Glasshouse horticulture in the Netherlands: governance for resilient and sustainable economies

Alwin Gerritsen, Annemarie Groot & Wim Nieuwenhuizen (Alterra Wageningen UR)

Contact: Alwin Gerritsen, Alterra Wageningen UR, Droevendaalsesteeg 3a, 6700 AA Wageningen, The Netherlands, T. +31 317481926, E. alwin.gerritsen@wur.nl

Abstract

The Netherlands have a strong and competitive horticulture sector, with regional clusters of glasshouse horticulture companies, of which the 'Greenports' of Westland – Oostland (near The Hague), Aalsmeer (near Amsterdam) and Venlo (near the German Ruhr Area) are the most important ones. The sector makes a strong contribution to the export position of the Netherlands. Since the 1990s, stimulated by changing societal expectations growers and surrounding actors engaged in improving the sustainability of the glasshouse horticulture sector, especially focussing on reducing energy usage, greenhouse gas emissions, water usage and land use. The glasshouse horticulture sector in the Netherland is often perpetrated as a successful example of a sustainability transition and is therefore interesting to derive lessons for sustainable regional economic development. This paper studies *how the glasshouse horticulture sector in the Netherlands did developed, became more sustainable and what modes of governance contributed to this process?* To answer this question, an evolutionary *transition perspective* and *mode of governance* theory were used. Our expectation was that *knowledge governance* (Gerritsen et al., 2013) interventions were important for the sustainability transition and would be needed because of the high complexity of transitions. Dutch agriculture as a whole and specially the horticulture sector traditionally has a strong focus on innovation. Over the years, many innovation projects and programs have been executed, and sustainability innovations have been central to it. These seemed examples of knowledge governance interventions; in our study other modes of governance were taken into account as well. The study entailed interviews with stakeholders involved in glasshouse horticulture in the Netherlands and a document analysis.

A finding of our research is that glasshouse horticulture became less unsustainable in the Netherland, but so far a full-fledged sustainability transition did not take place. Sustainability is embedded in developments in the horticulture sector which will either lead to large scale low cost based companies who are more or less self-sufficient, or to firms which focus on adding value to their produce and partly choose for niche products. In the first direction, sustainability is mainly a mean to decrease production costs and to achieve a license to operate. In the second group, sustainability is primarily an opportunity for adding value and to strengthen the position in the market. The second direction is a relatively new one; the first so far dominates the sector. This explains the focus on the reduction and the increase of the efficiency of energy usage, because this lead to decreasing

production costs, when the gas prices started to rise. When entrepreneurs were driven by such motivations this produced new perspectives, such as the energy producing glasshouse. For the reduction of emissions to the water system, the incentive was less strong, because water is not an important cost factor.

In the paper it is shown that knowledge and innovation played a role in the sustainability activities in the Netherlands. It was also found that next to knowledge governance also other modes of governance and especially network governance contributed the activities. Where informal privately funded innovations were very influential and were shared intensively between growers, formal innovation programs showed to have limitations. They created movement and room for societal action, but sometimes were too extreme to be adopted widely. The sector mostly innovates in an incremental manner, adapting to technologies which have been invented in other sectors, and is focused on technology, neglecting social and market innovations. The innovation potential of the sector is diminishing. Many companies, especially in vegetables, experience financial problems so the possibilities to invest in innovations and sustainability decreased.

Sustainability in the glasshouse sector in the Netherlands has primarily been an example of network governance. These networks of governmental agencies, the horticulture sector and environmental groups created the support to establish regulatory interventions and to fund research and innovation projects. A relevant issue is the recent demise of the corporatist institution 'Productschap Tuinbouw', which was an important part of a knowledge governance arrangement. The sector and its regional clusters are in danger to become less resilient. The differences between the biggest and the smallest companies have grown tremendously the last decade. The biggest companies developed themselves into almost self-sufficient entities which do not really need sector organizations and are less bound to one region, because they internationalised their businesses and moved up in the fresh chain. Sustainability still remains an issue for these growers. New institutions are needed to support this, including knowledge and innovation programs.

1. The transition towards sustainable agriculture

The Netherlands have a strong and competitive horticulture sector, with regional clusters of glasshouse horticulture companies, of which the 'Greenports' of Westland – Oostland (near The Hague), Aalsmeer (near Amsterdam) and Venlo are the most important ones. The sector has been described as a classical example of geographic specialization in a cluster (Jacobs & De Jong, 1992/1990; Porter, 1990). The sector makes a strong contribution to the export position of the Netherlands. Since the 1990s, stimulated by changing societal expectations growers and surrounding actors engaged in improving the sustainability of the glasshouse horticulture sector. The horticulture sector in the Netherland, and especially the glasshouse part of it, is often perpetrated as a successful sector in the sustainability transition, especially with regard to energy, greenhouse gas emissions, water and land use (Van der Velde & Smit, 2013; Boone & Dolman, 2010). This was part of a wider *"transition sustainable agriculture"* program in the Netherlands (VROM, 2004).

Sustainable development as a concept is at least 30 years old, bit it is still widely used by scholars, politicians and civil servants. Sustainable development has been defined as: "*... development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (World Commission on Environment and Development, 1987: 43). Later the storyline was added that sustainable development involves a balance between people, planet and profit. The concept also evolved and new story lines are added to this discourse. Among these are '*Green Economy*', (UNEP, 2008), '*Blue Economy'* (Pauli, 2010), '*Cradle to Cradle'* (Braungart &, MacDonough, 2002) and '*Circular Economy'* (Ellen Mc Arthur Foundation, 2012). These new story lines all focus on a further integration of economic development and environmental improvements.

In the 1990's new farm practices emerged which proposed alternative, more sustainable farm practices, such as '*multifunctional agriculture'* (e.g. Van Huylenbroeck & Durand, 2003)), and *organic farming* (e.g. De Ponti et al., 2012; Badgley et al., 2007). In high productive (or intensive or even industrial) agriculture sustainability is also an issue (Farjon et al., 2013), and concepts as *'Metropolitan Food Clusters'* (Smeets, 2011) and *'Sustainable Intensification'* Garnett & Godfray, 2012) emerged. In the glasshouse horticulture a reduction of the usage of energy and plant protection (such as pesticides) became an issue. Although many measures have been implemented, agriculture and horticulture today cannot be considered a sustainable practice because it uses national resource so intensive, that ecosystems deteriorate and the stock of ecosystem services is being diminished and ultimately depleted (Millennium Ecosystem Assessment, 2005; Netherlands Environmental Assessment Agency, in prep.). Farmers and growers restructure the living conditions

for plants and animals, use resources as water, soil, fertilizers, plant protection, etc. and they often removed 'green landscape elements' as hedgerows, trees, etc. At least since the Second World War, governments started to promote and support the realization of optimized production environments (De Haas, 2013; Bieleman, 2010), the environmental pressures increased. Cycles on farms, which used to be closed, became linear and highly dependent on non-renewable inputs. It gains in urgency when considering developments as climate change, the ecological crisis, resource scarcity, and the economic crisis which threatens the welfare of the European Union, which makes sustainability even more also an economic issue.

