


Identifying key network characteristics for agricultural innovation: A multisectoral case study approach

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Abstract

This article identified network characteristics critical for successful agricultural innovations within networks, or a set of interrelated organizations aiming at knowledge exchange for innovations. To explore key success factors, the research questioned how networks cope with innovation characteristics and combined network characteristics with four innovation characteristics in four agricultural sub-sectors. Data were collected from in-depth interviews with farmers and network coordinators and from focus group discussions with farmers active in Flanders, the northern part of Belgium. Factors particularly helpful for success in agricultural innovation networks include numerous contacts, integration of knowledge providers in the network structure, face-to-face communication, a self-initiated coalition and surpassing innovation beyond the mere agricultural level, through collaboration with people from outside the sector. The findings are useful for academics, network coordinators and network members, possibly leading to a higher innovation performance via networking.

Keywords

Flanders, success factors, collaboration, knowledge exchange

Introduction

In an agricultural system, innovation is a necessity more than ever before. The system is, for example, confronted with challenges related to feeding an increasing global population, next to increasing demand for feed and biomass applications, increased pressure on price levels, a series of standards to comply with and the deregulation trends in the frame of the European Common Agricultural Policy. Innovations can help to change these challenges into opportunities for individual farms and the sector in general. In this regard, there are indications that the agricultural system could benefit from participating in networks in terms of their innovations (Knierim et al., 2015; Pannekoek et al., 2005; Pascucci, 2011). In this article, a network is defined as a set of relationships through which companies acquire, assimilate, transform and exploit knowledge, serving as the medium for the combined transformation of the company's internal and external resources into an innovation. Advantages of networks for innovations mentioned in the literature are manifold. Through networking, firms are able to quickly identify and exploit opportunities and to manage their environmental uncertainties (Burt, 1997; Elfring and Hulsink, 2003). In addition, it allows knowledge exchange in a more efficient way. It enables access to new technologies, know-how and resources, vital for developing

innovations (Omta, 2004; Pittaway et al., 2004; Zahra and George, 2002) and hence this allows sustainable growth, a shorter innovation time, an increasing flexibility of operation, reduced transaction costs, the benefits of economies of scale and sharing risk and uncertainty among network organizations (Håkansson and Snehota, 1995; Leeuwis, 2000; Omta, 2004; Powell et al., 1996).

Many policymakers internationally have started to support the creation and maintenance of networks to increase the competitiveness of their country or region via innovation (Kingsley and Malecki, 2004; SCAR, 2012). Nevertheless, and despite these efforts, there is still a long way to go. Despite the increasing number of studies focusing on

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the relationship between networks and innovation, there is still considerable ambiguity and debate regarding appropriate network characteristics for successful innovations (Nieto and Santamaria, 2007; Pittaway et al., 2004). Many different designs exist for networks (Bek et al., 2012). They differ, for example, in terms of configuration, membership, ties and management (Pittaway et al., 2004). There has been little empirical evidence on the optimal design for networks to foster innovations (Hanna and Walsh, 2008; Huggins and Johnston, 2009; Pittaway et al., 2004; Thorpe et al., 2005). Furthermore, concrete anchor points to evaluate the ability of a network to stimulate successful innovation processes are missing. Hence, the objective of this article was to identify the network characteristics critical for successful innovations.

Networks and innovation

Network characteristics

In terms of network characteristics, some structural and structuring dimensions have been identified, based on the work by Lefebvre et al. (2010). The structural dimension of the network refers to its physical characteristics. Lefebvre et al. (2010) identified three broad types of elements relating to the structural dimension of networks: network configuration, network membership and network ties. Network configuration relates to the pattern of linkages between network members. Network membership refers to the composition of the network, such as the number and type of members. Network ties refer to the characteristics of the relationships between network members, such as the frequency and intensity of interaction. The structuring dimension includes the management and governance of the network. The network management refers to, for example, the way in which conflicts between the network members are dealt with, the development of shared goals and a network culture. Network governance involves the use of institutions and structures of authority and collaboration to direct, administer and control joint actions across the whole network. Networks can, for example, be governed by the members themselves, by a single participating member or by outsiders. Additional components of network governance include formal or informal network governance mechanisms, such as the use of contractual arrangements or trust-based relationships.

