Available online at www.centmapress.org

Int. J. Food System Dynamics 14 (4), 2023, 394-406

DOI: https://dx.doi.org/10.18461/ijfsd.v14i4.H3

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Market Formation and the Role of the Farmer in a Micro-level Agri-food Innovation System

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Received March 2023, accepted September 2023, available online November 2023

ABSTRACT

The aim is to investigate the dynamics and driving forces within a micro-level agri-food innovation system, focusing on market formation and the role of the farmer. We applied a qualitative case study approach to the introduction of sweet potato cultivation to Sweden, using the technological innovation systems approach as the analytical tool. The findings highlight the role of farmers as entrepreneurs, and market formation as a driver for the innovation system. Policy implications include that innovation policy instruments need to become more long-term, oriented towards both production development and pre-market formation, and facilitate new arenas for actors' joint problem-solving.

Keywords*: Agricultural innovation system; AKIS; technological innovation system; sweet potato; EIP-Agri.*

1 Introduction

According to Joseph Schumpeter (1934), an innovation is fulfilled only when it has been introduced to the market or otherwise put into practical use in society. However, reaching the market with new or even incremental innovation can be challenging. Studies of agricultural and agrifood innovation have illustrated the difficulties concerning market formation. For example, Menary et al. (2019) found a stark power asymmetry in favour of retail customers over suppliers in the British horticultural sector, restraining innovation and trust between actors. Schiller et al. (2020) found that market development and value chain creation were crucial for creating the potential to expand agroecological production in Nicaragua. An overall lack of market activities was found among actors in a study of agricultural innovation in New Zealand (Turner et al., 2016). In the Swedish context, Beckeman and Olsson (2011) and Frykfors and Jönsson (2010) found a lack of trust and information exchange between value chain actors, hampering collaboration and co-innovation.

The World Bank (2008) proposes that post-harvest and market actors, such as processors and traders, should be included in agricultural development efforts in order to enhance successful innovation. Within the EU, the concept of agricultural knowledge and innovation systems (AKIS), employed in policies (EU SCAR, 2019), has been criticised for too narrowly focusing on rural actors, neglecting the role of markets (Hall et al., 2006). The involvement of farm customers in European multi-actor partnerships is low according to Fieldsend et al. (2019), who suggest that the role of value chain co-innovation is underestimated and should be highlighted in AKIS contexts.

Although market demand has long been recognized as an important aspect for innovation (Schmookler, 1966; Pavitt, 1984), markets are often regarded as rather passive in innovation system literature. For example, Malerba (2002) sees markets as an institution generating demand feedback. Randelli and Rocchi (2017) note that the innovation system approach gives centre stage to the production and use of scientific and technical knowledge and tends to underestimate the co-creational aspects of market formation. According to Weber and Rohracher (2012, p 1041), "innovation system policies put supply-side issues into the foreground". This implies a risk of overlooking the role of markets and consumers as drivers of agricultural and agri-food innovation. Due to consumers' increasing awareness and individualism, market demand may be initiated and shaped through actions taken on entrepreneurial opportunities originating from customer demands (Grunert et al., 2008).

Despite the evidence of market difficulties, the role of market formation for the development of agricultural and agrifood innovations has received limited scientific attention (Randelli and Rocchi, 2017). A systematic literature review covering the period from 1997 to 2017 found that only a few scientific studies of agricultural and agrifood innovation systems include end-using customers or consumers (Spendrup and Fernqvist, 2019). Therefore, this paper aims to investigate the dynamics and driving forces within a micro-level agri-food innovation system, focusing on market formation and the role of the farmer. To meet this aim, two research questions have been developed. The first one relates to the role of market formation and customer demand in the development of the innovation system. This question is motivated by the way in which commercialisation manifests the difference between fulfilled inventions and innovative ideas (Schumpeter, 1934).

RQ1: How does market formation interact with other innovation system functions within a micro-level agrifood innovation system?

Historically, agricultural innovation is described as originating from research and being transferred through advisors to farmers in order to increase farm productivity (Rogers, 2003). This view reduces the farmer to an adapter of innovation, rather than an entrepreneurial force which can generate innovation. The shift towards more systemic and multi-actor approaches (Klerkx et al., 2012) acknowledges farmers' perspectives and motivations as central (Knickel et al., 2009). Autio et al. (2014) note that the entrepreneurship perspective is often overlooked in the innovation systems approach, and advocate a bottom-up perspective which pays more attention to the micro level of entrepreneurial firms and individuals. As farmers are seen as taking an increasingly active role (Knickel et al., 2009; Kangogo et al., 2021), this brings us to the second research question:

RQ2: What is the role of the farmer in a micro-level agrifood innovation system?

To answer these questions, we employ the case of the introduction of sweet potatoes grown in Sweden. Originating in South and Central America, the sweet potato is the sixth most cultivated crop in the world today and is renowned for its taste and high levels of vitamins and antioxidants (Mu and Singh, 2019). The introduction requires the creation of a new micro-level innovation system to ensure adaptation of production techniques to a cool climate like Sweden's and a new value chain from plant material to the consumers' plate.

