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Coordinating Clusters: A Cross Sectoral Study of Cluster Organization Functions in The Netherlands

Philipp J.P. Garbade[1], Frances T.J.M. Fortuin[1] , and S.W.F. (Onno) Omta[2]

1Food Valley Organization, P.O. Box 294, 6700 AG Wageningen, The Netherlands
2 Wageningen University, Management Studies Group, P.O. Box 8130, 6700 EW Wageningen, The Netherlands
Philipp.Garbade@foodvalley.nl ,Frances.Fortuin@foodvalley.nl, Onno.Omta@wur.nl

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ABSTRACT

The present paper aims at answering the question how cluster organization functions are implemented in a high-tech, a medium to high-tech and a low to medium-tech cluster. Data were collected by semi-structured interviews from three clusters in the Netherlands, an agri-food cluster (as an example of a low to medium-tech cluster), a green biotech cluster (medium to high-tech) and a high-tech cluster. Concerning the cluster organization functions a number of similarities were found. For all three clusters it can be concluded that the network support function is considered to be very important. Sector independence can further be found concerning the innovation process support function, specifically regarding the promotion of the region as an attractive living and working area for highly qualified employees. The results also show a number of clear differences among the investigated clusters. Only in the low-to-medium tech agri-food cluster there was a clear need for internationalization support for SMEs to reach foreign markets. Only in the green biotech cluster the demand articulation was focused on the region where the cluster is based, which stands in contrast to the highly international orientation of the member companies. Only in the high-tech innovation cluster technology road mapping was extensively used. This powerful tool, developed to align the innovation process at the company and sector level, impacted further on the execution of the demand articulation/ network formation support functions, and could also be helpful for the green biotech and the agri-food clusters. Throughout the paper different cluster categorization schemes are besides the tech level are applied and give insights on their limitations and how to possibly deal with them in inter sectorial cluster comparison research.

Keywords: cluster organization, regional innovation system, inter-sectoral comparison

1 Introduction

Since the success stories of Silicon Valley the organization of companies in clusters got the attention of governments around the world as a method to stimulate innovation. In literature we find a number of high-tech clusters that are compared with Silicon Valley, such as the Silicon Wadi in Israel (de Fontenay and Carmel, 2004), the software cluster in the Dublin region in Ireland, the software cluster in the Bangalore region in India (Arora et al. 2004), the Scandinavian clusters of mobile phones in Sweden and Finland (Richards, 2004) and the Hsinchu region cluster in Taiwan focusing on IT hardware (Saxenian, 2004). All these clusters showed annual double digit growth rates concerning the number of new firms, revenues, employment and exports (Bresnahan and Gambardella, 2004). The research of Bresnahan and Gambardella (2004) also focused on how to start a cluster and what role the government could have in terms of creating a framework to successfully create a new cluster.

Bresnahan and Gambardella (2004) point at the special role of the cluster coordinating organization (from now on cluster organization as intermediary organizations within the cluster) in creating successful clusters. Johnson (2008) indicates a need of research to clarify the role of contextual factors, such as the technology level, in the effectiveness of the cluster organization. While much is known about the clusters and cluster organizations in the high-tech sector, much less is known about their functioning in other sectors. Since clear sector differences have been identified in innovation (Malerba, 2004) linked to the technology level of different sectors (e.g. based on the R&D input level, Pavitt 1984) it was chosen to compare clusters in the high-tech, the medium-to-high-tech (the green biotech) and the low- to-medium-tech (the agri-food) sector.

In literature a number of functions of clusters organizations, such as innovation process management, demand articulation, network formation support, (Batterink, 2009, Klerkx and Leeuwis, 2008, 2009, Van Lente et al., 2003) and internationalization support (Omta and Fortuin 2012) are described. In this context Asheim and Coenen (2005) criticize the high-tech fascination (Asheim and Coenen, 2005:1174, Asheim et al., 2011), when it comes to cluster research, neglecting the differentiation of innovation mechanisms on other technological levels. Batterink et al., (2010) add that more research is needed to uncover *the way in which innovation brokers function in different types of innovation networks* (Batterink et al., 2010: 71), while Winch and Courtney (2007) conclude in their review on intermediary organizations, that *research has, to date, only just started to identify how innovation brokers and innovation intermediaries more generally operate, and in which conditions different types of brokers function most effectively* (Winch and Courtney, 2007:761). It is therefore the objective of this paper to investigate how cluster organization functions are implemented in the different clusters. The research question guiding this exploratory study is consequently:

How are the cluster organization functions implemented in a high-tech, a medium-to-high-tech (green biotech) and a low-to-medium tech (agri-food) cluster?

For the present study, three clusters were selected that are about the same age, but active in different industries at different technological levels, all situated in the Netherlands. An agri-food cluster is representing the low and medium-tech level, a green biotech cluster the medium to high-tech level and as a third cluster a non food high-tech cluster based on nanoelectronics, embedded systems and mechatronics was chosen. Per cluster three to four open interviews were conducted with the director of the cluster organization (and in the green biotech cluster also the Chairman of the Advisory Board, the CTO one of the big member companies), a representative of the knowledge institution working closely together with the companies in the cluster and one or two regional political representatives. In addition, semi-structured interviews were held with the CEOs of three to four SMEs, and the R&D managers (mostly CTOs) of four large member companies.