Innovation characteristics

In the literature, we found a study (Kanter, 1988) that identified the characteristics of innovations that seem to be important for each innovation process, defined as *uncertain, knowledge intensive, controversial and crossing boundaries*. These are briefly summarized in the following.

The innovation process is uncertain. The innovation goal may be confronted with little or no knowledge upon which to base forecasts. Expected timetables may prove unrealistic, and schedules may not match the true pace of progress, which means that ultimate results are highly uncertain.

Also, the source of innovation or the occurrence of opportunity to innovate may be unpredictable (Kanter, 1988). Innovations respond to changes occurring outside the immediate environment of the farm. It can be a breakthrough in technology or methodology (e.g. new planting technology), the development of a new market (e.g. short supply chains for vegetables) or a shift in demand (e.g. increasing interest in ancient vegetables). However, the requirements of customers, the occurrence of problems with the current way of working and changing social expectations with the resulting adjustment in rules or legislation also have an impact on the innovation behaviour of farmers. Hence, for innovators, it is important to detect such opportunities.

The innovation process is knowledge intensive. The innovation process generates new knowledge intensively, relying on individual human intelligence and creativity and involving 'interactive learning'. New experiences are accumulated at a fast pace. The knowledge possessed by the participants in the innovation effort is not yet codified or codifiable for transfer to others. Efforts are very vulnerable to turnover because of the loss of this knowledge and experience. There need to be close linkages and fast communication between all those involved, at every point in the process, or knowledge involved will erode.

The innovation process is controversial. Innovations always involve competition with alternative courses of action. Sometimes, the very existence of a potential innovation poses a threat to vested interests, whether the interest is that of a salesperson receiving high commission on current products, or a retailer unwilling to adopt the innovation.

The innovation process crosses boundaries. An innovation process is rarely, if ever, contained solely within one unit. First, evidence exists that many of the best ideas are interdisciplinary or inter-functional in origin, or benefit from broader perspectives and information outside the 'locus of innovation'. Second, regardless of where innovations originate, they inevitably send out a ripple effect to other organizational units, whose behaviour may be required to change, or whose cooperation is needed when an innovation is to be fully developed or exploited.

Methodology

Taking into account the above-mentioned four key characteristics of every innovation process, Kanter (1988) investigated the structural, collective and social conditions facilitating the ability to see new opportunities and to innovate. Kanter's assessment of innovation processes is conceived from the perspective of the individual organization, asking the question – how do individual firms cope with these characteristics of innovation? Building further on her work, this article studies the way in which existing and emerging networks deal with these innovation characteristics. This shifts the unit of analysis from the organization to the network. The characteristics of the network are

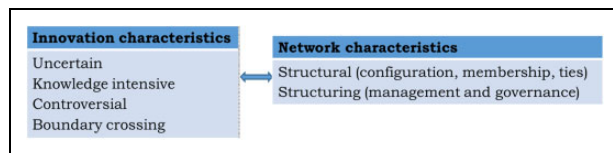


Figure 1. Linking innovation characteristics with network characteristics.

considered as a basis to investigate the conditions that facilitate innovation. This forms the link between the innovation characteristics and the network characteristics, which is the focus of this article. This link is illustrated in Figure 1.

Data collection

Based on the aim of this research, in-depth interviews and focus group discussions were conducted. Qualitative research techniques are suitable for relatively unexplored themes and can illustrate underlying motivations and attitudes (Malhotra, 1999). Data were collected between June 2011 and March 2013. In total, 38 farmers and 23 network coordinators were reached via in-depth interviews, and 48 farmers via focus groups, leading to the consultation of 109 respondents in total, spread over four sub-sectors, namely the poultry, fruit, vegetable and ornamental plant sectors. These four agricultural sub-sectors, or cases, have been selected because they differ in conditions and cooperative attitudes. In Flanders, these sectors are, respectively, characterized by a strong vertically integrated supply chain, a strong collaboration within a producer association (with special attention on the growers of kiwi berries), a highly cooperative attitude for the supply of products and a lot of collaborative initiatives set up due to geographical concentration of different players (with special attention on Sietinet, a network bringing together growers and researchers).

