



Horticulture Tomorrow



How to sustain the competitive position and innovative strength of the international Controlled Environment Agriculture cluster and its members based in the Netherlands?

5 October 2022

For entrepreneurs by entrepreneurs

This blue paper is intended to support entrepreneurs active in the field of Controlled Environment Agriculture (CEA) by providing strategic insights to help to address future challenges. The content is based on a series of discussions and workshops with a group of entrepreneurs and experts from CEA-field. It provides a reflection on the current situation in relation to competitiveness and challenges companies in the horticultural cluster to reconsider their individual and collective strategies. The topic is 'How to sustain the competitive position and innovative strength of the international Controlled Environment Agriculture cluster and its members based in the Netherlands?' This was chosen by the members of the 'International table' of Greenports Netherlands in collaboration with the Top Sector Horticulture & Starting Materials. The outcome of the discussions with the entrepreneurs provides direction and recommendations. It is not meant to be conclusive nor to provide a detailed action plan but rather a starting point for the development of alternative strategies with regard to value proposition design, commerce and partnerships.

The approach used is a try-out, called Horticulture Tomorrow, derived from the Shopping Tomorrow¹ initiative, and consists of four interactive sessions with a group of 15-20 entrepreneurs and experts. Their input and feedback from their expertise and experience has been compiled in this blue paper by an independent chairman and secretary with the help of a support team. You can read the rationale at the end of the blue paper.

¹ <https://www.shoppingtomorrow.nl/nl>

Take-aways:

1. The Dutch horticultural cluster should reorganise itself towards an **open, inclusive global CEA cluster** in which Dutch companies, based in the Netherlands, and knowledge institutions play a key role;
2. The cluster should be aware of the **rise of new players with large capital resources** from non-agricultural sources. These new integrated produce companies, backed by investors, expect suppliers to help them achieve ROI instead of just transactional business;
3. Opportunities for integrated services are coming up. Servitisation helps to align supplier and customer interests via **new business models**: e.g. via performance-based or output-based contracts;
4. At present awareness of a changing context is limited in the cluster. Therefore competencies needed and liabilities involved, ask for **stronger collaboration in temporary or more permanent consortia**;
5. **Protecting Intellectual Property (IP)** of a technology, but also of complete innovative (cultivation) systems, in patents is becoming increasingly important, as the new capitalised players regard IP as an essential asset in their business model. This calls for a professionalisation (awareness, skills, financial means) of the original Dutch stakeholders in the cluster. As a result, the traditional open innovation climate and knowledge exchange model has to cope with this change.
6. From a company and cluster perspective, the Triple Helix should transform to a **Multiple/Quintuple Helix** (including investors and NGOs) to represent the key collaboration partners to support innovation and transition towards new business models, societally and environmentally acceptable.

Part I: The Netherland's horticultural legacy and global thought leadership

Setting the scene

Greenhouse horticulture, a specific mode of CEA (Controlled Environment Agriculture), has its origin in the Netherlands, and evolved throughout almost 150 years, continuously adapting to challenges and trends. The contingent of thousands of hectares of glasshouses enabled researchers, consultants, plant breeders, suppliers of technology and crop inputs to successfully test and apply solutions and strategies to sustain the CEA industry for the future. Today, the industry faces many challenges, as most growers still depend on fossil fuel for heating, electricity, CO₂ and fertilisers. Innovators in the cluster and early adopters among the growers represent the dawn of a new era that sees a circular horticulture enabled by technology and new connections with other industries and focus on the social and environmental trends (see Figure 1). For more inspiration about the future vision of greenhouse farming in 2040 we refer to SIGN.² Another reference to be made here is the Horticultural Scenarios for the Future.³ The participants agree that especially the Dutch growers and the cluster hold the keys to sustainable greenhouse horticulture, inspiring and setting an example for the rest of the world.

This does not mean we can rest on our laurels. A new wave of entrepreneurs is entering the arena. New business models are being deployed, new technologies come in from all directions, there are new types of investors and this forces all actors in the cluster to rethink their business model and choose where to play and how to win.



