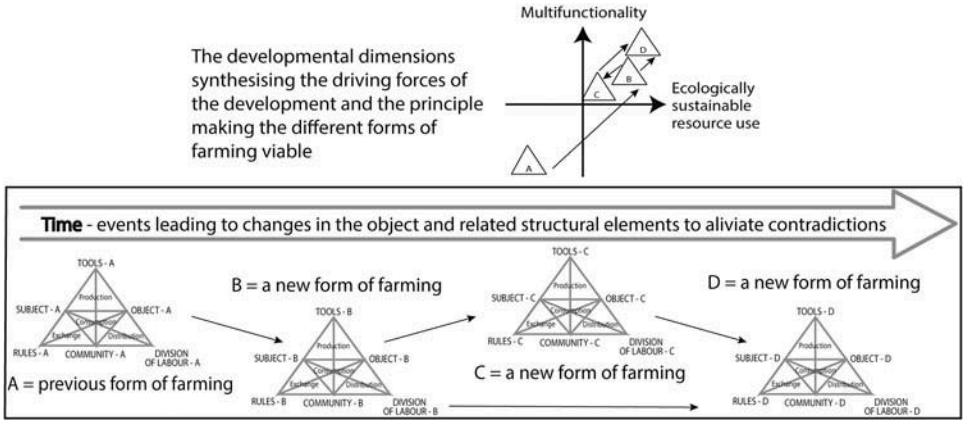

Figure 3. The suggested analytical framework based on cultural historical activity theory (CHAT). New forms of farming (farm concepts) emerge over time as a response to contradictions, which are solved by changing the object of farming and the related structural elements such as tools used and rules. Each new form of farming has a different principle that makes it viable and can be placed somewhere in the four corners of the two developmental dimensions (here exemplified by multifunctionality and ecologically sustainable resource use).

group meetings, and four seminars with farmers and extension workers from a previous participatory action research (PAR) project (Świergiel 2015). The secondary data used were government documents, websites, reports, and newspaper articles on OF, material produced by environmental organizations, and scientific publications.

The historical analysis was performed using the principles of the method "ascent from the abstract to the concrete" (Miettinen 2000; Virkkunen and Ristimäki. 2012), where "concrete" empirical material from the project was set in a dialogue with theoretical abstractions and the wider global history of corresponding concepts. Guiding questions for the historical analysis were based on the components of a theoretical concept according to activity theory: (1) How have the object and remaining activity system elements of farming changed over time? (2) Which historical events led to the development of different farming and OF concepts? (3) What are the guiding principles making a concept viable, with special focus on the dilemma between socioecological sustainability and profitability? Processes mentioned by interviewees or the literature, such as the increasing cost of land or the expansion of organic agriculture, were traced to historical events with large impacts on those processes. The events identified were then further investigated to obtain more complete information on their chronological order and how they affected the different elements of the farm activity system. Finally, the events were divided into coherent historical periods according to the changing object of farming and a narrative.

Based on the narrative of the historical development of farming, five farming concepts were devised with the help of the elements of the activity system as an analytical tool. The key principles making each concept viable were then formulated.

By comparing the objects, structural elements, and principles of the concepts, two hypothetical developmental dimensions were suggested, which helped to explain how different farming concepts have coped with root problems driving their development. Historically, newer concepts emerged as solutions to limiting factors, problems, and internal contradictions in existing concepts. We illustrate these dimensions using a conceptual model inspired by Seppänen (2004) and Pereira-Querol, Seppänen, and Virkkunen (2014), which is composed of a four-field matrix with two directions of each dimension to acknowledge the contradictory nature of the object.

Results

Historical narrative of Swedish conventional and OF, apple production

The emergence of CF and the crisis in apple production (1946–1980)

In Sweden, before WWII the dominant concept was still *traditional farming*, characterized by multiple functions for society apart from food and fiber production, such as landscape and natural resource management, development of rural culture and knowledge (Noe, Alroe, and Langvad 2008; Van Der Ploeg 2008), and preservation and development of family farms over successive generations (Wålstedt, Rosenkvist, and Browald 1992). Farms were often seen as a cultural heritage of rural life (Milestad, Ahnström, and Björklund 2011). The strategy to improve land productivity was based on increasing the resilience by proactive measures improving the natural resource base, such as soil fertility and natural enemies of pests (Milestad, Ahnström, and Björklund 2011; Van Der Ploeg 2008). However, there is almost no mention of apple farms from this time in the literature. It was presumably unusual to focus on apple production since farming was more diversified.

In 1946, the food shortage and economic crisis resulting from WWII prompted the Swedish government to define an agricultural policy based on three goals: (1) fair income to farmers, (2) increased national food-sovereignty, and (3) rationalization of farming, meaning increased productivity per labor hour so that fewer farmers could produce more food with fair consumer prices at a lower cost to the state (Domeij 1995; Encyclopedin 2015).

A protected and regulated market was important for transforming agriculture and included regulated prices of agricultural products (Rabinowicz 2004), import tariffs, export subsidies for surplus produce (Wålstedt, Rosenkvist, and Browald 1992), and a time-limited embargo to allow competition-free sales of the majority of Swedish produce (Tornéus, interview).

Domeij (1995) describes the implementation of principles as merging small farms into larger units, specialization, mechanization, and tools such as monoculture of high-yielding varieties, artificial fertilizers, and pesticides. Oil was a crucial resource and served as fuel for mechanization, input production, and transportation, as well as a raw material for pesticides and fertilizers (Domeij 1995). This is the widely known productivist concept of *CF*.

Efficiency increased rapidly and by 1961 the number of farms in Sweden had decreased by 46% (SCB 2015a). This fitted well with the goal of the state and private industries to move the labor force into the expanding industrial production in cities and exploit the natural resources in northern Sweden (Domeij 1995; Höglin 1998). When farms disappear, their key functions to rural life and culture, such as local production of food and fiber, small-scale forest management, businesses and jobs, local security, recreational aspects of landscape, social relations, and human services, also disappear (Milestad, Ahnstrom, and Bjorklund 2011; Noe, Alroe, and Langvad 2008). The reduction in number of farms in Sweden and the homogenization of agricultural land also reduced the potential of farming to support ecosystem services related to biodiversity, such as natural biological control and pollination (Milestad, Ahnstrom, and Bjorklund 2011). Farmers' desire to reproduce and develop rural life was thus threatened (Van Der Ploeg 2008). Labor-intensive operations were replaced in CF by increased mechanization and reactive use of pesticides and artificial fertilizers. In many cases this degraded the natural resource base and associated ecosystem services, such as soil formation, nutrient cycling, and climate regulation (MEA 2005).

By the 1950s, CF was starting to cause a problem of unwanted national surplus production (Domeij 1995). This, together with low world market food prices that had to be compensated for by the state, continuously increased the cost of agriculture to the state over the next decades (Rabinowicz 2004).

In the specific case of apple production, according to Tornéus (interview with extension worker), the development of conventional apple production had resulted by the 1970s in an increase from 300 to 800–1200 trees/ha. Weak-growing rootstocks and heavily pruned trees were smaller and easier to manage and needed less labor time and pesticides. However, diseases such as fungus apple cancer (*Neonectria ditissima*) became a major problem on these weak-growing trees, demanding increased numbers of pesticide applications. From the mid-1980s, the use of pyrethroid pesticides caused severe secondary pest outbreaks of spider mites due to the negative side effects on natural enemies. At the same time, resistance to pesticides evolved in some pests, such as the pear psyllid, *Cacopsylla pyri*. The agricultural authorities initiated extensionist-led integrated pest management groups for farmers and intense development work to find solutions to the increasing pest management problems. After 10 years of use, the pyrethroids were abandoned.

1970–1990: The emergence of first-wave OF

From the 1970s, criticism of the negative effects of conventional agriculture increased (MEA 2005; Rydén 2003), resulting in strong social and environmental awareness among some farmers and the wider society. *First-wave OF* emerged as a solution to these problems, by basing farming practices on knowledge about ecological mechanisms and interactions and principles such as diversification, recycling, resilience, and independence (Allen and Kovach 2000; Altieri 1995; Rigby and Cáceres. 2001; Röling 2009). State support for transition to OF strongly accelerated this process, contributing to a 2.4-fold increase in the number of organic farmers and 2.7-fold increase in the percentage of organic farmland in the year this subsidy was introduced (Rydén 2003). The number of organic apple growers at this time is not documented and it may be safe to assume that apple production was still only a small part of more diversified organic production on farms. Around the early 1980s, however, Tornéus (interview) noted an increase in organic apple growers.