We have structured the paper as follows. Section 2 describes the theoretical foundation of the study. Section 3 describes the development of the interview guide, the methods of data collection and the analyses used. Section 4 starts with the baseline description of the three clusters and presents communalities and differences regarding the intermediary functions. Finally, in Section 5 the results are discussed and the conclusions are drawn, while considering the limitations of this study.

2 Theoretical framework

A cluster is defined as a *geographic concentration of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields that compete but also co-operate* (Porter, 1998:197).

Breschi and Malerba (2005) list a number of important theoretical perspectives to research innovation within clusters, such as localized knowledge spill over, economic geography/ regional economics, evolutionary theory, social network approach and the concept of innovation systems. All these *theoretical perspectives share the common view that interactions, formal and informal relations and more generally network effects are the key mechanisms through which external economies benefit local firms and are ultimately responsible for the emergence, growth and success of a cluster of innovative firms* (Breschi and Malerba, 2005: 5). For this paper the concept of innovation systems is chosen to shed light on the cluster organization functions in clusters around different technology levels. The innovation systems concept was first applied on the national level. For national innovation systems we find a number of definitions (see

OECD, 1997:9). Cooke (2004) defines in contrast the Regional Innovation System (RIS), on which we focus in this paper, as *interacting knowledge generation and exploitation subsystems linked to global, national and other regional systems* (Cooke, 2004:3). Clusters and RIS are used as exchangeable terms throughout this paper. This means that the authors are not sharing the distinction made by Asheim and Coenen (2005: 1174) and Asheim et al., (2011: 879) since the distinction is based on a redefinition of the cluster term that has been defined differently before by Porter making the distinction between the RIS and Cluster term invalid.

An Innovation system (IS), in general, consist of all actors, contributing to developing, diffusing and utilizing new products and processes. Actors are entrepreneurs, suppliers, processors and retailers, but also researchers, consultants, and policy makers.

Gaps in connectivity and collaboration between those actors may reduce the performance of an IS (Bergek et al., 2008), creating the need for intermediary organizations to increase innovativeness. Howells (2006) defines an intermediary organization as *an organization or body that acts as agent or broker in any aspect of the innovation process between two or more parties* (Howells, 2006:720). Winch and Courtney (2007) use the term 'innovation broker' for intermediary organizations *focused on a particular industrial sector and dedicated to brokering innovations between the actors in the sectorial system as an instrument of public policy* (Winch and Courtney, 2007:750). In this paper the innovation broker role is fulfilled by the 'cluster organization'. They act as member of a network, enabling the other members to innovate and are semi-public organizations. Klerkx and Leeuwis (2009) identified three functions of the cluster organization.

Innovation process management

Enhancing alignment and learning of the multi-actor network, which involves facilitating learning and cooperation in the innovation process (Klerkx and Leeuwis, 2009:851).

Demand articulation

Articulating innovation needs and corresponding demands in terms of technology, knowledge funding and policy (Klerkx and Leeuwis, 2009:851).

Network formation

Facilitating linkages between relevant actors by scanning, scoping, filtering, and matchmaking of possible cooperation partners (Klerkx and Leeuwis, 2009:851).

Omta and Fortuin (2012) added the internationalization support function specifically aiming at SMEs.

Internationalization support

Providing *exposure at international [...] exhibitions*, supporting *international business missions* and integrating *'ambassadors' (researchers and business managers from other countries) advertising [...]* the cluster *member companies in their home country.* (Omta and Fortuin, 2012:8).

Differences accross sectors

Innovation systems may consist of companies active in all kinds of industries, but very often they focus on a specific industrial sector, the so-called sectorial innovation systems, which overlaps often with an RIS (Asheim et al., 2011). Here the differentiation between high-, medium- and low-tech industries (OECD, 1986) is assumed to play a role in the functioning mechanisms of the RIS and its 'cluster organization'. However with very different tech-levels of companies often found within one industry or even sector this categorization is weakened (see Asheim and Coenen, 2005: 1175). Therefore it will be tried to also use alternative categorizations schemes besides the tech-level of the RIS to explain the differences found between the researched RIS in this paper. Asheim and Coenen (2005) argue *that there are different logics behind constructing regional innovation systems contingent on the knowledge base of the industry it addresses as well as on the regional knowledge infrastructure that is available* (Asheim and Coenen, 2005: 1180). They discuss the varieties of RIS by dividing them into the territorially embedded regional, regionally networked and regionalised innovation system. These three RIS types are distinguished by the level of member interaction. In the first member companies source mainly from localised, interfirm learning processes, while in the second we find a regional supporting institutional infrastructure in place. For the third type the interaction of the members is to a larger extent focused outside the region on national or even international level. Asheim and Coenen (2005) further distinguish between ex ante and ex post approach in constructing a RIS. In cases of ex ante support, the RIS emerges from the knowledge developed by the knowledge institution/s within the RIS, while in the ex post support case often a rather mature industry relies on the problem solving provided by the knowledge institutions. Applied to the three different types of RIS mentioned above this means that we find ex-post support rather in territorially embedded RIS, while in the regionalised innovation system we rather find ex-ante support,

while for the regionally networked innovation system both elements are typical. (see Asheim and Coenen, 2005).