The realization of sustainable development in agriculture and horticulture can be perceived of as a transition, because *"sustainable development requires structural changes in social-technical systems and wider societal change, in beliefs, values and governance that co-evolve with technology changes"* (Kemp et al., 2007: 78). Therefore, sustainable development can be perceived of as a system innovation, which emergence needs a transition process (Loorbach & Rotmans, 2006; Rotmans, Kemp & Van Asselt, 2001), in which the system of 'unsustainable development' is left behind and a new system is being established. A transition is a long-term process of change in which a society or a subsystem of society fundamentally changes (Rotmans et al., 2000, Rotmans et al., 2001). System innovations change shared patterns of thinking and acting and alter networks (Rotmans, 2005) on the niche, regime and landscape levels of transition processes (Geels, 2002). Transitions start with novelties and gradually scale up. Transitions therefore are complex and evolutionary processes.

So, now we understand how complex the sustainability transition is, how can it be strengthened? The body of theory on *'modes of governance'* can provide insights to answer this question.

2. Analytical framework

In transition theory governmental authorities are sometimes treated as an environmental factor, because of the focus on self-organization. Some scholars who study transition processes use the concept of '*transition management, which'* entails the promise that transitions to some point can be managed (Termeer & DeWulf, 2012). Kemp, Loorbach and Rotmans (2007) state that most policy strategies are not able to cope with the challenges of transition processes and lead to suboptimal solutions, because the environmental problems which sustainable development aims to tackle *"... are not caused by clearly identifiable actors or factors, but by failures of a systemic nature"* (Termeer & DeWulf, 2012: 39). Transition processes are complex and wicked problems are to be expected.

Wicked problems cannot be successfully treated with traditional linear, analytical approaches, because they are ill-defined and ambiguous (Rittel & Webber, 1973). There is an increased recognition that knowledge and learning are key components for the effective governance of complex and wicked issues, (Hisschemöller, & Hoppe, 1996; Pahl-Wostl, 2006; Stehr, 2005; Michailova & Foss, 2010; Nowotny, Scott, Gibbons, 2001; Gerritsen et al., 2013). This thinking coincides with concepts as 'knowledge democracy' (In 't Veld, 2010), 'knowledge society' (Grundmann & Stehr, 2003) and 'knowledge politics' (Stehr, 2005) can be distinguished in scientific and popular debates. Authors as Back et al. (2004), and Owen-Smith & Powell (2012) mention the emergence of 'knowledge networks' that involve different types of public and private actors within and across organizational and national boundaries.

These discussions imply that knowledge production and knowledge dissemination can be a mode of governance, although it traditionally is not distinguished as such in the literature on modes of governance, which in the theory on modes of governance, which makes in distinction in 'hierarchy', 'network' and 'markets' (Meuleman, 2008) and self-governance from society. Hierarchic governance relates to the democratic nation state which uses legislation to intervene in society and markets. In the 1990s scholars as Rhodes (1997), Stoker (1998), Pierre and Peters (2000), and Kooiman (2003) noted the emergence of new types of governance in addition to more hierarchical types of governance who's potential to produce societal change in a complex society was criticized. Market governance involved the powers of the market place, where competition and pricing decide what is done. Much has been written on network governance (for instance Kickert et al. 1997; Rhodes 1997; Koppenjan en Klijn 2004; Sorenson & Torfing 2007) that makes use of the potentials of actor networks in order to arrive at better policy outcomes. Self-governance refers to the capacity of societal entities to govern themselves autonomously (Kooiman 2003: 79).

Some authors (Voß, & Kemp, 2006; Voβ et al., 2009) use the concept of 'reflexive governance', which means governance to change governance by engaging in reflexive processes, but this concept remains abstract on how this functions. The emerging concept of *'knowledge governance'* (Gerritsen et al., 2013; Van Buuren & Eshuis, 2010; Michailova & Foss, 2009) explicitly proposes to perceive knowledge and learning processes as a mode of governance. Knowledge governance can be defined as *"organising or enabling knowledge networks with the purpose of contributing to innovation, to problem definition, or to policy alteration.* (Gerritsen et al., 2012). A more elaborate definition states knowledge governance is about: *"purposefully organizing the development of knowledge in order to deal with societal problems. Knowledge governance is aimed at creating new insights, and innovative*

solutions which tempt actors to leave traditional insights and practices and get away from inert interaction patterns, stalemate negotiations, and interest conflicts. Knowledge governance is also used to raise awareness and deliver suggestions that give actors a perspective on purposeful action" (Van Buuren & Eshuis, 2010: 284). Michailova & Foss (2009) use the concept in the sense of the governance of knowledge management activities. In this paper we follow the definitions of Gerritsen (2012) and Van Buuren & Eshuis (2010).

3. Research questions and method

The main question of this paper is: *how the glasshouse horticulture sector in the Netherlands did developed, became more sustainable and what modes of governance contributed to this process?* Because Dutch agriculture as a whole (De Haas, 2013) and especially the horticulture sector traditionally has a strong focus on innovation (Pannekoek et al., 2005) and has a strong institutional connection with science (De Haas, 2013) we expected that knowledge governance played an important role in the emergence of sustainability in the sector. Therefore this article studies this in detail, but it was also decided to also study other governance developments.

To answer these questions the following questions were studied:

1) *What were the characteristics of the glasshouse horticulture sector in the Netherlands and its regional clusters and how did these change over time?*
2) *What was the contribution of the glasshouse horticulture sector to sustainability and how did this change over time?*
3) *How did the knowledge governance institutions related to the glasshouse horticulture sector change over time and how did it contribute to increasing sustainability?*
4) *How did other modes of governance contribute to the development and implementation of more sustainable practices in Dutch glasshouse horticulture?*

To answer these questions we conducted a mostly qualitative historical case study into the glasshouse horticulture sector in the Netherlands. This was studied by a literature review to provide an overview of the available information on the development of the sector, involving known quantitative data. The research also involved semi structured interviews with 13 respondents: 6 respondents from the sector (a grower, a banker, a glasshouse developer, and advisors), 2 from government, 3 from science and 2 from societal organizations. These interviews where meant to add

tacit knowledge insights to the data in research reports. The results of the interview round were confronted with the results of the literature review on the governance of transition processes.

