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## Innovation at the end of the life cycle: discontinuous innovation strategies by incumbents

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### ABSTRACT

This paper focuses on the strategies of incumbents that seek to develop discontinuous innovations within the boundaries of a mature innovation system. Mature innovation systems do not provide support for these discontinuous innovations. This article focuses on exploring why incumbents in these setting engage in discontinuous innovation and what strategies they deploy to become successful. We analyse 10 cases of incumbents developing discontinuous innovations in the mature Dutch greenhouse horticulture sector. The results of our analysis show that the incumbents are primarily triggered by dissatisfaction with the current way of doing business and that the existing institutions are the main barrier to discontinuous innovation. In response, the incumbents try to circumvent the existing innovation system in their innovation process, but when successful also engage in changing the existing innovation system. This paper contributes to the understanding of the role of incumbents as source of discontinuous innovation in mature innovation systems.

### KEYWORDS

Incumbents; discontinuous innovation; mature sector; innovation system strategies; greenhouse horticulture

## 1. Introduction

Well-performing, innovative sectors are an important source of national competitiveness and sectors continuously need to innovate to sustain their competitive advantage (Porter 1990). This is especially challenging for mature sectors. Life cycle perspectives on sectoral change state that while early in their life cycle sectoral systems can be adequately described as ‘sectoral systems of innovation’ the focus shifts towards production as the sector matures (Malerba 2002; McDermott and O’Connor 2002; Van den Hoed 2006; Markard and Truffer 2008a). In this, mature phase costs become the main basis for competition and innovations are mainly incremental, process oriented and developed by suppliers (Utterback 1994; Klepper 1997). Actors, technologies and institutions in this phase are all perfectly aligned making it difficult to introduce novelty into the sectoral innovation system. Consequently, these mature systems are often characterised by inertia.

In some cases, mature sectors break out of this inertia and a new wave of innovation starts. Such innovations are often labelled discontinuous innovations (Lynn, Morone, and Paulson

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1996) to indicate that the existing competences, production skills and knowledge fit poorly with the new innovations (Utterback 1994) or that technological trajectories are changing due to the introduction of the innovations (Dosi 1982). Common sources of discontinuous innovations in mature industries identified in the fields of industrial dynamics, strategic management and innovation systems are: exogenous shocks, technological developments, market changes and new entrants (Utterback 1994; Christensen 1997; Van den Hoed 2006; Bessant and Tidd 2007). Incumbent firms are not expected to introduce these innovations mainly due to organisational and environmental factors. This is coined as the incumbent's curse (Chandy and Tellis 2000). The organisational factors hindering incumbent firms to engage in discontinuous innovation include organisational filters, organisational routines and a lack of perceived incentives (Nelson and Winter 1982; Christensen 1997; Chandy and Tellis 2000), while environmental factors relate to the sectoral system of innovation and production in which the incumbent firm is embedded (Malerba 2002). This sectoral innovation system is an important source of innovation inputs, but can be ill-aligned with innovations that differ from the competence/knowledge base and technological trajectories that characterise the sector, as discontinuous innovations build on new knowledge, resources and competences and require institutional change (Freeman 1994). These organisational and innovation system factors explain that discontinuous innovations often have large effects on industry structure such as the exit of incumbent firms and the entry of new entrants (Breschi, Malerba, and Orsenigo 2000).

However, several studies argue that the incumbent's curse has been overstated (Danneels 2004). Indeed, literature on innovation persistence illustrates that incumbents can be an important source of discontinuous innovation (Cefis 2003; Clausen et al. 2012). Market changes and industry competition can provide attractive innovation opportunities for incumbents when they are in a strong position with respect to quality and quantity of resources and experience in the sector (Van de Ven et al. 1999; Chandy and Tellis 2000; Danneels 2004). Apparently in these cases, the sectoral innovation system does not withhold incumbents from the development of discontinuous innovations.

In this paper, we focus on how incumbents deal with the existing, mature sectoral innovation system when developing and commercialising discontinuous innovations. Our overall research question is therefore: What are the strategies used by incumbent firms to introduce discontinuous innovations within the boundaries of an existing mature innovation system?

With this study, we contribute to a more complete understanding of incumbents as source of discontinuous innovation. In the literature on discontinuous innovation by incumbents, the focus is traditionally on large and powerful incumbents that are able to force changes in sectoral technological trajectories. Less attention is given to sectors, like the agricultural sector, that are characterised by a very large number of incumbent firms with limited size, resources and power.

The Dutch horticulture sector has a strong innovation tradition and stands out for its global competitiveness and innovative incumbent firms (Berkers and Geels 2011) and was selected by Porter (1990) as a success case of an industrial cluster. Today, the sector faces typical problems associated with the mature phase of the life cycle as profits have been decreasing and many firms go bankrupt. Using a multiple case study method, we analyse 10 cases of incumbent entrepreneurs introducing discontinuous innovations in this sector. The cases represent a select group of pioneers, as the vast majority of breeders in this sector continues their business as usual. The breeder firms under study are all diversifying

incumbents that have many years of experience in the sector. The discontinuous nature of their innovations is primarily related to new business models and less to radical technological change, and builds on completely new competences that are currently missing in the sectoral innovation system (Utterback 1994).