3 Methods of data collection and analysis

In 2011, three clusters were selected that are about the same age, but active in different sectors, an agri-food cluster, a green biotech cluster and a high-tech cluster, all situated in the Netherlands. Per cluster three to four open interviews were conducted with the director of the cluster organization (and in the green biotech cluster also the Chairman of the Advisory Board, the CTO one of the big member companies), a representative of the knowledge institution working closely together with the companies in the cluster and one or two regional political representatives. In addition, semi-structured interviews were held with the CEOs of three to four SMEs, and the R&D managers (mostly CTOs) of four large member companies (see Table 1).

Table 1.
Respondents per cluster

Interviews conducted with:	Number of interviews per cluster		
	Agri-food	Green biotech	High-tech
Cluster organization director	1	2	1
Regional political representative (s)	1	1	2
Knowledge institution	1	1	1
Member companies	8 (4 SMEs*)	7 (3 SMEs*)	7 (3 SMEs*)

*SMEs: Companies < 250 full time equivalents (Ftes)

To make the interviews as consistent as possible, a detailed interview guide was developed, as well as a research protocol. The interview guide has been discussed extensively with an expert in the field and tested in a pilot interview. The open questions targeted at assessing the cluster configuration, the activities of the cluster organization and the clusters governance mode. The Likert 7-point type closed questions mainly covered the company's assessment of the importance of the cluster organization's support related to the company's innovation activities, the importance of innovation for the companies and the kind of innovation partners the companies use in their 'open innovation' projects. Also the company's innovation and business performance was assessed relative to their most important competitors (For the complete operationalization see Table A in the Annex).

The data collection started with contacting the respondents, and sending them the interview guide in advance, so that they could prepare the interview. The interviews were thoroughly prepared, by using information from the website of the organization, annual reports and by looking up public data, e.g. in a patent database. These data were used to use the time available for the interview as efficient as possible; and to be able to triangulate the findings of the interviews.

For the analysis of the data a mixed methodology approach was chosen, employing the qualitative and quantitative data in a complementary way to assess the nature of the researched clusters. The relation between the quantitative and qualitative data is twofold. The first is that the relations expected from the interviews (qualitative) will guide the searching for relations in the quantitative analysis. And the second is the other way around: relations found in the quantitative analysis only have value if they can somehow be explained by the qualitative data gathered. Kruskal Wallis exact tests were used to identify significant differences in the means of the three clusters.

4 Results

The results show a number of clear differences among the investigated clusters. General differences were found in the mode of financing and the level of interaction between the cluster organization and its member companies.

4.1 Baseline description

The agri-food cluster, founded in 2004, has currently more than 100 member companies of which around 60% are agri-food SMEs. The agri-food sector is taken quite broadly, from crop protection at the start to the production of consumer products at the end of the agri-food chain. The companies are mainly located within a circle of 100 kilometers, while a large part of these lies relatively close to the core of this circle, the knowledge institution. Since the knowledge institution provided large parts of the knowledge on which the cluster is based today the cluster can be classified as an ex ante regional innovation system also containing a significant number hands on solution ex post elements.

The goal of the cluster, as formulated by the coordinator, is *to increase the innovative power of the agri-food companies on the highest aggregation level by the best possible use of the existing knowledge*. The cluster organization of the agri-food cluster (9 full time employees) is governed by four CEOs of the member companies and the president of the board of the main knowledge institution and one policy maker; 80% of the funding is public and 20% private. The Cluster organization is also involved in a number of EU projects. Each year five “cluster members only” meetings, five open innovation seminars (not exclusively for cluster members) and an annual conference is held. The cluster organization offers a range of services, such as an innovation link, international matchmaking, and support for startup companies, e.g. to apply for subsidies, and support to find appropriate innovation partners.

The green biotech cluster, founded in 2008, is a cluster of companies active in the green biotech industry, such as plant breeders, seed producers and companies providing breeding support by testing products or providing machinery. It is a cluster composed of competitors as well as complementary companies; 10 of the 21 member companies are SMEs. The main drivers in founding the green biotech cluster were four big seed companies. Since it was not the knowledge institute that sparked the development of the RIS, but based on the fact that the majority of the companies emerged of a long technological tradition in this region, we find here an example of an ex post regional innovation system. The member companies are geographically clustered, as all companies are located within a circle of 30 kilometres. The cluster activities are financed for 80% by company contributions, whereas 20% comes from the central municipality. The cluster organization makes use of company resources in the form of working groups in order to execute its tasks and can therefore be regarded as a virtual organization supervised by the board of the CEOs and the cluster coordinator, the only employee of the cluster organization. There are two gatherings per year where the board and the workgroups meet. The board meets 5 to 6 times per year and the working groups meet 4 to 6 times per year. Furthermore, there is a lot of informal contact among the member companies, since the distances are small: on open days, receptions, and other networking moments. This informal contact has to be distinguished however in most cases form straight innovation cooperation contact, since this regionalized innovation system relies more on cluster independent collaboration contact on the national and international level.