OF was closely related to the participatory and systemic approaches which started to develop within research in the 1970s, and spread rapidly in the 1980s (Foot Whyte 1991; Röling 2009). Within farming, these approaches emerged to a large extent out of the failure of reductionist science and the transfer of technology concepts to address multifunctionality to support the livelihoods of most farmers and to develop ecologically and socially sustainable food systems (Allen and Kovach 2000; Altieri 1995; Röling 2009).

Until the 1970s, the focus of OF was mainly on product quality of nutrient-rich and pesticide-free food (Domeij 1995). During the 1980s, lower yields were also seen as a solution to overproduction, while simultaneously addressing the increasing environmental problems (Domeij 1995). In 1985 the Federation of Swedish Alternative Farmers (FSAF) and Kontrollföreningen för Alternativ Odling (KRAV), the certification organization for alternative farming, were formed (KRAV 2015). According to Rydén (2003), FSAF worked to improve the conditions for a general increase in agricultural sustainability and for OF in particular. It took until the end of the 1980s for the FSAF to achieve a place at the table of agricultural policy negotiations, although with limited influence.

At a meeting of the Nordic branch of International Federation of Organic Agricultural Movements (IFOAM) in 1989, OF was defined as: "a self-reliant, sustainable agroecosystem, based on local and renewable resources. Further, humankind was to take moral responsibility regarding the ecological, economic and social aspects of agricultural production" (Granstedt et al. 1998). The social focus was to produce high-quality food with fair and equal distribution locally and globally and social responsibility for the farmer to ensure a reasonable income, a safe working environment, and a meaningful job (Granstedt et al. 1998), strengthening rural communities (Darnhofer 2014) and the connection between urban and rural areas to create a societal

recycling of nutrients (Domeij 1995). Reactive measures such as adding artificial fertilizers to fast-growing plants or using pesticides were to be replaced by proactive practices to improve soil fertility, produce strong plants tolerant to diseases and pests, and create biodiverse environments to enhance natural enemies (Domeij 1995; Granstedt et al. 1998). The associated increase in labor time and, often, lower yield was solved by a price premium for the added value of the products, which was regulated by KRAV (Domeij 1995). Together with strong environmental and health awareness arising in society, this temporarily solved the problem for some farmers.

Mid 1980s–1990s: Commoditization of agriculture and intensive organic farming and apple production

Together, the events related to overproduction, urbanization, environmental degradation, health, and the political free-trade trend contributed to the decrease in the political importance of agriculture and food sovereignty in general and the Swedish CF concept became difficult to defend (Rabinowicz 2004). The productivity/readiness goal of Swedish agriculture was abolished (Rabinowicz 2004). These developments initiated a process of regulation to decrease production from 1985. On an international level, the view that agriculture should become more cost-efficient by deregulation and free trade began to dominate, and agriculture was introduced to the General Agreement on Tariffs and Trade between 1986 and 1994. Simultaneously, Sweden initiated a process of deregulation of land ownership, agriculture (Domeij 1995; Rydén 2003), the credit market, and several other product markets (Rabinowicz 2004).

Specialization, mechanization, and extensive use of external inputs to obtain high productivity remained the key principles of CF, with the addition of being competitive on the open market. However, during this time the state also began to support environmental considerations by taxing artificial pesticides and fertilizers (1984). A goal was set to halve pesticide use by the year 2000, along with redirection of subsidies to biodiversity measures in the landscape (1986), while in 1989 economic support was given for transition to OF (Domeij 1995).

In 1990, the price negotiations between farmers and the state, import tariffs and regulations, and export subsidies were abandoned and replaced by the free market (Rabinowicz 2004). The old structure and rationalization purpose of the agricultural authorities (Bylaw 1967:425) were revised to support market-oriented, competitive, and environmentally friendly agriculture (Bylaw 1988:854).

The focus on competitive agriculture adapted to the market, combined with scientific innovations transferred to farmers, resulted in the so-called product price treadmill, whereby early adopters benefit from new technologies that decrease costs (Levins and Cochrane 1996). However, when more

farmers adopt the technology, the prices go down and reduced profitability becomes a problem once again.

In the 1990s, land acquisition was further deregulated (Memorandum 1992/93:LU15). The motivation was the upcoming entry into the European Union (EU) in 1995 and its directive on free movement of capital (EU Council Directive 88/361/EEC). Sweden chose to open its borders also to countries outside Europe according to the Organisation for Economic Co-operation and Development (OECD) rules on progressive liberalization (Memorandum 1992/93:LU15). This opened the way for speculation in land, which increased its price and the competition for all farmers (Kjörling 2011; Latruffe and Le Mouel 2006; Östling 2014). When Sweden joined the EU, some of the agricultural regulations and subsidies were reintroduced (Rabinowicz 2004).

Insecurity about the effects of upcoming changes, and a very temporary offer of transition compensation (Rabinowicz 2004; Wålstedt, Rosenkvist, and Browald 1992), made many farmers sell their farms or change to non-regulated crops, since they feared their farm would not survive (Kjörling 2011). Organic farmers were less negatively affected by deregulation, since they had already incorporated many of the environmental costs into their organic production prices and had developed a relationship with consumers and supplied products with added values for which consumers were willing to pay (Rydén 2003).

Farmers described the struggle to keep their livelihoods, especially if they had not inherited their land and had large bank loans to pay (Kjörling 2011). Simultaneously, the farm estate price index in Sweden rose by 103% from 1990 to 2000 and by 328% by 2013 (SCB 2015b). Buying more land to gain economies of scale was only possible for those with sufficient available capital or those who could afford large bank loans (Kjörling 2011). To pay off the loans, high productivity became a necessity. This ongoing development has been described as the land market treadmill theory (Levins and Cochrane 1996). Farmers renting their land need to continuously adopt new technologies to pay the rent, and ultimately some are outcompeted. Farmers who own their land and are early adopters of technology can use the initial profits to buy more land. The competition for limited land on an open market, for agricultural and nonagricultural purposes, eventually leads to higher land prices. Farmers start earning less from their farming than from owning the land and, therefore, more farmers start to rent out or sell their land. This increases the price of land even further, making agriculture less profitable, and few people can afford to continue or enter farming.

Against this background, some small-scale and medium-scale conventional growers started to consider the premium prices in OF as an innovation that could provide temporary relief to the economic treadmill (Domeij 1995). Increased environmental and social awareness among consumers, the 1994

state policy of organic production on 10% of Swedish farmland by the year 2000, and new EU subsidies for OF also encouraged many producers to convert (Darnhofer 2014; Domeij 1995; Rydén 2003). From 1994 to 1995, the number of organic farmers increased 1.5-fold and the area almost doubled (Rydén 2003). At this time, the FSAF changed its name to organic farmers.

In the case of apple production, free trade flooded the Swedish market with cheaper, nice-looking apples (Tornéus interview). The value of national production decreased until 1991, and the number of fruit producers fell from 1500 in the 1970s to 425 in 1996 (KSLA 2015; LRF 2010). Tornéus (interview) explained that this forced the remaining apple growers to further intensify production and external quality parameters became stricter. It became common to buy trees from large producers in Holland and Belgium. With the trees came new diseases (*Erwinia amylovora*) and pesticide-resistant pest populations (e.g., *Phyllonorycter blancardella, Aculus schlechtendali*). The number of trees per hectare increased to 3000 and pruning was adapted to fit this dense planting.

The *Federation of Swedish Farmers* (LRF) adopted selected practices from OF to solve the pest problems while developing more sustainable production, called *integrated production* (IP) (Rydén 2003). This was seen as a comparative advantage on the national and international open market (Rabinowicz 2004).

According to Tornéus (interview), many of the County Administration Boards decided to remove most of their state-funded advisors, as the food industry was expected to fund extension services by itself. The industry decided to prioritize IP, but lowered the requirements since growers protested about overly strict rules and knowledge-intensive practices. Following this change, the participation in IP groups increased to 60% of growers. However, the shift of responsibility from the state to the industry and the relaxed regulations weakened the IP tool and strategy development.