Data analysis

All interviews and focus groups were audio-recorded and transcribed, followed by coding in Nvivo 10. First, the text fragments relating to how networks cope with the four characteristics of an innovation process are coded: 'in.char 1', 'in.char 2', 'in.char 3' and 'in.char 4'. Second, all the text fragments related to the network characteristics (structural and structuring dimensions) are coded: 'structural' or 'structuring', depending on their content. On the coded text, a series of advanced coding queries were run consecutively for each sub-sector, resulting in an overview of the network characteristics facilitating successful innovation processes across the four cases.

The first query results, for example, showed all text fragments relating to innovation characteristic 1 in the poultry sector. Similarly, this query was run for the other innovation characteristics and the sub-sectors. To form the link with the network characteristics, within these fragments, the text fragments coded 'structural' and 'structuring' were scrutinized. Furthermore, as not all the information about the network characteristics were included in the coded text fragments about the innovation

characteristics, another series of queries was run for each case, providing all the text fragments coded 'structural' or 'structuring'. The information from all these queries resulted in a description of how the network copes with the innovation characteristics per case, by including the relevant information about the network characteristics and the necessary background information to grasp the context. This description is summarized in Table 1 (step 1).

In the next step, network characteristics facilitating successful innovation processes were studied at a more detailed level across the four cases. This analysis was done manually, as it would be much more time-consuming in Nvivo. The results of step 1 were printed and laid next to each other. Characteristics such as 'central coordinator, heterogeneity, formal, independent person, direct ties, self-initiated, strong ties and horizontal network partners' are attributed to the text fragments. While doing this, common network characteristics were sought across the cases, or network characteristics of certain cases that could be inspiring for other cases.

Key findings

The findings of the first analytical steps are provided in Table 1, providing a short description of how the network copes with innovation characteristics, including crucial background information. The second section of the findings discusses how the network characteristics can be understood in terms of dealing with innovation characteristics. A distinction is made between structural and structuring elements.

To decrease the *uncertainty* inherent to innovation, in terms of the *structural dimension*, all four cases showed the importance of close contact with a heterogeneous group of people such as colleague farmers, suppliers, buyers and researchers. The findings on structural dimension suggest that more centralized and large networks constrain an equal dispersion of innovative potentialities that result from the anticipation of external knowledge acquisition. For instance, most growers participating in the vegetable auction do not have direct contact with the group of knowledge actors with whom the management board interacts. Only the most active network participants take part in these knowledge-sharing activities. In the case of the poultry sector, farmers have a tendency to shift the acquisition of knowledge to the level of their integrators, the non-farm actors, instead of looking for concrete opportunities to innovate themselves. On the contrary, smaller and more connected networks, such as the case of the producer organization of the kiwi berry, suggest that a stepwise accumulation of common expertise enables the network to more fully adopt external information. In addition, the four cases reveal the importance of strong and direct ties to decrease uncertainty. For example, in the case of the vegetable sector, there is a close contact with the producers via consultation with grower groups and with the market via the commercial unit. Also, in the case of the kiwi berry, strong and direct ties are evident between the producers and the market.

Table 1. Overview of how different cases deal with innovation characteristics.

