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Triple helix networks matching knowledge demand and supply in seven Dutch horticulture Greenport regions

This paper investigates the triple helix (industry, knowledge workers and governments) cooperation on knowledge co-production and valorisation for innovation, which took place in seven horticultural regions in the Netherlands. It thus provides more empirical insight into the functioning of this form of cooperation. Based on a secondary multiple case study analysis, this paper sets out to ascertain what enabled triple helix cooperation in the seven regions with respect to the organisation, the formulation and support for goals and action on knowledge co-production and valorisation. The results indicate that in order to stimulate innovation through triple helix cooperation, the different partners first need to build a proper working relationship and a common language. In order to accomplish this, primary aims for innovation should not be formulated too ambitiously (i.e. too far beyond the entrepreneurs' daily practice, in particular SMEs). Knowledge workers and policy makers often want to stimulate knowledge co-production and valorisation more radically and quickly. Hence, they have to temper their ambitions. Procedures regarding the cooperation should be rather simple and flexible. Once a steady working relationship and a common language are developed, then the triple helix collaboration can focus on taking the innovation ambition to a higher level in order to realise more valuable change. At first, entrepreneurs have to experience how they can profit from the cooperation and learn to incorporate knowledge co-production and valorisation step-by-step in their business strategy, including financial investments.

Keywords: knowledge co-production, valorisation, innovation, triple helix, horticulture, clusters

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Introduction

Agriculture has become more competitive and knowledge intensive over the years. Agricultural knowledge infrastructures are changing to better accommodate future economic and societal challenges (SCAR-AKIS, 2012, 2013). From the 19th until the end of the 20th century, Dutch agricultural policy was mainly aimed at intensifying food production through modernisation. In the 1950s, policy focused on enhancing the economic position of agriculture and agricultural entrepreneurs (Vermeulen, 1989). In the 1960s, both national and European subsidies aimed at the intensification of agricultural production in order to protect food production and international competition. This led to the introduction of the 'knowledge triptych' (Leeuwis *et al.*, 2006) as a policy instrument for knowledge production and dissemination through research, extension and education, to support developments and innovation in agricultural sectors. It was not until the 1990s that, partly as a consequence of increasing environmental challenges and societal criticism, the system for agricultural knowledge started to change (Mulder, 2004). Policy makers argued that new market-oriented knowledge, developments and innovation programmes were needed to contribute to the sustainable development of agriculture (Hoes, 2011). Nowadays the international trend is to emphasise the role of agriculture as part of an intertwined network of food, bio-based chains and other sectors such as water, energy, health and ICT (SCAR-AKIS, 2016).

The challenge for the agricultural domain is to develop a transdisciplinary knowledge infrastructure in which multi-actor networks are able to respond to the dynamic challenges faced by agricultural production and consumption (Hubeek *et al.*, 2006; Wielinga and Geerling-Eiff, 2009; Beers and Geerling-Eiff, 2013). This article addresses changes in the Dutch agricultural knowledge infrastructure towards the formation of networks in which multiple actors from different backgrounds cooperate in transdisciplinary settings, to live up to the dynamics of both economic and societal challenges. In particular, the article focuses on the cooperation between different actors on knowledge co-production and valorisation, to better match knowledge demand and supply. It takes the form of a secondary multiple case study analysis of seven Dutch horticulture regions. In 2012 the Dutch horticulture sector produced EUR 22 billion worth of outputs with an added value of EUR 10.3 billion, which was almost one quarter of the added value of the entire Dutch agricultural industry. The sector then consisted of 24,600 enterprises that offered employment to roughly 400,000 people (Topsector, 2015). Six of the studied horticulture regions are formally indicated as 'Greenports', one region (Gelderland) is indicated as a Greenport satellite region. Together the seven regions are part of Greenport Holland[3]. In the Greenport regions enterprises such as cultivators, auctioneers, distributors, trading companies, exporters, suppliers and seed producers operate within one regional cluster.

Since 2012, the national Dutch government has been stimulating public-private partnerships between industries, knowledge institutes and governments to enhance the Dutch economy (MEA, 2014). In public-private cooperation, private actors and public actors join forces through investments based on finances, labour and time to create innovations aimed at all parties involved (Hall, 2006; Spielman and Von Grebmer, 2006). This stimulated the Greenport regions to follow a similar approach. In the period 2012-2015, different knowledge workers (from research, education and advisory services[4]), entrepreneurs and in particular small and medium

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[3] The term 'Greenports' was introduced in 2004 by various Ministries formalising the cooperation between local, regional and national governments with the industry to enhance the economic position of horticulture clusters in the Netherlands. The name is derived from the term 'Mainport', which stands for a similar cooperation regarding the port of Rotterdam and Schiphol airport. The aim of the Mainport cooperation is to enhance the economic and viable position of logistics, trade and transport. The Greenports and Mainports also work together on logistical topics concerning horticulture.