We use the concept of technological innovation systems, TIS, to analyse the development and market instep of the new product. The TIS concept encompasses the development of new technologies for the exploitation of new business

opportunities (Carlsson and Stankiewicz, 1991), and is thus suitable for studying the link between innovation and market development. A TIS is defined as "a set of networks of actors and institutions that jointly interact in a specific technological field and contribute to the generation, diffusion and utilization of variants of a new technology and/or a new product" (Markard and Truffer, 2008, p 611). Although the TIS concept is extensively used and reported on in scientific studies, there are fewer studies focusing on the micro-level, taking the entrepreneur's perspective (Markard and Truffer, 2008; Planko et al., 2017). Planko et al. (2017) found that while the TIS framework broadly fits entrepreneurs' view of innovation processes, there is a need for more research on the dynamics of TIS from an entrepreneurial point of view. In order to facilitate our analysis, we combine the TIS concept with insights from marketing and entrepreneurship research, as presented in the following section.

2 Theoretical framework

Already in 1956, Smith recognized the importance of incorporating customer needs into the product development process. Kotler (1967) further elaborated on how marketers should strive to understand customer needs and allow them to influence the product development process. Actors who wish to enter or shape a market face competition in one or more areas, hence, Porter (1980) suggested three generic market strategies. Firstly, the cost leadership strategy entails competition regarding price. Secondly, a differentiation strategy requires the offering of a better or different product. The third strategy is a focussed strategy for specific market segments, so called niche markets. Niches are "protected spaces" where innovations can develop and grow strong (Geels, 2004). In the agri-food industry, niche market exploitation has been highlighted as a potential strategy, especially when it comes to sustainability related innovations (Kemp and Pearson, 2008), and explicitly for the Swedish agri-food industry (SGO, 2015). According to Phillips and Peterson (2007), agricultural niche producers can work with a broad range of market channels, from farm shops and farmers' markets to retailers, restaurants, wholesalers and processors. All of these are connected to specific risks, costs, potentials, requirements and strategies by the producer in the value chain (ibid). In this paper, we use the definition of a value chain from Porter (1990) as the sequence of value-adding activities in the production of goods.

Many innovation failures are explained with the phrase "the market was not ready" (O'Connor and Rice, 2013, p 210). Long et al. (2019, p 993) note that "[m]any innovations are developed, but few make it to the market". A general reason for market failure is that idea owners fail to create a working business model (Teece, 2010), i.e., the architecture to create the offer, reach the customers and generate profits through sales (Magretta, 2002). In fact, the commercialisation of an innovation requires a different set of skills compared to those needed when developing an innovative idea into a new technology, product, or service (O'Connor and Rice, 2013). De Lauwere (2005) shows how farmers with entrepreneurial behaviour and strong market orientation are generally more successful than those lacking these skills. Kangogo et al. (2021) suggest a need to educate farmers in entrepreneurship programs. Farmer entrepreneurship can also be facilitated through the building of value chains from the bottom up using professional process facilitators, as reported by Braun et al. (2023), in a case study of regional organic produce for school meals.

Regarding how entrepreneurs act, Sarasvathy (2001) has shown that entrepreneurs use effectuation strategies rather than causation, emphasising their active creation. This conforms with Stevenson and Jarillo (2007), who state that entrepreneurs act upon opportunities and gather the resources needed along the way. Edith Penrose (1959) pointed out how firms, regardless of size, depend on the resources they already have or those they can assemble. A market introduction, for example, may require just as much time and effort as developing the innovative product itself (O'Connor and Rice, 2013). This means that the resources needed for the comprehensive marketing measures required for market success of innovations can often be a barrier for new or small ventures (Klofsten, 2005). Supportive contextual factors, such as actors and networks, can contribute to a conducive environment for entrepreneurship (Van de Ven, 1993).

The TIS framework takes such an environment into account, encompassing the innovation system of a new technology or product. While it has mainly been applied to new technologies in sustainability transitions within energy and transportation sectors, the application of the TIS framework can be broadened beyond the high-tech field to include low and medium technology sectors such as agri-food (Randelli and Rocchi, 2017). The performance of a TIS can be assessed through the identification of functional patterns, i.e., the emergent sub-processes of the overall innovation process (Bergek et al., 2008; Hekkert et al., 2007). The functions of a TIS are as follows (Hekkert et al., 2007):

1. Entrepreneurial experimentation. Entrepreneurs turn perceived opportunities into concrete actions (Hekkert et al., 2007), and thereby generate new information on what does and doesn't work, and the reactions of other actors (Planko et al., 2017).

2. Knowledge development. Learning is fundamental for any innovation and can encompass a wide range of knowledge, such as production technology, value chains, and customer preferences (Bergek et al., 2008; Braun et al., 2023).

3. Knowledge exchange. Innovation systems consist of heterogeneous networks of actors, such as entrepreneurs, researchers, and traders, who exchange and co-construct knowledge in their interactions (Hekkert et al., 2007; Schiller et al., 2020).

