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Accelerating the transition towards sustainable agriculture: The case of organic dairy farming in the Netherlands

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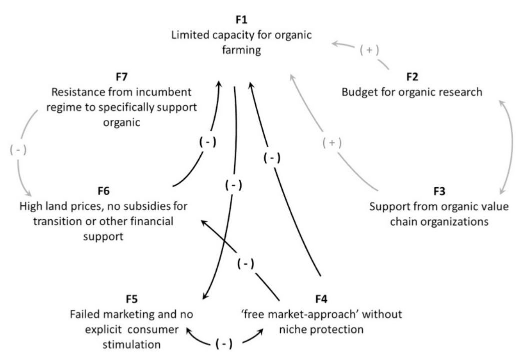
HIGHLIGHTS

- The upscaling of organic dairy farming in the Netherlands is still very low.
- An Innovation Systems Analysis was used to study barriers that may hamper further diffusion.
- Enabling factors in upscaling organic dairy were studied in Austria and Denmark.
- Market formation and weak governmental support appear to be partially blocking the diffusion in the Netherlands.

GRAPHICAL ABSTRACT



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ABSTRACT

CONTEXT: Regardless 30 years of similar regulations and a common internal market, the diffusion of organic farming strongly differs amongst European member states. While the share of organic farmland in 2018 in Denmark and Austria was respectively 9.8% and 24.7%, in the Netherlands it was only 2.3%.
OBJECTIVE: The aim of this paper was to analyze what factors may determine the very different diffusion of organic dairy farming in the Netherlands, compared to Denmark and Austria.
METHODS: We applied the Technological Innovation System (TIS) framework to the case of organic dairy farming in the Netherlands, for which a literature review and interviews with key actors within the dairy value chain were carried out. To identify potential leverage points for upscaling also interviews with key actors from Denmark and Austria were held.
RESULTS AND CONCLUSIONS: Various barriers in the fulfilment of the seven TIS functions of Dutch organic dairy farming could be identified. With regard to the system function market formation a diversification in certified dairy products are signaled as important factors for upscaling. The function entrepreneurial activities will benefit from an reinforcement of governmental subsidies, since farmers who convert to organic run financial risks. Regarding the function guidance of the search, more consistent and systemic governmental support is needed, since the conversion to organic encompass a regime shift rather that supporting newcomers entering the sector.

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SIGNIFICANCE: By studying the blocking mechanisms that hinder diffusion of organic dairy, the paper provides several leverage points that may also be applicable to the arrested diffusion of organic farming in other countries as well as the larger sustainability transition in European agriculture.

1. Introduction

Modern day agriculture in Europe has evolved towards a highly industrial sector by intensification and farm scale enlargements in order to contribute to global food production (Daugbjerg and Swinbank, 2016; Godfray et al., 2010; Kearney, 2010; Popkin, 2011). The produced commodities compete on world markets resulting in low consumer prices, but also forcing farmers to continuously decrease costs and increase yields through technological innovations and management intensification to maintain their competitiveness (Duru et al., 2015). Although food production has considerably increased, it has also led to many adverse impacts on the environment and biodiversity (Henle et al., 2008; Hodge et al., 2015; Stoate et al., 2009). As a response and triggered by societal pressure, a wide spectrum of sustainable forms of agriculture has been developed over time (Garibaldi et al., 2017; Pretty et al., 2018). These sustainable production systems depend less on external and synthetic inputs and may result in reduced environmental degradation and biodiversity conservation.

In many instances, forms of sustainable agriculture start as grassroot movements initiated by social interests (e.g., Schiller et al., 2020). Today, many types exist (e.g., Pretty et al., 2018) but are relatively immature to study a long-term sustainability transition (e.g., Darnhofer et al., 2015). Organic farming emerged in Europe in the early 20th century largely independently by private activities (Offermann et al., 2009). From 1991 it has been 'institutionalized' by the establishment of a European wide organic regulation, the EC Regulation 2092/91 (Michelsen, 2001; Offermann et al., 2009). This replaced most national policies which were established in the 1980s (Seufert et al., 2017). The regulation of 1991 was repealed, and the current organic legislation falls under council regulation EC NO 834/2007 (The Council of the European Union, 2007). For the period from 2014 to 2020 the CAP provided funding for organic farming through the European Agricultural Fund for Rural Development (EAFDR). Each EU country implements their own Rural Development Programme (RDP) specifically tailored to their own challenges and capabilities (Meredith et al., 2008). Currently, the European Commission has set out an ambitious action plan for the further development of organic production by member states towards 25% of organic agricultural area by 2030 (European Commission, 2021).

Due to the relatively long history, the long term sustainability transition of organic farming can be well studied. Interestingly, despite the more than 30 years of EU legislation and a common internal market, organic farming in EU member states has developed at different rates (e.g., Darnhofer et al., 2019). For example, in 2018 the share of total organic agricultural land, including arable farming and horticulture, was relatively low (3.1%) in the Netherlands, but much larger in Denmark and Austria, respectively 9.8% and 24.7% (Eurostat, 2021). For dairy farming, the share of organic dairy cows in the Netherlands was 2.3% in 2017, and in respectively Denmark and Austria 12.3% and 21.2% (Eurostat, 2021). Although consistent and reliable statistics on organic markets and commodity breakdown is still non-existent (Meredith and Willer, 2016), some organic consumption patterns show marked differences. In 2019 Danish and Austrian consumers purchased respectively € 344 and € 215 per capita on organic food, while Dutch consumers spend €71 per capita (Research Institute of Organic Agriculture, 2021). Finally, the market share of organic dairy in 2019 was ca. 21% in Denmark, 16% in Austria and only 4.1% in the Netherlands (Bionext, 2019; Vandewijngaarden and Verbeke, 2020).

These figures raise the main research question addressed in this paper: '*what factors may determine the very different diffusion of organic farming in EU member states*?'

Within the full range of organic farming (i.e., arable, horticulture, livestock, dairy), each can be identified as single niches. Organic dairy farming therefore is a niche, and in transition studies niches are often defined as "protected spaces where new socio-technical practices can develop" (Ingram, 2018, 117). A transition is a long term, complex and multidimensional process, where a societal subsystem radically or incrementally changes (Loorbach and Rotmans, 2006). The socio-technical regime is a central concept within transition research and defined as "a relatively stable configuration of institutions, techniques and artefacts, as well as rules, practices and networks that determine the development and use of technologies" (Smith et al., 2005). Sustainable transitions can be seen as a long-term goal, and therefore what is considered 'sustainable' can change over time.

Changes within a regime occur at different dimensions such as technological, material, organizational, institutional, political, economic, and socio-cultural. This is due to the fact that established technologies and practices are highly intertwined within these systems (Markard et al., 2012). As a result, numerous difficulties in the upscaling of organic dairy farming could be identified, related to organizational, technological and knowledge exchange issues (Grabs et al., 2016; Wezel et al., 2018), power relations (Dentoni et al., 2017; Dolinska and d'Aquino, 2016; Pigford et al., 2018; Van Oers et al., 2018) and a variety of other institutional problems (Dentoni et al., 2017; Gernert et al., 2018).

Innovation system frameworks have shown to be useful to study the transition of agricultural systems towards more sustainability (Darnhofer and Strauss, 2015; El Bilali, 2019; Lamprinopoulou et al., 2014; Schiller et al., 2020; Vermunt et al., 2022). More specifically the Technological Innovation System (TIS) is used to assess the barriers and drivers of a niche as it grows and institutionalizes to further challenge the existing regime (Sixt et al., 2018). A TIS is defined as a set of networks of actors, infrastructure (physical, knowledge and financial) and institutions that jointly interact in a specific technological field that contribute to the generation, diffusion and utilization of variants of a new technology and/or a new product (Hekkert et al., 2007; Wieczorek and Hekkert, 2012; Musiolik et al., 2012). Central to a TIS is that innovation and diffusion is steered both by individual and collective actions (Hekkert et al., 2007) and as such includes an analysis of system functions. Next to mapping the structure of the innovation system (i.e., the respective networks of actors, infrastructure and institutions of the organic dairy farming system), it is therefore important to identify the most important key processes that are needed to build up the respective innovation system (Hekkert et al., 2007; Wieczorek and Hekkert, 2012; Musiolik et al., 2012). These key processes are coined in Hekkert et al. (2007) as the seven system functions and can be mapped throughout time in order to identify system dynamics (in the section below these seven system functions will be described in more detail).