Poultry sector – Strong vertically integrated supply chain	
Characteristic 1: Uncertain	Integrated farm: integrator employee is an important unidirectional source of knowledge, enabling to reduce the uncertainty of the innovation process. Farmer is mostly solely interested in technical knowledge. Spot market: earnings depending on performance. Farmer needs to be aware of every aspect relating to his business and even beyond. He has an extended heterogeneous network.
Characteristic 2: Knowledge intensive	Knowledge exchange through strong ties between integrator and farmer, characterized by trust and personal guidance.
Characteristic 3: Controversial	Both farmer and integrator strive for profit maximization at their own level. Need for horizontal collaboration between farmers.
Characteristic 4: Crossing boundaries	Farmer used to be considered as the adopter of productivity increasing innovations. Tension between productivity increase and market-oriented innovation.
Fruit sector – Strong collaboration within producer association of kiwi berry	
Characteristic 1: Uncertain	Kiwi berry was new product in Belgium, with high uncertainty about the possible return on investment. Coordinator of producer association forms the link between several stakeholders – researchers, growers, the auction and suppliers – which ensures that the network members are rapidly aware of changes in the market, reducing uncertainties.
Characteristic 2: Knowledge intensive	Newsletters and a website are provided and pruning demonstrations and growers meetings are organized where all members interact with each other. Coordinator plays an important role by bringing the different stakeholders together on a regular basis. Coordinator approachable for all kind of questions.
Characteristic 3: Controversial	Coordinator is associated with a neutral institution. In this way, no conflicts of interest are involved such as making profit. The interests of growers and the auction sometimes differ in relation to product support and expansion.
Characteristic 4: Crossing boundaries	Young network, members are not yet rooted in expectations and routines. Collaboration between different auctions to market the product is a unique construct in Belgium.
Vegetable sector – Highly cooperative attitude for the supply of products	
Characteristic 1: Uncertain	Commercial unit has good knowledge of the needs of the market and the possibilities to fulfil those needs.
Characteristic 2: Knowledge intensive	Management board of the auctions has frequent contact with the members to inform them about new knowledge via newsletters, intranet and extension activities. Importance of good relationship with researchers.
Characteristic 3: Controversial	Looking for opportunities to distinguish themselves within the cooperative. Horizontal coalition can be a solution via an additional quality label with a subgroup of growers.
Characteristic 4: Crossing boundaries	Rigid division between growers and management board partly hinders ongoing reorganization from purely producer-oriented services towards more marketing and buyer-oriented activities.
Ornamental sector – Collaborative initiatives set up due to geographical concentration of different players	
Characteristic 1: Uncertain	Product innovation very important, but very time-consuming and money consuming and involving high risks. Successful heterogeneous network of farmers with consultancy agency, a coordinator for the purchase of flowerpots, a sales coordinator and a research institute to improve or develop new cultivars enables sharing of costs and differentiation possibilities. Elimination of links in the chain, bringing the farmer in closer contact with the end consumer.
Characteristic 2: Knowledge intensive	Network established and coordinated by a research institute with the aim to improve the translation and transfer of research results to the sector. Research institute organizing workshops, courses and answering questions from individual ornamental plant growers lowers the threshold to research institutes, increasing the strength of the ties and the network density. Organization of events increases the connectedness between growers, offering the opportunity for horizontal networking.
Characteristic 3: Controversial	Direct contact with end consumers is an important factor for introducing product and market innovations. Retailers and end consumers should be open to the new product. Collaboration between growers to promote their novelties: access to each other's networks makes the group more visible and leads to competitive advantage for all the members.
Characteristic 4: Crossing boundaries	Networking with people from outside the sector is perceived as much more important than with people from within the sector.

Regarding the *structuring* dimension, it was observed in all cases that governance via a central coordinator that forms the link between multiple stakeholders was very important. This can be fulfilled in different network settings. In the case of the poultry sector, the integrator has a

connection with suppliers, farmers and buyers. Among the producers of the kiwi berry, the network manager, who is affiliated to the university, takes the lead in connecting and informing the different stakeholders. In the vegetable sector, this role is fulfilled by the management board of the

auction, which is connected to the farmers, research institutes and via the commercial unit with the market players. Within the ornamental plant sector, a similar construct is, for example, seen in the Sietinet network, in which a research institute coordinates contact between the associated farmers and with the eight other collaborating Flemish research institutes.

As the innovation process is knowledge intensive, communication and innovation in communication is important. To arrange this communication, those networks *structured* around a central contact person who is occupied with a multitude of tasks and who, therefore, possesses a lot of knowledge, is shown to play an important role in each of the analysed cases. For example, the integrator in the poultry sector, the coordinator in the kiwi berry case and the private consultants in the ornamental plant sector fulfil this role. Additionally, a close link between research and practice has a positive impact on the knowledge transfer. The management board in the vegetable auction and the project manager in the producer association for the kiwi berry fulfil this role, by providing connection between research institutes and the farmers.

Regarding the *structuring* dimension, it is found that distant one-way communication that is very formalized and impersonal and directed at a large group hinders creativity. This can be illustrated by, for example, the difficulty in translating the knowledge available in research centres to the sector. According to our findings, an innovation-oriented network better aims at effective face-to-face or direct communication. This allows for a more adequate interaction between the different agents involved in the process of innovation. The producer meetings in the case of the kiwi berry form a perfect example here. Direct communication can be governed through logistical support and the organization of knowledge transfer processes by appointing an independent person or management board who can arrange regular meetings, draw up the agenda, guide the discussion, send out newsletters and so on and by providing an inspiring and professional environment in which network members can communicate.