4. Guidance of search. This function denotes the perceived market opportunities attracting entrepreneurs and others to join the innovation system, such as demand articulations from leading customers, as well as the search within the system for improvements (Bergek et al., 2008).

5. Market formation. Market formation includes both actual market developments and factors that drive the market (Bergek et al., 2008); it relates to both input and sales markets (Schiller et al., 2020).

6. Resource mobilisation. For new technologies or products to develop and compete with incumbent systems, both human and financial resources are needed (cf Braun et al., 2023).

7. Creation of legitimacy. An innovation needs to be socially accepted by relevant actors, meaning it must be considered appropriate, relevant and desired (Randelli and Rochi, 2017).

The TIS functional analysis can contribute to improved policy making, as it provides an analysis of what actually happens in an innovation system (Bergek, 2008). Historically, innovation policies have been focused on supporting pre-competitive research and network-building, while not intervening within markets (Schot and Steinmueller, 2018). Support for market related activities is usually not allowed within the different kinds of innovation support programmes available (Norrman, 2018). For example, the implementation of the European Innovation Partnership program for Agriculture (EIP-Agri) in Sweden requires a plan for market instep as one of the approval criteria for project proposals, yet the general rule is that marketing activities are not eligible for support (Eckerberg et al., 2021).

3 Methods

3.1 Case selection

The introduction of Swedish-grown sweet potato is an interesting case for the investigation of the study's main premise, for several reasons. First, the consumption of imported sweet potato has increased rapidly in Sweden (figure 1) over the past decade. While this trend has prompted interest in domestically grown sweet potato, it has also meant that the market for the domestic produce has developed under strong pressure of competition from the imported goods.

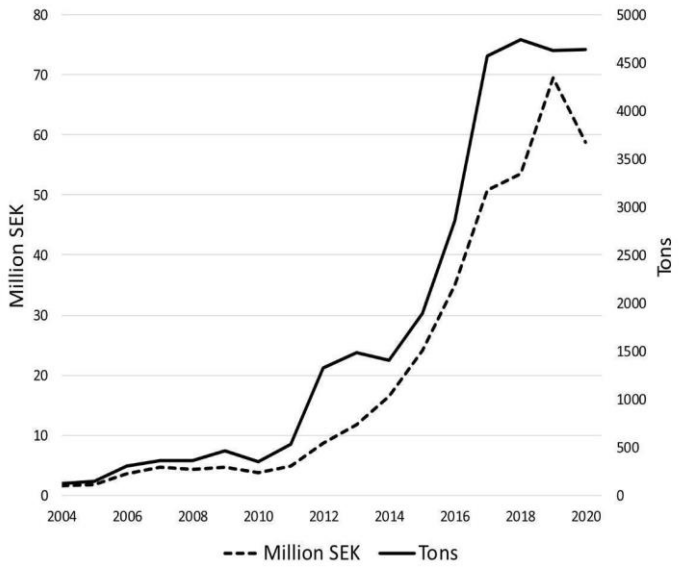

Figure 1. Imports of sweet potato to Sweden during the years 2004 - 2020, in weight and value (Statistics Sweden, 2021); Import has increased from negligible to more than 4,500 tons per year. 1 SEK ≈ € 0.1.

Second, the volume and value of fresh fruit and vegetables in general sold in Swedish supermarkets is increasing annually and is expected to continue to grow (Fernqvist and Göransson, 2021). The main drivers of this growth are consumer interest in healthy foods, local fresh produce, and food variation (ibid), making the sector a point of interest for further attempts at product innovation. Thirdly, while sweet potato is a well-known crop in warm climates, in a cool-climate country like Sweden, production techniques must be adapted to enable profitable production and to mitigate

the risk of harvest loss due to cool weather. The need for knowledge development and experimentation has led to the rise of a micro-level innovation system. A fourth argument is that the number of actors involved at the start was limited, enabling a substantial part of the innovation system to be grasped more easily.

3.2. Research design, data collection and sample characteristics

We chose a qualitative case study approach as it is appropriate for exploring complex situations in rich detail and over a period of time (Yin, 2009; Eisenhardt, 1989). We collected documentation on a two-year research project and a three-year EIP-Agri project related to the introduction of the new crop, such as project reports and information materials. We used semi-structured interviews as is often done in innovation system analysis (Menary et al. 2019). The interview respondents were selected based on purposeful sampling in order to cover the different influential actors involved in the case (see table 1). The interviews were conducted from December 2020 to September 2021, with nine carried out as web-meetings, ten by telephone, and one by e-mail, depending on the accessibility of respondents. Each voice interview lasted 20-60 minutes; they were all recorded and transcribed, with the exception of four which were carefully note-taken. Both authors were present for seven of the interviews. Secondary data was collected, such as articles in industry media, trade regulations, authority reports, and terms of innovation support measures. The collection of data from multiple sources contributed to a rich and varied data set (Yin, 2009; Miles et al., 2020).

Table 1.
List of interviewees by their role in the empirical case (n=20).