[4] Note that the Netherlands does not have a public extension service.

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enterprises (SMEs), developed multi-actor knowledge programmes with policy makers to stimulate knowledge co-production and valorisation in their specific region (Table 1). The intended outcome was that knowledge was both co-produced and valorised for Dutch horticulture clusters to be able to further develop, innovate and flourish at international level. The topics of the knowledge programmes were diverse, varying from the reduction of energy consumption, greenhouse gases, air or water pollution in combination with cost reduction and sustainable production methods, to topics on short supply chains, mechanisation, precision agriculture, innovative products, public relations and new markets opportunities, and so on.

Knowledge co-production and valorisation

Although the message is not new, knowledge and practice should better bridge the gap between them (Tijssen and Van Wijk, 1999; Debackere and Veugelers, 2005; Klerkx, 2008). Our knowledge-based economy is challenged by globalisation and sustainability issues such as climate change and scarcity of natural resources. Individuals and organisations need to be able to generate and exploit knowledge to develop solutions that address these challenges (Boreham and Lammont, 2000; Poppe *et al.*, 2009). In such dynamic settings, the co-production between different actors and the valorisation of knowledge follows an interactive, often transdisciplinary path. A path in which knowledge is actively constructed by different actors with diverging interests and values, thus not merely absorbed, unaltered, by individuals, companies or networks (Gibbons *et al.*, 1994; Prahalad and Ramaswamy, 2000; Beers and Geerling-Eiff, 2013).

Etzkowitz and Leydesdorff (1995, 2000) refer to the cooperation between industry, knowledge workers and governments on knowledge co-production as Triple Helix (TH) networking. In these TH networks, overlapping boundary interests and stakes are sought to combine public-private forces on knowledge production to stimulate knowledge valorisation. Boundary objects (Star and Griesemer, 1989; Turnhout *et al.*, 2007; Regeer, 2009) are the common and collective grounds that all three helices connect, yet they may have different meanings for each helix. The challenge is that the three helices commit themselves to cooperation based on these boundary objects through common trust, needs and stakes. By doing so, they reframe their own needs and visions into a common ambition (Sol *et al.*, 2013). Knowledge valorisation refers to the process of being able to convert knowledge into commercial, feasible products, processes, services and/or societal value (Leloux *et al.*, 2009; Drooge *et al.*, 2011; Arits and Duijvesteijn, 2012). In other words, knowledge co-creation and valorisation support innovation. Knowledge valorisation is not a linear process but occurs through the interaction of multiple actors in diverse phases (SCAR-AKIS, 2013).

The interaction between the three helices is an important factor for change. Structural TH cooperation can support continuous creative destruction (Schumpeter, 1942) which creates a dynamic upward spiral for learning, innovating and so-called third generation knowledge production

Table 1: The seven Dutch horticulture regions and their knowledge programmes.