The used qualitative approach enables us to make a detailed analysis of the interplay between entrepreneurial incumbents and the innovation system. This qualitative approach allows us to uncover actor-level details within an innovation systems approach. Our main contributions are threefold. We contribute to the understanding of drivers for incumbents to engage in discontinuous innovation that go beyond strong capabilities or opportunities as drivers. Secondly, we contribute to the understanding of strategies these incumbent can use that go beyond forcing change based on their power. Finally, we contribute to innovation systems literature by showing how incumbents can be a source of discontinuous innovations that do not have a strong technological component, as current literature mainly focuses on new entrants as source of discontinuous change through radical technological innovations. These insights are important for understanding why and how incumbent firms break out of existing sectoral institutional structures and start discontinuous innovation.

## **2. Discontinuous innovation and incumbents**

### **2.1. Sectoral systems of innovation and production**

The innovation system concept highlights the collective nature of innovation and the interdependencies between organisations and institutions in the development and diffusion of innovation. A system in general consists of *components* and *linkages* between the components (Chaminade and Edquist 2005; Markard and Truffer 2008b). In this study, the components are actors and institutions. Actors are located in several subsystems: the production or value chain, governmental organisation, research and education organisations, and the market. Institutions are more passive. They shape the behaviour and interactions between actors, but are also made/changed by actor behaviour and interaction (Markard and Truffer 2008a). Innovation is primarily understood as emerging from actors that interact in an institutional context (Hekkert et al. 2007). Three types of institutions are identified: regulative, normative and cognitive institutions (Scott 2001). Institutions favour specific sets of activities and constrain others. The different actors and institutions are related in a systemic way and influence the development, diffusion and implementation of innovations (Bergek et al. 2008; Negro and Hekkert 2008). A well-functioning innovation system is required to successfully develop and diffuse innovations, although the way in which this is realised may differ over the life cycle of an innovation system (Alkemade, Kleinschmidt, and Hekkert 2007; Negro and Hekkert 2008).

As this study focuses on the Dutch horticulture sector, we use the sectoral system of innovation and production as our theoretical framework. A sectoral system of innovation and production is 'a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products' (Malerba 2002). The elements of a sectoral system include its knowledge base, technologies, inputs and demand, the organisations and individuals and the interactions between them. These interactions are shaped by institutions that are also included in the system definition. Major changes in the innovation pattern of the sector are usually

the result of major market and technological discontinuities and have a disruptive effect on the sector since existing institutions, practices and knowledge bases are poorly aligned with the discontinuity. (Breschi, Malerba, and Orsenigo 2000).

## **2.2. Discontinuous innovation in innovation systems**

The process of breakthroughs and discontinuous innovation is a central topic in innovation studies (Markard and Truffer 2008a). Discontinuous innovations, as opposed to incremental innovations, build on new knowledge, resources and competences and are completely new to firms in the sector (Freeman 1994). Discontinuous innovation may also require new markets or significant changes in existing markets, and/or new marketing skills for firms (Garcia and Calantone 2002; McDermott and O'Connor 2002; Borreau, Gensollen, and Moreau 2012). Therefore, these innovations often require new business models to succeed in the marketplace; new business models can even be considered a crucial part of discontinuous innovation, illustrating that discontinuous innovations go beyond just technological advances (Teece 2010; Borreau, Gensollen, and Moreau 2012).

The development and commercialisation of discontinuous innovations is far more difficult compared to sustaining innovations within mature innovation systems (Van de Ven et al. 1999). The knowledge base and institutional rules in mature innovation systems are perfectly aligned with sustaining innovations while they may be a poor match with discontinuous innovations. Furthermore, the influence of sustaining innovations on the innovation system is limited while discontinuous innovations have major impacts on the structure and functioning of mature systems of innovation and production (Garcia and Calantone 2002).

Ideally, firms developing discontinuous innovations can use innovation systems as a source of new knowledge, resources and competences. However, in mature industries, the existing innovation system can be ill-aligned with discontinuous innovations (Freeman 1994; Van de Ven et al. 1999). There is often little knowledge and experience regarding discontinuous innovation processes in existing systems since the required knowledge, resources and competences differ significantly from those that are in place in the current system. Additionally, there can be an unwillingness to change current practices or to support discontinuous innovations by other actors. This can be related to the aforementioned lack of knowledge, resources or competences, but can also be the result of more strategic behaviour. Actors with large vested interests in the current system will likely protect their position, which could be overthrown by discontinuous change. However, despite the unlikely appearance of discontinuous innovation in mature systems, it still occurs.