Stakeholder category	Organisation	Role/description of interviewee
Research and education	Agricultural university Agricultural university	Researcher and project manager Food scientist
Suppliers	Plant nursery Seed and plant supplier	CEO CEO
Advisory services	Private advisory company	Advisor/specialist in horticultural field production
Farmers	Farm 1 Farm 2 Farm 3 Farm 4 Farm 5 Farm 6	Early adopter, large-scale farmer Potato entrepreneur, large-scale farmer Large-scale farmer Small-scale farmer Farm shop farmer Market gardener
Producer organisations	Producer org. 1 Producer org. 2 Local produce wholesaler and retailer	Salesperson Marketing manager CEO
Retail actors	Supermarket chain Supermarket store 1 Supermarket store 2	Wholesale manager Head of fruit and vegetable department Head of fruit and vegetable department
Authorities and policy makers	Public administration Public administration Public administration	Trade specialist EIP-Agri specialist AKIS and EIP-Agri specialist

3.3 Data analysis

The analysis was done by carefully reading and comparing interview transcripts, notes and documents in several rounds (Rennstam and Wästerfors, 2018). In the first round, the actors, their relations, and the unfolding events were mapped on a timeline. We used the graphic technique of digital murals to allow for a detailed data display; an illustration of such a mural is presented in figure 2. In the next step, we sorted the data according to the seven TIS functions described in the previous section. Thirdly, in order to gain a deeper understanding of the market formation function, the data concerning the market function was analysed in depth, revealing a variety of pathways to market formation (see figure 4) and the interaction of the market function with the other system functions. In all steps, secondary data was used to validate and triangulate the primary data (Yin, 2009). The use of data displays and figures facilitated the analysis and discussion between the authors (Miles et al., 2020).

4 Results

This section presents the results structured using the seven TIS functions described in the theory section.

4.1 Entrepreneurial experimentation

Two horticultural farmers saw the crop on a study trip abroad and became interested. At the time, no one grew the crop domestically, and the farmers had difficulties finding plant material of suitable varieties. Sweet potato is propagated through vegetative cuttings from a mother plant, these are known as slips. The available slip varieties were adapted for southern Europe, were short in supply and had long delivery times, causing an issue surrounding their quality during transport. Meanwhile, a university researcher visited a horticultural research conference abroad and saw new varieties which were more adapted to cool climates. The researcher imported nine varieties and started cultivation trials on university grounds. When the results were reported in industry media, a representative of a producer organisation saw it and put the researcher in contact with the farmers mentioned earlier. Together, they started experimenting with field trials on their farm.

In another part of the country, a pair of potato farmers were asked by one of their customers, a supermarket store, if they were interested in growing the crop domestically. Through the industry media article, they contacted the researcher, which in turn led to contact with the adviser and the plant nursery. They have since grown the crop yearly and learned successively about its production, handling and storage. In a third example, a pair of arable farmers were interested in increasing their crop diversity. They heard about the new crop through their advisor and, as they had facilities that could easily be adapted to the special storage requirements of the crop, they decided to try the unusual crop. The main actors and events in the introduction of domestic sweet potato cultivation are illustrated in figure 2.

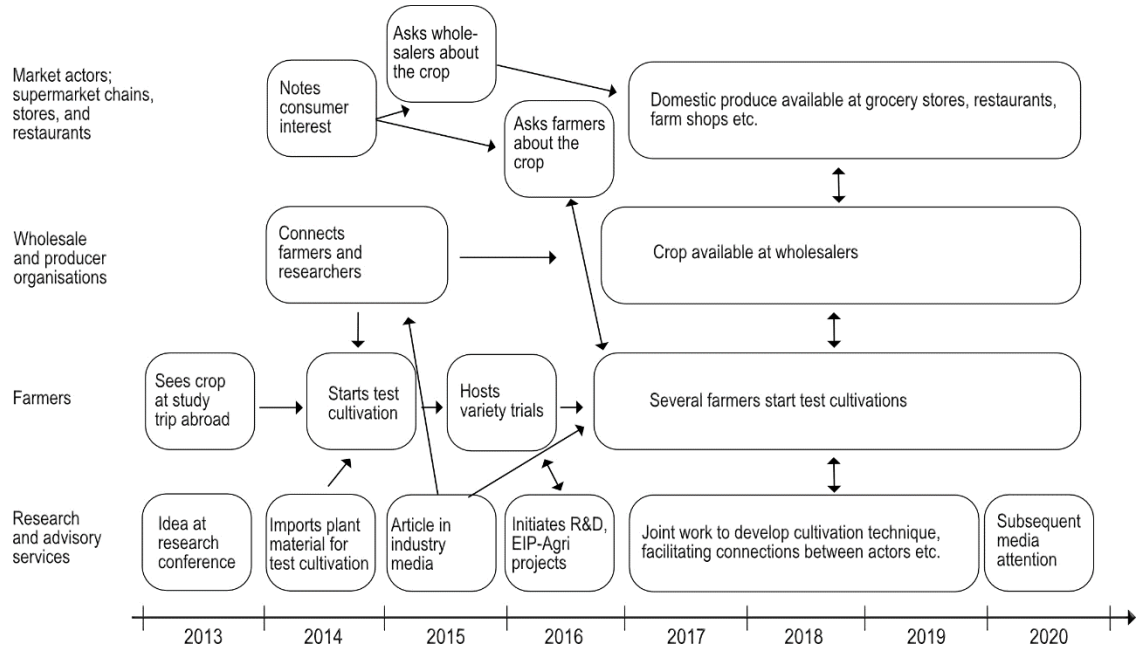

Figure 2. The main events of the introduction of domestic sweet potato cultivation, mapped on a timeline from 2013 to 2020.