In this paper we apply the TIS framework to the Dutch case of organic dairy farming in order to understand what may hamper upscaling. To identify potential leverage points, the development of the organic dairy sector in Denmark and Austria will be studied alongside as examples of countries in which the organic niche is much more advanced. For this study we use a mixture of information sources, i.e., a literature review, a newspaper review, and semi-structured interviews of key stakeholders within the organic dairy value chains from the Netherlands, Denmark and Austria.

2. Methodology

2.1. Analytical framework

In the study of agricultural transitions, slight adaptations to TIS have been made in the past, such as the Agriculture Innovation System (AIS), where innovation is seen as an outcome of the different interactions between the actors, institutions, and the economic, environmental and societal systems and as such less focused on the development of new technologies but rather on organizational and institutional change (Klerkx et al., 2012; Spielman et al., 2009). Indeed, the emphasis within the organic farming transition is not only about the technological aspects of the innovation, but also about the understanding of the system dynamics and performance of a system within the wider 'conventional agricultural practices' (Bergek et al., 2008). As such, in the current study AIS was applied, while using the functional aspects of TIS. The TIS uses five steps to analyze the functioning of an innovation system based on Wieczorek and Hekkert (2012), i.e., the analysis of the structural components of the system such as actors, institutions, networks and interactions, infrastructures (knowledge, financial and physical structures), the functional analysis and the identification of system problems, and formulation of systemic instruments.

The analytical framework of TIS contributes to the understanding of the complex nature of the diffusion of a niche, such as organic farming, by analysing the obstacles that may block this process (e.g., Bergek et al., 2015). As such, problems that are identified from the coupled structural-functional analysis may hinder the diffusion of an innovation and are referred to as systemic problems (Bergek et al., 2015; Wieczorek and Hekkert, 2012). In this respect, Weber and Rohracher (2012) identified three types of failures of transformative change. i) Market failures that are linked to the niche level and may include leakage effects and the higher costs associated with sustainable production. ii) System failures that could affect infrastructures such as a lack of knowledge, capability problems such as competences, and institutional failures such as a regime that strongly hinders the uptake. This can be further divided into soft institutional failures that relate to habits and culture, and hard institutional failures that refer to laws and regulations that block the diffusion of an innovation. Finally, iii) transformation failures referring to directional failure by a lack of a shared vision, weak consumer support (demand articulation failure), policy coordination failure and reflexivity failure that signifies a lack of long term commitment and learning ability.

2.2. Data collection

To gain a better understanding and to identify the current state of development of the organic dairy sector, including value chain actors, first literature reviews were conducted on organic dairy farming in the Netherlands, Denmark and Austria. Literature searches were performed in Google Scholar, ScienceDirect and Scopus. Search strings included (transition OR development OR innovation) AND organic AND (agriculture OR farm*) AND sustainable AND country names to find relevant papers. This search string includes more than organic dairy since the research is focused on transitions rather than practices alone. Related governmental documents and websites were also examined. Once theoretical saturation of the literature was achieved the results were used to formulate questions for interviews.

Second, semi-structured interviews were conducted with interviewees in all three countries. Most interviews lasted between 30 and 60 min and were carried out face to face or over the telephone. In total 23 interviews were performed with experts of the organic dairy sector in the Netherlands, Austria and Denmark (Table 2). The sample included representatives from governmental bodies, NGOs, universities, farmers, processors and retailers. The 13 Dutch interviewees were asked questions which were formulated around the seven functions of the TIS framework (Table 1).

Table 1
Functions of an innovation system adapted to the organic dairy sector (adapted from Hekkert et al., 2007).

Function	Description
F1: Entrepreneurial Activity	Entrepreneurs are essential for growth and innovation of the organic dairy sector. They take the risks and initiatives to experiment with new technologies, practices, business models, etc.
F2: Knowledge Development	Scientific and technological knowledge can be developed in different ways. Experimentation by farmers, research public and private institutes or R&D within companies and organizations. Knowledge development is needed for the continuous growth of the organic dairy sector.
F3: Knowledge Exchange	Knowledge exchange between actors and stakeholders are essential for the development of the organic dairy sector. Agricultural cooperation's, conferences and trade fairs can be used as a tool to exchange knowledge. Through these networks the sector can share information on certifications, innovations and governmental policies.
F4: Guidance of the Search	The establishment of a short- and long-term vision for the growth of the organic dairy sector will stimulate the development of the sector. A common vision on the expectations, needs and requirements is needed.
F5: Market Formation	Consumers and producers will have to be stimulated to choose for organic products. The organic dairy sector will have to compete with the conventional dairy sector. Different activities (as stimulation of supply and demand, and marketing campaigns) will have to lead to expansion of the organic dairy sector.
F6: Resource Mobilization	For the organic dairy production all involved actors must have access to sufficient knowledge and resources. Financial resources, governmental support, education, skilled labor and accessible farmland.
F7: Creation of legitimacy	The rise of the organic dairy sector can (have) led to resistance of different actors (consumers and actors within the conventional dairy sector). Trust needs to be built within the sector to create legitimacy

To strengthen the solutions found in the literature review for Denmark and Austria, 10 interviews were held with experts within the Danish and Austrian agricultural regime. Questions were related to the seven functions, and the observed barriers. Also country specific solutions to barriers were identified and are further referred to as enabling factors.

Most experts were found after a review of relevant policy documents from government and industry. Using snowball sampling (Robinson, 2014) subsequent interviewees were found. Finally other relevant stakeholders were found by visiting a trade fair (Bio-beurs). In total 63 experts were contacted (Table 2).

Third, the Lexis Nexis search engine was used to retrieve relevant Dutch newspaper articles, published between 1991 and 2018 on organic farming to get a better understanding of the public debates and discourses on organic farming in the Netherlands. The primary search using

Table 2
Number of interviews by organization in the Netherlands, Denmark and Austria.

Organization	Number of Interviews		
	Netherlands	Denmark	Austria
Government	1		2
Milk Processor	2	1	
Farmers	3	1	
Bank	1		
Feed industry	1		
Research/Education	1	2	1
Supplier	1		
Dairy cooperation	1		
Farming Association	1	1	
Organic Chain Organization	1		
Certification Organization			1
Governmental extension service			1
Total (n)	13	5	5

'biologische landbouw' (organic agriculture) resulted in 8157 newspaper items, though many of those are published multiple times in different imprints of national newspaper agencies, or published papers that did not have a link to Dutch organic farming (e.g., organic farming elsewhere). Based on relevant article headings and removing duplicates a corpus of 260 papers was retrieved as pdf documents. Within the corpus search strings such as 'government', 'cabinet', 'Minister', 'organic policy', 'retail', 'supermarket', and 'consumer' were used to retrieve relevant information. The information flow of the different steps are depicted in Fig. 1.

2.3. Data analysis and data coding

The grounded theory method was used to analyze the interviews. Grounded theory is "a systematic method for constructing a theoretical analysis from data", and as such an iterative process between data collection analysis and theory building (Gubrium et al., 2012). An initial coding framework for the barriers in the Netherlands was created through an iterative process in which the seven functions were used as categories. After the first interviews were transcribed the coding framework was created. An iterative comparison between the data and concepts was made to convert the verbal data into barriers. Adoptions to the framework were made until theoretical saturation was achieved.

The coding framework for Austria and Denmark was created based on the enabling factors found in literature. After an interview was performed, the transcribed data was coded. The coding framework was adjusted when more interviews where established. By using this iterative process possible missing enabling factors were added into the coding framework.

The barriers found through the coding process were further analyzed to provide the most common and important barriers. To decide which barriers were key in the development, a scoring system for the functions and barriers was developed. Every mentioned barrier was scored within the coding framework with value 1, if a respondent did not mention a barrier, the barrier got the value of 0. To calculate how often one barrier was mentioned, we divided the number of times a barrier was mentioned by the sample size and multiplied by 100%. The Dutch sample size was 13, the sample size in Denmark and Austria was 5. To calculate how often a function was mentioned we divided all mentioned barriers within a function to the total mentioned barriers and multiplied by 100%.