According to the cluster coordinator the main targets of the green biotech cluster are PR and image improvement of the sector, education and labour market support as well as knowledge and innovation support. All targets relate to the major problem of the green biotech industry. The sector is growing at a rate of about 6 % per year and the demand for highly qualified staff cannot be fully satisfied. This mission is recognized by one of the member companies, the CEO phrased the green biotech cluster mission as follows: *finding new personnel and land development plan related issues*.

The high-tech cluster, an active cluster within a larger high-tech ecosystem, founded in 2006, is a cluster of 120 high-tech companies in nanoelectronics, embedded systems and mechatronics, including eight big multinationals with an annual turnover exceeding € 0.5 Billion, as well as 92 SMEs. The companies in the cluster, which has the legal status of an association since 2009, are high-tech companies, producing all kinds of products, machinery as well as consumer products. The companies are mainly located within a circle of 120 kilometers. The cluster further includes one major technical university and 11 research

institutes. The construction approach of this cluster as a RIS includes ex ante and ex post elements regarding the knowledge institutions contributions.
The financing of the cluster splits in equal parts in private and public funding. The cluster organization is run by four persons. There is a program council and an executive board. In each of them are 10 representatives of the cluster members, mainly CEOs of the big companies. Most influence comes via the program council and the executive board. The member assembly, where all CEOs are present, takes place twice a year. All activities are executed by the staff from the member companies. In total 100 to 150 employees of the member organizations contribute on an irregular basis about 5% of their working time, which adds up to another 7-8 ftes. Every year a road map is created by this partly virtual organization. Twice a year there are SME matchmakings and SME workshops are held 2 to 3 times per year.

4.2 Company performance per cluster

The self-evaluation of the companies in the three clusters was rather good, both in terms of profitability and innovation level. The respondent groups per cluster show no significant differences in terms of relative company performance. They all indicated to slightly outperform their most important competitors in terms of profitability, growth and speed of introducing new products to the market. As could be expected, being all members of innovation clusters, all companies indicated to address high importance to innovation as a mean for staying competitive {mean of 6.7 (standard deviation, stdv 0.6) on a 7-point Likert scale}. This finding weakens however the distinction of the clusters based on the technological level of the industry (see OECD, 1986) and to conclude from there on the innovativeness of the clusters. Indeed the companies in the agri-food cluster indicated that 45% of their turnover was based on products that were introduced to the market in the last 3 years, with a stdv of almost 40 %. We assume that this high standard deviation might derive from the diversity of companies in terms of tech level in this cluster. In the green biotech cluster and the high-tech cluster the percentage of the turnover amounted to 26% (stdv 14%) and 49% (stdv 17%), respectively. A significant difference was found in terms of finding new market segments and different type of customers, where the agri-food cluster companies clearly outperformed the companies from the other clusters. The same applies to finding new market area and introducing new business models (although these differences are not statistically significant, see Table 2). We assume that these differences can be related to a catching up situation in the low-to-medium tech agri-food sector, compared to the medium-to-high-tech green biotech and the high-tech sector. It gives however also support to divide the researched clusters by the interaction level of its members into different types of RIS following Asheim and Coenen (2005). In this case the green biotech cluster has the status of a regionalised innovation system, the same applies for the high-tech cluster, while the agri-food cluster shows more the characteristics of a regionally networked innovation system. Also from this classification of the clusters this catching up situation in terms of internationalization can be followed. The agri-food companies also indicated in line with RIS categorization that the cluster organization played a pivotal role in finding new clients and markets, which means to cross the typical boundaries of the RIS.

Table 2.
Innovation performance of the companies in the three clusters

Indicator Question		Mean (Stdv)		
		Agri food	Green biotech	High-tech
Which innovations did your company achieve over the last 3 years?	New or improved products or services	6.5 (1.1)	6.3 (0.8)	6.8 (1.2)
	New or improved processes	5.5 (1.7)	5.4 (1.5)	4.2 (1.9)
	New market segment; different type of customers	5.9 (1.0)	4.0 (1.7)	2.3 (1.3)
	New market area (geographical)	5.7 (1.8)	3.0 (1.6)	4.0 (2.1)
	New business models	4.8 (1.3)	3.2 (1.3)	3.6 (2.6)
	New cooperative partnerships	6.1 (1.4)	4.8 (1.5)	5.5 (1.4)
Innovation performance indicators total mean		5.8 (1.0)	4.4 (0.9)	4.8 (1.4)

Significant differences at p<.05 among the three clusters are shaded grey

4.3 Cluster organization support

4.3.1 Innovation process support

Concerning the innovation process support function of the cluster organization, the promotion of the industry was evaluated of high importance by the companies in all three clusters (see Table 3). Especially in the high-tech cluster, promotion of the industry towards the government played a pivotal role also for receiving subsidies to overcome the crisis. Here the importance to speak with a common voice, reflected in *the industry roadmap* (see below) was highlighted by the respondents of the SMEs and the big companies. Also a high identification level could be observed, e.g. *we are the high-tech cluster* was stated by an R&D manager of a big high-tech company.