Figure 1 A vision of a circular horticulture, developed with the support of, and in collaboration with, the Club of 100. (Source: Wageningen University & Research, business unit Greenhouse Horticulture & Flower Bulbs)

² <https://www.innovatieglastuinbouw.nl/sign/toekomstbeelden/>

³ <https://www.tuinbouwscenarios.nl>

Key figures on CEA in the Netherlands

Companies in the Dutch CEA cluster contribute €21.1 billion directly and indirectly to the Dutch economy. The sector is showing annual growth in production (at least until recently), job creation, and R&D expenditures. The CEA cluster, which consists of private and public entities in the value chain of vegetables, fruit, ornamentals, seeds and other plant propagation materials and technology, accounts for 3.4 per cent of total national employment, providing approximately 300,000 jobs (254,000 FTE). Of the total expenditure on research and development (R&D) in the Netherlands, 4.5 per cent is made by the CEA chain. The total contribution of the CEA chain to the Dutch economy is 2.7 per cent of the gross domestic product, which is more than 2 times larger than Schiphol Airport (source: Tuinbouwcijfers 2019, CBS and WUR 2020).⁴

Today's economic map of the world is characterised by what Porter calls *clusters*: critical masses in one place of linked industries and institutions, from suppliers to universities to government agencies, that enjoy unusual competitive success in a particular field. There's a strong CEA cluster, with its roots in the Netherlands, that is evolving into an increasingly international cluster. Although today many leading companies and universities have emerged from and are based in the Netherlands, most participants of Horticulture Tomorrow prefer referring to the cluster without the label 'Dutch' as the future requires a cluster that wants to act as an open platform to be able to include a wide array of actors and innovators from various countries. Everyone agrees that inclusivity and connectivity are the keys to future success for the cluster.

Actual situation and forecast of the global market

Presently, there are an estimated 500,000 hectares of protected horticulture worldwide of which 75,000 hectares are CEA or high-tech greenhouses and a few hundred hectares of Indoor/vertical Farming (not using sunlight) (Source: WUR, Rabobank, FAO, Van der Vliet & Van der Oost BV). There is an increasing demand for CEA, and several predictions indicate a growth of several ten thousand to as much as 35,000 hectares of high-tech greenhouses by 2030. At present, however, the development of new greenhouse projects has almost come to a standstill. This is due to disruptions in the market for energy and other resources, caused by the Covid-19 crisis that affected global supply chains and the recent energy crisis caused by the war in Ukraine. This is temporarily inhibiting the growth of the industry but for the mid and long term it is expected to pick up speed again as governments encourage local, secure, sustainable production of food. Local food security, climate change and scarcity of water and other key resources are giving an extra boost to the trend towards CEA. In addition to food, there is also demand for more urban vegetation to improve well-being and the climate in cities, and for plants such as cannabis for medicinal use.

Greenhouse horticulture was once invented in Europe and the continent is still number one in terms of the adoption and acreage of (high-tech) greenhouses and the cluster of companies and institutions that drive the industry. While the adoption of CEA is expected to grow fast in North America and Asia, there will also be growth opportunities on the European continent. In the coming years, France, Germany, Poland, Morocco, Turkey, the US, Canada, the Gulf region, China, Japan, Uzbekistan, Kazakhstan are the new areas for the expansion of high-tech greenhouses. By 2050 and later due to huge population growth also to sub-Saharan countries in Africa such as Senegal, Nigeria and Kenya. The growth of mid-tech greenhouses is even greater. The choice of new locations is subject to trade-offs between water, energy, distance to market and available labour and capital.

In addition to greenhouses, vertical farms are a very popular investment opportunity even though the technology involved has yet to be improved and perfected. Vertical farming promises completely controlled production of ultra-fresh and clean produce from any place in the world. This brings along a big wave of radical innovations which may be applicable in greenhouses too: efficient use of space, improved lighting strategies, automation of climate control and other processes like crop work and harvesting, novel innovative cultivation systems, new plant traits (like dwarf tomatoes that can be harvested completely in one short cultivation cycle).

⁴ <https://www.cbs.nl/nl-nl/maatwerk/2020/26/tuinbouwcijfers-2019>

Estimated greenhouse vegetable production area and vertical farming concentrations

Total global area of vegetables and herbs grown in greenhouses (permanent structures) is estimated at about 500,000 hectares, of which about 40,000 hectares in glasshouses and the remainder in plastic greenhouses.