The 3.7-fold increase in organic farmers and 10-fold increase in percentage of organic agricultural area from 1988 to 1995 caused a niche-or-mainstream conflict of interest within the OF association (Rydén 2003). It had to act in favor of its members, who would benefit economically from being a niche market with premium-price products (Rydén 2003). It also aimed at transforming the entire agricultural production system to a more environmentally friendly concept (Rydén 2003) and making organic food available at reasonable prices (Milestad et al. 2008). Since OF worked within the same competitive market concept, including more farmers would continue the treadmill (Rydén 2003). However, the OF did not wish to abandon the second task and chose to implement it by cooperating with, rather than resisting, the dominant LRF (Rydén 2003). The conflict kept re-emerging, while the solution remained to increase sustainability in all agriculture and simultaneously

modify the organic standards to become increasingly strict and hence keep the price premium and higher environmental subsidies.

The sudden organic upswing also caused a distribution crisis. The organic food system had not developed its own food distribution system, regulated by rules based on organic principles, that could handle a large part of the national production (Rydén 2003). It has been internationally confirmed that farmers converting to organic production simply continued with the conventional food chains with which they had co-evolved in previous decades, developing specialist, large-scale, industrial bulk production of standard quality (Allen and Kovach 2000; Darnhofer 2014; Goodman 2000; Raynolds 2004). Additionally, larger-scale producers, processors, wholesalers, and retailers saw an opportunity in this growing niche market. Their domination of the food chain, together with a consumer preference for shopping in the associated supermarkets, has pushed prices down and is associated with large environmental costs for transportation, storage, and waste (Darnhofer 2014).

During the 1990s, resource management and recycling of nutrients began to gain more attention in OF (Domeij 1995; Milestad et al. 2008). Farmers often felt forced to compromise long-term sustainability and resilience of the farm for short-term profitability (Darnhofer et al. 2010a). To fully integrate organic principles with economic viability, societal commitment was needed, for example, the recirculation of nutrients, renewable energy and fuel, and reimbursement for managing common goods, (Darnhofer et al. 2010b; Domeij 2007; Kahilouto et al. 2005). Lacking such support, many first-wave organic farmers experienced heavy price pressure and were outcompeted by the farmers producing according to OF regulations, but using rationalized practices motivated by profit maximization principles (Allen and Kovach 2000). Land speculation and alternative economic activities were also a threat.

OF with its price premiums and the conventional food chains offered a means of survival for some conventional and first-wave organic farmers (Darnhofer et al. 2010b; Rydén 2003). This solution created a hybrid system, *intensive OF*, where some actions caused contradictions between socioecological principles and rationalization and profit maximization principles (Allen and Kovach 2000; Darnhofer 2014). This normally required specializing in fewer crops, increasing external inputs, and mechanization to manage labor peaks (Darnhofer et al. 2010b).

At this time organic apples, with a few exceptions, were not grown using the intensive rationalized methods required by the food industry. A review of organic apple production (Pettersson 1994) revealed that it was not adapted to supply the high yields, low labor demands, and standardized quality required by the intensive OF concept.

The PAR project interviews and group meetings confirm this historical development. The first specialist organic apple farm was probably initiated in

the early 1990s in central Sweden. This farm was an intermediate step between first-wave and intensive OF. From around the turn of the century, the number of intensive organic apple farms slowly increased both in numbers and in size. These farms follow the general design of IP orchards, use biological control, pesticides based on natural compounds, are mechanized, and have a high focus on increased productivity and bulk sales to wholesalers. They actively seek collaborative learning together with extension workers and researchers to minimize ecological disturbances and increase productivity based on scientific and experience-based ecological knowledge.

By 2009, both the economic value of agronomic crops and the number of farmers had decreased by 50% compared with 1975 (LRF 2010). The resistance to OF was increasing from advocates who claimed that OF was no more sustainable than IP and not capable of feeding the world due to its low yields (Rydén 2003). There is also criticism that some intensive OFs practices do not fulfill the principles of OF and sustainability (Rigby and Cáceres. 2001). When organic farms adopt rationalization principles with specialization and long food chains, they lose much of their power to be strong engines for rural development and food sovereignty in their communities (Darnhofer 2014; Goodman 2000; Milestad, Ahnstrom, and Bjorklund 2011). It became common to employ nonunionized, casual, and cheap labor (Goodman 2000). The alienation between producers and consumers began creating a low understanding of production conditions and hence made informed choice difficult (Allen and Kovach 2000). The higher prices of organic food, together with low incomes of the unemployed, students, retired people, and lower-valued professions, make healthier and environmentally friendly food inaccessible for these groups (Agricultures Network 2015).

Several authors investigating both Swedish and European settings, for example, Björklund and Johansson (2010) and Darnhofer et al. (2010b), argue that when OF moves from a high level of local self-sufficiency of renewable inputs to specialization with increased mechanization, it creates similar, although not as extensive, problems as found in conventional production. The levels of resource use with energy-intensive inputs increase, and cause related problems such as a decrease in biodiversity. Long food chains and regional specialization increase the problem of closing the nutrient cycles and global warming due to fossil fuel-based transportation (Darnhofer 2014). Unsustainable use of oil, coal, and phosphorus is not ultimately solved by intensive OF practices in conjunction with conventional food chains (Aleklett and Campbell 2003; Bentley, Mannan, and Wheeler 2007; Rigby and Cáceres. 2001). Monocultures and extensive use of reactive solutions to pests and nutrient supply, instead of preventive solutions, are causing low ecological resilience and higher dependence on external inputs such as (botanical and mineral) pesticides to achieve high yields (Altieri, Funes-Monzote, and Petersen 2012; Ponisio et al. 2015).

At the same time, Darnhofer (2014) points out that there is increased awareness about global warming. Therefore, conventional growers have started branding themselves within the local food trend as climate-smart and good for rural development. This increases the competition for organic farmers, while at the same time it offers a critical mass able to advocate for supporting local production.

2000–2013: De-coupled production and ecology of food systems

At the start of the 21st century, the focus of the EU common agricultural policy (CAP) was on decreased overproduction, partial deregulation, and support for environmental practices and rural development (EU 2012). A strong underlying motive was the expected increase in EU agricultural subsidy costs with the entry of Central and Eastern European countries (SLI 2001). Food prices were lowered, and in 2003 agricultural subsidies were partially decoupled from production and more based on area size and environmental actions, causing land prices to increase (Brady, Ekman, and Rabinowicz 2010; LRF 2010). The CAP from 2013 totally decoupled agricultural subsidies from productivity. They were now entirely based on area, basic agro-environmental practices or putting land out of production, and rural development (EU 2013). According to Darnhofer et al. (2010b), these changes exemplify a shift toward multifunctionality and an ecological sustainability discourse in society.

Some farmers have looked for alternatives to the problems related to CF and food chains that will allow for profitability and still advance the principles of multifunctionality and ecological sustainability. This development builds on redesigning the food system to be based on community food sovereignty and sharing of knowledge, machinery, labor, and risks in a new type of localized rural–urban community involving growers, consumers, and other food chain actors (Feagan 2007). Examples of new tools within this emerging food system are, for example, community-supported agriculture (DuPuis 2006; Milestad and Kummer 2012) and participatory guarantee systems (Källander 2011). These communities appear to be geographically localized to create tighter social relations and to facilitate the development of increased resource cycling and decreased pollution caused by, for example, transportation. These are not traditional farming village-based communities, but rather rural–urban regional communities where the distinction between producer and consumers is blurred and the specialist food chain activities become re-integrated into one activity system. Research on Swedish experiences has shown that selling locally is a driving force for increased on-farm biodiversity (Björklund et al. 2009). The use of local renewable resources and proactive farming practices are also important strategies (Altieri 1995). Similar emerging and experimenting development is occurring worldwide under the name of "agroecology" (IAASTD 2008; Wezel et al. 2009).