Table 3.
Innovation process support

Indicator Question		Mean (Stdv)		
		Agri food	Green biotech	High-tech
Could you indicate where the cluster contributed over the last 3 years?	Housing or expanding production facilities	2.0 (1.9)	3.4 (2.6)	1.5 (0.5)
	Acquiring new knowledge or technology	3.1 (1.6)	2.0 (1.7)	4.7 (2.1)
	Support in receiving innovation subsidies	3.6 (2.4)	1.4 (0.9)	6.3 (0.8)
	Finding new ideas for innovation. e.g. through innovation seminars	2.5 (1.5)	1.6 (1.3)	3.0 (1.4)
How important was the role of the cluster in the achieving the following innovation?	New or improved products or services	2.0 (1.5)	2.0 (1.7)	4.1 (1.8)
	New or improved processes	1.4 (0.9)	1.2 (0.4)	2.4 (1.7)
	New business models	1.4 (0.9)	1.0 (0)	2.8 (2.7)
The cluster organization contributes…	to the promotion of our sector	6.5 (0.5)	5.2 (1.2)	6.0 (0.9)
	to the innovation capacity of our company	4.0 (2.1)	2.6 (1.6)	4.2 (2.1)
	by eliminating obstacles to innovation	4.4 (2.2)	2.3 (1.3)	4.2 (2.2)
	by creating chances for innovation	6.0 (0.8)	2.9 (1.9)	5.8 (0.8)
Innovation process support, total mean		3.6 (1.3)	2.4 (0.9)	4.1 (0.7)

Significant differences at p<.05 among the three clusters are shaded grey

The contribution of the cluster organization in creating an environment that provides chances for innovation was evaluated high by the agri-food cluster respondents with a mean of 6.0 and the high-tech cluster respondents with a mean of 5.8. As stated by the R&D manager of a big high-tech company: *that is simply the high-tech cluster organization's task*. The green biotech cluster's relative low score of 2.9 was reflected by the CEO and the R&D director of two big companies who stated that the green biotech cluster is not targeting at innovation directly and that innovation would happen anyway within the companies and in alliances between companies. However, it is surprising, because it is not reflecting the high satisfaction level indicated by the respondents with the achievements of the green biotech cluster organization in improving the labor market situation for the companies. They all gave credits to the achievements of the green biotech cluster organization concerning the goals it was set up for: *labor market, image, infrastructure and education*, as phrased by the CEO of a big company. A similar statement came from the Director of a university group, who stated: *you don't hear what other companies are into or are going to invest in. It is about the image of the sector, to attract personnel.* Apparently, the company respondents did not realize that this type of support certainly creates an environment with higher chances for innovation.

A significant difference among the three clusters was found in terms of subsidy application support. The high-tech cluster respondents indicated that their cluster contributed greatly with a score of 6.3 in receiving subsidies, while the agri-food cluster respondents gave it a 3.6 and the green biotech cluster respondents only a 1.4 on a 7-point Likert scale. To put this finding into context it should be mentioned that it was stated in the interviews with both SMEs and large companies that the high-tech cluster organization had played a pivotal role in overcoming the problems of the economic crises that had

strongly affected the high-tech sector, even more than the green biotech and the agri-food sector. While the purchase of new electronic devices is immediately postponed if buyers and end consumers experience a shortage in financial resources, in the green biotech industry the cut is first made on more expensive products, while the food processors do experience the crisis effects to a much lower extent.

The high-tech cluster organization helped in setting up open innovation collaboration projects between high-tech SMEs and large companies and supported in finding subsidies for these projects. As phrased by a CEO of a high technology providing SME: *The high-tech cluster organization did more than only matchmaking* and the technology manager of a broadcast technology producer adds: *The high-tech cluster organization also developed the road map that determined where subsidies were paid for*. It was emphasized by the R&D director of a big multinational that *this allowed companies to keep their R&D staff and made companies coming closer together*.

In case of the agri-food cluster, the R&D director of a big feed company and the CEO of a food technology providing SME mentioned the importance of the cluster organization for finding subsidies for open innovation cooperation. The coordinator of the green biotech cluster explicitly stated to not support companies in the application process for innovation subsidies, but to limit the support by pointing at upcoming subsidy possibilities.

As could be expected, the importance of the three cluster organizations for the process of achieving innovations was evaluated rather low by the company respondents. E.g. the R&D director of a big feed company stated that the agri-food cluster organization did not play a direct role in innovation, but indirect as a means to extent the company's network, not to miss out on interesting SMEs (see 4.3.3 network formation support). A manager of a research institute also stated: *Innovation we can better do ourselves, but the lobbying and providing market insights are the cluster organizations' strengths*. However, within the agri-food cluster a number of SMEs indicated that the cluster itself could play a role in the innovation process. The CTO of a very innovative food SME praised the the *agri-food cluster concept as real strong and due to it a lot can happen*, while another CEO of a food technology provider indicates the agri-food cluster had speeded up his innovation process.

4.3.2 The relative importance of the different open innovation partners

Before assessing the cluster organization's roles in demand articulation and network formation support, the relative importance of the different open innovation partners in the different clusters is shown in Figure 1.