Firstly, a description will be given of the glasshouse horticulture sector in the Netherlands, its characteristics and what has happened in the transition towards more sustainable practices. After that we will provide a historic overview of the role of knowledge and innovation in Dutch horticulture and on its connection with the sustainability transition. After that other modes of governance are addressed.

4. Sustainable development and the Dutch glasshouse horticulture sector

4.1 Characteristics of the glasshouse horticulture sector in the Netherlands

The Netherlands has developed a very strong horticulture sector, which widely uses glasshouse structures to grow vegetables, cut flowers and decorative plants. These were introduced in the Netherlands in 1850 and were firstly used for growing grapes (Bieleman, 2010). In 2012 the Netherlands had 5,000 glasshouse horticulture firms (CBS, 2012). Especially to the cut flower and pot plant sub sector is strongly export oriented. According to Snijders et al. (2007) has the Netherlands a 60% position in the world export in flowers (which is only 25% of the world production). In 2010 the yearly export for horticulture amounted be 15.5 million euro (TKI Tuinbouw en Uitgangsmaterialen, 2012). The production is concentrated in a select number regions within the Netherlands, including the 'Greenports' of Westland – Oostland (close to the harbour of Rotterdam), Aalsmeer (close to Amsterdam and Schiphol airport), increasingly North-Holland North (to the north of Amsterdam) and the Venlo region (close to the German Ruhr metropolis), of which the first two are the oldest ones. Most of the vegetable production is also limited to these regions. The sector knows big firms. Since the 1970's the number of growers has decreased from 20,000 to about 5,000 growers (CBS, 2012), but T the area on which glasshouses are located have increased strongly over the years. New glasshouse locations as Agriport A7, Emmen, Bergerden, Biopark Terneuzen, Bommelerwaard, etc. for example did not have glasshouse before the 1970s and some were only developed much later.

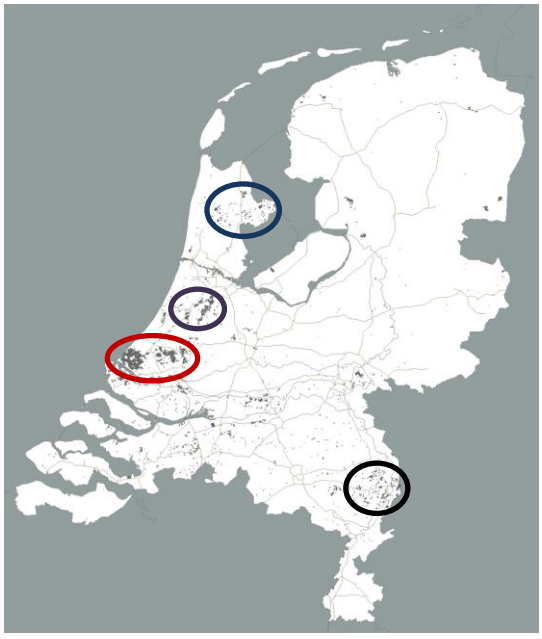

Figure 1 The glasshouse horticulture related Greenports in the Netherlands (map data from RVO Netherlands Enterprise Agency

In the Greenports over the years a high standard network has arisen of suppliers en traders. For example, seed companies, who are clustered near Edam or 'Seed Valley', delivered the base material so that creating new products was also not an activity in which the growers participated. Traditionally the growers limit themselves on the production (Snijders et al., 2007) and are focused on technology and to the reduction of the production costs (Alkemade et al., 2011). They brought their produce to the auction and that was it. The producers did not really engage in marketing and selling activities. Because of the auction system, this was not necessary for them. For vegetables the role of the auctions recently has been diminished strongly, after a process in which the auctions merged into one big firm, 'The Greenery'. In cut flowers the position of the auctions, as Aalsmeer and Naaldwijk, is still strong and even flowers from Africa are traded here and distributed mostly over Europe (Snijders et al., 2007). Most clusters outside of the four Greenports are struggling. They did not succeed in developing themselves as functional clusters and miss closeness to specialised service providers.

The demise of the auction system in vegetables seems to lead to lower incomes for growers, because their influence in the chain diminishes. According to the Netherlands Environmental Assessment Agency (2012) only five trade houses buy the food products for the supermarket (for the whole food sector, not limited to glasshouse horticulture), of which there are also only 25. Because there are about 5,000 growers and because there is according to the respondents also an oversupply in vegetables as peppers, cucumbers and tomatoes. The energy costs also increased for all growers,

which forms a major part of the production costs. The establishment of producer organisations did not stop this downward trend. Also because of regulation against market distortions. With the economic crisis since 2008 many companies got into problems and some companies have gone bankrupt. This is increased in severity because of a 'mortgage' crisis in glasshouses in which the debt level became too high for many firms. Ending the firm mostly is not an option because of taxes to be paid at retirement. So firms remain existing, but do not invest much. Some of the production (especially roses) has been moved to Africa and there is also some migration to the Berlin region, Poland and elsewhere in Europe. The number of growers in 2012 was only 25% of the number in 1970; from 20,000 to 5,000. Between 1999 and 2007 the firms grew with 79% (Agricola et al., 2010). 39% van de growers could be rated as very big (Agricola et al., 2011). The last years there is a small decrease in the total land use of glasshouse horticulture in the Netherlands (CBS, 2012) to 10,000 hectares. Berkhout et al. (2011) expect this area to remain more or less equal and anticipate an end to the scale enlargement of the firms.

Although there are many production firms with problems respondents stress that the sector is doing quite well and will remain to do so in the future. Some of the growers aimed for adding value to their produce and partly directed their attention to niche products, as 'honey tomato's, or aromatic products (cresses). Some growers aim to establish a closer relation with the consumer. This can mean opening a shop in the glasshouses, or selling directly to the retail or restaurants. Scale enlargement and cost price reduction is also still a common and dominant strategy of entrepreneurs. The movement of some firms to Germany, Poland, Africa or elsewhere is not seen as a real threat. They still are Dutch firms and are located close to growing markets. These new locations also do not offer the full range of specialized services the glasshouse clusters in the Netherlands can provide. For the cut flower sector, the produce still is being traded in Aalsmeer, only the production emigrates. Still many firms will close down the coming years, as happened in the past decades. The remaining horticulture firms will likely be very big or entrenched in niche products and by this route add value to their produce. Also the growers will have to improve their position in the market and to know what is demanded in the market and to act accordingly.

4.2. An innovative sector

Dutch agriculture and Dutch horticulture in particular are very knowledge intensive, which is location bound and therefore increases of the economic resilience of the glasshouse regions. *"Knowledge-intensive processes have less of a tendency to disappear to Eastern Europe, South America or China. This leads to an important economic position within the national economy"* (Poppe et al. , 2009: 20).