Regional programme	Partners involved	Main activities
Northern North Holland (NHN): Agrivizier	Greenport NHN, the regional and national governments, two research institutes, one school, one cooperation on education, one advisory organisation.	Innovation projects, thematic meetings and explorations to enhance innovation in agri-business in the NHN region. Main topics: markets and chains, sustainable production, 'more with less', energy and green resources, health and welfare.
Aalsmeer: the Innovation Motor	Greenport Aalsmeer, the national sector organisation, one chamber of commerce, the regional and local governments, one research institute, one university of applied sciences, one advisory organisation, one publisher.	Innovation projects, thematic meetings and working groups to enhance: (a) the innovation potential of regional horticulture, (b) knowledge exchange and (c) innovation processes and developments.
Gelderland: Spearhead knowledge and innovation	Horticulture business cluster Gelderland, six horticulture and business representative organisations, the national sector organisation, one chamber of commerce, one innovation support organisation, the regional government, local governments, one research institute and various regional schools.	Various innovation projects to realise the ambition that Gelderland will become one of the top five most sustainable and competitive horticulture regions in the European Union.
Venlo: GreenBrains	Greenport Venlo, one regional innovation support organisation, the regional government, one research institute, one school, two universities of applied sciences.	GreenBrains acted as a knowledge service point, aimed at conducting knowledge projects to support entrepreneurs in horticulture with various innovation challenges.
Westland-Oostland: six Innovation and Demonstrations Centres (IDCs)	Greenport Westland-Oostland, two sector organisations, the former levy board, the regional, local and national governments, three research institutes, Greenport related schools, one education centre, two universities for applied sciences, one advisory organisation, one bank.	Six physical IDCs organised and conducted innovation projects, thematic meetings, demonstrations and innovation support to enhance knowledge co-production and valorisation for innovation. The topics were: robotics, taste, energy, water, cultivation and LED lighting.
Duin- and Bollenstreek: IDC flower bulbs and plants	Greenport D&B, five horticulture representative organisations, the regional and local governments, one research institute, the education centre, one knowledge centre.	See Westland-Oostland. Main topics: phytosanitary aspects, bio-based production, precision agriculture and logistical technology.
Boskoop: Knowledge and innovation impulse	Greenport Boskoop, one sector organisation, three business support organisations, one business association, one chamber of commerce, two local governments, one research institute, the regional study club, one school, two advisory organisations, one bank, one high council.	Innovation projects, education and knowledge exchange to give the innovation capacity of the horticulture cluster for trees and plants an impulse, to develop sustainable entrepreneurship and to take care of sufficient and qualified personnel, currently and in the future.

Source: own composition

(Wissema, 2009). This refers to demand-driven knowledge that is co-produced and valorised to enhance both economic- and societal-oriented innovation, next to traditional forms of knowledge production such as curiosity-driven academic research or dissemination through education and advice. Critics argue that theories on transdisciplinary knowledge co-production need more empirical support (Hicks and Kats, 1996; Weingart, 1997; Godin, 1998, all cited by Hessels and Lente, 2008; Shinn, 2002). This paper provides more insight into the cooperation between different actors in TH networks, by studying the seven knowledge and innovation programmes in the Greenport regions. In all these networks the aim of the TH cooperation in the knowledge programmes was to better connect different knowledge workers, entrepreneurs and policy makers, to enhance the match between knowledge supply and demand and to enhance the enabling environment to do so. All actors involved cooperated on strengthening the economic, innovative, sustainable and resilient position of the horticultural clusters at the regional level. In almost all knowledge activities in the different Greenports, multiple enterprises were involved. Most participating enterprises were SMEs.

Methodology

For this paper we performed a secondary analysis (Long-Sutehal *et al.,* 2010) based on the results and publications of 34 research projects that were conducted and connected under the wing of one research programme, which ran from 2012 to 2015. All research projects addressed a particular sub-question and they were closely interconnected because of the intensive cooperation within the research team. Our research approach was twofold: (a) analysing the developments in the TH networks for knowledge co-production and valorisation, the aim of which was to derive lessons learnt and to serve as a mirror for reflection for the three helices involved, to learn and improve for further developments; and (b) facilitating research per Greenport to support the TH partners in their cooperation on knowledge co-production and valorisation.

This type of both empirical and facilitating research is identified as reflexive (Van Mierlo *et al.*, 2010) and action research (Almekinders *et al.*, 2009; Van Paassen *et al.*, 2011) in which the researchers intervene in the actual developments. All studies included a qualitative research approach consisting of observatory research, semi-structured interviews, workshops, focus group discussions, other meetings, field trips and literature research. A total of 252 different actors were interviewed and/or participated in group discussions organised by the researchers. Some actors were interviewed multiple times and several interviewees also participated in workshops or group discussions. In addition to the qualitative research methods, a survey was conducted which resulted in additional data from 60 enterprises.

Understanding TH collaboration on knowledge co-creation is complex because of the multiple interacting factors. Therefore, an overall multiple case study analysis (Stake, 2006; Yin, 2009) was constructed based on all 34 studies in the seven Greenport regions. To do so, the researchers organised two annual meetings with all project leaders of the knowledge and innovation programmes. In these gatherings, the developments in the different programmes were reconstructed and exchanged, using a timeline method and narrative analysis. This is an approach to study qualitative data in depth (Coffey and Atkinson, 1996). The results of the multiple case study analysis were published in Dutch (Dijkshoorn and van Os, 2015; Geerling-Eiff and Dijkshoorn, 2016).

The secondary analysis described in this paper addressed the following research question: 'What enables TH transdisciplinary cooperation on knowledge co-production and valorisation in the different Greenport regions?' We decomposed this research question into the following two parts: (a) How did the Greenports organise TH collaboration in their region? and (b) How were goals and action for knowledge co-production and valorisation collaboratively formulated and supported in all Greenports?