The third challenge for an innovation network is to handle the different, often controversial, interests that are involved in an innovation process. Concerning the *structural* dimension, the question as to whether or not the interests of the network members are homogeneous or heterogeneous is an important issue to take into account. For networks with different, opposing interests, it is often hard to find a good balance between the different needs of the network members. In the case of the poultry sector, this seems to have resulted in a displacement of innovation, outside the locus of the farm. Other networks focus on the strengthening of shared interests, which is, for example, the case in the ornamental plant sector in which buyers collaborate to promote their novelties and the kiwi berry association where everybody wants to improve the production process and increase sales. Thereby, horizontal collaboration to promote innovation was observed as a key element, complemented by the importance of the coalition being self-initiated. However, in reference to the *structuring*

dimension, again the role of an independent coordinator was expressed in terms of governance. His task is only to facilitate, not to establish the network.

To facilitate the crossing of boundaries to achieve innovations, in terms of the *structural* characteristics of a network, heterogeneous network members are found to be crucial. It is vital that a network provides the means to meet a range of several expertise and experience, for example, by organizing a study trip, a workshop, network meetings and so on and hence meet people from different backgrounds, for example, from another sector. However, the required heterogeneity in the membership is not the only prerequisite. Network members should also be willing to change their routines. This is exemplified by the construct in the kiwi berry case where growers deliver their berries to different auctions spread across Flanders, but marketing of the berries is arranged via one single auction. Another example involves the ornamental plant growers attending cross-sectoral networks to become inspired about generic issues relating to business and management. The *structuring* dimension shows the importance of different network members taking on an active role in contacting people and organizations beyond the contacts with whom they are familiar, to be able to realize their innovative idea. This managerial task leads to the development of a network culture with shared goals.

Discussion

Innovation and network characteristics

This article offers insight into the network characteristics observed as particularly helpful for successful innovation processes. In this section, the findings are discussed and confronted with findings from the literature, and structured according to the four innovation characteristics. First, to decrease the uncertainty inherent in an innovation process, numerous contacts are seen as particularly helpful, especially via a central person who coordinates the links with the different stakeholders. This will increase the chance of discovering crucial opportunities. In the literature, this concept is often referred to as ‘innovation broker’, whose main purpose is to build appropriate linkages in innovation systems and facilitate multi-stakeholder interaction in innovation. Similarly, the role of connecting people was found to be important by Koopmans et al. (2011) within organic farming. Furthermore, the importance of close contact with a heterogeneous group of people is observed. Other literature confirms that firms in networks composed of partners with heterogeneous experiences will be in a better position to benefit from the present experiences than firms in networks composed of partners with homogeneous experiences, and they will therefore make better decisions (Beckman and Haunschild, 2002; Kanter, 1988; Koopmans et al., 2011). Everybody has his own vision of the challenge and possible solutions. Also the role of strong ties is found to be important, which leads, according to the literature, to the creation of trust, making the network ties a perfect channel for knowledge exchange (Coles et al., 2003;

Larson, 1991), reducing the uncertainty. Kanter (1988) found that potential innovators benefit from being linked directly to the market, to gain a fuller personal appreciation for what users need, as well as from being connected with those functions inside the organization that manage the interface with the outside. These contacts ensure that ideas generated or opportunities encountered have a chance of success, both on the level of profitability and market potential (Kanter, 1988).

Second, to cope with the knowledge-intensive character of an innovation process, a central coordinator of a network possessing knowledge relating to a multitude of aspects, seems to be very fruitful. However, it should be noted that this could also involve high risk in terms of the success of the innovation network as if this person leaves, expertise concerning the different topics will be lost from the network. This is also valid for subsidized innovation projects, in terms of losing the subsidies and hence often the coordinator of the project and his expertise. Second, a network better aims to achieve effective face-to-face or direct communication. In other studies, direct ties are also found to be instrumental in providing immediate access to other members' knowledge and are especially helpful for knowledge which is difficult to transfer (Hansen, 2002). Another positive network characteristic is a close link between research and practice. Despite the continued generation of knowledge through scientific projects, research results are still often insufficiently exploited and taken up in practice, and innovative ideas from practice are not captured and dispersed (EC, 2014).