'The glasshouse horticultural sector is considered to be much more innovative than other agricultural sectors. Between 3% (Pannekoek, 2005) and 10% (Breukers et al., 2008), of the companies in greenhouse horticulture can be regarded as being innovators which means that these entrepreneurs were the first in the Netherlands to introduce a new product or process. In addition to product and process innovations, there are also advancements in the management of the companies and their sales and distribution (for example quality control, tracking and tracing), including marketing activities. These innovations can be caused by the initiative of the entrepreneurs, as a response to market development or to governmental developments. Regulations and subsidiary programmes for instance developed by governments have led to a number of regional initiatives to stimulate reconstruction and innovation of areas with greenhouse vegetable horticulture' (Breukers, Hietbrink & Ruijs, 2008: 9). An innovative entrepreneur, according to Pannekoek (2005), *'... has a strategic vision of how to serve the market and create value. Also, team communication was extremely important. Successful entrepreneurs maintain an open atmosphere and show real commitment to the innovation process. They are in contact with a diverse network of business relations to develop innovations. Intensifying the network relations, e.g. by clustering glasshouse companies, leads to more successful innovation. The more firms in the horticultural production chain were actively involved in the innovation process, the bigger the chances of success.'* (Pannekoek et al., 2005: p. 39).

Alkemade et al. (2011) studied the innovation system in the Dutch glasshouse horticulture sector. They concluded that the growers innovate, but are mainly focused on process innovations, meaning new production systems. This focus is typical for mature sectors and also implies competing on costs and low profit margins (Alkemade et al., 2011) as is the case in Dutch horticulture. This focus also is a threat to the vitality of the sector, because innovations which are directed to market development or positioning received far less attention and support from the horticulture chain and from government (Alkemade et al., 2011). Another nuancing comment on the sector being very innovative is that the sector mostly innovates in an incremental manner (Berkers & Geels, 2011) adapting to technologies which have been invented in other sectors (Vermeulen & Poot, 2011). Bentvelzen & Roza (2007) also state that the innovation potential of the sector is diminishing.

4.3 The emergent issue of sustainability

Although in the 1960s first steps were made in the introduction of organic plant protection products, sustainability became a major issue only in the 1980s. The sector was known as a wasteful sector, which used too much pesticides, water, fuel and energy and generally had a bad influence on the environment. In the early 1990s grower frontmen decided that they would have to come with an

answer to the challenges of society. Government also stressed the need for change and would otherwise very likely have had to take regulatory measures. At the start, the usage of energy was the major issue for sustainability. Growers already were optimizing and reducing the usage of energy, because it was a big cost factor for them and the energy prices were rising. Energy, therefore was a good starting point for sustainability measures by the growers, because it had benefits for both planet and profit. When climate change became an issue, these measures increasingly were framed as contributing to climate mitigation. The impact of horticulture on water quality became an issue only much later. Water was not an important cost factor in glasshouse horticulture, but the pressure to take measures was mounting. The sector was willing to improve its impact on the water system, but mostly from a licence to produce perspective. Another sustainable development issues was reducing light pollution, which caused that areas with many glasshouses did not really became dark anymore at night and therefore the support of the other inhabitants of these regions for the glasshouses diminished. Also ambitions where programmed to reduce the number of many decentred glasshouse locations and to cluster glasshouses in a select number of clusters.

In the current sustainability agenda of the sector, the elements water, energy, CO^2 emissions, and living environment are central. For energy these are: solar energy, geothermal energy, bio fuels, growing strategies, using of light, sustainable energy and sustainable CO^2, etc. (Breukers et al., 2011). The planning and optimization of the usage of land is a new issue. The biggest challenge for the coming years will be water (Platform Sustainable Glasshouse Horticulture, 2011). The actors who signed the agreement committed themselves to zero sum emissions of minerals (N and P) to the water systems in 2027, the end date for the European Water Framework Directive).

4.4 *Impact of sustainable development initiatives*

The sustainability measures which were taken since the 1990s produced results. Until 2006 the usage of natural gas was reduced by the sector, but since then increases again (Netherlands Environmental Assessment Agency). The measures resulted in a sharp improvement of the energy efficiency which in 2012 was about 40% of what it was in 1990. (Van der Velden & Smit, 2012), therefore lowering the production costs per product unit. The sector did invest massively in cogeneration of energy between 2006 and 2010 leading to a high energy efficiency and lead to additional income for the growers. They often produce more energy (about 10% of the national consumption in 2012) than they consume (about 6% of the national consumption, according to), produced with gas, and sell the rest (Van der Velde & Smit, 2012). The contribution to the income of the growers has disappeared over the last years, because of increasing gas prices and changes in financial regulations. With only 2.3%

usage of sustainable energy, the sector is no frontrunner in that respect and remains below policy objectives (Van der Velde & Smit, 2013). Recently growers start to use geothermic energy, which can lead to a growth in the usage of sustainable energy and after large investments lead to more or less free warmth.

Since 1990 the CO2 emissions from companies using glasshouses has increased slightly to 7.2 Mton CO2, but was in 2007 below the 6 Mton, coming from almost 7 Mton in 1990 (Van der Velde & Smit, 2012). This again has to do with the production of energy with natural gas by glasshouse firms since 2006. When one only takes into account the CO2 needed to grow vegetables and cut flowers, the contribution to CO2 emissions actually diminished to 5.1 megaton CO2 in 2012 (Van der Velde & Smit, 2012). The Platform Sustainable Glasshouse Horticulture (2010) sees the sector as a first mover in CO^2 emission reductions.

For the usage of plant protection against pests, mostly fungicides and insecticides, the impact also has a mixed picture. Since 2009 the usage of plant protection increased slightly to 20 kg acting compound (Buurma et al., 2012). This is mostly caused by the cut flower firms. The Platform Sustainable Glasshouse Horticulture (2010) concluded that the usage of plant protection measures and of energy had decreased profoundly. This can be contributed mostly to the firms where vegetables are grown in glasshouses increasingly use biological plant protection. It is an issue for these firms because of a zero tolerance to residuals for vegetables. The costs of using plant protection also increased to 5,000 euro per hectare in 2011, coming from below 3,000 euro in 2002 (Buurma et al., 2012).These firms therefore have a clear incentive to reduce the usage of chemical plant protection. Especially the cut flower companies have much to do to make them more sustainable in plant protection. According to one respondents many firms are in violation of existing legislation and once this legislation would be enforced, many growers would go out of business. The emissions of plant protection to the water system have decreased (Buurma et al., 2013), but according to the Platform Sustainable Glasshouse Horticulture (2010) still much needs to be done, because the emissions of minerals and plant protection measures are still higher than aimed for.