Results

In the different Greenport regions, visions, agendas and approaches to knowledge and innovation were developed independently from each other. This resulted in unique ways in which the different Greenport regions organised TH collaboration. In addition, in all Greenport regions private partners, and in particular SMEs, collaborated to empower the competitiveness of their regional horticulture cluster. However, the degree of partnership differed per region. In this section we first address how the Greenport regions organised TH collaboration. We do this by first describing three cases that differed the most, on which we subsequently reflect. Then, we address how goals and action for knowledge co-production and valorisation were collaboratively formulated and supported in all Greenports.

Ways in which Greenport regions organised TH collaboration

The different ways in which Greenport regions organised their TH collaboration is best illustrated by comparing three out of the seven Greenport cases. For reasons of privacy, these three cases have been anonymised. Case A primarily focused on identifying practical knowledge questions on innovation challenges by entrepreneurs. Case B, on the other hand, illustrates a structured approach in which time and effort were spent in realising a shared vision and agenda among all partners involved. Case C started out with formulating ambitious innovation projects. However, because this was done without a clear structure, this was not effective and the partners involved changed their strategy after a difficult start.

The primary objective of case A was to execute projects in which multiple entrepreneurs and other TH partners collaborated, which were valued highly by the entrepreneurs involved. To realise this, the initiators of case A organised TH events to articulate the knowledge needs of the regional entrepreneurs. The first event was not so successful because

mostly researchers, teachers and intermediary actors were present, while entrepreneurs formed a minority. For the following TH event, much effort was put into raising awareness of the events, approaching and stimulating regional entrepreneurs to participate. This was successful: many regional entrepreneurs attended the subsequent TH events. The interaction between the different TH participants led to 70 projects in which 300 entrepreneurs were involved. This was neither foreseen nor planned before the start of the programme and it was considered successful. The involvement of this number of entrepreneurs and their active participation in the projects were due to the fact that these addressed topics which were closely related to the daily work of the entrepreneurs.

Case B, on the other hand, initially focused on developing a shared vision, plan and structure among the programme partners. Eventually it took 30-36 months to come from preliminary discussions to finalising the common vision, strategy, roles and tasks among the 14 different organisations that were initially involved. Collaboration between the different TH actors was already common in this region, which is characterised by a relatively small independent horticulture cluster. Many of the enterprises have been there for generations and many different TH actors know each other well, both on a professional and non-personal level. Collaboration between different actors on knowledge activities was already common, both on formal and non-formal basesí. However, the development of the regional agenda was time consuming. It was people's work which can be best referred to as 'putting the pieces of the puzzle together' when the timing was right. Priority had to be given to carrying out their own jobs. Perseverance, willingness, belief in the intended cooperation and pride in their cluster, in particular among a few actors that took the lead in forming the cooperation, were important factors that led to a successful shared problem definition. The time and investment in discussing 'who does what and when' was well spent, because the implementation of the intended knowledge activities went rather smoothly afterwards, as illustrated by the example given in Box 1.

The programme team in case C was ambitious in wanting to stimulate breakthrough innovation in which the THs collaborated both at strategic and operational levels. This meant that the partners involved in the knowledge programme decided on and fine-tuned the content of the projects together, in strategic management meetings. Next, the protocol prescribed that researchers, advisors and teachers had to work closely together in each selected innovation project. However, the innovation ambition in the knowledge programme was too far removed from the regional entrepreneurs' demands. Also, it was difficult to match vocational education to the formulated ambitions which better connected to academic and applied scientific knowledge co-production. The actors in case C learned from the more flexible approach in case A, resulting in an adaptation of the programme ambition and approach. A distinction was made between a steering group who focused on the strategic implications of the knowledge results and an operational core group that was responsible for the execution of the knowledge activities. The intervention took quite some energy and caused some friction among some partners. Yet it also led to the clarification and fine tuning of each other's roles and capacity, necessary for the continuation of the programme. It was a reflective process among the actors involved, which led to more understanding and willingness to enhance the TH cooperation. An evaluation by an external party highlighted that this intervention had strengthened the TH network.

Box 1: Case study: development of a series of masterclasses in Greenport Case B.