To handle the controversial elements in an innovation process, the importance of self-initiated coalitions is identified. In the poultry sector, for example, only limited horizontal networks are available. Although personal relationships exist among the farmers, these relationships are only seldom used to form a coalition and become more innovative. Although a lot of these tasks are fulfilled by sector associations, two important remarks should be made in this regard. First, these associations are structured around a hierarchical model, which results in a minority of the members effectively collaborating at a horizontal level (Halpin, 2006). Second, these associations focus on an aggregate of interests (different sectors, feed firms, farming infrastructure, etc.), often resulting in difficult support for specific innovation projects. Also, the literature shows that the success of an innovation often depends more on the determinants of the quality of a coalition, than on the technical-economic aspects (Kanter, 1988; Leeuwis and Van den Ban, 2004). Thereby, the promotion, defence and presentation of the innovation and the establishment of a network around the innovation are key elements.

To ensure that an innovation is boundary crossing, the network is required to be heterogeneous and farmers should be willing to surpass innovation at the mere agricultural level. Reconsidering their own role in the innovation process can be relevant for all types of members: the farmers, policymakers, researchers, extension officers, consumers and suppliers. Long-term relationships are very strong and often result in homogeneity, leading to less diversity of

experiences (Beckman and Haunschild, 2002), as is the case in the poultry sector, in which relationships are particularly based on routines. These routines from the past have become institutionalized within the network structure, yet they are unsuitable for integrating new ideas, motivations and approaches from the various actors involved. Also, in the literature, it is found that in uncertain situations, actors are inclined to collaborate with commercial contacts or partners with equal status (Podolny, 1994). A success factor in this frame is hence found in the function of establishing a collaboration dynamic, without falling back on existing relationships.

Transferability

The rigorous selection process regarding the cases generated several interesting results. Although some findings regarding network characteristics for successful innovations are found to be valid for all the cases, the translation to the specific cases was different. The four cases reveal that no single best solution exists to cope with innovation characteristics, but they show elements relating to the network characteristics that can be important for achieving successful innovations, and interesting ways to fulfil them within the network. The way in which the different cases exhibit important network characteristics can serve as inspiration for other emerging networks.

Concluding remarks

The aim of this article was to add to previous research on networked innovation by investigating the research question: How do network characteristics facilitate or constrain the ability to cope with innovation characteristics? The findings are useful for academics, network coordinators and network members, potentially leading to a higher innovation performance via networking. The results help to gain insight into the success factors of innovation networks active in the agricultural system. They reveal that the following factors are particularly helpful for success: numerous contacts, integration of knowledge providers within the network structure, face-to-face communication, a self-initiated coalition and surpassing innovation at the mere agricultural level, through introducing heterogeneity in the network.

A second novelty of this article arises from a methodological viewpoint, namely, the combination of existing studies on innovation characteristics and network characteristics. Kanter (1998), who defined the innovation characteristics, investigated the conditions facilitating innovations. That study was set up from the perspective of an individual firm and investigated the structural, collective and social conditions. In contrast, this study is conceived from the perspective of the network. The innovation characteristics form the basis for linking innovation behaviour with network characteristics. To the best of our knowledge, this has not been done so far. In addition, by studying the link between networks and innovation within the agricultural system, this article contributes to empirical research.

The network characteristics are used as a basis for investigating the success factors of innovation networks. However, alongside network characteristics, other factors such as social conditions (Kanter, 1988) and agency-related aspects (Emirbayer and Goodwin, 1994; Mehra et al., 2001) can also influence the success of innovations. These aspects refer to the importance of the characteristics of nodes and motivations external to the network as well considering innovative action. In future research, a more detailed focus on social conditions and agency-related aspects could be applied, possibly combined with interaction with network characteristics. Furthermore, Kanter (1998) found that some of the conditions facilitating innovations are more important at some points in the innovation process than at others. Future research could, therefore, focus on the conditions for innovation by splitting the innovation process into its major tasks.

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