Using a three-point Likert scale (Vagias, 2006) the priority of the various barriers was assessed. This scale divides the barriers in three levels of priority according to the number of times a barrier was mentioned by the respondents. If less than 33% of the respondents mentioned a barrier it was of low priority (−), between 34 and 66% the barrier was of medium priority (+) and 67–100% was of high priority (++). Following this, each barrier was linked to one of the seven functions. To get a clear understanding which barrier resisted the development the most, the barriers starting from medium priority or higher within the most important functions were evaluated in the results. After linking each specific barrier to the structure of the system, the systemic problem can be identified. This systemic problem will point at which function(s) mostly hindering the development and upscaling of the organic dairy innovation system.

3. Results

3.1. Structural-functional analysis of Dutch organic dairy farming

Based on the interviews, 19 barriers could be identified, while these barriers were mentioned in total 92 times by the Dutch respondents. These barriers are linked to the seven TIS functions in such way that 7% of the barriers was associated with the function entrepreneurial activities, 5% with the function knowledge development, 0% with the function knowledge exchange, 34% with the function guidance of the search,

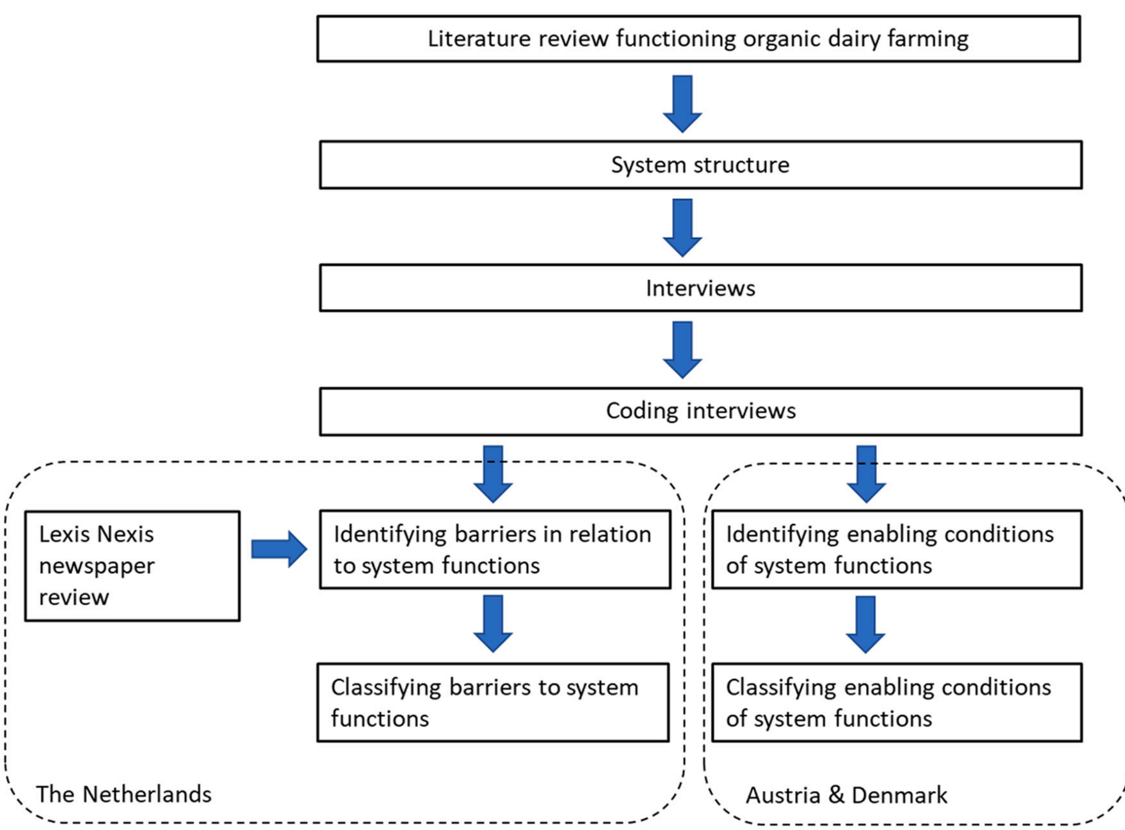

Fig. 1. Visualization of the information flow (literature review, interviews and Lexis Nexis review) applied to the Dutch, Austrian and Danish organic dairy sector.

37% with the function market formation, 15% with the function resource mobilization and 2% with the function counteract resistance to change (Fig. 2).

3.1.1. Function 1: entrepreneurial activities

Since 1991, in Europe, including the Netherlands, organic farming has been institutionalized by the EC Regulation 2092/91 (Michelsen, 2001). This regulation includes, amongst others, strict rules regarding use of fertilizers, pesticides etc., while the organic certification guarantees farmers a higher milk price. The share of organic dairy farmers in the Netherlands slowly increased from 1.1% in 2001 to ca. 2.9% in 2019. Milk production per cow is lower, but due to higher organic milk prices farmers receive a higher income per labor hour (Wageningen Economic Research, 2021). Since 2013 organic milk prices are decoupled from conventional milk prices, which also resulted in a larger difference because conventional milk prices strongly dropped after the milk quota abolishment in 2015 and subsequently a larger supply (Wageningen Economic Research, 2021). In 2020 organic farmers received 49.5 Euro per 100 kg milk, which is 12.5 eurocent higher per kg milk than conventional farmers (Wageningen Economic Research, 2021). Because organic milk prices are less volatile, income of organic farmers is more stable (Wageningen Economic Research, 2021). Milk processing is carried out by a few but large (conventional) milk cooperatives. In recent years, also due to the milk quota abolition in 2015, a (temporary) stop was promulgated on new requests of organic milk by the cooperatives. But, as the interviewees indicate, the supply of farmers willing to shift to organic is still large and growing.

To shift from conventional to organic farming, a transition period of between 2 and 3 years is needed in which livestock but also the flow of input materials such as animal feed need to be produced organically. Six out of 13 interviewees (46%) addressed the barrier of the 'difficult transition process for the farmer'. As one interviewee stated:"*The conversion period is a large investment. During this two year transition process* [from conventional to organic farming] *a farmer makes many extra costs while only receiving the conventional milk price for their product*". This makes farmers reluctant due to the risk of conversion, and the future profitability of organic products (Musshoff and Hirschauer, 2008). However, due to the European wide legislation on organic produce, all European farmers have to comply by the same two-year timeline and regulations.

Although the number of Dutch organic dairy farms is slowly growing (Wageningen Economic Research, 2021), Regouin (2003) already indicated the number of farmers ceasing organic farming in the early 2000s was large as well, leading to relatively small positive increments. Newspaper articles confirm this pattern after 2015, but no scientific papers have recorded this. In 2003 reasons for abandoning organic farming practices were, amongst others, higher labor costs, and weak financial support for loans due to the abolishment of green funds after 2002 (Regouin, 2003).

3.1.2. Functions 2 and 3: knowledge development and exchange

Interviewees indicated that within the sector knowledge is continuously evolving, innovations developed, such as new types of dairy cow breeds (e.g., Nauta et al., 2009; Rodríguez-Bermúdez et al., 2019), and knowledge is also exchanged by specialized knowledge brokers. As one interviewee indicated the large cooperatives have mentors to aid farmers during their transition. Also knowledge about regulations appear to be sufficient, according to the respondents. Although a lot of agricultural research at universities is carried out (i.e., Wageningen University and Research), budgets to study organic farm practices were decreasing from 7 million to 2.4 million Euro in 2012, particularly due to decreasing investments by private companies (Braakman, 2012). As a response, an amendment to the governmental budget of the Ministry of Agriculture was made in 2013 (Ministerie Van Economische Zaken, Landbouw en Innovatie, 2013). This resulted in an additional budget of 5 million Euro per year up to 2017 for research on the organic sector. Five interviewees indicated some barriers in knowledge development and exchange, that mostly focus on a lack of specialized organic research from companies and a declining research budget. Nonetheless, most interviewees did not indicate these functions to be problematic.