A major challenge was based on the indication by the regional entrepreneurs that there was a lack of educational activities in the region to fulfil the sector's needs. Education, research, advisers and entrepreneurs then combined their skills to develop a series of masterclasses together. The entrepreneurs involved brought in the topics and vocational school students were stimulated to join the masterclasses. The interaction between students, entrepreneurs, researchers, advisors and teachers led to refreshing ideas and the follow-up of innovative developments in the sector. In total, nine masterclasses were organised with 300 participants. The masterclasses were evaluated in the research programme and the results showed that the masterclasses were appreciated among the actors involved. Its success led to a structural education programme which brought sector-oriented education back to the region.

Source: own composition

The three cases show us that an incremental, step-by-step approach to articulate and operationalise the knowledge demand into practical knowledge activities can successfully unite entrepreneurs' knowledge demands with the knowledge supply. Furthermore, the cases illustrate that knowledge co-production and valorisation is a creative process in which entrepreneurs exchange their experiences with knowledge workers to be able to adapt and build further on existing knowledge, based on new information and insight.

Formulation of goals and action for knowledge co-production and valorisation

How were goals and action regarding knowledge co-production and valorisation for innovation collaboratively formulated and supported? Despite the illustrative examples described above, for many knowledge activities in all the seven Greenports, it was predominantly the knowledge workers together with the different representative organisations of different horticultural branches that formulated the knowledge activities, often with the support of policy makers. Individual entrepreneurs often did not know which possibilities there were, or indicated they did not have the time to think about their knowledge needs properly. This was partly due to a lack of information and effective communication strategies to inform entrepreneurs about the particular knowledge programme and its possibilities. Entrepreneurs could 'not ask for what they did not know'. Hence, in all regions the knowledge partners utilised their existing networks of entrepreneurs, business representatives and policy makers, expertise and experience to articulate the goals and actions regarding knowledge co-production and valorisation. Advisors played an important role in involving and inspiring SMEs in particular, because of their capacity, experience, proximity to the SMEs and personal contact. For example, the joining of an advisory group in the core team of case C provided a boost in the number of knowledge applications.

Although representative organisations of different horticultural branches played an important intermediary role to articulate the goals and actions for knowledge co-production and valorisation, the challenge remains to inspire and attract individual entrepreneurs to articulate their own knowledge demands that match the innovative ambitions of knowledge workers and policy makers. The different approaches in the knowledge programmes revealed good examples of how to better match knowledge demands by business partners and knowledge supply. Many entrepreneurs participated actively in the projects and other knowledge activities. However, the knowledge programmes did not fully succeed in developing sustainable regional knowledge systems for horticulture based on equally supported public-private partnerships. This counts in particular for financial support.

Each region had the ambition to attract more enterprises for knowledge activities and to stimulate private cash investments in knowledge activities by the entrepreneurs involved. Yet their contribution was mostly in kind (in hours and time), although some would pay cash for, for example, fees and some provided materials or facilities. From the interviews we learned that entrepreneurs were willing to support projects that directly corresponded to their own business strategy at that present time, with a time span of roughly 1-2 years. They did not have the will or capacity to invest in knowledge activities from which the entrepreneur will likely profit after a longer term (>3 years). This leads to contradictory interests between industry and governments as public demands for knowledge are often focused on strategic solutions for societal problems focused on the long term. Furthermore, we found that most enterprises involved were not keen on sharing knowledge for which they had paid. They argue that: 'he or she who pays, should gain' and free rider's behaviour should be avoided. However, although knowledge production is not seen as a core business by most entrepreneurs in horticulture, they do acknowledge that new knowledge development becomes more and more important for survival in the current knowledge-based society.

Discussion

The Netherlands has emerged from an era in which the government took care of the agriculture sector, yet it is moving towards an era in which equal TH collaboration provides for the agricultural sector. In other words, agriculture is moving towards a shift in which the helices worked more separately from each other, to TH integrative cooperation. In this transition phase, governments, at both the national and regional levels, are rethinking their roles and strategies. Within the agricultural knowledge infrastructure, they are moving from their steering position in the front seat towards an equal cooperative partnership role. The Greenport cases show us that it is not an easy transition. In a multi-actor setting, learning depends on incremental steps, based on iterative learning and rethinking strategies by all parties involved. This corresponds to earlier findings by Argyris and Schön (1978).