4.2 Resource mobilisation

Implementing a new and demanding crop is risky, as noted by one of the farmers: “It is a new crop and it’s the farmers who have to take all the risk.” Another farmer explained the balance between autonomy and risk and argued that if others would share the risk, they would also want part of the control. So, the farmers mobilised the contacts and resources they needed to do their own experimentation with cultivation, storage, and market channels. One of the researchers noted in the final report of the EIP-Agri project: “The food industry and supermarket wholesalers are interested in new products and product development but … stand completely aside as long as small volumes and uncertain quality are involved. It is the producer level that must bear the risks and costs of the development work.”

The researchers formed a network with a few interested farmers, a producer organisation, an advisor, and a plant nursery, and applied for funding. They started a small research project focused on testing suitable varieties and assessing techniques for the establishment of the field crop. Next, the group applied for funding from the EIP-Agri program with the aim of finding a working model for the introduction of the new crop, from field to consumer. All participating actors mobilised the time and other resources necessary for their active participation in the research and development work.

4.3 Knowledge development

Through the research and EIP-Agri projects, field trials were performed of crop varieties, cultivation techniques and post-harvest storage, both at the university campus and hosted by farmers (see figure 3). A report with practical guidelines for cultivation, post-harvest treatment and storage was developed to inform growers. Knowledge on vegetative propagation and slip production began to build through the involvement of the plant nursery. In addition, the slips imported by the supplier were of increasingly improved varieties and quality. The post-harvest treatment and storage requirements were a learning process for farmers and actors handling the crop on its way to consumption, such as wholesalers, retailers, and restaurants. While most vegetables prefer cool storage in order to keep fresh, the opposite is true for sweet potatoes. This illustrates how knowledge development is needed all along the value chain.

Figure 3. The left panel, a field trial testing varieties and methods of establishing the sweet potato crop. Photo: H. Karlén. The right panel, a test harvest in early September. Photo: O. Hansson.

4.4 Knowledge exchange

The early article in industry media (Karlén, 2014) contributed to an increase in possible uptake of the new crop. It led to contacts being made between researchers, farmers and producer organisations. Subsequent media reports from the projects contributed to further dissemination (Thunberg 2016; Rölin, 2017; Hansson 2021), together with seminars and field excursions arranged within the projects. The advisor formed a peer learning group of interested farmers, visiting field trials located at farms and at the university. It became a platform in which farmers learned from each other, facilitated by the advisor. Even if the group was perceived as valuable by the farmers, the knowledge sharing only went so far, as reflected through this quote from one of the farmers: “Everyone runs their own race, and tries, and some are very secretive”.

4.5 Guidance of the direction of search

The farmers’ experiences of customer preferences in terms of size, shape and colour of tubers, along with taste, price and packaging, contributed to joint learning and acted as a guide for continuous research and knowledge development. The research and EIP-Agri projects aimed to support the production, developing methods of efficient and economically feasible production of the crop. They experimented with slip production, planting, weed control, fertilising, irrigation, harvesting and storage.

4.6 Market formation

Market formation relates to both input and sales from the farmers' perspective. Regarding the input market, some respondents noted that the cost of slip imports was affecting their profit margins. The varieties available, the slip quality, and the long transportation were all constraints on the domestic sweet potato cultivation. However, starting up domestic slip production as a complement would require time and investments.

The sales market formation included four pathways to market (see figure 4), with some of the farmers pursuing more than one of the following four strategies.

Via producer organisations and supermarket wholesalers.

A supermarket chain integrated wholesaler had noted increasing sales of imported sweet potatoes and asked their suppliers, producer organisations, for domestic produce. The producer organisations took the question to their farmers, who started experimenting with the crop. Subsequently, deliveries were made to the supermarket wholesaler. While this market channel has the potential of distributing large volumes of the domestic crop, the wholesaler emphasises that the price and quality of domestic products must not deviate too much from those of imports. In addition, to maintain interest long-term, they need certain volumes to keep the product in store. The large volumes needed by supermarket wholesalers poses a potential difficulty in scaling up new crop production.

Direct delivery farm - supermarket.

Some farmers had already established direct distribution channels to individual supermarket stores, which they could use with the new crop. At the supermarket store, the product was prominently placed, with signs made by the farmers which emphasised the local connection and offered recipes. The farmers remarked that they preferred to keep the chain short, as the crop is costly to produce.