## **2.3. Incumbents as a source of innovation**

The literature generally states that outsiders introduce discontinuous innovation. Incumbents are not expected to introduce discontinuous innovation. However, several instances of incumbents as developers of discontinuous innovation have been identified. These studies have identified three main factors that explain why incumbents can become a source of discontinuous innovation. First, large incumbent organisations often have strong technological capabilities. Their R&D and human resources can help in developing, absorbing and marketing of discontinuous innovations (Ettlie, Bridges, and O'Keefe 1984; Dewar and Dutton 1986; Chandy and Tellis 2000). Second, dynamic organisational structures

and competences can prevent the barriers created by organisational filters and routines mentioned earlier (Nelson and Winter 1982; Ettlie, Bridges, and O'Keefe 1984; Dewar and Dutton 1986; Chandy and Tellis 2000). Large incumbent firms can have a large diverse workforce, and also a division in competing business units that innovate. Finally, market changes and industry competition can provide attractive discontinuous innovation opportunities for incumbents (McDermott and O'Connor 2002). Discontinuous innovations can form the foundation of a strong competitive advantage (Veryzer 1998). If large existing markets demand discontinuous innovation, incumbents can be in a resource position to meet this demand (Danneels 2004; Greenwood and Suddaby 2006). In fact, in some cases incumbents can be in such a strong position with respect to quality and quantity of resources, access to market and experience in the sector, that they lead the sector (Van de Ven et al. 1999; Chandy and Tellis 2000; Danneels 2004; Greenwood and Suddaby 2006). In this case incumbents can force change, even without the need for a supporting system. However, not all sectors are characterised by the presence of large incumbents that are in such a strong position to force change.

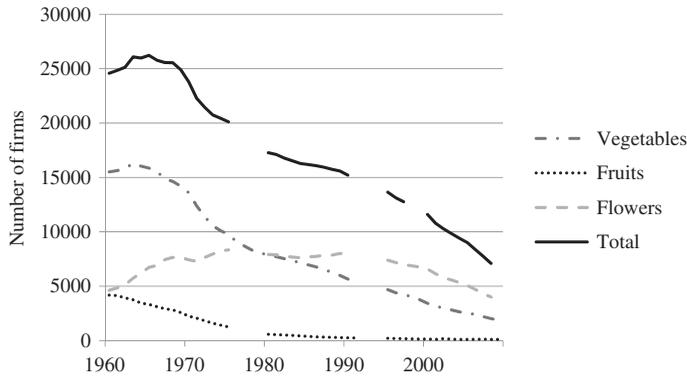
Focusing on incumbents without the power/resource position that can force change, we expect that it is even harder for these incumbents to withstand the forces of inertia within mature innovation systems. Under what circumstances incumbents in this position are likely to start discontinuous innovation and what strategy they deploy is an unresolved issue in the literature.

### 3. The Dutch horticulture sector

The Dutch greenhouse horticulture sector is a typical example of a sector that is characterised by a large number of incumbent firms with a relatively modest size; in 2013 there were around 5,000 firms with an average of 30 employees (LEI Wageningen UR 2014). The sector contributes approximately 10% added value and employment to the Dutch economy (Berkhout and Roza 2012).

The sector is known for its innovativeness; after the Second World War, Dutch greenhouse farmers became world leaders, especially in tomatoes and flowers (Berkers and Geels 2011). This is remarkable when one considers that the primary inputs, land and climate, are far from optimal in the Netherlands (Porter and Van der Linde 1995; Berkers and Geels 2011). Berkers and Geels (2011) show that the success of the sector can be attributed to its innovativeness.

One of the crucial innovations in this sector was the development of efficient closed greenhouses that substantially increased production. Porter and Van der Linde (1995) argue that the sector responded to its environmental problems by implementing strict regulations and highly efficient closed-loop systems that limit energy and land use. Organisational innovations contributed to the emergence of a cooperative culture with farmers as production managers of 'vegetable factories'. Farmers saw each other as colleagues, not as competitors (Berkers and Geels 2011). Furthermore, there were important technological and organisational innovations in logistics and auction houses. The innovations implemented in the auction systems increased productivity, structured competition and markets and provided an international competitive advantage due to reduced transaction costs. The innovations in the value chain created a highly specialised value chain that characterises the sectoral innovation system.



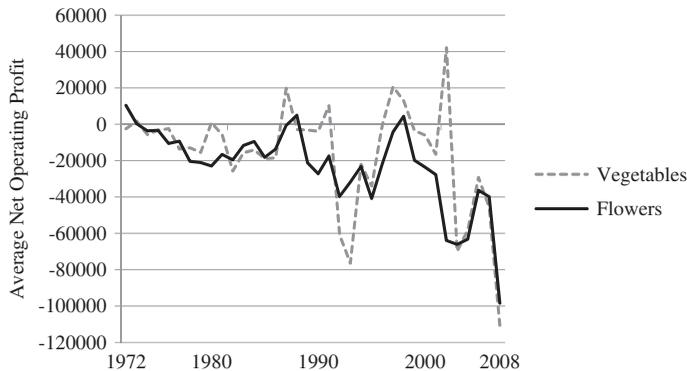
**Figure 1.** Decreasing number of firms in sector (Alkemade, Hekkert, and Farla 2010).