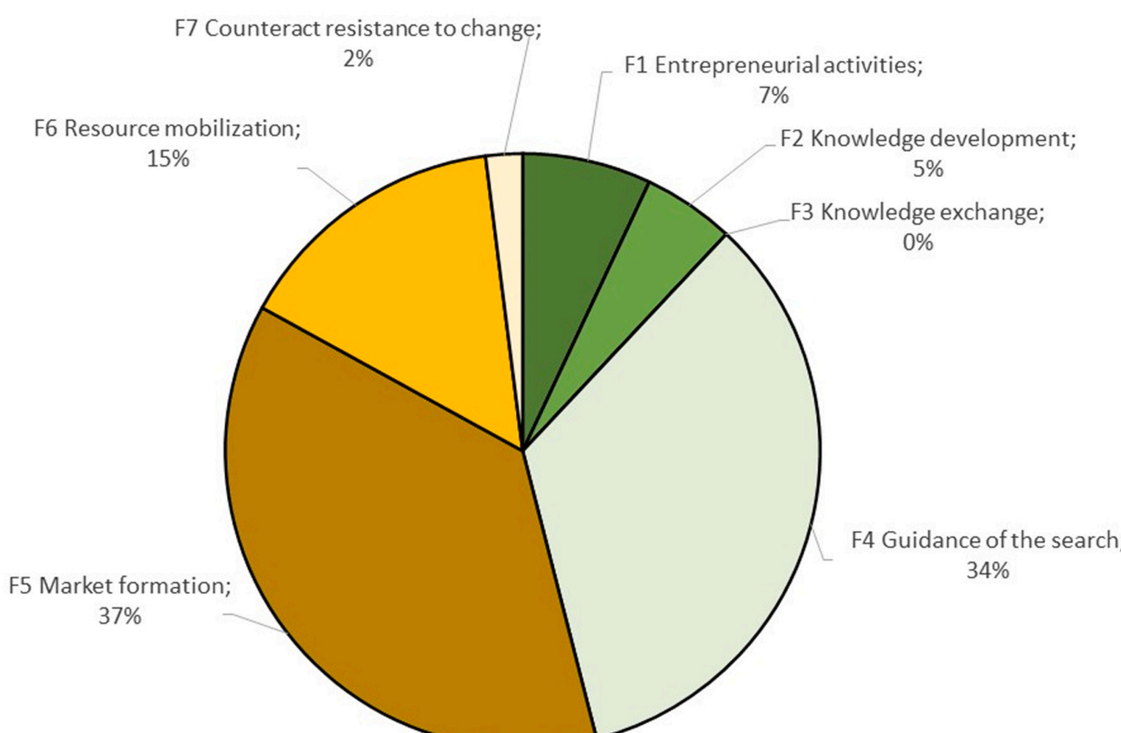

Fig. 2. Chart diagram of the percentage barriers associated with the functioning of the TIS functions, rated by the Dutch organic dairy experts. $N = 92$.

3.1.3. Function 4: guidance of the search

Since the EU regulation on organic farming (2092/91) required a national implementation, the Dutch Ministry of Agriculture developed over a period of more than a decade a series of bi-annual policy notes. The first note or memorandum "Landbouwkwaliteitsbesluit biologische productiemethode" in 1992 (agricultural decision on the organic production method, own translation) and the subsequent action plan (1997) had the ambition of 10% organic agricultural land by 2010 and a 5% market share by 2007. At first and since 1994, subsidies for the two-year transition period were obtainable and a subsidy to continue organic farming, though the interest of farmers was much larger than the available budget (Bok and Lössbroek, 2000). The evaluation of the action plan (Bok and Lössbroek, 2000) suggested a stronger focus on market development, quality improvement and research. The memorandum "Een biologische markt te winnen" (to win an organic market, own translation) published in 1999 and expanding into the period of 2001–2004, emphasized the demand driven vision of the government. Amongst others, the vision focused on a better development of the organic value chain, increasing consumer demand, developing knowledge by research investments, the establishment of an organization to support and advocate the organic sector (i.e., Platform Biologica) and a closure of the 'transition subsidy' by 2002. The successive memorandum (2005–2007) continued the demand side approach. The policy vision corroborated the observed large consumer price differences between conventional and organic food and dairy products but argued technological development and logistic innovations within the organic sector could reduce these differences. The memorandum 2008–2011 set ambitious targets in growth (in area, market share and research) of organic farming and products. To create more demand, the memorandum also set targets for catering organic products in governmental buildings, including hospitals. It was also acknowledged a shortage of organic supply was observed because potential farmers became more reluctant to transform to organic farming. The note 'Duurzaam Voedsel' (sustainable food, own translation) was the last memorandum in which organic farming was mentioned in governmental documents. The memorandum stated conventional farming should be stimulated to produce more sustainably, while consumers should purchase more sustainable food. Organic farming was only mentioned as one example of sustainable agriculture, but no further governmental support to organic farming was provided (Ministerie voor Landbouw Natuur en Voedselkwaliteit, 2009). Since 2018 the vision and policy of the government fully shifted towards circular agriculture including the enhancement of sustainability, in which organic farming was no longer addressed.

With regard to the governmental vision, the respondents indicated the problematic and dual emphasis to support the organic sector on one hand while simultaneously stimulating export driven high tech and polluting conventional agriculture on the other hand. As one respondent stated "*the abolishment of the milk quota and the preceding problems on nitrogen emissions and exceedance of phosphate emission rights did also affect the organic diary sector* [for which many organic cattle were brought to the slaughterhouse to meet the emission rights in 2018] *while they were not the cause of the problem*". The duality was further enhanced by the governmental vision to invest in and improve organic farming only by technological advancements, rather than to rely on farmers' expertise. It appears, as another respondent argued, that a real 'belief' in the organic sector was missing since the same mechanisms were applied as on the conventional agricultural sector and that "*the vision solely raised the issue of economic growth, export, and business, not a change in mindset*". Other respondents pointed at the absence of a long-term vision, as no apparent organic policy has been implemented since 2011.

3.1.4. Function F5: market formation

Despite the governmental ambition to have a 5% market share of organic products by 2007, Bionext – a value chain organization for organic agriculture and food in the Netherlands and the successor of Biologica – reported a total organic market share of 3.2% and a 4.07% share of organic dairy in the Netherlands in 2019 (Bionext, 2019). During the market entrance in the 1990s, first only specialized shops sold organic products. Later the large supermarkets started selling organic products and are now by far the largest sales channel, both in volume and cash flow (Bionext, 2019). Consumer price differences have also been reduced by pressure of the supermarket purchasing channels (Bionext, 2019), but price differences are not diminished.

Although organic products are currently widely available to consumers, and the organic market is still growing, the share remains rather small compared to other countries. Many respondents signaled the relatively low consumer demand that hampers further market growth. Here, respondents addressed the issue of a large portion of consumers that can be defined as 'price deal searchers' who are not willing to pay more for organic dairy. In a large review, Aschemann-Witzel and Zielke (2017) found that the large price differences between organic and conventional products indeed hampers the further market development. However, the observed price differences and potential lack of willing to pay more for organic products are not solely responsible for the lack of growth.

A large price experiment initiated by the policy memorandum "Een biologische markt te winnen" that run for 4 months in 2006, conducted in supermarkets within 10 Dutch municipalities which differed in geographical location and income level, showed that prior market price knowledge of consumers was strongly determining the purchase of organic products (Bunte et al., 2010). In this experiment a temporal discount of organic products was introduced to monitor differences in purchase. The experiment showed that price elasticities remained low, since many consumers were not aware of lower prices. These results thus also indicate the relevance of improving the predictability of market and price information. Although organic prices were lower and sometimes below that of conventional products, consumers still expected this to be high and did not purchase organic products. An additional effect, also described by Aschemann-Witzel and Zielke (2017) was the limited offer of organic brands. Finally these results also hint on the consumer expectation of getting more value for money. This is similar to what one of the respondents noted: *"Consumers are disappointed by the quality and taste of an organic dairy product and therefore do not buy them"*. In other words, for many consumers it is not visible why they should pay more while getting a similar product. This may constrain further upscaling, since organic products remain competing with similar bulk products from the conventional sector.