Agroecology has evolved from a study of ecological interactions in the field to a farm-level redesign and, since the turn of the century, redesign of the whole food system and reintegration of specialist activities into one concept, called "ecology of food systems", where rural–urban development, food production, and ecological principles all merge under the concept of food sovereignty (Patel 2009; Wezel et al. 2009).

Our interviews and meetings with four advisors and five Danish and five Swedish organic farmers showed that a few appear to follow some of the principles of ecology of food systems. These are often, but not always, smaller farms rather than intensive OF farms. Apples may only be one crop among many on these farms, and income is diversified through food processing or nonagricultural activities. Expensive external inputs are minimized and in some cases totally excluded. The farmers have a direct relationship with their customers and most or all of their production is sold through direct sales. The extent to which these farms are involved in cooperation with other farmers and share risks with consumers, or rather community members, in community-supported agriculture schemes remains to be investigated. The differences between this OF concept and that of intensive organic apple production are sometimes perceived, by the farmers themselves, as being too large for them to benefit from collaborative learning and development.

Theoretical farming concepts

The purpose of our theory-historical analysis was to discover how empirical historical farming concepts have emerged and developed and the key principles making the concepts viable, particularly focusing on the dilemma of achieving ecological principles and profitability at the same time. Figure 4 illustrates the timeline of farming concepts suggested by our research. Traditional farming preceded these.

Based on the historical narrative, we present Tables 1 and 2, which add to the theoretical concepts by summarizing commonly occurring and important

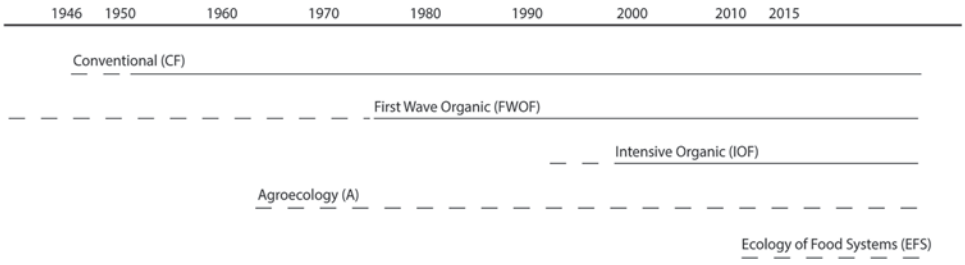

Figure 4. Timeline of Swedish farming concepts. Dashed lines represent a period of design or decline of a concept. The design phase may have partly occurred outside Sweden and gradually entered Swedish development. A full line after a dashed line represents a Swedish consolidation phase of a concept.

Table 1. Traditional and conventional farming concepts presented with the most prominent characteristics of their activity system (AS) elements and main principles making the production viable.

Element of the AS	Traditional farming (TF)	Conventional farming (CF)
Subject	Traditional farmer family as member of rural community	Specialized rational farmer
Object (functions)	Food production mainly for local community, agroecosystem, family and local rural community, rural culture	Food production and farmers
Desired outcomes	Food and reproduction and development of rural culture and social services for the family and local community	Increased productivity to assure food at affordable prices to low income consumers and fair income to farmers at a national scale
Undesired outcomes	Relatively high demand of labor and physically demanding work	Surplus production and high state costs, rural exodus, broken ecological cycles, pollution, loss of food sovereignty
Tools	Reproduction and development of natural resources and ecosystem services through, for example, improvement of soil fertility, robust locally adapted varieties, diversification, and crop rotation. Handicraft and local knowledge, manual labor and limited mechanization, experiential learning farmer to farmer	Land concentration, mechanization, monocultures, improved varieties, chemical pesticides and fertilizers, transfer of technology tools, productivity subsidies
Rules	Community norms, cultural traditional knowledge, and local agricultural and natural processes.	Land concentration to rational farmers, price negotiations, protectionist politics
Community	Rural community dominated by farmers	Network of activity systems, principally the state, state advisors, reductionist scientists
Division of labour	Local collaborations, diversification, local food chains	Specialization, long food chains, the state takes the production risk, price negotiations farmers and state, transfer of technology through state advisory system
Principles	Agroecosystemic approach to farming, economy of scope, independence, resilience, and multifunctionality	Agrotechnological approach to farming, economy of scale, specialization, concentration of land, and external resources

properties according to *the elements* of a general activity system and the *main principles that make them compatible and the concept viable*. Agroecology is merged here into the ecology of food systems concept. These characteristics are further analyzed when constructing the developmental dimensions in the next step.

On charting how and why the objects and remaining structures of the different concepts developed, two conclusions can be drawn. The number of functions that farming is expected to fulfill and the importance of following ecological principles, and hence the strength of the dilemma between ecological sustainability and short-term profitability, vary between the farming activity systems. Hence the key principles making their production viable

Table 2. First wave organic, intensive organic, and ecology of food system farming concepts presented with the most prominent characteristics of their activity system (AS) elements and main principles making the production viable. The description of ecology of food systems activity is tentative, since it is a recently emerging activity.

Element of the AS	First wave organic farming	Intensive organic farming	Ecology of food system (tentative activity and elements)
Subject	Multifunctional organic farmer as organic farming movement member	Specialized organic farmer as commodity producer on the open market	Multifunctional organic farmer as rural–urban community member
Object	Food production for mainly local/regional markets, local and global environment, rural communities	Added value food as a commodity for a niche on the global open market, global resources, local and global environment	Food production mainly for local to regional rural–urban communities, agroecosystem, local resources, local and global environment and communities
Desired outcomes	Healthy food mainly for local markets. Reproduction and development of local and global natural resources and ecosystem services. Fair income and working conditions for farmers and rural development	Healthy food, high productivity to keep competitive prices and increase profits, reproduction and development of local and global natural resources	Healthy food from environmentally friendly and socially just production accessible to all, reproduction and development of natural resources and ecosystem services, rural–urban community food sovereignty, fair working conditions and income to farmers, development of rural–urban culture
Undesired outcomes	Relatively high labor demand, limited distribution/accessibility to consumers	Broken ecological cycles, loss of food sovereignty, rural exodus, limited distribution/accessibility to consumers	Labor demanding social organization?
Tools	Crop rotations, robust varieties, local nutrient cycling, conservation biological control, botanical and mineral (non-synthetic) pesticides, systemic and PSARD[1] tools	Land concentration, mechanization, specialization on few crops in separate monoculture fields, improved varieties, crop rotation, botanical and mineral (non-synthetic) pesticides, inundative and inoculative biological control, local nutrient cycling and/or external biological fertilizers, and PSARD[1] tools	Land and labor sharing, polyculture, crop rotation, robust locally adapted varieties, biodiversity management, conservation biological control, local renewable resources for nutrient cycling, energy management and pest management, and PSARD[1] tools

(*Continued*)

Table 2. (Continued).

Element of the AS	First wave organic farming	Intensive organic farming	Ecology of food system (tentative activity and elements)
Rules	Organic principles and certification rules, price negotiations farmers and the State, protected markets, price premium for added value, environmental and production subsidies	Organic principles and certification rules, price premium for added value, EU organic rules, environmental regulations, environmental and area subsidies, and free market competition	Agroecological principles and participatory guarantee systems, environmental regulations, environmental and rural development reimbursement
Community	Mainly collaborative with multifunctional farmers, rural community members, advisors, and systemic scientists. Network of AS with the state and reductionist scientists	Mainly network of AS with specialized organic farmers, consumers on free market, food chain actors, private advisors, reductionist scientists, the state or EU. Collaborative with advisors, systemic scientist	Mainly collaborative with multifunctional farmers, rural and urban community members, advisors and systemic scientists. Network of AS with the state/EU and reductionist scientists
Division of labour	Diversification, local food chains, local collaborations, state takes the production risk, and PSARD[1]	Specialization, long food chains, international competition, niche market focus, and PSARD[1]	Collaboration sharing risk and labor in rural and rural–urban communities, localized, diversified, and integrated food chains, and PSARD[1]
Principles	Agroecosystemic approach to farming, mainly economy of scope, mainly local renewable resource use, multifunctionality, resilience	Hybrid agroecosystemic/technological approach to farming, mainly economy of scale, intensification, niche market focus, specialization, concentration of land and some external resources	Agroecological approach to farming, localization, rural–urban collaboration, local renewable resource use, multifunctionality, resilience, mainly economy of scope, economy of scale through cooperation

[1]*PSARD = participatory systemic action research and development.*

differ, and profitability is achieved by different means depending on how the purpose of farming is perceived.