The value chain starts with specialised technology suppliers of equipment and seeds. The next step consists of breeding firms. These breeding firms employ greenhouses to create the final products of the sector (such as fruit, vegetables and flowers). The third step consists of auction houses and seller associations, followed by wholesale and retail businesses in the final two steps. Seller associations and auction houses have a strong influence on innovation processes in the sector, as they directly control the flow of goods between producers and consumers. Supermarkets are the most prominent actors in at the end of the value chain. The value chain is highly linear and interactions between actors in the value chain are heavily institutionalised. Breeders, the primary producers, only have direct contact with their suppliers and seller associations/auction houses, but not with the market. The retail step is the only part of the value chain that has direct contact with end consumers. As a result of this structure, auction houses and supermarkets have relatively more power compared to breeder firms. Most products from this sector are not differentiated by brand names.

The government and research organisations played crucial roles in the innovation trajectories that dominate the sector (Berkers and Geels 2011). The government influenced innovation processes by means of support in the form of innovation programs, subsidies for energy efficient technologies and voluntary agreements with the sector to reduce energy. Research organisations, especially the well-known agricultural university of Wageningen, played a central role by actively participating in the development and implementation of many radical technological innovations related to the construction and functioning of greenhouses, providing the sector with a strong knowledge base regarding process technology (Berkers and Geels 2011).

Currently, the Dutch greenhouse horticulture is experiencing tough conditions; the number of firms in the sector has steadily been decreasing since the 1990s (see figure 1) and this number is expected to decrease even more in the coming years. This trend is present in all different subsectors. The number of active firms in fruits and vegetables has even been decreasing well before the 1990s, showing the maturity of these subsectors.

While the average size of firms in terms of greenhouse surface area has increased since 2000, the total amount of greenhouse surface area in the Netherlands has decreased from 10,500 ha in 2000 to 9,800 ha in 2013 (LEI Wageningen UR 2014). A large drop in the average net operating profit of firms in the sector is also observed (see Figure 2). This drop is similar for both the vegetable and flower subsectors. The described trends are not uncommon for



**Figure 2.** Decreasing average net operating profit of firms in sector (Alkemade, Hekkert, and Farla 2010).

a mature sector, but are problematic with respect to long-term economic performance. At the same time, changing consumer preferences (related to increased attention for health and sustainability topics) might provide a window of opportunity for a new wave of innovation.

#### 4. Methods

This study applies a qualitative approach to answer the research question. In order to determine what innovations can be labelled as discontinuous we first assessed the dominant innovation focus of the sector. We used data on several innovation awards and sectoral innovation programs to assess what type of innovations are considered important in the sector. These outcomes were validated during a workshop with key players in the sector.

Hereafter, we analysed the sector with the help of the Foundation for Innovation in the Greenhouse Sector (Stichting Innovatie Glastuinbouw – SIGN), a government-sponsored sector-supporting organisation, in order to identify discontinuous innovations that were currently (2011) being developed in the sector. This organisation has a clear overview of the current state of the sector and has direct connections to many actors in the value chain. Based on the analysis of SIGN's data-set and the earlier overview of innovation award/program participants, a total set of 17 discontinuous innovations was identified.

In order to effectively contribute to theory development, it is important that the individual cases are comparable. We therefore only focus on firms that are responsible for the production of the final products (i.e. flowers, fruit and vegetables). The selected firms are breeding firms – they produce the final product that is sold on the market. Three of the previously identified firms pursuing discontinuous innovation were not breeders, and therefore excluded from our sample. The remaining firms were contacted. Eventually, 10 cases were included in this study (a response rate of 72%). Section 5.2 discusses the selected innovations in more detail. It must be noted that the selected breeders are not representative for the entire population. As is clear from the numbers, only a small subset of breeders engaged in discontinuous innovation. The vast majority of breeders only pursued non-discontinuous innovations (mainly cost-saving process innovations). The 10 studied cases are considered representative for the total set of entrepreneurial pioneers that pursued discontinuous innovation at the time.

We used semi-structured interviews with the founders or managers of the firms that developed the selected discontinuous innovations. The interviews consisted of three parts. First, we asked about the characteristics of the discontinuous innovation. Then, we focused on the motivation for the innovation and, finally, we focused on the innovation strategy and how it relates to the sectoral innovation system. More specifically, we asked what components of the sectoral innovation system were involved in contributing to the innovation and what components were hindering the innovation process. To adequately discuss all components of the innovation system, we explained the innovation system concept and we brought an abstract graphical illustration that shows the structure of the Dutch horticulture innovation system including supply chain, research and education organisations and rules and regulations. After the interviewees discussed the most important actors and institutions, questions about the remaining components were asked to determine if these components did not impact the innovation strategy or were overlooked by the interviewee.

The studied firms have all been active in the sectoral innovation system before they started the development and implementation of their discontinuous innovation. They have many years of experience in the sector and either branched out to develop their discontinuous innovation or sold their original firm in order to start over with their discontinuous innovation as primary focus.