For land use, it was found that glasshouses have been relocated towards central areas or clusters, but at the same time much spread out glasshouses remain and the growers often are only willing to sell them for high prices, which were no longer available since the economic crisis started in in 2009. Newer glasshouses widely use covering techniques to reduce light pollution. For other aspects of

glasshouse technology respondents stated that many growers did not implement the latest technology, such as glasshouses which produce energy, instead of using energy.

The initiatives in sustainability and their results provide a mixed picture. Little proof has been found of a clear system change or transition towards sustainable agriculture. Generally the sector took steps when it contributed to production cost reduction. The economic arguments were embedded in the wider developments in the horticulture sector which will either lead to large scale low cost firms who do many things alone, or to firms which focus on adding value to their produces and partly engage in niche products. In the first group, sustainability is mainly a mean to decrease production costs and for the license to produce and operate. In the second group, sustainability is a prerequisite for being able to operate as a firm and can function as an opportunity for adding value and to strengthen the position in the market. Although, this claim is often stated by participants in the sector, but it is above all an opportunity for the future and to reinvigorate the regional glasshouse clusters.

5. Modes of governance in the glasshouse horticulture sector in the Netherlands

5.1 Changing knowledge governance institutions

Supported by sector organizations, government and research institutes Growers chose to contribute to sustainability by engaging in innovation in the production process: less heating, less net emissions of greenhouse gasses, using semi-closed glasshouses, adopting heat couplers, using geothermal energy, etc. Actors engaged in the innovation program 'Energy Producing Glasshouses'. Innovations derived from these programs were tested on the research centre for glasshouse horticulture at Bleiswijk and some growers adopted it in their businesses. The energy producing glasshouses proofed too expensive, so it was not adopted widely. The experiments did create a moment and movement in the sector; a paradigm shift was mentioned in the interviews. After the Energy producing glasshouses 'the New Growing' was introduced. An adjustment to the first program was that the innovations could be implemented gradually at a speed which was feasible for the entrepreneurs. Much later innovation programs were developed to make glasshouse Horticulture 'Water Proof' and to develop solutions to light pollution problems. The results of the application of these innovations was monitored by research institutes to see if there was enough progress and to be able to decide whether it would be needed to intervene more directly. Later the European Union became important, particularly for the funding of research and innovation projects in the sector.

Behind these innovation programs, knowledge governance institutions can be distinguished. At least since the 20th century The Netherlands developed a strong linkage between agriculture and horticulture in particular, and education and research institutes. The system of agricultural schools with Wageningen University as the academic institutes is in itself an example of this. This infrastructure did not fall within the responsibilities of the Ministry of Education, Culture and science as all the other schools and universities, but of the Ministry of Agriculture (Anno 2014 this is part of the Ministry of Economic Affairs). In the 'OVO triad' research, extension and education (or Onderzoek, Voorlichting, Onderwijs in Dutch) all were organized by government in separate directorates, each with its own institution. Next to the education infrastructure, there was an organization for agricultural research (Dienst Landbouwkundig Onderzoek) and an organization for agricultural extension (Dienst Landbouw Voorlichting). In the OVO triangle the institutions worked to increase the productivity of agriculture and horticulture in the Netherlands. The OVO triad was developed in the 1910's and 1920's and functioned until l the 1980's (Bieleman, 2010), before sustainability became an important issue. The OVO triad caused the implementation of many technological innovations in agriculture in general and in the glasshouse horticulture sector (Bieleman, 2010). Although in the OVO age government had a very active role in innovation, many innovations actually were the result of the activities of private firms (Bieleman, 2010). An example is the company Koppert Biological Systems which developed organic plat protection, since the 1960s. The influence of the OVO triad still exists, because the organizations behind it still exist and because of the example it set for collaboration.

The OVO institution ended in the 1980's. Government no longer wanted to play this strong a role. The extension services were privatized and the research directorate was set at a distance from the Ministry of Agriculture with incentives to become a commercial research institute, although publicly funded research programs remained a very important and mostly dominant part of the funding of the former 'Dienst Landbouwkundig Onderzoek' (DLO) research institutes, including the glasshouse research centre at Bleiswijk. Education remained a public domain. The 'Productschap Tuinbouw' played an important role in the funding of horticulture related research. Many sectors in the Netherlands have such a producer authority (or 'productschap' in Dutch), which are business organizations under public law. These platform organizations provided growers with a consultation platform. Productschap Tuinbouw also had law making capabilities, which were binding to the sector and executed the implementation of EU market policies in the Netherlands.

Productschap Tuinbouw had a platform for knowledge development and dissemination (paid for 50% by the sector and for 50% by government) which functioned as a major assigner for glasshouse related research and innovation projects. Respondents claim that the co-financing of research made it possible that government could set its own priorities on the agenda and also engage in research the sector does not find interesting yet, because its benefits will not be manifest on the short term, next to more practical short term research done. In this knowledge governance generation there was therefore room for 'wild' subjects and Productschap Tuinbouw actively organized research and innovation into energy efficient glasshouses (Termeer & De Wulf, 2012), together with organizations as the Innovation Network, LTO Glass Power, SIGN, etc. This also included research and innovation programs focussed on sustainability, as 'TransForum' and 'Innovation Netwerk', which were partly paid for by funds derived from the state benefits of natural gas winning, and co-funded by Productschap Tuinbouw, governmental organizations and research partners. The projects from these programs were meant to actually realize both radical and incremental innovations leading to a real sustainability transition in de agro sector, including horticulture. Most of these projects were ended by the start of 2011. When after 2011 national government introduced the 'Topsector' policy, which made the public funding of the DLO research institutes dependable from the agenda of the horticulture chain, the Productschap Tuinbouw made sure that the program 'Energy from glasshouses' scored well in Productschap Tuinbouw could co-finance these funds and therefore was very successful. It also supported projects into market development and marketing, therefore to a certain extent transcending the dominant focus on production and technology.

The 'Productschap Tuinbouw' ceased to exist at the start of 2014 because of a decision by the government of the Netherlands. This seems mostly the result of changes in political priorities after election and by a lobby activities of a select group of growers. Most respondents perceive this development as a negative one, although some respondents feel this institution was too conservative and not supportive enough of innovative entrepreneurs. The perceived positive effects of government promoting long term research was doubted strongly by these respondents, who thought innovations in sustainable development were taken in spite of government involvement and not because of it. Part of the tasks of Productschap Tuinbouw will be incorporated into the Ministry of Economic Affairs and private parties are sought to take over the knowledge and innovation activities. Some of the respondents question whether the entrepreneurs will be eager to fund long term research, and instead will opt for incremental short term innovations. They likely will remain using test facilities to study pest developments in crops, or lightning techniques. That will work for a couple of years and then the knowledge base will become depleted. Will they also want to pay for

more system changing issues related to sustainability or for fundamental research? Other respondents mention that the knowledge governance institutional mentioned here were not very important for the innovative capacity of the sector. In the end the Energy Producing Glasshouse was too innovative for the growers, and they cost too much to be of much use to them. Its value is mostly in the changing of the minds and to see new possibilities, but the innovation itself was not viable and ambitions to reduce energy usage and greenhouse gas emissions were reduced in the program "The New Growing".