We suggest that two *developmental dimensions* can be discerned: (1) level of multifunctionality and (2) level of ecological sustainability. The first dimension spans from a few decoupled functions dominated by the productivity function to integration of multiple functions. The latter developmental dimension consists at one extreme of short-term use of global resources, which are dislocated from their geographical origin and concentrated to the farm, breaking with their natural cycles and causing pollution. At the other extreme is sustained use of local renewable resources in accordance with their natural cycles.

When farming is attributed to few functions (or aspects of the object) and outcomes, such as producing food and maximizing profits, profitability is achieved mainly by economies of scale through specialization, mechanization, concentration of land productivity, land subsidies, and replacing labor with external inputs.

The more functions and outcomes farming is perceived to have and produce, the more diverse the methods of achieving profitability. Different functions, such as food sovereignty, healthy and environmentally friendly food, and rural development, are integrated in various ways and given different emphasis in each activity's object. Profitability in multifunctional farming is achieved not simply by increasing productivity and selling more of the same products, but mainly by economies of scope, cooperation, strengthening the local resources and ecosystem services, nonagricultural services to the community, rural development subsidies, tourism, direct sales, and sharing of risks.

The location of historical farming concepts in the developmental dimensions is shown in Figure 5. The placement of the activities is related to the

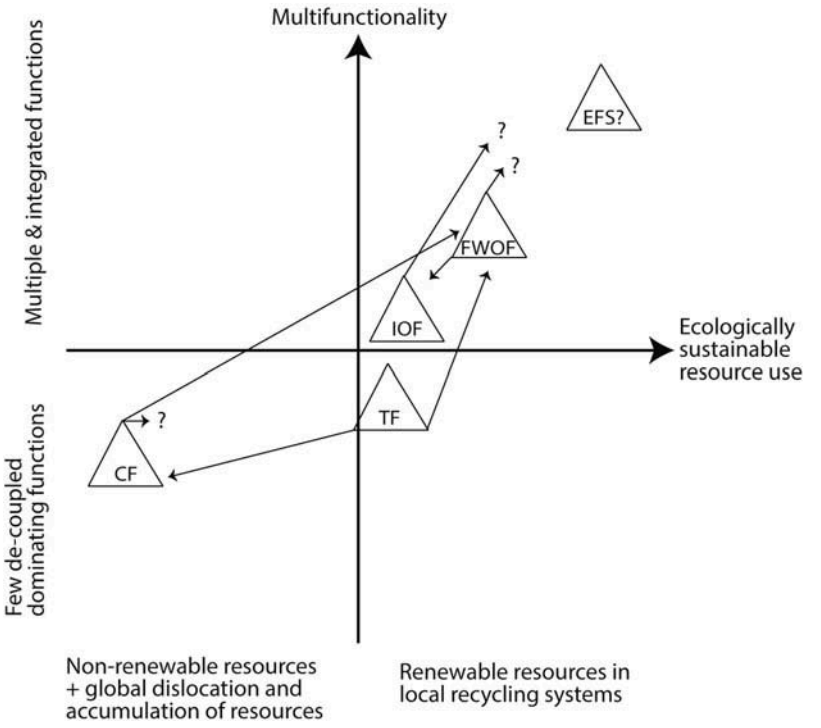

Figure 5. The historical dimensions of Swedish farming. Triangles represent historical farming concepts and arrows their movements within the dimensions. Concepts in approximate order of historical appearance: TF: traditional farming; CF: conventional farming; FWOF: first-wave organic farming; IOF: intensive organic farming; EFS: ecology of food systems. EFS is an emerging activity system in an early development phase. The distance of concepts from axes is qualitatively defined for easy visual comprehension.

first dimension of the level of multifunctionality that is an *explicit* part of each activity, and to the second dimension of how amply and strictly they adhere to ecological principles. While traditional farming was rather multifunctional, it mainly addressed the needs of the immediate family and the rural community. CF addressed the dilemma of achieving profitability and socioecological sustainability by rejecting the importance of the two developmental dimensions and focusing only on the needs of the individual farmer and the need to provide cheap food to low-wage industrial workers. This involved a regression in the developmental dimensions. In the first-wave OF, the importance of the dimensions was strengthened and more needs were addressed, particularly health and ecological sustainability. Intensive OF regressed somewhat due to the strengthening of the dilemma between profitability and socioecological sustainability driven by the competitive mechanisms of the treadmill. Ecology of food systems involves barely developing and strives to solve this dilemma by creating new social relations that will address a wider set of needs of a wider rural–urban community and by building long-term productivity and resilience through strengthening natural resources and ecosystem services. Naturally, this conceptual abstraction requires a simplification and in real life individual farms may be spread over a wider area of the developmental dimensions, even if they identify with one of the concepts.

Discussion and conclusions

The historical narrative analyzed with the help of the activity system-based framework including elements (subject, object, tools, rules, community, and division of labor) and developmental dimensions suggests that the key characteristic of the object of Swedish OF is to fulfill more societal needs (multifunctionality) than *CF* and that the expected outcomes include a development toward ecological sustainability. The objects of the OF concepts differ in the amount of societal needs they address, as do the expected outcomes of each OF concept. This needs to be considered when they are compared. These developmental dimensions have much in common with those identified by Seppänen (2002) in Finnish OF, particularly the dimension spanning from short-term and intensive use of resources to ecological and sustainable use of resources. Although Seppänen's dimension of societal integration bears some resemblance to the multifunctionality dimension, it appears to stem from a more recent historical learning challenge related to adaptation of Finnish farming to a more deregulated market on joining the EU. According to our historical analysis, the object of farming at that time was already reduced compared with in earlier OF and the emerging "ecology of food system" approach. The longer time span in our study revealed the broader second developmental dimension spanning from few decoupled, productivity-dominated

functions of farming to multiple, integrated functions responding to more societal needs.

The proposed framework allows for analysis of whether either a single concrete farm or a new concept of OF is experiencing conventionalization, by examining the content of its activity system elements and the historical trajectory. If a farm or a new concept of OF decreases in multifunctionality and ecological sustainability, this means a regression toward the CF concept. If a farm strategy or OF concept emerges due to similar dilemmas and developmental drivers, and is made viable to a large extent based on the same principles as in CF, this is also an indicator of conventionalization. The principles will be manifested in all the structural elements of that concrete farm or concept. Hence, we argue that if this framework of classifying OF theoretical concepts were integrated with frameworks for directly observable farm level indicators, as suggested by Darnhofer et al. (2010b), it would allow for a more comprehensive and systemic comparison between concepts. However, indicators should address the full food chain to include aspects such as pollution from transportation, level of resource recycling, food sovereignty, and others.

The case study of Swedish OF and apple production to which we applied the analytical framework suggested that the developmental drivers of first-wave OF were the social and environmental dilemmas and undesired outcomes produced in CF. The object of farming changed from being central to rural life, while its multiple functions became reduced to food production. Food sovereignty became lost from the object, as farmers had increasingly less influence in shaping food systems and rural areas. This process has been confirmed internationally (Allen and Kovach 2000; Guthman 2004; Patel 2009). The material aspect of CF, namely its natural resource base and its associated ecosystem services essential to farming, began degrading (MEA 2005). The first-wave OF solution was to incorporate environmental sustainability and rural development into its object and develop new rules, tools, and division of labor partly based on similar principles as in traditional farming.

The historical events in our empirical case study appear to support the treadmill theory (Gould, Pellow, and Schnaiberg 2004; Levins and Cochrane 1996), which in turn explains an important driving force of the conventionalization process. Three main historical factors appear to have pushed Swedish first-wave OF onto the agricultural treadmill: (1) the commoditization and deregulation of farming brought about by a strong neoliberal trend from the late 1980s, (2) a rapid increase in conventional farmers converting to OF as a solution to the treadmill and supported by environmental subsidies, and (3) the lack of an alternative distribution system based on new social relations and organic principles and capable of managing an increasing proportion of organic food. These factors are clear manifestations of the tension between the use and exchange value of farming, and have been identified also in other countries (Best 2008;

Glin, Mol, and Oosterveer 2013; Guthman 2004). First-wave OF was exposed to the same price-pressing mechanisms as CF and, since it did not alleviate this contradiction by creating an alternative food system, it was only able to keep high prices as long as it stayed a niche market and developed into the intensive OF concept. Public financial support resulted in a rapid increase in the amount of certified organic farmers, as confirmed in many European countries (Best 2008; Michelsen 2001), with export demand appearing to be the driver in, for example, New Zealand (Campbell and Liepins 2001) and price premiums, together with high land values, being the driver in California (Guthman 2004).