## **5. Results**

### **5.1. Dominant innovations**

What type of innovation is dominant in the horticulture sector? The sector can be characterised by many small firms with weak R&D capabilities (Berkers and Geels 2011). Technological innovations therefore mainly arise from supplier-dominated dynamics, where breeders depend on specialised suppliers such as equipment/material suppliers and seed firms. Research organisations are also important sources of technological innovations. Furthermore, competition is cost based due to the large amount of firms in a homogeneous, price sensitive market (Berkers and Geels 2011). Therefore, process innovations that focus on reducing costs are likely to be dominant in the sector. Our analysis of the Hortifair Innovation Award (one of the largest innovation awards in the sector) confirms this. Between 2005 and 2009, 61 out of the 91 award winning innovations were process innovations. Our study of Dutch subsidy grants in this sector presents the same pattern. Six out of seven subsidy programs that we studied only focus on supporting process innovation. Only one (Flowers and Food) explicitly mentions other types of innovation like product innovations. Furthermore, there are six additional large subsidy programs aimed at energy-reducing innovations, which can be categorised as process innovations from the breeders' perspective.

The Dutch greenhouse horticulture innovation system has steadily evolved into a system that focuses on price-based competition, mass production and process innovations to cut costs and improve efficiency. The multitude of technology suppliers that are present in the sector support this innovation direction. Also, the knowledge base is mainly developed by universities and research organisations and focuses on efficiency improvements. Even the financial system favours investments in scale improvements and cost-reducing innovations. This innovation direction ensured that the sector remained competitive and highly

**Table 1.** Overview of studied discontinuous innovations.

Entrepreneurs	Sub-sector	Innovation types	Product competes with:
E1	Snack vegetables	Product, marketing	Snacks (candy bars, potato chips)
E2	Snack vegetables	Product, marketing	Snacks (candy bars, potato chips)
E3	High-end vegetables	Product, process, marketing	Spices and specific flavours, but also enters new high-end market segments
E4	Tomatoes	Product, process, marketing	Regular tomatoes, but also enters additional markets, such as catering and soup
E5	Tomatoes	Products, process, marketing	Regular tomatoes, but tries to establish high-quality sustainable market segment
E6	Strawberries	Product, marketing	Regular strawberries, but tries to establish high-quality market segment and enters additional markets, such as jams
E7	Orchids	Product, process, marketing	Regular flowers, but establishes high-quality market segment
E8	Orchids	Product, marketing	Regular flowers, but establishes high-quality market segment
E9	Flower delivery	Product, process, marketing	Postcards and mail gifts
E10	Vegetables and flowers	Marketing	Traditional horticulture markets and retail

innovative during many years. As such, the institutional setting of the sector provides strong support for incremental, technological process innovations, but not other types of innovation.

## 5.2. Description of discontinuous innovations

Given the focus on process innovations in the Dutch horticulture sector and price-based competition between homogenous products, we consider innovations that break out of this trajectory. In this case, such discontinuous innovations can be innovations that have distinctive product characteristics, are aimed at different market segments, use new business models or create value through branding and marketing.

Table 1 below presents an overview of the discontinuous innovations in our sample. The interviewed entrepreneurial incumbents are labelled E1–E10. Firm sizes are difficult to assess in a single number. The number of full-time employees ranges from 0–10 (for E1, E8, E9 and E10) to 50–100 (for E3 and E7). However, many firms employ part-time employees, especially students, and this number is generally large during peak season moments. E1 and E2 developed new types of snack vegetables (‘snack veggies’) such as small tomatoes, cucumbers and peppers. They opened a new type of market for vegetables by offering healthy alternatives for, for example, candy bars. E3 sells new vegetable types that are sold to top chefs in restaurants. These vegetables are produced in small quantities, have very distinctive characteristics in terms of taste, colour and texture. They are so unique that they led to the creation of a new high-end market segment. E4 and E5 developed sustainably produced high-quality tomatoes that are sold under newly created brand names. Here, the marketing aspect of these innovations is crucial, as the added value (sustainability) needs to be clear to consumers. E7 through E9 focus on new flower types that are sustainably produced and sold through new channels under unified brand names. Again the marketing aspects of these innovations are crucial. E7 and E8 offer sustainable orchids to garden centres in combination with stands, posters and other marketing information that can be used by garden centres to profile these products. E9 organised his innovation in such a way that it

competes with postcards and other mail gifts. By developing special packaging material, the flower bouquets fit through regular mailboxes which dramatically reduces transport costs and time. Finally, E10 offers a platform for breeders to sell high quality flowers and food directly to local end consumers. The platform is organised in such a way, that online orders can be customised and that it allows breeders to market the added value of their products.

While the following sections go into more detail, it is important to note that all included innovations can be considered discontinuous for the following reasons. The innovations build on knowledge and competences that are traditionally not required from breeders. Primarily marketing competences are needed while these competences are traditionally not used by breeders. Furthermore, the innovations need market and institutional changes to become successful. Due to the newly developed business models interactions between actors that are normally not directly connected in this sectoral system take place. Additionally, the business models often skip or ignore current value chain actors, potentially making them obsolete. These aspects illustrate the discontinuous nature of the innovations under study.