Via small-scale wholesalers.

Small-scale wholesalers deliver local produce to restaurants and small-scale stores directly from their network of supplying farmers. Some of their restaurant customers were quick to ask for domestic produce of the popular crop, as they were constantly looking for new items for their menus. While this market pathway appears promising, the capacity to distribute large volumes is limited compared to the two earlier alternatives.

Direct delivery farm - consumer.

An example of sales directly from farmer to consumer was the farm shop grower, who grew small volumes sold as premium produce in their farm shop. This trend is connected to consumer interest in farmers' markets, consumer subscriptions of vegetable boxes, and similar local market channels. However, the sales volumes are far lower than the earlier pathways.

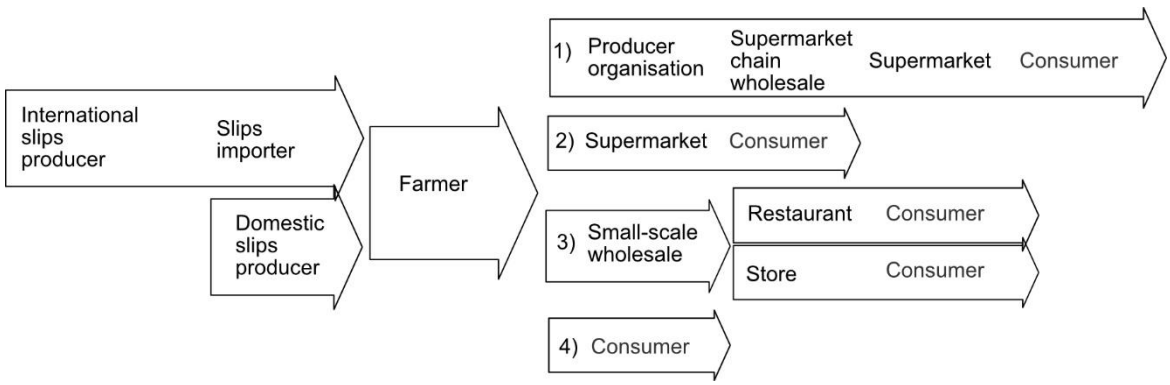

Figure 4. The value chain with its actors and the four pathways to market.

The group working with the EIP-Agri project built contacts with actors along the value chain, such as suppliers, farmers, wholesalers and restaurants, with the aim of encouraging cooperation in order to increase production and sales of the domestic crop. Their contacts with market actors suggested that while it may be economically feasible to produce certain volumes sold directly to supermarkets and restaurants (pathway 2 and 3), the scaling up for supermarket supply (pathway 1) would require considerable investment and cooperation throughout the value chain. One of the researchers reflected in the final report of the EIP-Agri project: "The most important obstacle to succeeding in increasing the volumes is the one-sided price focus and the reluctance to take risks." The EIP-Agri researchers suggested that in

order to increase the volumes of new crops for supermarket sales, new forms of cooperation between value chain actors would be required, with an aim towards broadening the competence and strengthening financial resources in order to speed up the introduction of new crops in a profitable way. In order to form a market strategy which was less susceptible to price changes, the researchers suggested investing in new domestic varieties that would differentiate the domestic produce from imported varieties and to develop a common branding and quality control system for marketing. However, this would require deeper cooperation between farmers and other actors, and substantial investment in research, technology and marketing.

4.7 Creation of legitimacy

The creation of legitimacy for the domestically grown crop was facilitated through the already established imported crop and the overall consumer interest in local produce. However, for consumers to keep buying the higher priced local produce, they need to be convinced of the added value of the local product.

5 Discussion

In this section, the results are analysed and discussed in relation to the two research questions.

5.1 How does market formation interact with the other innovation system functions within a micro-level agrifood innovation system?

The results presented in the previous section reveal how market formation appears to energise the other system functions, acting as a driving force for the new innovation system. An estimated market potential is an essential driver of *entrepreneurial experimentation*. The interviewed farmers were all motivated by the perceived market opportunity, combined with their ideas of how to realise this opportunity, i.e., growing and delivering the crop based on their own prerequisites. The farmers' focus on their sales channels and how to organise their production, illustrates the close relation between the functions of entrepreneurial experimentation and market formation, as also noted by Schiller et al. (2020). In order to realise the market opportunity, the farmers *mobilised their resources*, including both their already existing resources for experimentation and new contacts in order to acquire the knowledge and resources of others. The research and EIP-Agri projects contributed resources in the form of variety testing, development of production techniques and experimentation with domestic slips. In this way, the farmers and the participants of the research and EIP-Agri projects contributed to *knowledge development.* The learning activities included the exploration of new ideas and approaches, as well as the improvement and finetuning of existing practices, in line with the findings of Braun et al. (2023). As shown by Randelli and Rocchi (2017), the learning from customers was also important in this case, both in terms of delivery preferences and the acquisition of information about actual and future developments. Reciprocally, the farmers' customers had to learn how to handle the new crop in terms of storing and presentation to their customers and consumers. This kind of knowledge about users, and the integration of user information in the learning activities, has generally been less studied in TIS contexts (Planko et al., 2017).