According to the founders of the conventionalization theory (Buck, Getz, and Guthman 1997), OF is divided into two main developmental directions; an industrial profit-maximizing and market-oriented type, and a small-scale, diversified, and localized type, with the former increasingly dominating the scene. Some critics of the conventionalization theory (Campbell and Liepins 2001; Michelsen 2001) allege that its founders regard conventionalization as inevitable and universal, whereas they and other authors merely point to the limitations of market forces and hence the need for political changes to prevent conventionalization in the long run (Allen and Kovach 2000; Guthman 2004). Our analytical framework captured this issue by showing how deregulation and entry of agriculture into free trade agreements unleashed the treadmill pushing the conventionalization process.

According to the treadmill theory (Levins and Cochrane 1996; Röling 2009), as soon as an innovation (such as OF) becomes mainstream the prices go down, and hence also the price premiums supporting the more expensive sustainable practices. Therefore, technical innovations may slow the treadmill, although ultimately the treadmill drives OF to either stay as a market niche or lower standards in order to lower costs (Obach 2007). A similar process has been described for Californian OF (Guthman 2004). In the less capitalistic agro-political setting of West Germany, Best (2008) found only early signs of such a process, although no longitudinal studies were performed of structural changes on early converting farms.

The exclusion of developmental drivers and contextual differences, such as the presence of public financing, from the concepts of OF has created confusion in attempts to generalize on the extent of conventionalization (Guthman 2004; Michelsen 2001). Our suggested analytical framework could alleviate the confusion by incorporating these factors into the theoretical concept itself. The emergence and domination of intensive OF in Sweden shows that public financial support, at least as it has been shaped so far, has not been able to solve the contradiction manifested as the treadmill. This imbalance between the force of the treadmill and limited public policy measures or civil society actions has been emphasized elsewhere as a problem not solely for agriculture, but for production in general (Gould, Pellow, and Schnaiberg 2004). Hence, the treadmill continues driving the

conventionalization process by the price-pressing mechanism of competition and resulting intensification. Others challenge this hypothesis, claiming that the two types of OF can be complementary (Coombes and Campbell 1998; Darnhofer 2014). Our proposed analytical framework solves these contradictory views by showing that theoretical OF concepts and their principles may well be in contradiction, while concrete farms can employ elements from both at a single point in time. However, activity systems are constantly evolving and hence it is crucial to understand their developmental drivers in order to predict their direction. The dominant principles that make both individual "mixed concept" farms and mainstream farming viable on a societal level will be dominated by one of the concepts, due to the dependency on the macro-political level or the activity system network. Our suggested framework provides a tool for connecting on-farm practices (tools) to the macro-political level (rules, division of labor, and developmental dimensions) when comparing the different farm strategies for achieving profitability depending on their object.

The ecology of food systems concept is trying to solve the treadmill contradiction and avoid conventionalization by experimenting with its division of labor element through new rural–urban relations in Sweden and internationally (DuPuis 2006; Milestad and Kummer 2012). This involves various forms of collaboration in order to create not only economy of scope, but also economy of scale, based on multifunctionality instead of specialization and resource concentration within the developmental dimensions (Pereira-Querol, Seppänen, and Virkkunen 2014). It also involves the sharing of risks and labor, aiming at greater short-term economic stability that allows larger short-term variability in production results, but long-term resilience related to organic practices. It remains to be seen whether it can influence the macro-political level (DuPuis and Gillon 2009).

The key characteristics found for the activity system elements of Swedish OF concepts, and hence the indicators of conventionalization, are generalizable to other contexts to the extent that similar developmental drivers have resulted in concepts based on similar principles. The concrete expressions of the structural elements, such as rules and tools, will be adapted to the local specific context. However, the abstract level of the analytical framework (activity system elements and developmental dimensions) can be employed in any setting and used to compare settings. This will be necessary in determining to what extent the treadmill theory explains the conventionalization process, for example, different crops and geographical and sociopolitical settings.

Activity theory also allows for a more in-depth and future-oriented analysis of the contradictions that drive the development process and whether principles such as specialization and concentration of land and resources are in contradiction with the object and desired outcomes of some OF concepts,

such as food sovereignty and recycling of renewable resources. This will be the subject of a future paper.

A distinguishing aspect of the ecology of food systems concept is its object expansion into the wider food network. This calls for further inquiries into whether the activity system, or perhaps the activity system network, should be the smallest unit of analysis when developing a theoretical concept. We expect that future formative interventions into concrete manifestations of the ecology of food systems concept can shed some light on this issue.

Notes

1. Such as nutrient and CO_2 balance, biodiversity level, level of external inputs, and crop rotation.
2. Such as value chain organization, systems of learning and innovation, and price setting mechanisms.
3. A value chain is the process or activities by which a company or a network of companies adds value to an article, including production, marketing, and the provision of after-sales service.
4. Divided into object, subject, tools, community, rules, and division of labor; see further explanation in the section "Theoretical Framework".
5. The general components of a conceptual farm(ing) system.

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References

Agricultures Network. [Webpage]. Accessed April 18, 2015. http://www.agriculturesnetwork.org/magazines/global/towards-fairer-trade/growing-a-local-organic-movement-the-mexican/at_download/article_pdf.

Aleklett, K., and C. J. Campbell. 2003. The peak and decline of world oil and gas production. *Minerals & Energy* 18:5–20. doi:10.1080/14041040310008374.

Allen, P., and M. Kovach. 2000. The capitalist composition of organic: The potential of markets in fulfilling the promise of organic agriculture. *Agriculture and Human Values* 17 (3):221–32. doi:10.1023/A:1007640506965.

Altieri, M. A. 1995. *Agroecology – The science of sustainable agriculture*, 2nd ed. UK: Westview Press.

Altieri, M. A., F. R. Funes-Monzote, and P. Petersen. 2012. Agroecologically efficient agricultural systems for smallholder farmers: Contributions to food sovereignty. *Agronomy for Sustainable Development* 32 (1):1–13. doi:10.1007/s13593-011-0065-6.

Bentley, R. W., S. A. Mannan, and S. J. Wheeler. 2007. Assessing the date of the global oil peak: The need to use 2P reserves. *Energy Policy* 35 (12):6364–82. doi:10.1016/j.enpol.2007.08.001.

Best, H. 2008. Organic agriculture and the conventionalization hypothesis: A case study from West Germany. *Agriculture and Human Values* 25 (1):95–106. doi:10.1007/s10460-007-9073-1.

Björklund, J., and B. Johansson. 2010. Assessing multifunctionality in relation to resource use: A holistic approach to measure efficiency, developed by participatory research. Building sustainable rural futures: The added value of systems approaches in times of change and uncertainty. 9th European IFSA Symposium, Vienna, Austria, July 4–7, 2010.

Björklund, J., L. Westberg, U. Geber, R. Milestad, and A. Johan. 2009. Local selling as a driving force for increased on-farm biodiversity. *Journal of Sustainable Agriculture* 33 (8):885–902. doi:10.1080/10440040903303694.

Brady, M., S. Ekman, and E. Rabinowicz. 2010. Impact of decoupling and modulation in the EU. Working paper 2010:2. Agrifood Economics Center. OECD Workshop on the Disaggregated Impacts of CAP Reform 10–11 March 2010, Paris, France.

Buck, D., C. Getz, and J. Guthman. 1997. From farm to table: The organic vegetable commodity chain of northern California. *Sociologia Ruralis* 37 (1):3–20. doi:10.1111/soru.1997.37.issue-1.