### **5.3. Motivations and innovation strategy**

The prime motivation for the interviewed incumbents to depart from the existing innovation direction in the horticulture sector is a growing frustration and dissatisfaction with the current state of the sector. As E1 explains: *I don't want to have the biggest firm, I want to have fun [innovating] ... That's a reason for why we transitioned from bulk production to new innovations.* In his view, the price-based competition in mass produced tomatoes is so strong that profit margins keep diminishing and innovations are only aimed at lowering costs. This general view arises from all interviews; breeders are dissatisfied with the lack of appreciation for quality and product innovation in the supply chain, small margins for breeders and the power-imbalance in favour of supermarkets and retail. Furthermore, many breeders admitted that they took risks, as it was unclear from the start if there were attractive markets for their innovations. E1 argued that he became motivated to look for something new, when his previous innovation (a new type of tomato) transitioned to mass production. He sold off part of his firm and started with his new innovation, but it took three years before it became clear to him that there was demand. In a similar way, E8 argued that in his case, it became clear that there was some demand for the product after the decision to start a new innovation trajectory had already been made; his decision was not based on market studies. Therefore, dissatisfaction with the current way of doing business is a fundamental trigger for discontinuous innovation by incumbents in this mature sector. This differs from the explanations that are dominant in the literature. It illustrates that incumbents can be a source of discontinuous innovations, which is an addition to the generally mentioned sources – exogenous shocks, technological developments, market changes and new entrants. Furthermore, dissatisfaction as a trigger of discontinuous innovation is an addition to the triggers of innovating incumbents mentioned in literature, as the studied incumbents were not triggered by strong technological capabilities, a diverse workforce or attractive opportunities. The dissatisfaction was mainly the result of a conflict between the incumbents' desires and the institutional pressures of the current system (that steer towards incremental process innovation).

While the innovations and incumbents in Table 1 are diverse, they have several important similarities. As stated, all entrepreneurs in our sample either branched out to develop

their discontinuous innovation or sold their original firm in order to start over with their discontinuous innovation as primary focus. All innovations go beyond technological process innovations even though process innovations may still be part of these innovations as is the case for sustainable flowers and vegetables that require innovative sustainable greenhouses using new technologies.

The breeders entered new markets or approached existing markets in a new way, demonstrating that marketing is an integral part of the developed innovations. Marketing skills are traditionally not required by breeder firm. They traditionally have no direct contact with end consumers. Direct contact with end consumers is even forbidden for breeders that are part of seller associations and sell through auction houses. This makes marketing and product differentiation difficult in the traditional value chain. Furthermore, at the end of the traditional value chain, marketing is mostly performed by supermarkets. However, supermarkets market the price or general quality of their greenhouse products and do not use specific brand names for these products. Consequently, there are almost no strong brands in the fruits, vegetables and flower businesses. The relation between breeders and customers is radically different in the studied cases. In many cases, entrepreneurs seek direct contact with customers or consumers and circumvent auction houses and retailers who are not eager to trade these novel products. This shows the discontinuous nature of these innovations, as they follow interaction patterns that differ from those traditionally present in the sectoral innovation system.

The studied breeders focus on moving away from the lowest cost strategy that dominates the innovation system. They focus instead on less price-sensitive consumers, use unique characteristics of their innovation to serve the needs of these consumers and focus heavily on marketing activities. Branding is a central strategic aspect of the studied innovations, again illustrating the discontinuous nature of these innovations. The primary competitive advantages identified by the interviewees are the unique characteristics of their product innovation (such as appearance, nutrition value and taste). This is contrary to the homogeneous product quality in the sectoral innovation/production system and the absence of specific product brands. They also argue that their own marketing knowledge and skills, their personal networks and their reputation are crucial advantages. E5 even expressed this with the statement *Relations are more important than transactions*, arguing that, in contrast to products, a reputation as innovator/pioneer cannot be copied and is therefore a very valuable strategic asset.

The entrepreneurial incumbents target specific customer segments that have different, quality-related needs and are less price-sensitive. In this way, they differ from the traditional supplier-push innovations triggered by seed firms or specialised suppliers. However, due to this new discontinuous approach, the incumbents encounter several barriers.

#### **5.4. Innovation system barriers**

The existing innovation system is primarily perceived as hindering discontinuous innovation. The foremost systemic barrier, identified by nine entrepreneurs, is the functioning of the traditional supply chain. More specifically, they point to the role of auction houses, export companies and supermarkets/retail. In short, these actors have no interest in the innovative products since they do not fit well with their current practices. E1 argues that his innovation process could have been finished significantly faster with support from his

seller association. However, this association was not interested in new products or markets and ignored the innovation. This forced the entrepreneur to find an alternative route, *as the chain is very difficult to change* (E1). In some cases, the influence of supply chain actors is even worse. The vested supply chain actors view these innovations as threatening to the existing system and use different strategies to stop entrepreneurs developing these innovations such as refusing to handle regular products by innovative entrepreneurs or by convincing other actors not to do business with the defiant entrepreneurs. For this reason, most of the firms studied try to get around auction houses and seller associations, by trying to establish a new supply chain by themselves. E9 for example stated that *the market is controlled by a few large import and export firms. These were instructed to not deliver flowers to me anymore*. Entrepreneurs also argue that the largest issue with supermarkets/retail is their unwillingness to accept brand names for vegetables and flowers. Brand names could shift the balance of power away from retail organisations towards breeding firms, which is not in the interest of the supermarkets/retail firms. This shows that the interactions between the studied breeders and other actors are different from the interaction patterns of the traditional system. The traditional value chain is considered highly specialised and linear. As a result of the unsupportive institutional setting, the studied breeders attempt to circumvent the sectoral system.