In an attempt to increase the market share of sustainable dairy and fresh produce, supermarkets created the 'Better life' ("Beter Leven") label in close cooperation with the Animal Protection Society, a national NGO (Wijk-Jansen et al., 2009). This label includes different tiers on animal welfare issues, for which the highest tier (three stars) are organic products and includes for example meat, milk and eggs. By 2017 the market revenues of the one and two star tier combined were 1.6 billion Euro, and surpassed the share of solely organic products (three stars) (Logatcheva, 2018). Moreover, the old 'Environmental label' ("Milieukeur"), established in 1992 by a Dutch NGO, was recently (2017) renamed as "On the way to planet proof" label. This label includes certification of Dutch horticulture, fruits, eggs and dairy products, and led to a considerable increase of certified dairy purchase. In 2019, the market share of certified dairy (including "Beter Leven", "On the way to plant proof" and organic) reached 15% (Logatcheva, 2019).

3.1.5. Function F6: resource mobilization

Since the abatement of the transition subsidy (see function F4) and later in 2011 the abolishment of subsidies for certification, the shift from conventional to organic farming required more financial reserves of farmers. During the transition additional costs are made but since milk and dairy are not yet organic certified no price premiums can be received. All respondents noted the high land prices as the major problem in terms of resources. As a number of interviewees indicated "*farmers need much more financial resources for conversion, it is costly and* *high land prices also require a high milk production to pay off loans and earn income*". Indeed, in 2018 average agricultural land rent was circa 60,000 Euro per ha and the highest value in Europe (Silvis and Voskuilen, 2018). These high land prices also puts a burden on conventional farms, for which only labor cost reductions and yield improvements through intensification can pay off these high fixed costs. However, organic farmers have less leverages, since the agricultural production is less intensified.

As one respondent noted, value chain actors, such as the large milk cooperatives, need financial assets to separate the different milk supplies, since they both process conventional and organic milk. Partly, costs are also driven by economies of scale and due to the small growth of organic farmers, organic milk processing is more expensive. The ex post evaluation of the governmental policy note on organic farming 2005–2007 by Ecorys (2007), indicated the previous subsidy tools, such as the subsidy for the transition period, organic maintenance and certification (see also function F4) were highly appreciated by farmers for the execution of organic principles, while the respondents note these subsidies are still needed due to the worsening financial situation of many Dutch farmers.

3.1.6. Function F7: creation of legitimacy/counteract resistance to change

The EU regulation, the certified controlled production standards, and the EKO labelling for consumers provide institutional legitimacy to organic farming. By this, organic farming finds itself in a position between a voluntary movement from civil society and governmental support by strict regulations and public policy (Michelsen, 2001). Main critics found in Dutch newspapers point at the much lower yields obtained from organic farming and therefore is not capable 'to feed the world' (e.g., De Volkskrant, 2007; Haarlems Dagblad, 2019; Trouw, 2000).

The respondents noted that 15 to 20 years ago resistance from conventional farmers was much larger than nowadays. In general, respondents acknowledged the much improved image of organic farmers over the years. Yet, they also recognize resistance from regime actors, such as governmental regulations that are never beneficial to organic farming and lobby from pressure groups, such as feed suppliers, to favor policies and rules in maintaining conventional farming. As one

Table 3

Detailed overview of the barriers linked to their systemic problems which are hindering the development of the Dutch organic dairy innovation system. Including the frequency, priority and structural element related to each barrier. Only the barriers with medium priority and above are explained. Systemic problems adapted from Bergek et al. (2015) and Wieczorek and Hekkert (2012).

Function	Barrier	Frequency	Priority (−/+/++)	Structural Element	Type of Systemic Problem	Description Links Between Systemic Problems
F1 Entrepreneurial activity	Difficult and expensive transition process	46%	+	Actor & Institution	Capacity failure & hard institutional failure	Farmer does not receive governmental subsidies. The process is very lengthy and difficult which leads to high investments while only receiving conventional milk prices.
F2, F3 Knowledge Development & exchange	Lack of research and education	38%	+			
F4 Guidance of the Search	Vision on economic growth and export	69%	++	Institution	Soft institutional failure	Lack of coherence between European and national policies, a continuous change of governmental vision by the Ministry of Agriculture which leads to a lack of long-term vision. Governmental policies to support economic growth but not on sustainable practices.
	Cultural influences	54%	+	Institution	Soft institutional failure	
	Lack of national policy	46%	+	Institution	Hard institutional failure	
	No long-term policy vision	38%	+	Institution	Hard institutional failure	
	Unequal vision	23%	−			
	No intrinsic value of farmer	8%	−			
F5 Market Formation	Lack of demand	77%	++	Actor	Capacity failure	The lack of consumer demand is possibly influenced by the high prices and low quality of the organic products. But also, by the missing stimulation of government to the retail sector through e.g. marketing campaigns.
	No stimulation of consumers through actors	62%	+	Network/ Interaction & Institution	Presence failure & hard institutional failure	
	Expensive/low quality products	38%	+	Other	Other	
	Too little demand processors	31%	−			
	Lack of supply retailers	23%	−			
	No trust of banks	15%	−			
	Competition foreign countries	15%	−			
F6 Resource Mobilization	Lack of governmental support and subsidies for farmers	38%	+	Infrastructure & Institution	presence & hard institutional failure	Lacking resources include financial instruments for organic production and limited accessibility to farmland
	High land prices	38%	+	Institution	Hard institutional failure	
	Low milk prices	31%	−			
F7 Resistance to change	Resistance from feed suppliers	15%	−			

interviewee from the Ministry of Agriculture noted "*is organic farming sustainable? We think conventional farming is producing sustainable as well and we will support this*". This can be further illustrated by the example of the continued manure problems (see also Function F4) in the livestock sector, which resulted in a strong exceedance of phosphate emissions in 2018. Based on EU rulings, the Dutch government had to decide reducing the dairy livestock sizes and numerous animals had to be slaughtered. However, organic farmers felt not to be responsible for this problem, while also an expected shortage of organic manure was expected. In 2018 organic farmers' associations started a lawsuit against the Dutch government, supported by positive findings of the EU commission on Environment. However, strong resistance came from the conventional Dutch agricultural association (LTO) which led to the governmental decision not to handle organic livestock differently (Leeuwarder Courant, 2019). As a result, also many organic dairy cows were slaughtered.

3.2. Systemic problems and blocking mechanisms in the Netherlands

Regarding the 19 reported barriers, two barriers were identified as high priority (>67%), eight barriers a medium priority (33–66%) and seven barriers a low priority (< 32%) (Table 3). Within the function market formation that accounted for 37% of all barriers, the barrier 'lack of demand' was mentioned most often; by 10 of the 13 respondents, and with 77% of high priority. Within the function guidance of the search, one barrier had a high priority (vision on economic growth and export), and four had a medium priority. The barrier of the 'vision on economic growth and export' was mentioned by 9 of the 13 respondents. Within the function resource mobilization three barriers were identified; two with medium priority and one with low priority. Function F1 (entrepreneurial activities) accounted for only one medium priority barrier. The functions F2 and F3 (knowledge development and exchange) had one medium priority barrier and the function F7 (counteract resistance of change) one low priority barrier.

3.2.1. Systemic problems

The observed barriers may lead to systemic problems in the upscaling of organic dairy farming, since they relate both to soft and hard institutional failures (Fig. 3). From the first national organic memorandum the Dutch policy vision was to develop the demand side while regular market mechanisms would result in a larger supply and hence an increase of organic dairy farmers. Newspaper articles published at that time were very critical regarding the implementation of the policy. Those articles stated that the Minister of Agriculture relied heavily on market forces and it was questioned whether it could lead to upscaling while price differences between organic and conventional goods remained high. A hard institutional failure can be found in the interplay between the Ministries of Agriculture and Environment (formerly the Ministry of Spatial Planning, Housing and Environment). While the Ministry of Environment embraced the sustainability targets of organic farming it did not support this with policy instruments, while within the Ministry of Agriculture the incumbent socio-technological regime blocked specific support to organic farming (see also de Haas, 2013 for a historic overview of the Dutch Ministry of Agriculture).