Bylaw. 1967:425. Förordning (1967:425) med instruktioner för lantbruksstyrelsen och lantbruksnämnderna. Agricultural Board. Accessed March 20, 2015. http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Forordning-1967425med-inst_sfs-1967-425/.

Bylaw. 1988:854. /r1/Förordning (1988:854) med instruktion för lantbruksstyrelsen och lantbruksnämnderna. Agricultural board. Accessed March 20, 2015. http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/r1-Forordning-1988854med_sfs-1988-854/?bet=1988:854.

Campbell, H., and R. Liepins. 2001. Naming organics: Understanding organics standards in New Zealand as a discursive field. *Sociologia Ruralis* 41 (1):21–39. doi:10.1111/1467-9523.00168.

Coombes, B., and H. Campbell. 1998. Dependent reproduction of alternative modes of agriculture: Organic farming in New Zealand. *Sociologia Ruralis* 38 (2):127–45. doi:10.1111/soru.1998.38.issue-2.

Darnhofer, I. 2014. Contributing to a transition to sustainability of agri-food systems: Potentials and pitfalls for organic farming. In *Organic farming, prototype for sustainable agricultures*, edited by S. Bellon, and S. Penvern, 439–52. Dordrecht: Springer.

Darnhofer, I., S. Bellon, B. Dedieu, and R. Milestad. 2010a. Adaptiveness to enhance the sustainability of farming systems. A review. *Agronomy for Sustainable Development* 30 (3):545–55. doi:10.1051/agro/2009053.

Darnhofer, I., T. Lindenthal, R. Bartel-Kratochvil, and W. Zollitsch. 2010b. Conventionalisation of organic farming practices: From structural criteria towards an

assessment based on organic principles. A review. *Agronomy for Sustainable Development* 30 (1):67–81. doi:10.1051/agro/2009011.

Davydov, V. V. 1990. *Soviet studies in mathematics education. Types of generalization in instruction: Logical and psychological problems in structuring school curricula*, Vol. 2. Reston Virginia: National Council of Teachers of Mathematics.

Domeij, Å. 1995. Vägar till framtidens jordbruk. Aktuellt från Lantbruksuniversitetet. Accessed April 9, 2015. http://www.vaxteko.nu/html/sll/slu/aktuellt_fr_slu/ALU432/ALU432.HTM.

Domeij, Å. 2007. Lantbruket och människan – en studie av sociala effekter av ekologisk produktion. Accessed April 4, 2014. http://www.slu.se/Documents/externwebben/centrum bildningar-projekt/epok/Publikationer/Sociala_effekter_2007.pdf.

DuPuis, M. E. 2006. Civic markets: Alternative value chain governance as civic engagement. Organic Agriculture: Innovations in Organic Marketing, Technology, and Research: Introduction to the Proceedings, Washington D.C., USA, 6-7 October 2005. Crop Management Issue September, 1–7.

Encyclopedin. 2015. Jordbrukspolitik. Accessed March 31, 2015. http://www.ne.se/uppslagsverk/encyklopedi/lång/jordbrukspolitik.

Engeström, Y. 2001. Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work* 14:122–56. doi:10.1080/13639080020028747.

Engeström, Y. 2005. *Developmental work research: Expanding activity theory in practice*. Berlin: Lehmanns Media.

Engeström, Y. 2015. *Learning by expanding: An activity-theoretical approach to developmental research*. 2nd ed. In *Learning by expanding: An activity-theoretical approach to developmental research*, 2nd ed., Cambridge: Cambridge University Press.

EU. 2012. The common agricultural policy. A story to be continued. Accessed May 16, 2015. http://eur-lex.europa.eu/legal-con-tent/EN/TXT/PDF/?uri=CELEX:31988L0361&from=SV.

EU. 2013. Overview of CAP reform 2014-2020. Agricultural Policy Perspectives Brief. Accessed May 15, 2015. http://ec.europa.eu/agriculture/policy-perspectives/policy-briefs/05_en.pdf.

EU Council Directive. 88/361/EEC. Accessed June 23, 2015. http://eur-lex.europa.eu/legal-con-tent/EN/TXT/PDF/?uri=CELEX:31988L0361&from=SV.

Feagan, R. 2007. The place of food: Mapping out the 'local' in local food systems. *Progress in Human Geography* 31 (1):23–42. doi:10.1177/0309132507073527.

Foot Whyte, W. 1991. Participatory strategies in agricultural research and development. In *Participatory action research*, edited by W. F. Whyte, 169–78. London: Sage Publications.

Glin, L. C., A. P. J. Mol, and P. Oosterveer. 2013. Conventionalization of the organic sesame network from Burkina Faso: Shrinking into mainstream. *Agriculture and Human Values* 30 (4):539–54. doi:10.1007/s10460-013-9435-9.

Goodman, D. 2000. Organic and conventional agriculture: Materializing discourse and agro-ecological managerialism. *Agriculture and Human Values* 17 (3):215–19. doi:10.1023/A:1007650924982.

Gould, K. A., D. N. Pellow, and A. Schnaiberg. 2004. Interrogating the treadmill of production everything you wanted to know about the treadmill but were afraid to ask. *Organization & Environment* 17 (3):296–316. doi:10.1177/1086026604268747.

Granstedt, A., H. Bovin, K.-Å. Brorsson, V. Lund, and Å. Rölin. 1998. *Ekologiskt lantbruk – fördjupning*. Natur och Kultur/LTs förlag.

Guthman, J. 2004. The trouble with 'organic lite' in California: A rejoinder to the 'conventionalisation' debate. *Sociologia Ruralis* 44 (3):301–16. doi:10.1111/soru.2004.44.issue-3.

Höglin, S. 1998. *Agrarhistorisk landskapsanalys över Norrbottens län. Länsöversikt*. In Lanskapsprojekt. Accessed April 20, 2015. http://raa.se/publicerat/rapp2008_5.

IAASTD. 2008. International assessment of agricultural knowledge, science and technology for development. Accessed May 13, 2015. http://www.unep.org/dewa/assessments/ecosystems/iaastd.

Kahilouto, H., P. G. Berg, A. Granstedt, H. Fischer, and O. Thomsson. 2005. The power of local – sustainable food systems around the Baltic Sea. Interdisciplinary Synthesis of the Baltic Ecological Recycling Agriculture and Society (BERAS) project No. 7. http://www.slu.se/Documents/externwebben/centrumbildningarprojekt/epok/Publikationer/BERAS_slutrapport.pdf.

Källander, I. 2011. Participatory guarantee systems – PGS. Accessed January 4, 2015. http://www.docstoc.com/docs/102064237/Participatory-Guarantee-Systems-C-PGS.

Kallio, K. 2010. The meaning of physical presence: An analysis of the introduction of process software in a chemical pulp mill. In *Activity theory in practice. Promoting learning across boundaries and agencies*, edited by H. Daniels, A. Edwards, Y. Engeström, and T. Gallagher, 25–48. London: Routledge.

Kjörling, L. 2011. *Naturbruksupproret – lokal och global kamp för jord, skog och hav*. Göteborg: Jordens Vänner.

Klonsky, K. 2000. Forces impacting the production of organic foods. *Agriculture and Human Values* 17 (3):233–43. doi:10.1023/A:1007655312687.

KRAV historik. Accessed May 3, 2015. www.krav.se/historik.

KSLA. 2015. Det svenska jordbrukets historia. Band 5 kap. 7 Grödor och husdjur. The Royal Swedish Academy of Agriculture and Forestry (KSLA). Accessed March 31, 2015. http://www.ksla.se/anh/files/2012/06/Inneh%C3%A5llsf%C3%B6rteckning-band-5.pdf.

Latruffe, L., and C. Le Mouel 2006. Description of agricultural land market functioning in partner countries. Accessed May 5, 2015. http://www.agrifood.se/idema/WPs/IDEMA_deliverable_9.pdf.

Launis, K., and J. Pihlaja. 2007. Changes in production concepts emphasize problems in work-related well-being. *Safety Science* 45:603–19. doi:10.1016/j.ssci.2007.01.006.

Levins, R. A., and W. W. Cochrane. 1996. The treadmill revisited. *Land Economics* 72 (4):550–53. doi:10.2307/3146915.

LRF. 2010. Nya vägar till matmarknaden – nulägesanalys, utveckling av LRFs livsmedelsstrategi. LRF. Accessed Maj 15, 2015. www.lrf.se.