Private inventors and technology distributers, such as the glasshouse developers, were deemed to be much more important for the introduction of innovations. The sector also has a strong tradition in study groups in which growers share experiences or tacit knowledge with a group of growers. This type of knowledge is just as important to them as more formalized knowledge (Snijders et al., 2007). Because of the relatively short investment cycles (once in 10 years) and the high investments innovation in the technology of the glasshouses. Sharing knowledge is perhaps risky, because other companies adopt what you have invented, but a grower knows that when you need to invest can use what you learned too. This is even strengthened by the fact that, especially in de Westland area, many growers had kin relationships to one another. The scale enlargement in the sector makes this characteristic becoming less important.

It is not yet clear whether there will remain a formalized knowledge governance institutions in which governments will play an active role. Respondents fear that businesses will only want to fund applied and short term research. There are initiatives to form grower cooperatives for research activities, but until know there activities remained very modest. Now Productschap Tuinbouw has been ended, the need for its development could grow. The Topsector Policy remains and horticulture is still an issue in it. Therefore the Topsector policy will be a part of the new institution, but this will have to be co-funded and it is not likely that many growers will be able to do this alone. There is also no central chain organiser which can take up this role for the growers. The New European Horizon 2020 program has a focus of bridging the gap between knowledge and innovation and the European Innovation Programs are an important framework to work on this. Research and education institutes can help the sector to write and execute these projects. At the same time the bigger growers and chain organizations are able to fund their own R&D and increasingly also organise this themselves in their own R&D organisations. They did not felt at home at the Productschap Tuinbouw anyway, and some think they do not really need the universities, and DLO or other research institutes.

The knowledge governance institutions were mostly not directed specifically to sustainability. The second and third generations dealt with sustainability, among other issues and specific innovation programs were started. The end of the second generation made it more difficult to finance sustainability knowledge projects. New institutions are needed, but so far have not been established properly. Until now, energy and CO^2 reduction were the most important sustainability subjects in which actors fully engaged in knowledge and innovation projects. Some research has been done into water quality issues in glasshouses and to land use issues, but those were not at the heart of the implementation of sustainability measures in these fields. The sector most easily takes up issues which fit into cost reduction strategies. More system changing and value adding issues were more difficult to program. It took a long time for instance before stakeholders were willing to program an innovation program to reduce emissions to the water system, under the top sector policy.

5.2. The influence of other modes of governance

In the 1990s governments, sector, banks, growers and glasshouse developers started to engage in discussions about the need for more sustainability in the glasshouse horticulture sector and signed the covenant 'Glasshouse horticulture and the Environment' in 1997. In 2011 this covenant was followed by the 'Platform Sustainable Glasshouse horticulture' with the Sustainability Agenda 2011-2015. These platforms decided on a package of measures for the environmental and energy ambitions where the sector committed itself to. Also other platforms were established, as 'Platform Light Pollution'. In the 'Platform Light Pollution' measures were selected to reduce the usage of light and to cover the glasshouses at night. The concentration of the occupation of land of glasshouses in a limited amount of clusters was agreed on by government, sector and NGO's. By collaboration in the Platforms on agreements could be made and sustainability measures taken, for instance the objective to reduce the use of energy by 40% and the use of plant protection projects by 90%, or te objective for zero sum emissions to the water system in 2027. In these platforms also agreements were made about the need for research and innovation projects.

The sector to some point was self-governing in how to achieve these objectives and this was a reason why they chose measures which fitted to the reduction of production costs and investments in glasshouse technology. This also was the case for the spatial concentration of glasshouse locations, because it was important for the sector to maintain enough space for glasshouses and the spatial concentration was seen as a prerequisite for that. Other stakeholders included their preferences too. With the usage of the instrument 'Green deals' national government communicated it was in support of measures the sector wanted to take. It did not provide extra funding, but pledged to remove

unnecessary regulations. The growers still had to abide to other regulations. Growers for example used European funds from the 'Common Organisation of agricultural Markets' (COM) for investments in sustainability. These funds were meant to improve the position in the market and not to implement technological innovations, which was done widely. This lead to fines from the European Commission.

There were also measures taken by governmental and commercial parties. Governments and infrastructure project developers for example engaged in the development of new clusters as Emmen, or Bergerden, and Agriport A7. In areas were the glasshouses were envisaged to be removed, entrepreneurs were bought out and governments and private parties invested in land and development. With the economic crisis and the stagnation of area development the spatial concentration slowed tremendously. An example of governmental interventions was the assignment of the Greenport status to some regions, which promised funds and standing. These clusters are seen as of national importance and government invested in them.

The governance interventions deployed were a mix of different modes governance. Central was the establishment of platform organizations which were the place to make agreements between actors and to decide to engage in innovation programs and what content should be part of this. It also delivered support for other measures such as regulating, funding, etc., by public and by private stakeholders.

6. Conclusions and discussion

In the paper it was described how the glasshouse horticulture sector in the Netherlands developed, became more sustainable and what modes of governance contributed to this process. Firstly, we described characteristics and trends of the glasshouse horticulture sector in the Netherlands and its regional clusters. More specifically it was studied what its contribution to sustainability was and how knowledge and innovation activities supported this. Ultimately we studied the contribution of other modes of governance in these activities and particularly network governance.

Glasshouse horticulture became less unsustainable in the Netherland, but so far, a full-fledged sustainability transition did not take place. Sustainability is embedded in developments in the horticulture sector which will either lead to large scale low cost based companies who are more or less self-sufficient, or to firms which focus on adding value to their produce and partly specialise in

niche products. In the first direction, sustainability is mainly a mean to decrease production costs and to achieve a license to operate. In the second group, sustainability is primarily an opportunity for adding value and to strengthen the position in the market. The second direction is a relatively new one. So far, the first direction dominates the sector. This explains the focus on the reduction and the increase in the efficiency of energy usage, because this lead to decreasing production costs when the gas prices started to rise. When entrepreneurs were driven by such motivations this produced new perspectives, such as the energy producing glasshouse. For the reduction of emissions to the water system, the incentive was less strong, because water is not an important cost factor.