Moreover within the functions 'market formation' and 'entrepreneurial activities' persistent capacity and capability problems can be identified. First, the lack of consumer demand (77%) and lack of stimulation of the consumer (62%) were strong barriers. Although earlier organic products could only be purchased through a few specialty shops, this was no longer the case in the second half of the 1990s. Yet from 2010 onwards, newspaper articles also reported a lack of organic supply, and supermarkets had to import organic dairy from other EU countries. Despite this imbalance, some newspaper articles as well as a number of respondents indicated low consumer willingness to purchase organic products due to higher prices. Second, the 'free-market' approach also led to a capacity problem of farmers or how Smith (2000) states it, a transition problem. This problem was mainly enforced by a hard-institutional failure of lacking transition subsidies, and a soft institutional failure of lacking moral support to farmers during the transition stage.

3.3. Enabling factors in Denmark and Austria

The respondents in Denmark and Austria identified 6 enabling factors that can be linked to the different functions (Table 4). All factors had strong links with the specific governmental interventions in Denmark and Austria. The functioning of 'guidance of the search' may therefore strongly influence and steer the functioning of the other TIS functions.

3.3.1. Guidance of the search

Danish respondents rated the factor 'goals and initiatives' an 80% priority as the Danish government has facilitated strongly the development of the sector. By 1986, the Danish Ministry of Agriculture showed an explicit interest in organic farming. This led amongst others to administering of the red Ø-label, providing subsidies for farmers and a strong support for development and innovation initiatives (Daugbjerg and Halpin, 2010). Farmers not only received subsidies for the transition phase, but also received environmental subsidies (Daugbjerg and Svendsen, 2011). In 1995 Denmark introduced its first national action plan to promote organic farming. The progress of this action plan was monitored closely and led to a considerable increase in cultivated areas. In 1999 a second action plan was announced with the main goal obtaining a 10% share of cultivated agricultural land (Dabbert et al., 2004). In 2011 'The Organic Action Plan 2020' was introduced. The main goal of this action plan was to double the organically cultivated area by 2020. To realize this plan stakeholder involvement was a necessity. By 2007 this led to a gradual shift from only 'supply side' subsidies towards more 'demand side' subsidies. More funding was allocated to research, sales promotion, and purchase subsidies for local government canteens, kitchens and hospitals to supply 60% with organic products (Daugbjerg and Svendsen, 2011). Moreover, on the 'supply side' also pesticide taxes were introduced that had a direct but moderate effect on the organic sector (Daugbjerg and Svendsen, 2011). Since the implementation, organic farmland has grown by 57% and organic retail sales doubled (Eurostat, 2021; Research Institute of Organic Agriculture, 2021). Due to these implementations the organic sector went from a small group of self-regulated farmers to a large group of strong legally regulated farmers (Darnhofer et al., 2010; Michelsen, 2001).

Also Austrian respondents rated the factor 'goals and initiatives' key (60%) in the development of the organic sector (Table 4). Austria joined the EU in 1995, and faced a low competitive agricultural sector (Michelsen, 2001). This was due to the less productive mountainous environment that also resulted in relatively small household farms. The government therefore prepared the sector by "promoting conversion to organic farming as a general strategy for the survival of Austrian agriculture" (Darnhofer et al., 2019; Michelsen, 2001; Schermer, 2008). Well before the EU accession, farmer organizations, such as the 'Ernte' association, developed organic principles independently from the EU regulation (Darnhofer et al., 2019). Since its accession and from 2001, Austria continuously implemented organic action programs. These action plans were established to enhance the development of the Austrian organic agriculture sector. Currently the 5th action plan (2015–2020) is in place to maintain Austria's largest share of organic farmland within the EU (Bundesministerium für Land- und Forstwirtschaft Umwelt und Wasserwirtschaft, 2015).

3.3.2. Market formation

All Danish and Austrian respondents indicated the market conditions were paramount for the further development of organic dairy. In Denmark, both market conditions and the specific red Ø organic label (Daugbjerg and Halpin, 2010) were identified crucial by the respondents. After the Danish Organic Farming Act in 1987, the red Ø-

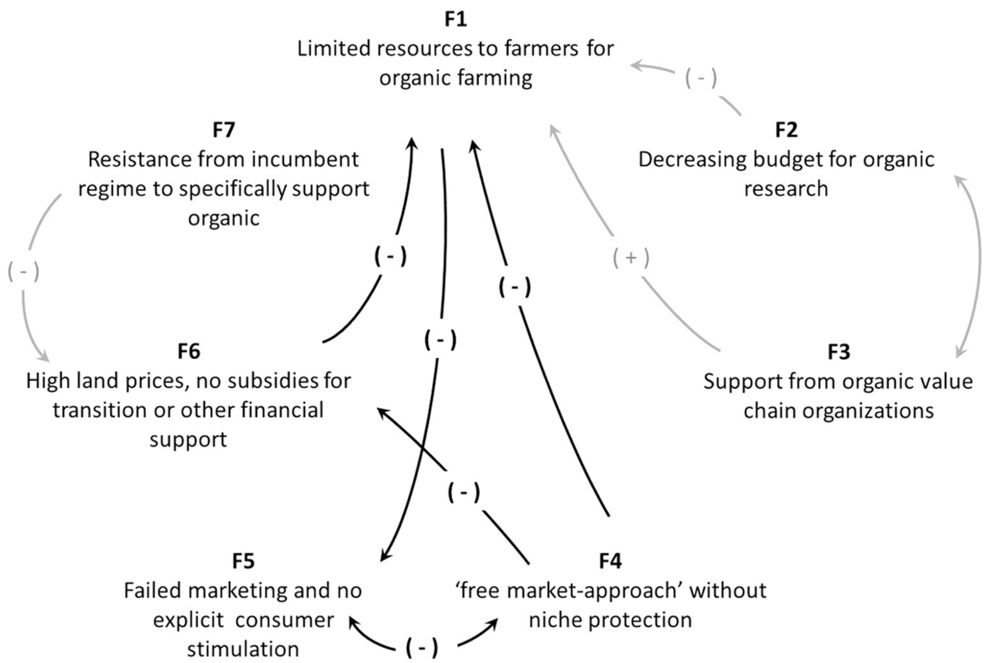

Fig. 3. Blocking mechanisms in the upscaling of organic dairy farming in the Netherlands. Bold arrows with (−) marking indicate strong blocking, grey arrows indicate weaker blocking. (+) indicate support.

label was implemented (Michelsen, 2001) and only state-certified farms were allowed to sell organic products (Daugbjerg and Halpin, 2010). The red Ø-label has been a large success; currently 98% of the total Danish population knows about the label and it has received much consumer trust (Danish agriculture and Food Council & Organic Denmark & Food Nation n.d.). The consumer trust helped increasing organic purchases (Hjelmar, 2011). Moreover, the Danish government has applied an active market development strategy where interest groups target consumers and retailers (Thongplew et al., 2016). The collaboration between Danish supermarket chains and Organic Denmark (a non-profit organization, which represents the entire organic food industry in Denmark) has led to the expansion of organic product lines, higher visibility and increased consumer communication. These included campaigns of the government and the retail sector (Danish agriculture and Food Council and Organic Denmark and Food Nation, 2021; Thongplew et al., 2016). All Danish supermarkets have embraced organic products and thereby using branding strategies to promote organic by the consumer, and especially attract families with children. To boost sales, retail sectors introduced their own organic brand and increased the number of products. This led to competition between retailers, and reduced prices of organic products which in turn made it more affordable for the consumer (Danish agriculture and Food Council and Organic Denmark and Food Nation, 2021). The first marketing campaign for organic produce was established in 1993 and led to a major increase of consumer demand (Lynggaard, 2001). All respondents confirmed that marketing strategies increased the awareness of the consumer.

Table 4
Enabling factors by function and subsequent scoring by respondents from Denmark and Austria.

Function	Denmark	Austria
F1 Entrepreneurial activity		Farming conditions (80%)
F2, F3 Knowledge Development & Exchange	Stakeholder cooperation (80%)	
F4 Guidance of the Search	Goals and initiatives (80%)	Goals, laws and initiatives (60%)
F5 Market Formation	Organic label (80%) Marketing (100%)	 Marketing (100%)
F6 Resource Mobilization	Subsidies (80%)	Subsidies (80%)
F7 Resistance to change		

In Austria, in 1994, intensive advertising occurred by conventional food retailers and processors (Musshoff and Hirschauer, 2008; Pohl, 2003; Vogl and Hess, 1999) that was not restricted by specialized food shops (Musshoff and Hirschauer, 2008). The biggest Austrian retailer Billa-Merkur started its own organic Product line "Ja natürlich" (Michelsen et al., 2001; Pohl, 2003). These companies did not only advertise organic products and their brand names but also linked the product to positive and healthy attributes as; "well-being" or "pleasure". These features created a positive image and more public awareness by the consumer (Pohl, 2003).