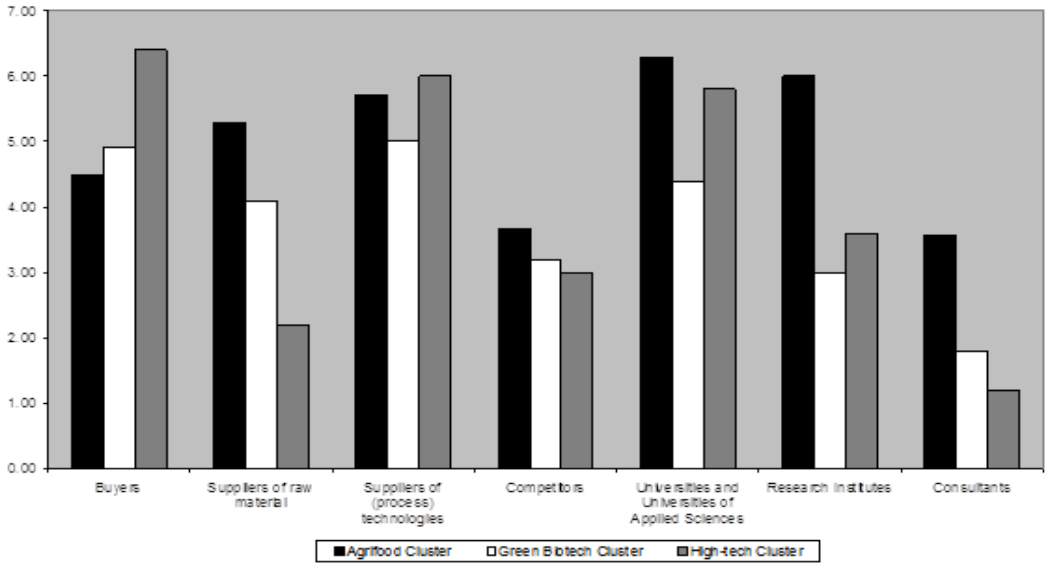

Figure 1. Importance of different types of innovation partners per cluster

The buyers play a prominent role as open innovation partner in the high-tech and the medium-to-high-tech green biotech cluster, followed by the suppliers of process technologies and the universities. For the agri-food cluster the order of importance is different. Here the universities take the lead, followed by the research institutes and suppliers of process technology and those of raw material. This order of partner importance supports the classification of the agri-food cluster as a regionally networked innovation system in which ex ante and ex post support by the knowledge institutions are regarded as typical. This sets it apart from the two other clusters that are rather regionalized innovation systems. Significant differences were respectively found regarding the importance of universities, research institutes and consultants that were found to be significantly more important in the agri-food cluster, compared to the green biotech and the high-tech cluster. In the agri-food and the green biotech clusters the suppliers of raw materials play a more prominent role as open innovation partner than in the high-tech cluster, although this difference is not statistically significant due to high standard deviations. In all three clusters cooperation with competitors and consultants is regarded of the lowest importance. E.g. the CEO of an SME in the green biotech cluster members stated that he would rather *cooperate with other small companies, or research institutes and universities, or with a client, but not that quickly with competitors,* because of the risk of leaking out of confidential information. However, in spite of the low preference, competitors were found to be involved in precompetitive open innovation projects in all three clusters.

Seen in the light of the above mentioned fear of leaking out of confidential information, it was remarkable that in the interviews in all three clusters the non-competitor clause as a protection mode to leaking out of confidential information was regarded to be of little importance, although almost all companies, except two SMEs, had it in their employees' working contracts. In general, the problem of staff leaving the company to get hired by a competitor was regarded to be solved by gentlemen's agreements not to abuse the knowledge imported with new staff. This gentlemen's agreement is based on *solidarity*, the circumstance that the staff of most competitor companies knows each other and there will be social sanctions in case of abuse.

4.3.2 Demand articulation and network formation support

Table 4 shows that the cluster organization function, demand articulation support, was not regarded as very important by the companies in the three clusters at least what concerns the quantitative measurement level.

Table 4.
Demand articulation and network formation support

Indicator Question		**Mean (Stdv)**		
		Agri food		Agri Food
Could you indicate where the cluster contributed over the last 3 years?	Identifying new opportunities in existing or new markets	3.0 (1.7)	1.4 (0.9)	2.3 (1.2)
How important was the role of the cluster organization in finding:	New market segments, types of customers	2.0 (1.7)	1.3 (0.5)	1.5 (1.0)
	New market areas (geographical)	2.3 (1.5)	1.2 (0.4)	1.0 (0)
	Demand articulation, total mean	2.5 (1.4)	1.3 (0.5)	1.6 (0.6)
Could you indicate where the cluster contributed over the last 3 years?	Setting-up or expanding your network	4.5 (1.5)	4.0 (2.8)	4.8 (1.2)
	Access to highly-trained personnel	4.0 (1.5)	4.4 (1.9)	3.2 (2.1)
Did the cluster organization play a role in establishing the cooperation with the following partners? [yes/no]	Buyers	0 %	40%	0%
	Suppliers of raw material	0%	20%	0%
	Suppliers of (process) technologies	14%	20%	20%
	Competitors	0%	0%	0%
	Universities and Universities of Applied Sciences	0%	40%	60%
	Research Institutes	0%	20%	20%
How important was the role of the cluster in the achieving:	New cooperative partnerships	2.0 (1.7)	3.3 (2.1)	5.2 (1.1)
	Network formation support, total mean	3.7 (1.4)	3.8 (2.0)	4.2 (1.2)

The company respondents regarded Identifying new opportunities in existing or new markets more as a central responsibility of the company and stated a lower importance of the cluster organization on these aspects. On the qualitative level a number of findings should be added. In the green biotech sector it was indicated by the CEO of a big seed company that the fundamental knowledge was growing at such a speed that the development of applications cannot keep up and that there is a lack of absorptive capacity at the company level, which triggers the search for technology integrators. However this need was partly expressed on the cluster organization level by promoting green biotech related education in the region. In the high-tech cluster road mapping was used to articulate demand towards the national government in terms of support needed by the sector.