MEA. 2005. Ecosystems and human well-being. Synthesis. Millenium ecosystem assessment. Accessed November 21, 2008. http://www.millenniumassessment.org/en/index.aspx.

Melanie, D. E., and S. Gillon. 2009. Alternative modes of governance: Organic as civic engagement. *Agriculture and Human Values* 26 (1–2):43–56. doi:10.1007/s10460-008-9180-7.

Memorandum. 1992/93:LU15. Utländska förvärv av fast egendom. Riksdagen. Accessed June 23, 2015. http://www.riksdagen.se/sv/Dokument-Lagar/Utskottens-dokument/Betankanden/199293Utlandska-forvarv-av-fa_GG01LU15/.

Michelsen, J. 2001. Recent development and political acceptance of organic farming in Europe. *Sociologia Ruralis* 41 (1):3–20. doi:10.1111/soru.2001.41.issue-1.

Miettinen, R. 2000. Ascending from the abstract to the concrete and constructing a working hypothesis for new practices. In *Evald Ilyenkov's philosophy revisited*, edited by V. Oittinen. Helsinki: Kikimora Publications.

Miettinen, R. 2005. Object of activity and individual motivation. *Mind, Culture and Activity* 12 (1):52–69. doi:10.1207/s15327884mca1201_5.

Milestad, R., M. Wivstad, V. Lund, and U. Geber. 2008. Goals and standards in Swedish organic farming: Trading off between desirables. *International Journal of Agricultural Resources, Governance and Ecology* 7 (1/2):23–39. doi:10.1504/IJARGE.2008.016977.

Milestad, R., J. Ahnstrom, and J. Bjorklund. 2011. Essential multiple functions of farms in rural communities and landscapes. *Renewable Agriculture and Food Systems* 26 (2):137–48. doi:10.1017/S1742170510000529.

Milestad, R., and S. Kummer. 2012. Does growth hurt? Resilience of farms in growing local organic food networks. Producing and reproducing farming systems. New modes of organisation for sustainable food systems of tomorrow. 10th European IFSA Symposium, Aarhus, Denmark, July 1–4, 2012.

Murphy, E., and M. A. Rodriguez-Manzanares. 2008. Using activity theory and its principles of contradictions to guide research in educational technology. *Australasian Journal of Educational Technology* 24 (4):442–57. doi:10.14742/ajet.1203.

Noe, E., H. F. Alroe, and A. M. S. Langvad. 2008. A polyocular framework for research on multifunctional farming and rural development. *Sociologia Ruralis* 48 (1):1–15. doi:10.1111/j.1467-9523.2008.00451.x.

Nuutila, J., and S. Kurppa. 2016. The Finnish organic food chain—an activity theory approach. *Organic Agriculture* 6:49–56.

Obach, B. K. 2007. Theoretical interpretations of the growth in organic agriculture: Agricultural modernization or an organic treadmill? *Society & Natural Resources* 20 (3):229–44. doi:10.1080/08941920601117322.

Östling, T. 2014. "Livsnödvändiga resurser säljs ut." *Östersundsposten*. Accessed March 8, 2014. http://www.op.se/opinion/debatt/livsnodvandiga-resurser-saljs-ut.

Patel, R. 2009. Food sovereignty. *Journal of Peasant Studies* 36 (3):663–73. doi:10.1080/03066150903143079.

Pereira-Querol, M. A., L. Seppänen, and J. Virkkunen. 2014. Exploring the developmental possibilities of environmental activities: On-farm biogas production. *Environmental Science & Policy* 37:134–41. doi:10.1016/j.envsci.2013.09.010.

Pettersson, A. 1994. Ekologisk äppleodling – en litteraturstudie. SLU Info/Trädgård rapporter. Accessed May 7, 2015. http://www.vaxteko.nu/html/sll/slu/slu_info_rapp_tradg/IRT381/IRT381.HTM.

Ponisio, L. C., L. K. M'Gonigle, K. C. Mace, J. Palomino, P. De Valpine, and C. Kremen. 2015. Diversification practices reduce organic to conventional yield gap. *Proceedings of the Royal Society B-Biological Sciences* 282, 20141396 doi:10.1098/rspb.2014.1396.

Rabinowicz, E. 2004. The Swedish agricultural policy reform of 1990 – A window of opportunity for structural change in policy preferences. IATRC Summer Symposium, Adjusting to Domestic and International Agricultural Policy Reform in Industrial Countries, Philadelphia, Pennsylvania, USA, June 6–7, 2004.

Raynolds, L. T. 2004. The globalization of organic agro-food networks. *World Development* 32 (5):725–43. doi:10.1016/j.worlddev.2003.11.008.

Rigby, D., and D. Cáceres. 2001. Organic farming and the sustainability of agricultural systems. *Agricultural Systems* 68 (1):21–40. doi:10.1016/S0308-521X(00)00060-3.

Röling, N. 2009. Pathways for impact: Scientists' different perspectives on agricultural innovation. *International Journal of Agricultural Sustainability* 7 (2):83–94. doi:10.3763/ijas.2009.0043.

Rydén, R. 2003. *Medvindens tid. Ekologiska Lantbrukarna och jordbrukspolitiken 1985–2000*. Ultuna: Centre for Sustainable Agriculture, Swedish University of Agricultural Sciences. Accessed March 20, 2015. http://www.slu.se/Documents/externwebben/centrumbildningar-projekt/epok/Publikationer/ekolantbruk36.pdf.

SCB. 2015a. Jordbruksföretag, antal efter region, storleksklass och år. Statistiska Centralbyrån. Accessed May 30, 2015. http://www.statistikdatabasen.scb.se.

SCB. 2015b. Real estate price index for agricultural real estate (1992=100) by region. Year 1988–2013. Statistiska Centralbyrån. Accessed May 13, 2015. http://www.statistikdatabasen.scb.se.

Seppänen, L. 2002. Societal integration in organic vegetable farming: Exploring the learning challenges. *The Journal of Agricultural Education and Extension* 8 (2):87–100. doi:10.1080/13892240285300071.

Seppänen, L. 2004. Learning challenges in organic vegetable farming. An activity-theoretical study of on-farm practices. Dissertation, Institute for Rural Research and Training, University of Helsinki, Helsinki, Finland.

Seppänen, L., and J. Helenius. 2004. Do inspection practices in organic agriculture serve organic values? – A case study from Finland. *Agriculture and Human Values* 21 (1):1–13. doi:10.1023/B:AHUM.0000014021.76147.7d.

SLI. 2001. Subsidiarity, the CAP and EU enlargement. Swedish institute for food and agriculture. Report 2001:3 ISSN 1650-0105. Accessed May 16, 2015. http://www.agrifood.se/Files/SLI_rapport_20013.pdf.

Świergiel, W. 2015. Co-developing pest management for organic apple production: Combining participatory action research, activity theory, laboratory and field trials in a Swedish context. PhD dissertation, Dep. of Plant Protection Biology, Swedish University of Agricultural Sciences, Alnarp, Sweden.

Van Der Ploeg, J. D. 2008. *The new peasantries. Struggles for autonomy and sustainability in an era of empire and globalization*. London: Earthscan.

Virkkunen, J. 2006. Dilemmas in building shared transformative agency. *Activités* 3(1):43–66.

Virkkunen, J., and D. S. Newnham. 2013. *The change laboratory. A tool for collaborative development of work and education*. Rotterdam: Sense Publishers.

Virkkunen, J., and P. Ristimäki. 2012. Double stimulation in strategic concept formation: An activity-theoretical analysis of business planning in a small technology firm. *Mind Culture and Activity* 19 (3):273–86. doi:10.1080/10749039.2012.688234.

Wålstedt, K. B., B. H. Rosenkvist, and C. I. Browald. 1992. Farmers decision making under uncertainty: Affecting factors and farmers reactions to changes in the environment. In Report 50, Department of Economics, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Wezel, A., S. Bellon, T. Dore, C. Francis, D. Vallod, and C. David. 2009. Agroecology as a science, a movement and a practice. A review. *Agronomy for Sustainable Development* 29 (4):503–15. doi:10.1051/agro/2009004.