It was found that knowledge and innovation played important roles in sustainability activities in the Netherlands. Research and innovation projects created new perspectives, such as the energy producing glasshouse or zero emissions to the water system. The strong focus on cost reduction and technology limited the ability of the sector to incorporate radical innovations. Sustainability in the glasshouse sector in the Netherlands has primarily been an example of successful network governance. The various platforms functioned as arena where agreements could be made. It could be argued that more efficient objectives could have been selected and that many growers did not adhere to the agreements in their actions, but some real progress was made. When before their establishment actors mainly criticized one another and not much happened. These networks also made it possible to establish regulation activities and to subsidize sustainability innovation projects. A relevant issue is the weakening of the sector representatives and the end of Productschap Tuinbouw. The sector has developed itself and the differences between the biggest and the smallest companies have grown tremendously. The biggest companies also develop themselves into almost self-sufficient entities which do not really need sector organizations. How can one engage in network governance in that situation? Probably a stronger focus on establishing a level playing field will be needed in which companies upfront know what objectives they should adhere to and to enable them to make investments. For the rest it will be mainly self-governance. Government can also guarantee the existence of strong knowledge institutions (both private and publicly funded); especially for fundamental and medium to long term research.

What do we learn for designing knowledge governance institutions as an intervention in transition processes in sustainable agro, food and horticulture? Some of the major technological innovations took place outside of the flash lights by private firms. Formal innovation programs have their limitations. They created movement and room for societal action, but in hindsight the energy producing glasshouse was not too realistic. It worked as a vehicle though for entrepreneurs making

incremental adjustments. The question remains whether this will lead to the needed system wide change in which agriculture and horticulture becomes sustainable. Therefore pressure from government and societal groups could be needed, but even more effective will it be when retail or processing firms demand that the produce is sustainable. Than entrepreneurs will need to apply and have a clear incentive for this.

Acknowledgements

The authors thank the Netherlands Environmental Assessment Agency and WOT Nature and Environment for funding the research behind this paper and the contact persons Hans Farjon and Joep Dirkx for encouraging to write this paper and for their comments on draft versions.

References

Alkemade, F., Hekkert, M. & Farla, J. (2011). *Het innovatiesysteem van de Nederlandse glastuinbouw in 2020: marktgerichte innovatiestrategieën.* Innovatienetwerk / SIGN. Utrecht / Bleiswijk. [in Dutch]

Back, A., Von Krogh, G., Seufert, A. (2004). *Putting Knowledge Networks into Action. Methodology, Development, Maintenance.* Heidelberg: Springer.

Badgley, C., Moghtader, J., Quintero, E., Zakem, E., Chappell, M.J., Avilés-Vázquez, K., Samulon, A., Perfecto, I., 2007. Organic agriculture and the global food supply. *Renewable Agriculture and Food Systems* 22 (2), pp. 86–108.

Bentvelzen E. & Roza, C. (2007). *Vlugschrift Innovatiekracht van de Nederlandse Glastuinbouw.* Innovatienetwerk, Utrecht. [in Dutch]

Berkers, E. & Geels, F. (2011). System innovation through stepwise reconfiguration: the case of technological transitions in Dutch greenhouse horticulture (1930 – 1980). *Technology Analysis & Strategic Management*, vol. 23, No. 3: 227-247.

Bieleman, J. (2010). *Five centuries of Dutch Farming*. Wageningen Academic Press, Wageningen.

Boone, J.A. & M.A. Dolman (Ed.) (2010). Duurzame Landbouw in Beeld 2010; Resultaten van de Nederlandse land- en tuinbouw op het gebied van People, Planet en Profit. Wageningen, Wettelijke Onderzoekstaken Natuur & Milieu, WOt-rapport 105. [in Dutch]

Braungart and McDonough, W. (2002), C*radle to Cradle: Remaking the Way We Make Thing*s, Powell's Books.

Breukers, A., Hietbrink, O. & Ruijs, M. (2008). *The power of Dutch greenhouse vegetable horticulture: An analysis of the private sector and its institutional framework*. LEI-Report 2008049. LEI: Wageningen / Den Haag.

Buurma, J., B. Smit, P. Leendertse, L. Vlaar & T. van der Linden (2012). Ge*wasbescherming en de balans van milieu en economie Berekeningen bij de 2e Nota duurzame gewasbescherming* . LEI rapport 2012-026, Den Haag. [in Dutch]

Buurma, J., P. Leendertse & A. Visser (2013). *Waterkwaliteit binnen de normen. Haalbaarheid en betaalbaarheid van ambities in 2e Nota duurzame gewasbescherming,* LEI-rapport 2013-044, Den Haag. [in Dutch]

De Haas, Michiel, (2013). *Two centuries of state involvement in the Dutch agro sector. An assessment of policy in a long-term historical perspective*. Web publication 72, Netherlands Scientific Council for government policy, The Hague.

De Ponti, T., Rijk, B. & Van Ittersum, M.K. (2012).' The crop yield gap between organic and conventional agriculture', *Agricultural Systems* 108: 1–9

Ellen MacArthur Foundation. 2012. *Towards the Circular Economy: an economic and business rationale for an accelerated transition*. Ellen MacArthur Foundation.

Farjon, H. & Arnouts, R. (Eds.) (2013). *Leren van het energieke platteland. Lokale en regionale coalities voor duurzame plattelandsontwikkeling*. Netherlands Environmental Assessment Agency, Den Haag. [in Dutch]

Garnett, T. & Godfray, C. (2012). *Sustainable intensification in agriculture. Navigating a course through competing food system priorities,* Food Climate Research Network and the Oxford Martin Programme on the Future of Food, University of Oxford, UK

Geels, F.W. 2002. Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy* 31, no. 8/9: 1257–74.

Gerritsen, A. L., Stuiver, M., Termeer, C. J. A. M. (2013). Knowledge governance: An exploration of principles, impact, and barriers. *Science and Public Policy*, Doi: 10.1093/scipol/sct012.

Gerritsen, A.L., Stuiver, M. & Termeer, C.J.A.M. (2012). *Knowledge governance for sustainable economic development: models for organising and enabling knowledge networks*. Paper for the Expert Group Meeting on Knowledge Networking and Network Governance, Vienna, 18 September 2012, United Nation Industrial Development Organizations & the Leuven Centre for Global Governance.

Grundmann, R., & Stehr, N., (2003) 'Social control and knowledge in democratic societies', *Science and Public Policy*, 30 (3): 183-188.

Hisschemöller, M. & Hoppe, R. (1996) 'Coping with intractable controversies: The case for problem structuring in policy design and analysis', *Knowledge and Policy*, 8/4: 40-60.