Companies in the three clusters were relatively satisfied with the network formation support function of the cluster organization. In all three clusters, the cluster organizations organize so-called matchmaking events in terms of annual consortium meetings and/or conferences. In order to facilitate matchmaking, the number and choice of attendants to these meetings is regarded crucial. The cluster member companies see the cluster organization as a pre-selector to specifically introduce people and knowledge to these meetings.

In a number of cases, the cluster organization plays a direct role in linking organizations. Especially the green biotech cluster organization is active in this respect, linking member companies to buyers, suppliers, universities and research institutes. The same holds for the high-tech cluster organization that helped linking member companies to process technology providers, universities and research institutes (see Table 4). These findings are supported by the interviews. The companies in the high-tech cluster indicated that the cluster organization played a pivotal role in providing a reliable network for setting up innovation collaborations. In the green biotech cluster the CEO of an SME providing contract research indicated as the advantage of the cluster to get in touch with the CEOs of the big companies, which did not happen before in such an informal way. Another SME CEO called the green biotech cluster even *a contact pool* and *important for developing new ideas*. In the green biotech cluster especially the improvement of the labor market situation and the access to highly trained personnel was stressed. *A few years ago, we were happy to receive one application on a vacant position, now we can choose*, was stated by the R&D director of a big company. The positive assessment was also found on the quantitative level where the green biotech cluster scores highest on providing access to highly trained personnel.

In the agri-food cluster the direct network formation support role of the cluster organization was limited to linking to technology suppliers. However, the matchmaking meetings were regarded as very important. The 'members only' society meetings and the annual conference were mentioned to be of special importance to get inspired by other companies and as a means of network formation. This function was summarized by the statement of the CEO of a technology providing agri-food SME: *We are meeting people that we would not have met otherwise*.

In terms of network formation support the borders per cluster are considered differently. In the internationally oriented medium-to-high-tech green biotech cluster, as well as the high-tech cluster the collaboration focus is European and global, which makes them regionalised innovation systems. Whereas in the agri-food cluster the innovation matchmaking is mainly at a national level. The mainly national orientation of the agri-food SMEs is also reflected in the special importance of internationalization support (Omta and Fortuin 2012). Here the agri-food cluster organization takes up the important role of promoting member SMEs products, processes and technologies at a global scale by representing them at international fairs. The internationalization support function is also reflected in the fact that the agri-food cluster organization, (and the green biotech cluster organization to a lesser extent) act as an intermediary that organizes visits of (international) delegations to interested member companies.

4 Discussion and conclusions

The results highlight the role of the cluster organization as facilitator providing innovation process, demand articulation, network formation and internationalization support, whereas the company is emphasized as the locus of innovation. Concerning the cluster organization functions it can be concluded on a number of similarities as on a number of differences between the clusters.

Innovation process support

Innovation process support function is to a large extent sector independent, specifically regarding the promotion of the region as an attractive living and working area for highly qualified employees.

Differences in level of innovation process support can be concluded to be more related to the actual economic situation of the sector than to the tech level differences or differences in RIS types between the clusters. Overall the cluster organizations innovation process support is still rather low while the promotion of the region states a positive exception as part of this function for all three clusters. In all three clusters the perception of innovation process support received falls apart with only a number of SMEs that showed high appreciation for the innovation process support. With the road mapping the high-tech cluster provides a more structured way in enhancing the *alignment and learning of the multi-actor network* (Klerkx and Leeuwis, 2009:851) compared to the other two clusters.

Demand articulation

Also regarding the demand articulation support function road mapping in the high-tech cluster makes the difference in *articulating innovation needs and corresponding demands in terms of technology, knowledge funding and policy* (Klerkx and Leeuwis, 2009:851). In the two other clusters this function is executed in a less formalized way.

Another difference found between the clusters is the level and scope of demands that are articulated. The two regionalized RIS differ here remarkably. While the high-tech sector cluster organization articulates mainly subsidy needs related to the technological future of the whole sector, the cluster organization of the green biotech cluster puts the focus on emphasizing educational issues and on land development plans, which means focusing on articulating demands on the regional level.

Network formation support

For all three clusters it can be concluded that the network support function in terms of organizing annual consortium meetings and/or conferences is considered by all companies to be very important. The cluster member companies see the cluster organization as a pre-selector to specifically introduce people and knowledge to these meetings based on invitation. Matchmaking is regarded by the company representatives as an interpersonal business where the formalization possibilities are limited. As the coordinator of the agri-food cluster phrased it: *there is no possibility to really formalize it* and the problem highlighted even more specifically by the CEO of an SME in the green biotech cluster: *also really bad people can become member of the cluster*. Another CEO formulated it as follows: *For me it is most important to get to know these* [good and bad] *people; the personal level is the most important for building trust.*

Further it can be concluded that in terms of network formation support the borders per cluster are considered differently. In the internationally oriented medium-to-high-tech green biotech cluster, as well as the high-tech cluster the collaboration focus is European and global. Whereas in the agri-food cluster the innovation matchmaking is mainly at a national level.