The advisor-led peer-learning group of farmers was a source of both new knowledge and *knowledge exchange* among the involved actors. The industry media articles, seminars and workshops facilitated by the research and EIP-Agri projects also contributed to knowledge exchange. This included both knowledge building within organisations, as mentioned by Braun et al. (2023), and inter-organisational knowledge exchange, carried out vertically between, for example, producers, customers and consumers, and horizontally between, for example, farmers, as observed by Randelli and Rocchi (2017). The *direction of search* appears to have been guided mainly by demand from leading customers. This prompted a search for efficient and economically feasible production of the crop, more stable harvests of larger volumes and increasing quality, to meet market demands. The problems with imported slips prompted experimentation with domestic slip production. In other studies (e.g., Planko et al., 2017), government interventions play a leading role in the guidance of search; however, in this case, national policies had a passive role in terms of generally encouraging sustainable and domestic production. The *creation of legitimacy* was influenced by the already established imported crop and overall consumer interest in local produce. Yet, legitimising a higher price requires convincing consumers of the value of the local product. A lack of resources for market formation may impede further market formation, as found by Schiller et al. (2020).

The initiatives taken by supermarkets and wholesalers, asking their suppliers for the new crop, illustrate how market demand can induce new innovation, and how customers and consumers can act as drivers in the innovation process (Randelli and Rocchi, 2017). Their demand caused the acceleration of domestic production, energising the functions of entrepreneurial experimentation, resource mobilisation, development and the exchange of knowledge, and contributed to guiding the direction of search. While there was an interest in domestic produce from supermarket chains, the higher risks and production costs of domestic produce meant difficulties for the producers in matching the price of imports. The profiling of domestic produce as a premium product, competing based on quality and local proximity rather than on price, still involves an inherent risk of price pressure if consumers do not appreciate the difference between local

and imported produce (Grunert et al., 2008). The use of small-scale market channels, such as farm shops and farmers' markets, appeals to consumer interest in buying local fresh produce from nearby growers (Fernqvist and Göransson, 2021; Phillips and Peterson, 2007). However, the small-scale production and marketing model is costly, and runs the risk of losing consumer interest in an economic downturn. Furthermore, small-scale production alone would struggle to motivate both long distance slip imports and further research efforts, making this alternative alone hardly a viable option. Hence, for the new crop to survive its introduction phase and increase its sales volumes, it has to meet the strong competition of the imported produce by both increasing production volume and quality, and reducing its production costs.

In order to do this, a sustained effort of production development, variety testing and, perhaps, domestic slip production would be needed, which the research and EIP-Agri projects were unable to establish. The introduction of a new product is both difficult and costly, which conflicts with the scarcity of resources available for small firms (Klofsten, 2005). In this case, innovation policy measures would need to be more long-term, and oriented towards both technology development and market formation. Policy support for agricultural innovation has hitherto mainly focused on technical support and network building for innovation actors in pre-competitive stages (EU SCAR, 2019). There has been less reciprocal focus on actions on the demand-side, as also noted by Schiller et al. (2020), even though market demand is crucial for any innovations' societal impact. If inventors fail to create working business models and commercialise their ideas in the market, the innovation process will fail (Teece, 2010). While the EIP-Agri program can support pre-market activities to some extent (cf Braun et al., 2023), general support for marketing activities is not allowed (Eckerberg et al., 2021). Therefore, the development of pre-market activities such as arenas for actors' joint problem-solving may be needed, as will be discussed in the following section.

5.2 What is the role of the farmer in a micro-level agrifood innovation system?

Entrepreneurship equals risk-taking (Stevenson and Jarillo, 2007), and this holds true also for sweet potato farmers. The accounts of the horticultural farmers illustrate the kind of difficulties encountered when planning to introduce a new crop, related to both input and sales market formation. There was a large initial cost to establishing the crop in the field, and cultivation and storage contain relatively large risks in a cool climate. The farmers alone took the full risk, and benefits, of the production as also noted by De Lauwere (2005), as there were no guarantees of either a harvested volume, quality or pricing. The results illustrate how the farmers' entrepreneurial experimentation started the introduction of the new crop, following the paths that worked for the individual farm. The growers made use of the resources they already had, noted as the bird-in-hand-principle by Sarasvathy (2001). As the market formation unfolded through various channels, the cohesion between the farmers on market aspects was low. This made the farmers vulnerable to price pressure and may indicate difficulties for them in achieving future profitability. The risks associated with the new crop were too high for the farmers to invest fully, and they would therefore continue to consider the cultivation as an experiment. A lack of sufficient and feasible market formation may influence entrepreneurial experimentation negatively, as noted by Schiller et al. (2020).