3.3.3. *Resource mobilization*

In 1987, Denmark introduced conversion subsidies for organic farmers. According to 80% of the respondents, these subsidies enhanced the growth of the organic dairy sector in Denmark. Between 1989 and 1994 the subsidies were mostly aimed at livestock producers (Daugbjerg and Halpin, 2010). In 1994 permanent subsidies for organic farming were implemented (Daugbjerg et al., 2008). This was extended in 1996 where additional funding was provided for advice to farmers in the transition phase. At the same time subsidies for development initiatives were also given by the state for processing, marketing and distribution of organic products. Denmark also invested into schools, institutions and universities to educate farmers, increase knowledge and product development. (Daugbjerg et al., 2008). Currently the Danish government provides farmers with subsidies for conversion and maintenance of organic farming (Stolze et al., 2016).

To encourage organic farming in Austria the government implemented several subsidies and incentives to help create the image of "Ecoland Austria" (Vogl and Hess, 1999). "Without a doubt, the organic farming boom in Austria was caused by government subsidies distributed on a federal scale" (Pohl, 2003). This is confirmed by Musshoff and Hirschauer (2008), who stated that financial subsidies increased the willingness of farmers to convert. In 1989 three Austrian provinces started to provide subsidies to individual farmers for switching to organic farming. In 1991 the Federal Ministry of Agriculture and Forestry stimulated the growth by introducing subsidies and an incentive program. Grants for organic farming associations and national conversion subsidies were implemented. Also, during and after conversion, assistance was given to the farmer (Michelsen et al., 2001; Pohl, 2003; Vogl and Hess, 1999). In 1992 these subsidies where supplemented by a program which supports organic production for existing producers (Michelsen et al., 2001). After entering the EU in 1995 Austria implemented a new agri-environmental program: ÖPUL. This five-year national aid program encouraged conversion and maintenance of organic farmers (Darnhofer and Strauss, 2015; Pohl, 2003; Schneeberger et al., 2002). The respondents confirmed the positive influence of subsidies on the organic sector.

3.3.4. Entrepreneurial activity and knowledge development and exchange

Respondents in Denmark indicated both farming conditions and stakeholder cooperation as highly relevant. For policy development of the sector it was very important that there was little competition between (organic) farm organizations. Consensus between parties on organic support and resource availability for the organic sector eases the establishment of new policies (Daugbjerg and Halpin, 2010). Besides this, the development of the Danish Agriculture and Food Council (i.e., represents the farming and food industries of Denmark including companies, trade and farmers' associations) has linked the interest of the organic sector with the agricultural sector. The association considered the interests of all parties as consumers, ministries and industrial organizations (Dabbert et al., 2004). The close cooperation between the organic agricultural sector and the Danish Agriculture and Food Council led to positive features. It increased the dissemination of new knowledge, establishment of advisory services and development of organic policies (Dabbert et al., 2004; Danish agriculture and Food Council and Organic Denmark and Food Nation, 2021).

4. Discussion

In this paper, we analyzed potential barriers for upscaling organic dairy farming in the Netherlands and making a comparison with organic dairy in Austria and Denmark, two EU countries that have shown a strong growth in organic dairy farming. Here we first discuss the findings from the TIS analysis and the diffusion of organic dairy, while in the second part we discuss the larger ramifications with respect to a sustainability transition in agriculture.

4.1. Barriers in upscaling organic dairy farming in the Netherlands

In TIS, the functioning of an innovation system is analyzed in relation to the transition phases of the innovation process (Suurs, 2009). Typically, in the early phases of development, the functions guidance of the search, market formation, resource mobilization, and counteract resistance to change may hamper the further upscaling if they are not positively fulfilled. In the final acceleration phase, where the innovation diffuses into the socio-technical regime, barriers in market formation may hamper diffusion (Hekkert and Negro, 2009; Suurs, 2009). Additionally, Schiller et al. (2020) identified various interdependencies amongst the TIS functions in agroecological food systems, and as such (moderate) weaknesses of functions could cascade throughout the whole innovation system. Based on the barrier analysis, our results of Dutch organic dairy farming indicate that the functioning of guidance of the search, entrepreneurial activities, resource mobilization and market formation are hampered by various barriers that lead to an arrested diffusion of organic dairy farming.

The lack of diffusion in the Netherlands can be explained first by a weak governmental support. The introduction of organic farming in the Netherlands in the 1990s occurred during a time of large policy reforms at the Ministry of Agriculture, triggered by a neoliberal political discourse that is still visible today (De Haas, 2013). One example of this was a separation between policymaking at the Ministry on one hand and implementation through privatized organizations on the other hand. This had impacts on agricultural research and education and led to a larger emphasis on technical solutions, export orientation and competitiveness of the agricultural sector (De Haas, 2013). During the early 1990s organic farmers were strongly limited in their abilities due to the privatized networks of institutes and agribusiness and these hurdles were not solved by the Ministry (Horlings, 1996). As can be found in many newspaper articles published in the early 2000s, critics of organic farming saw the possible diffusion of organic agriculture as a step back. As such, the organic niche had to prove itself on a competitive market without much public support.

The lack of explicit policy support in the Netherlands can also be illustrated by the many newspaper articles that dealt with environmental issues such as the long history of persistent manure problems in livestock farming, and this problem was reinforced after the abolishment of the milk quota in 2015. As a result the long-term negotiated derogation on manure application at the EU-level by the Dutch government came under political pressure. Because livestock density is lower on organic farms it adds less to the problem. Yet, governmental decisions to cut emissions were not alleviated for organic farmers. The governmental laissez-faire demand-side support towards organic farming and the strong belief that organic farming should grow by mainstream market mechanisms without niche protection was also reinforced by the incumbent regime. Repeatedly newspaper articles mentioned the resistance from the Dutch farmers association LTO to provide concrete measures to support organic farming.

In contrast, Austria and Denmark applied supply-side support to organic dairy farming. In for example Denmark, explicit government support towards organic dairy can also be illustrated in relation to the use of pesticides by conventional farmers. Here, the Danish government found that this use was threatening the groundwater wells, and decided to tax pesticide use while tax revenues were used to further support organic farming (Daugbjerg and Svendsen, 2011). As such, the Danish government created a new level playing field between conventional and organic dairy farmers, making it more attractive for farmers to produce organic.

Second, regarding resource mobilization (to farmers) the Dutch government only developed demand side policy instruments that mainly addressed knowledge development on market formation. The Dutch government did not use CAP payments to support organic farming during transition (Stolze et al., 2016) and national transition subsidies were already phased out by 2002. Respondents indicated the high agricultural land prices in the Netherlands to be a barrier for transition. Indeed, agricultural land prices[1] are about 6 times higher in the Netherlands compared to Denmark and Austria[2] (Eurostat, 2021), and are the highest in Europe. Moreover, in the past organic farmers also indicated problems with additional labor force (Regouin, 2003) since organic farming is more labor intensive. Although from its onset the organic policy in Denmark was also demand side driven, it gradually shifted by 1995 towards a supply side approach to support farmers during and after the transition (Daugbjerg and Svendsen, 2011). Currently both in Denmark and Austria farmers are supported by transition subsidies and maintenance payments, using measure 11 of the European Agricultural Fund for Rural Development (EAFRD) (Stolze et al., 2016). Both respondents and literature suggest resource mobilization remains a critical issue to retain organic farmers, as many would shift back to conventional farming due to higher costs (Berentsen et al., 2012; Regouin, 2003). Indeed, according to the annual report of Skal in

[1] Land prices of pastures in 2018 from Eurostat are 56,600 €/ha in the Netherlands, 8949 €/ha in Denmark and 8546 €/ha in Austria.

[2] Land prices of Austria are based on rent prices from Eurostat. Land price was estimated using linear regression of land rent and land prices of other countries ($y = 37.727\times + 208.78$, $R^2 = 0.93$).

2019, 24% of the Dutch farmers that ceased organic farming indicated this for financial reasons (SKAL, 2020).