Internationalization

Only in the low-to-medium tech agri-food cluster there was a clear need for internationalization support for SMEs to reach foreign markets, while in the green biotech and the high-tech sectors the SMEs already acted at European and even global level. It could however also be argued that this finding results from the different type of RIS that the researched clusters state, a regionally networked innovation system in case of the agri-food cluster versus two regionalized innovation systems (the green biotech and the high-tech cluster). The two regionalized innovation systems had cluster activities executed by virtual organizations based on cluster member staff dedication. This strengthens the bounds between the cluster members, which is not the case for the regionally networked RIS, the agri-food cluster.

For regionalized RISs it can therefore be concluded that the cluster organization executed their functions in a way that made cluster members come closer together again on a number of topics. For the regionally networked RIS it was rather executing the cluster organization functions to reach out beyond the cluster borders.

Merging of the functions

In the high-tech sector the impact of the economic crisis was more severe than in the other two sectors and stated a specific challenge. The high-tech cluster organization was the only one to intervene concerning the economic crisis, which can be seen as the crisis management function. This goes beyond the demand articulation, network formation and innovation process support function as described in literature. The key to the cluster organization acting as a crisis manager can rather be seen in merging these functions as one support package tailored towards the specific needs originating from the crisis.

Summarizing it can be stated that the present study shows that a comparison of clusters can indeed lead to meaningful results and to the identification of tools used in one sector that are potentially useful for

other sectors. This applies especially to the road mapping tool used in the high-tech sector to align the company and the cluster functions. However the present study also shows the limitations of using the tech-level or the RIS type as described by Asheim and Coenen (2005) exclusively to distinguish between the researched clusters.

The use of different categorization schemes for the cluster type

For this paper dividing the clusters in regionally networked and regionalized RIS helped in explaining the differences in internationalization function of the cluster organization. At the same time the division of clusters into tech levels failed to explain quite comparable levels in innovation importance per cluster. For explaining the differences in the innovation process support function both schemes failed to add explanatory value. Here the goal behind setting up the cluster organization was the key to explain the findings per cluster.

The green biotech cluster is an ex post regionalized innovation system, a possibility to was not considered in the RIS classification system of Asheim and Coenen (2005). The same applies to the high-tech cluster which states a regionalized innovation system with ex ante and ex post elements concerning the contribution of the knowledge institutions, which is at inconsistency with the stereotype described by Asheim and Coenen (2005).

All three clusters, although regarded as focused on one sector, contained companies operating at real different technological levels and can therefore not be treated as simple agglomerations of low-to-medium tech or high-tech companies. The heterogeneity of companies has to be regarded. Therefore a complementary use of both classifications is suggested for further research in order to compare clusters across sectors. Further an extension of the classification system by including an SME proportion component per cluster should be considered.

Since this exploratory cross sectoral study is based on one cluster per sector the conclusions have however to be treated with caution. It is therefore not possible to generalize from the results obtained in this study. Further research based on a larger number of clusters would be needed.

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Annex

Table A.
Questionnaire operationalization

Concepts		Closed questions	
Company level	Innovation importance		
		Please indicate the contribution of products introduced over the last three years on the total company turnover [in percent]	
	Innovation performance		
		New or improved products or services	
		New or improved processes	
		New market segment; different type of customers	
		New market area (geographical)	
		New business models	
		New cooperative partnerships	
	Business performance		
		our profitability is [1: much lower; 7: much higher]	
		our growth rate is [1: much smaller; 7: much higher]	
		we are much quicker in introducing new products/ services to the market [1: strongly disagree; 7: fully agree]	
	Open innovation partners		
		Buyers	
		Suppliers of raw material	
		Suppliers of (process) technology	
		Competitors	
		Universities and Universities of Applied Sciences	
		Research Institutes	
		Consultants	
Cluster organization level	Support		**Cluster function**
		Buyers	Network formation support
		Suppliers of raw material	
		Suppliers of (process) technologies	
		Competitors	
		Universities and Universities of Applied Sciences	
		Research Institutes	
		Could you indicate where the cluster contributed over the last 3 years? [1: contributed nothing; 7: contributed greatly]	
		Setting-up or expanding your network	Network formation support
		Access to highly-trained personnel	
		Housing or expanding production facilities	Innovation process support
		Acquiring new knowledge or technology	
		Support in receiving innovation subsidies	
		Finding new ideas for innovation. e.g. through innovation seminars	
		Identifying new opportunities in existing or new markets	Demand articulation and internationalization support

		How important was the role of the cluster in the achieving the following innovations? [1: not important at all; 7: very important]	
		New or improved products or services	Innovation process support
		New or improved processes	
		New business models	
		New market segments, types of customers	Demand articulation and internationalization support
		New market areas (geographical)	
		New cooperative partnerships	Network formation support
		The cluster organization contributes… [1: strongly disagree; 7: fully agree]	
		to the promotion of our sector	Innovation process support
		to the innovation capacity of our company	
		by eliminating obstacles to innovation	
		by creating chances for innovation	