The project funding for variety testing, production development and the farmers' peer learning group contributed to rapid knowledge development and exchange between the actors. However, these efforts alone would not have been sufficient to form the basis for sustained domestic cultivation. The market actors, in terms of the farmers' customers, were mainly involved in the innovation process through purchasing the products and thereby expressing demands for price, quality, and delivery terms. This positions the farmers in the nexus of production development and market formation, illustrating innovation as both an individualistic and a collective endeavour. While entrepreneurship stems from individual agency, it is collective in the sense that it is dependent on its structural and institutional context (Van de Ven, 1993; Hekkert et al., 2007). These findings indicate a lack of contexts where market actors, including farmers, farmer's customers and their customers in turn, can meet with innovation support actors, such as researchers and advisors, and work towards joint problem-solving and co-innovation related to pre-market formation challenges. Earlier studies have shown a lack of dialogue and trust building between value chain actors (Menary et al., 2019; Randelli and Rocchi, 2017; Beckeman and Olsson, 2011; Frykfors and Jönsson, 2010). There is a need to encourage and maintain collaborative learning processes along the value chain, for example through facilitation services, as suggested by Braun et al. (2023). Menary et al. (2019) propose the forming of retail-led groups in order to build trust among value chain actors and support producers, as the authors place a significant responsibility on retailers for creating a defensive innovation climate through constant price pressure. However, the farmers in this study point to the balance of autonomy and being controlled by others. Randelli and Rocchi (2017) suggest that consumers may positively influence market formation, calling for policy actions to promote innovative ways of organising consumer involvement in market formation and innovation processes. The case of public procurement of school meals illustrates the potential for sustainability-aware procurement (Braun et al., 2023; Randelli and Rocchi, 2017).

The limitations of the study include the use of a single case study, with its own context-specific actors, interactions and institutions. Case studies contribute to building experiences which can be used in relation to other cases (Yin, 2009). The strength of the technological innovation systems framework lies in the identification of functional patterns, i.e., the

emergent sub-processes of the overall innovation process (Bergek et al. 2008). These patterns can provide a means of comparison with other cases.

For a system to work as an enabler of innovation, a multi-level infrastructure needs to be in place, including policies and regulations (Van de Ven, 1993), dynamic systems functions (Bergek et al., 2008; Hekkert et al., 2007), and the micro-level of entrepreneurial individuals (Autio et al. 2014; Planko et al., 2017). This study contributes the understanding of the dynamics of TIS at the micro-level and from an entrepreneurial point of view. Furthermore, it is a study of an agri-food innovation system which includes farmers' customers, as called for by Spendrup and Fernqvist (2019). It is a contribution to the understanding of the driving forces of agri-food innovation systems.

6 Conclusions

The aim of this paper was to investigate the dynamics and driving forces within a micro-level agri-food innovation system, focusing on the market formation and the role of the farmer. The results reveal how the market formation appears to energise the other system functions, acting as a driving force for the innovation system. The demand from customers and consumers caused the acceleration of domestic production, energising entrepreneurial experimentation, resource mobilisation, knowledge development and exchange, and contributed to guiding the direction of search. This illustrates the importance of the market formation function in an innovation system, which is traditionally more concerned with technical development. In addition, the case illustrates how user knowledge is integrated in the innovation system, which has often been overlooked in technological innovation systems contexts (Planko et al. 2017). In this way, the study contributes the understanding of the dynamics of innovation systems at the micro-level and from an entrepreneurial point of view. As a study of an agri-food innovation system which includes farmers' customers, as called for by Spendrup and Fernqvist (2019), it is a contribution to the understanding of the driving forces of micro-level agri-food innovation systems. The implications for research include highlighting the role of farmers as entrepreneurs, market formation, and the integration of user knowledge, into further innovation systems studies.

For the new crop to survive its introduction phase and increase its volumes, it has to meet the strong competition from the imported produce. This would require resources for production development and market formation. Herein lies the main implication for policy makers; agricultural innovation policy instruments may need to become more long-term and oriented towards both technological development and pre-market formation activities. The findings indicate a lack of contexts where market actors, such as farmers, their customers and consumers, can meet with innovation support actors, such as researchers and advisors, to work towards joint problem-solving and co-innovation related to pre-market formation challenges. The creation of such meeting places for collaborative learning processes along the value chain is an implication for both practice and policy makers.

Finally, the results illustrate how farmers were the connecting link between the market actors and innovation support actors, positioning the farmers in the nexus of production development and market formation. This underlines how farmers, especially in their role as entrepreneurs, should not be seen merely as passive adapters of innovation. In fact, farmer entrepreneurship, building on generations of experience in adapting the use of the farmland to changing market conditions, should be recognized as a crucial driver of innovation in agri-food innovation systems.

Acknowledgements

We are grateful to our interview respondents for giving their time and sharing insights with us, and to Professor Lena Ekelund Axelson for support. This work was supported by Sparbanksstiftelsen Färs & Frosta/Sparbanken Skåne, SLU Partnership Alnarp and SLU RådNu – thank you. We are also grateful for the very helpful reviewer comments.

Declaration of interest

The authors have no relevant financial or non-financial interests to disclose.

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