Third, the weak organic market formation in the Netherlands is probably related to the higher consumer prices. In a study on the repeated purchase of organic products, Marian et al. (2014) indeed found high prices to be an obstacle to consumers. However, high prices alone did not explain the low repeated purchase in their study. In conventional products, high prices are usually perceived as a quality cue (Marian et al., 2014). This is not always the case for organic products and consumers may perceive high prices as additional costs rather than quality improvement (Marian et al., 2014). To gain more repeated consumer purchase, Marian et al. (2014) suggested to further differentiate organic products through branding.

To illustrate the effects of such a brand differentiation, the sustainable coffee market in the Netherlands can serve as an example. Here, certified coffee (UTZ, Fair Trade, organic and Rainforest Alliance) together reached a market share of 45% in 2010 (Ingenbleek and Reinders, 2013). The rapid market creation (before 2001 the niche market was for a long time less than 2%) was the result of a competition between different brands on the market and the rivalry of multiple certification systems (Ingenbleek and Reinders, 2013). Importantly here, retailers started to push the 'less sustainable certification label' as a standard brand in their collection. This also had positive effects on the purchase of more stringent coffee labels as discussions amongst coffee market leaders and retailers arose on the sustainability aspects, which led to an increased market share of all labels (Ingenbleek and Reinders, 2013). This diversification approach is recently also applied to fresh domestic produce in the Netherlands. For example the market share of the new label "On the way to Planet proof" has grown 492% between 2018 and 2019 (Logatcheva, 2018). The approach shows a strong growth of total market share of sustainable produced dairy to more than 15% in 2018, although the specific sustainability criteria of the various types of certification (e.g., "Beter Leven" and "On the way to Planet proof") differ from organic (e.g., Vermunt et al., 2022).

To conclude, our barrier analysis on the functioning of Dutch organic dairy farming innovation system thus indicates that the current development is more associated with the early phases of the transition (i.e., the take-off phase of the innovation system) than with a late transition stage (i.e., the acceleration phase). In contrast, in Denmark and Austria the diffusion of the organic market is in an acceleration phase, illustrated by exponential growth of organic purchase per capita since 2000 (Research Institute of Organic Agriculture, 2021). It is suggested that in both Denmark and Austria mass distribution of organic dairy by large retail (75%–80%) is the main driver of the diffusion and have led to smaller consumer price differences, but to a much lesser extent in the Netherlands where large retail contributes to around 50% of total organic sales (Agence Bio, 2019). In Austria and Denmark also strategic marketing campaigns were developed targeting regional origin (Austria), or health issues (Denmark) (Agence Bio, 2019).

4.2. Implications for the sustainability transition in agriculture

Recently, agricultural transitions have been studied using the Multi-Level Perspective (MLP) (e.g., Darnhofer et al., 2015; Dumont et al., 2020; Gaitán-Cremaschi et al., 2019), drawing on earlier research conducted on the energy transition (e.g., Geels, 2002; Geels et al., 2017). However, agricultural sustainability transitions might be fundamentally different in comparison to the more 'technology driven' energy transition.

First, farming is a land based activity where innovations such as organic practices are very often developed by regime actors (farmers) who switch to alternative practices to challenge the incumbent socio-technical regime, and not by the challenges of newcomers (Dumont et al., 2020; Vermunt et al., 2022). This is referred in the transition literature as a 'regime transformation' (e.g., Vermunt et al., 2022). A regime transformation can occur through an accumulation of novelties in niche spaces that allow for radical practices to emerge (Ingram et al., 2015; Schot and Geels, 2008), in which novelties are strongly related to so-called second order innovation changes in which pressure is put on the incumbent regime (Knickel et al., 2009). Niches are the outcome of various processes, including knowledge development and sharing and social embedding (e.g., Knickel et al., 2009) that may lead to the certification of practices through standards, also to protect niches (Renard, 2005). To develop niches further, appropriate incentives to (regime) actors need to be in place, such as taxation systems or regulatory support (Knickel et al., 2009). In addition, governments can facilitate niche development through financial support, a purchasing policy of certified products to increase market share, and active interventions at international declarations of intent with various market actors in the case of international commodities (PBL Netherlands Environmental Assessment Agency, 2014; Vermeulen and Kok, 2012).

Second, farming takes place in spatially diverse settings with very different farm structures (Darnhofer et al., 2015) resulting in different 'transformation pathways' (Vermunt et al., 2022). Various certification labels may be able to tackle these different settings through specialization and diversification of sustainability criteria (Knickel et al., 2009). Indeed, motives and pathways towards sustainable farming may differ considerably between regions and farm types (Darnhofer et al., 2010). In some areas organic farming might be a solution to the low competitiveness of family farms that produce under sub optimal conditions (e.g., in Austria), in other regions, like in the Netherlands or Denmark, it may motivate farmers to escape the 'productivist' paradigm of conventional farming competing on world markets (Duru et al., 2015; Gaitán-Cremaschi et al., 2019; Vermunt et al., 2022).

Third, a sustainability transition in agriculture based on for example organic principles, is much less driven by technological improvements as they include mostly extensification of practices, leading to agricultural products that are always more expensive to produce than their conventional counterparts. This is due to the higher labor force and/or land it requires. In for example the energy transition, economies of scale have led to strong cost reductions and therefore cheap renewable energy sources (e.g., Bogdanov et al., 2021) that make their diffusion also economically feasible. In the example of the Netherlands, the market share of multiple certification labels combined steadily increases, and it may create a new level playing field in which farmers receive higher prices for their certified products. However, also policy changes are needed in creating a fair level playing field (Streimikis and Baležentis, 2020), as illustrated by the Danish example on pesticides taxes (Daugbjerg and Svendsen, 2011).

However, Knickel et al. (2009) and Ingram et al. (2015) also suggested a regime transformation by niche development could be restricted by various components of the incumbent regime, such as imposed by regime actors, rules and institutions. In a study on the niche-regime interactions of 17 so-called Learning and Innovation Networks for Sustainable Agriculture (LINSA), Ingram et al. (2015) found these LINSA were not the outcome of a process to challenge the paradigms of the incumbent regime, but to improve practices by regime actors who had wider societal and sustainability ambitions. Furthermore, Ingram et al. (2015) argued that the influences of niches on the regime are dependent on the compatibility of niches with incumbent practices. Indeed, the relatively new Dutch labels ("Beter Leven" and "On the Way to planet proof") have different sustainability criteria added to the current agricultural practices. These criteria are less stringent than for example organic dairy farming (Vermunt et al., 2022), but do include criteria related to the uptake of agroecological schemes or animal welfare issues (Logatcheva, 2019). With respect to the organic (dairy) niche, Darnhofer et al. (2010) refer to such an uptake as a 'conventionalization process of organic principles', where organic farm structures and practices are adapted to meet the certification requirements, but the organic principles are much less adopted (Darnhofer et al., 2010; Schermer, 2008). Hence such niches may provoke incremental changes in the incumbent regime rather than radical changes. Indeed, the new dairy labels in the Netherlands are much less 'radical' in terms of sustainability criteria, but their introduction have led to an acceleration of sustainable produced dairy market share.

The slow diffusion of organic farming in the Netherlands also illustrates the difficulties in making the EU action plan operational to increase the area under organic farming practices in member states to 25% by 2030. This target is currently only met by Austria, while the average share of organic farmland in all member states was only 9.3% in 2018 (Eurostat, 2021). Our research indicates that goal seeking targets alone will not be effective for a diffusion. During the time the organic policy was operational (1990–2011), the Dutch government repeatedly set the ambitious target of 10% organic farmland in 2010, but this ambition was never met, while additional policy instruments facilitating the earlier demand-side paradigm were not developed.

Drawing on the Dutch example, it becomes clear organic farming principles are one of the many niches in the larger sustainability transition in agriculture. To make the EU action plan work, it requires foremost a more explicit governmental support to domestic farmers who apply various kinds of sustainable practices rather than focusing on the transition to organic farming alone. Currently the long-term perspectives of farmers applying such sustainable practices remain under strong pressure by the detrimental policy choices initiated by a strong incumbent regime that also blocks further greening of European agriculture.

Declaration of Competing Interest

All authors state that this manuscript has not been not published elsewhere and is not under review with another scientific journal.

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