The second barrier is a lack of knowledge regarding marketing and product differentiation strategy in the existing supply chain. In several cases cooperation between the entrepreneurs and other actors in the supply chain (such as export firms) did not arise due to the lack of this specific knowledge in existing chains. For instance, E7 initially tried to sell his sustainable flowers and the attached marketing concept through regular export channels. However, the export firms lacked the marketing competences needed to sell the innovative flowers and to justify the higher price of the flowers, meaning that E7 could not make use of the services of the export firm. This lack of knowledge was perceived by all entrepreneurs. This lack of marketing knowledge is inherent to the traditional focus of the sector on low-priced bulk products. This shows that the knowledge base of the traditional system does not match with the needs of the studied breeders.

The third issue is related to institutional incompatibilities and also strongly linked to the supply chain barrier. There are many institutional arrangements related to the organisation of the supply chain that hinder innovations. A key example is that entrepreneurs that are part of a producer's association are not allowed to have direct contact with customers and they are obliged to sell all their products through the association. Diversifying entrepreneurs can therefore not sell their original bulk products through a producer's association while selling innovative products through other channels. In addition, membership of a producer's association is required to receive several EU-level subsidies. Not being part of an association thus comes at a cost and puts the innovative incumbents who intend to sell their products directly to customers in a disadvantaged position. Several entrepreneurs also encounter problems with the regulative institutions related to patents. The process of obtaining protection for product innovations is difficult and ineffective due to the character of the innovations. It is, for example, not possible to patent a sustainable flower and the patents for new type of vegetables are held by seed companies. This makes it difficult to shield innovations from cheap imitations. Competing traditional incumbent firms are often seen as so-called *straddlers* (Porter 1996): they copy aspects of the product innovation without changing their business model or introducing other innovation types. For

example, several traditional firms have copied the snack vegetables that were developed by a few of our interviewees. The copied products are not branded and are produced and sold through the traditional supply chain. The brand names for snack vegetables are apparently not strong enough to compete with the non-branded lower price competitors. From a free market point of view, this is all legitimate, but the tragedy is that the sector falls back in the low-cost bulk products strategy instead of producing higher quality branded products with higher added value. This hinders the development of new markets needed for the success of the discontinuous innovations.

The barriers above illustrate the misalignment between the studied discontinuous innovations and the functioning of the sectoral innovation system. As one would expect, the existing system offers hardly any support for discontinuous innovations and in some cases even actively fights these innovations. Other actors in the system refuse to give support due to strategic reasons, or are unable to give support due to a lack of relevant knowledge, and due to the institutional set-up of the system.

### **5.5. Innovation system strategies**

Developing and commercialising discontinuous innovations that are a poor fit with existing innovation system structure places the entrepreneurial incumbents (partly) outside the existing system. The entrepreneurial incumbents therefore mainly focus on using their personal networks to assemble and start new supply chains. In general, the new supply chains include other breeders, specialised suppliers and customers. The main difference with the existing innovation system is that the supply chain is much shorter. The entrepreneurs have direct access to customers and organisations like auction houses and retailers are cut out. E1 for example convinced other breeders to join his snack vegetable concept and deliver to the market directly, by establishing agreements with several (local) stores. He stated that setting up a reliable network in which he can work together with actors and make long-term arrangements is crucial for his innovation and business. In this way, new markets can be entered with combined efforts, shared learning generates new knowledge, there is less competition with other incumbents in these new markets and the negative effects of imitation are reduced. Furthermore, E1 is able to build on one of the strong normative institutions of the sector, where breeders view each other as colleagues and not competitors. E3 explicitly took strategic actions to directly create demand in the highest market segments and 'reverse' the functioning of the chain. Chefs and restaurants would demand his products at retailers, which led to importers/exporters contacting E3 to order the product. This approach makes seller associations and auction houses completely obsolete. E9 established a formal collaboration with a Dutch postal company in order to deliver his goods, thereby removing his dependency on traditional transport actors in the greenhouse sector, again transforming the standard way of doing business in the sector. The collaboration with actors from outside the sector to lessen or remove dependency on traditional chain actors and enter new markets is seen in almost all cases. The entrepreneurs try to avoid being associated with the (products of the) traditional incumbents.

New knowledge was generated by collaborating in the newly constructed networks. Surprisingly, only E5 actively collaborated with a university. This is striking, considering the important role of universities as knowledge and innovation supplier in the traditional innovation system. The other entrepreneurs either intentionally avoided research organisations

(E2: *I would rather gather the knowledge myself*) or did not know how to collaborate with them (E7: *I have no idea what they would have to offer*). E9 had personal contacts with a packaging firm outside the sector that cooperatively developed a critical component of his innovation, while E1, E4 and E8 contacted other breeders and actors in order to *learn together*. Another reason for not collaborating with agricultural universities and research centres in the innovation system is their knowledge base. These organisations are very well equipped to supply knowledge regarding process innovations and improved breeding conditions but lack knowledge related to marketing, business strategy and sales. Through their networks our interviewees came in contact with business schools (who can supply this type of knowledge, but are not part of the traditional innovation system) and other education organisations that supported them in obtaining relevant strategy knowledge.