In the knowledge programmes TH collaboration was organised differently. Some Greenports focused on realising bottom-up projects that were considered desirable by the entrepreneurs involved (as illustrated by Case A), while others focused on stimulating ambitions, in terms of multi-stakeholder collaboration and innovativeness (as illustrated by Case C). Case B started with the development of a shared regional knowledge agenda that specified what the involved TH partners wanted to achieve and which support was needed to establish this. The cases illustrate that starting knowledge programmes with bottom-up projects is a good way to include and activate entrepreneurs in transdisciplinary knowledge co-production. For example, in case A this strategy resulted in 70 projects in which more than 300 entrepreneurs participated. A downside of this approach is that the projects were not very ambitious in terms of innovativeness and stimulating TH collaboration. However, in the transition phase towards TH collaboration, it is advisable to take some intermediary steps first in which entrepreneurs, researchers, advisers and teachers start to collaborate in less complicated projects to build up a good working relationship and a common language. These preliminary steps are required to be able to learn from experience and build on previous experience. These initial steps were not taken in case C, which started so ambitiously that no projects were granted, leading to frustration among the actors involved.

Also, if a relationship between TH partners is formed through preliminary bottom-up actions (e.g. projects), it is easier to develop a shared vision in which the partners agree on what they want to achieve together in their region. Developing a shared, common vision sounds self-evident but it is quite complicated to achieve reframed ambitions between multiple actors that have collective but also conflicting needs and stakes. This corresponds with the work of Sol *et al.* (2013). In particular, case B illustrates that it is time consuming and it takes quite some investment in the TH network and each other to build up trust and common commitment to reframe individual mind-sets into a collective vision. After all, it is people's work, depending on the perseverance, beliefs and persuasion of the actors involved.

Furthermore, our study illustrates that it is challenging to develop a knowledge and innovation agenda with related research questions in collaboration between entrepreneurs, researchers and regional governments. Although there was recognition and acknowledgement for the need to engage entrepreneurs in the exploration and decision-making of the knowledge and innovation agenda, it was still hard to realise this in practice. Individual entrepreneurs lack the time, experience and sense of urgency to be actively involved in formulating goals and operational actions such as projects for knowledge co-production and valorisation. Often it was the horticulture representative organisations that acted as the TH partner on behalf of the entrepreneurs themselves.

A major challenge in the TH collaboration was to match both economic and societal stakes. The government and public focuses on knowledge production to develop long-term strategic solutions for societal problems. Industry is more interested in knowledge production that offers practical solutions for problems they encounter in the short term. As such, SMEs invest mostly in content that best suits their

business strategy on the short term. This relates to the findings of Hermans *et al.* (2013). In addition, the advantages of open knowledge and innovation models were acknowledged by the different parties involved in the Greenports, yet the dominant mind-set among the involved entrepreneurs was to keep the developed knowledge to one's self. They do not have the capacity or will, meaning it does not fit their business strategy, let alone the means to invest substantially in the infrastructure, to coordinate, organise and disseminate knowledge and innovation activities and results. The latter is (still) considered to be a primary task for governments and knowledge workers.

Finally, all activities in the knowledge programmes were at least 50 per cent publicly financed on a project basis. The programmes had a time span of four years. This influenced the continuation of knowledge activities and the interactions between the actors involved. If the TH cooperation in the programme with the four-year time span had not been successful in embedding the collaboration in a sustaining regional TH network, the initiated collaboration stopped.

Despite these challenges, the Greenport cases teach us that regional clusters can indeed provide a good basis to form TH networks. The various ambitions are closely interrelated. Regional governments need resilient and viable enterprises to enhance a sustainable regional economic position. Different knowledge workers create the learning environment for sustainable and resilient entrepreneurship. The Greenport cases show that direct contacts between THs play an important role in enlarging the chance of regional knowledge co-production and valorisation to succeed. This is in line with other work on regional clustering which claims that for innovation to succeed, industry and governments have to collaborate with knowledge workers on forming a critical knowledge mass with multi-disciplinary expertise and diverse competences (Hekkert and Ossebaard, 2010; Looy *et al.*, 2001; Vaas and Oeij, 2011).

In order to sustain TH cooperation on knowledge co-production and to be able to demonstrate and disseminate results for valorisation, further investments have to be made in the development of a structural TH knowledge infrastructure. Inherently, instruments and subsidies for knowledge (through research, education or advice) should be more often or better combined with instruments and subsidies that stimulate (social) innovation. Organising knowledge and innovation contests or stimulating contact between entrepreneurs and financial intermediaries (such as banks, venture capitalists or business angels) with regard to knowledge and innovation developments are also possibilities. More synergies between publicly-financed instruments and private funding mechanisms are a prerequisite to optimise TH knowledge co-production and valorisation.

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