In 't Veld, R. J. (2010) 'Towards knowledge democracy', In 't Veld, R. J. (ed.), *Knowledge democracy - consequences for science, politics and media,* Springer Verlag: Berlin / Heidelberg 2010: 1-11.

Jacobs, D & De Jong, M.W. (1992). Industrial clusters and competitiveness of the Netherlands. Empirical results and conceptual issues. *De Economist*, 140 (2): 233 - 252.

Kemp, R., Loorbach, D. & Rotmans, J. (2007). Transition management as a model for managing processes of co-evolution towards sustainable development. *International Journal of Sustainable Development and World Ecology*, 14 (1): 78 – 91.

Kooiman, J. (2003). *Governing as Governance*. Sage publications.

Loorbach, D. & Rotmans, J. (2006). Managing transitions for sustainable development. In Wiczorak, A.J. & Olsthorn, X. (eds.): *Industrial Transformation – Disciplinary Approaches Towards Transformation Research*. Kluwer Academic Publishers: Dordrecht.

Meuleman, L. (2008). *Public Management and the Metagovernance of Hierarchies, Networks and Markets. The Feasibility of Designing and Managing Governance Style Combinations*. Physica-Verlag: Heidelberg.

Michailova, S. & Foss, N. J. (2009) 'Knowledge governance: themes and questions', Foss, N..J. & Michailova, S. (2009). *Knowledge governance: Processes and Perspectives,* Oxford University Press: Oxford: 1-24.

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-Being: Synthesis*. Island Press, Washington DC.

Nowotny, H., P. Scott, M. Gibbons (2001). *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*. Polity Press, Cambridge.

Owen-Smith, J., & W. W. Powell (2004). Knowledge Networks as Channels and Conduits: The Effects of Spillovers in the Boston Biotechnology Community. *Organization Science*. 15 (1), 5-21.

Pahl-Wostl, C. (2006) 'The importance of social learning in restoring the multifunctionality of rivers and floodplains', *Ecology & Society*, 11/1: 10.

Pannekoek, L. Kooten, O. van, Kemp, R. & Omta, S.W.F. (2005). Entrepreneurial innovation in chains and networks in Dutch greenhouse horticulture. *Journal on Chain and Network Science*, 5: 39-50.

Pauli, G. (2010) *The blue economy. 10 years, 100 innovations 100 million jobs. Report to the Club of Rome.* Paradigm Publications: Taos, NM, USA.

Platform Duurzame Glastuinbouw (2010). *Convenant Glastuinbouw en Milieu Evaluerende eindrapportage 1997- 2010*. Utrecht. [in Dutch]

Poppe, K.J. (2009). Business Dynamics with Scenario's on Dutch Agriculture and its Institutional Arrangements. In: Fritz, M., Rickert, U., Schiefer, G. (Ed.). *Proceedings of the 3rd International European Forum on System Dynamics and Innovation in Food Networks*, organized by the International Center for Food Chain and Network Research, University of Bonn, Germany February 16-20, 2009, Innsbruck-Igls, Austria: pp. 17-24.

Porter, M. (1990). *The competitive advantage of nations*. New York

Rittel, H., & Webber, M. (1973). Dilemmas in a General Theory of Planning. *Policy Sciences*, 4, 155-169.

Rotmans, J. (2005). *Maatschappelijke innovatie; tussen droom en werkelijkheid staat complexiteit*. Rotterdam, Drift. [in dutch]

Rotmans, J., R. Kemp, M.B.A. van Asselt, F.W. Geels, G. Verbong and K. Molendijk (2000), *Transitions & Transition Management: the case of an emission-poor energy supply*, Maastricht: ICIS (International Centre for Integrative Studies).

Rotmans, J., R. Kemp and M.B.A. van Asselt (2001), More Evolution than Revolution. Transition Management in Public Policy, *Foresight* 3, 15-31

Smeets, P.J.A.M. (2011). *Expedition agroparks. Research by design into sustainable development and agriculture in the network society.* Wageningen Academic Publishers: Wageningen, the Netherlands.

Snijders, H., Vrolijk, H., Jacons, D. (2007) . *De economische kracht van agrofood in Nederland*. Hooberg, Epe. [in Dutch]

Sorenson, E., & Torfing, J. (2009). Making governance networks effective and democratic through metagovernance. *Public Administration*, 87(2), 234-258. doi: 10.1111/j.1467-9299.2009.01753.x

Stehr, N. (2005) *Knowledge Politics: Governing the Consequences of Science and Technology*, Paradigm Publishers: Boulder Colorado.

Stoker, G. Governance as Theory: Five Propositions. International Social Science Journal. 50: 17-28

Termeer , C.J.A.M., Stuiver, M., Gerritsen, A.L. & Huntjens, P. (2013). Integrating Self-Governance in Heavily Regulated Policy Fields: Insights from a Dutch Farmers' Cooperative, *Journal of Environmental Policy & Planning*, DOI:10.1080/1523908X.2013.778670

Termeer, C.J.A.M. & DeWulf, A. (2012) Towards theoretical multiplicity for the governance of transitions: the energy-producing greenhouse case. *International Journal of Sustainable Development* 15 (1/2): 37 – 53).

TKI Tuinbouw en Uitgangsmaterialen (2012). *Innovatiecontract Tuinbouw en Uitgangsmaterialen*. [in Dutch]

Van Buuren, M. W. van, & Eshuis, J. (2010) 'Knowledge governance: complementing hierarchies, networks and markets?', In 't Veld, R. J. (ed.) *Knowledge democracy - consequences for science, politics and media*. Springer: Heidelberg: 283-297.

Van der Velden, N.J.A. & Smit, P.X. (2013). *Energiemonitor van de Nederlandse glastuinbouw 2012*. LEI-rapport 2013-061. LEI Wageningen UR, Den Haag / Wageningen. [in Dutch]

Van Huylenbroeck, G. & Durand, G. (Ed.) (2003). *Multifuntional agriculture. A new paradigm for European agriculture and rural developmen*t. Ashgate, Aldershot UK / Burlington USA.

Vermeulen, T. & Poot, E. (2008). *Transitie en toeleveranciers*. Wageningen UR Glastuinbouw: Bleiswijk. [in Dutch]

Voβ, J. P., Bauknecht, D., Kemp, R. (2006) *Reflexive governance for sustainable developmen*t, Edward Elga Publishing: Cheltenham / Northampton, Massachusetts, USA: 3-28.

Voß, J. P., Adian Smith, A. & Grin, J. (2009) 'Designing long-term policy: rethinking transition management', *Policy Sciences,* Volume 42 (4): 275-302.

VROM (2004). *Nationaal Milieubeleidsplan 4*. The Hague. [in Dutch]

World Commission on Environment and Development (1987). *Our common future*. Oxford: Oxford University Press, Oxford.