Another interesting finding is that half of the entrepreneurs intentionally undertake activities to promote the sector in general; these entrepreneurs try to enlarge the market for all breeders and share knowledge throughout the system. Activities include: the establishment and management of educational centres, demonstration projects in which technologies and strategies are shared with other breeders and the establishment of sustainability labels for the sector. Through these activities the entrepreneurs put pressure on the existing system, and try to let other breeders benefit from their knowledge and experience. Thus, the entrepreneurs' strategies go beyond merely building personalised supply chains. By means of their activities they add components to the existing innovation system and by involving other actors they purposefully try to change existing institutions. In the innovation systems literature, these activities are labelled system-building activities (Hellsmark and Jacobsson 2009; Musiolik, Markard, and Hekkert 2012). This active role in innovation system building also has a positive impact on the entrepreneurs themselves, as it strengthens their marketing, networking and lobbying position. For example, one of the entrepreneurs invites policy-makers to come to his educational centre. Direct contact with policy-makers allows him to enter new networks and enhance his visibility. Another entrepreneur argues that his activities in setting up an environmental label almost made him a celebrity within the sector, while at the same time he was able to enter many different networks. However, the entrepreneurs stress that the main goal of these activities is improving the innovation system in general; the personal benefits are judged as a nice side effect. E3 describes this as *making the pie bigger, instead of fighting for the same piece*. This corresponds well with the motivations of the entrepreneurs to engage in discontinuous innovations: frustration about the current state of the sector.

## 6. Concluding remarks

The purpose of this paper was to investigate the interplay between innovating incumbents and the sectoral innovation system in which they are embedded. More specifically, our goal was to uncover what strategies incumbent firms use to introduce discontinuous innovations within the boundaries of an existing mature sectoral innovation system. Our conclusions are threefold:

First, the main drivers for the innovation activities of these incumbents are the problematic characteristics of the existing innovation system. Dissatisfaction with current system functioning is the main trigger of discontinuous innovation development by incumbents. The dissatisfaction follows from personal ambitions and a mismatch with the institutional

pressures of the current system. This is an additional insight to current literature that emphasises strong technological capabilities, a diverse workforce or attractive opportunities as drivers for incumbents to pursue discontinuous innovation.

Second but related, the innovating incumbents seek to circumvent the existing sectoral innovation system in their innovation processes since the existing system has limited value to the entrepreneur and entrepreneurs even experiences negative impacts from defensive strategies by other organisations in the sectoral innovation system. In this way, we contribute to the understanding of sectoral change processes by incumbents. While innovation system literature often studies new entrants that overthrow incumbents or incumbents that force changes, our study adds this more nuanced insight regarding incumbents' strategies for pursuing discontinuous innovation.

This brings us to our third and main conclusion: the main barriers to discontinuous innovation as expressed by the firms in our sample are system-level barriers. More specifically, the institutions that co-evolved with the existing sectoral innovation system are an important source of inertia and lock-in and a main barrier to discontinuous innovation. In their strategies to deal with these barriers, the entrepreneurial incumbents use their personal networks to build new compact value chains and establish direct contact with customers. In some cases, organisations from outside the sector are involved. Innovating incumbents start learning processes in their small networks and by doing this they create niches where discontinuous innovations are further developed. This illustrates that besides exogenous shocks, technological developments, market changes and new entrants, incumbents can be sources of discontinuous innovation.

When successful, the innovating incumbents strive for sectoral change. They recognise that changes in the existing innovation system are necessary to change the innovation direction of the sector. Several incumbents undertake discursive activities to promote new business models in the sector, for instance through the establishment and management of educational centres, demonstration projects in which technologies and strategies are shared with other breeders and the establishment of environmental labels for the sector. At the same time, the success of the incumbents that circumvent the current system puts pressure on the legitimacy of established supply chain actors.

At the moment, it is too early to tell what the effect will be of these discontinuous innovations on the greenhouse innovation system in The Netherlands. Without doubt these brave entrepreneurs have received a lot of positive attention in the sector and are often portrayed as entrepreneurs who have managed to step out of the race to the bottom. This obviously shakes the foundations of current institutional structures as it casts doubts on whether the current innovation direction is sustainable. However, many reinforcing dynamics make change very difficult. Especially the highly specialised supply chain with very powerful retail organisations (who will not benefit from change) will surely slowdown change. Furthermore, there is clear evidence of established firms that copy product innovations using the straddler strategy. This could lead to a situation in which the dominant sectoral innovation system benefits from the discontinuous innovation attempts, without fundamentally changing. It will be interesting to keep studying the process of change in this sector, as it can provide us with more insight on discontinuous innovation and change in mature innovation systems triggered by incumbents, which could be used to establish policy recommendation regarding rejuvenating mature sectors.

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