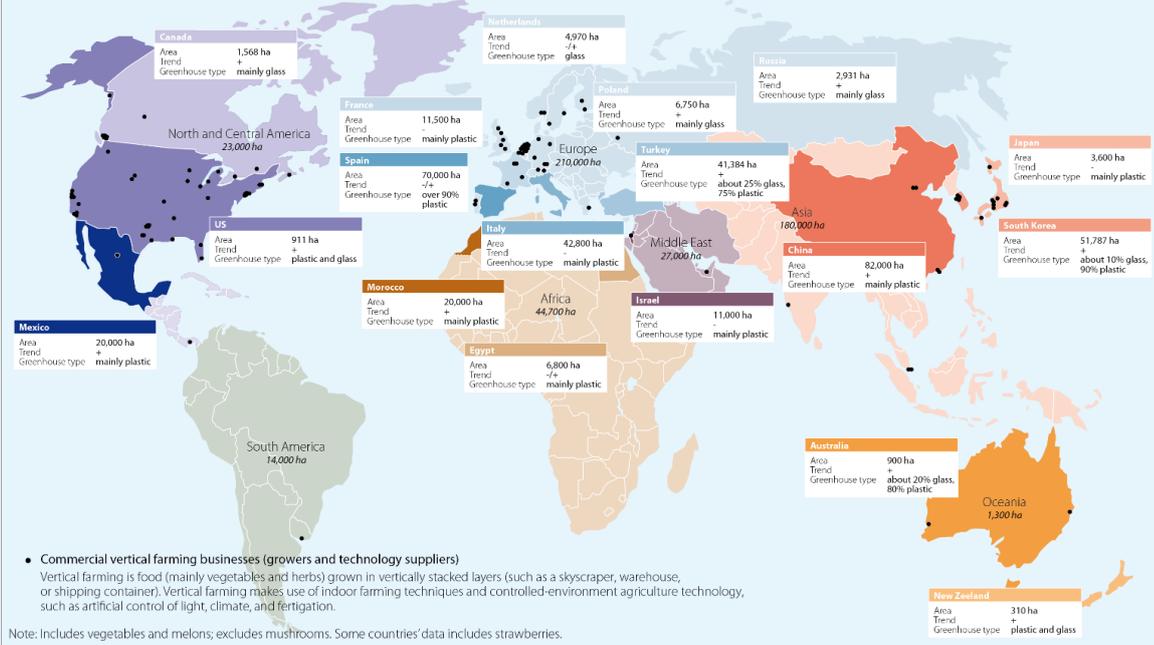


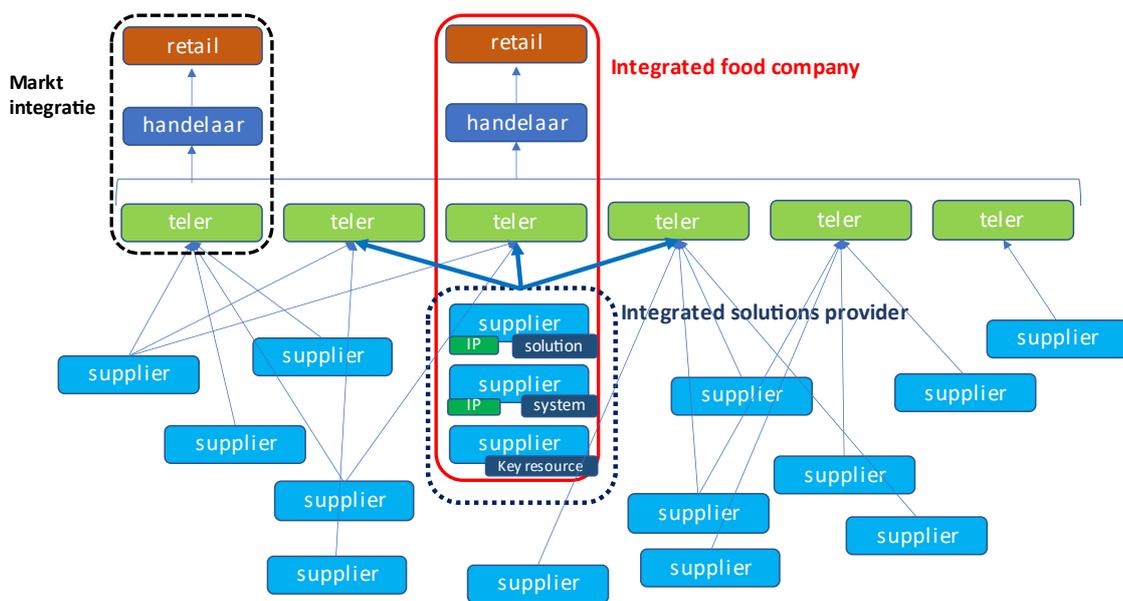
Figure 2 Estimated greenhouse vegetable production area and vertical farming concentrations (Source: World Vegetable Map 2018, Rabobank).⁵ Note: data Japan: 36,000 hectares

⁵ https://research.rabobank.com/far/en/sectors/regional-food-agri/world_vegetable_map_2018.html

Part II: Tomorrow's customers are integrated food production companies, backed by large investors. They have different needs

New business models

Traditionally, the horticultural value chain consists of separate actors with horizontal collaborations such as growers' cooperatives and few examples of vertical integrations mainly connecting production with produce marketing (see Figure 3). Global trends force companies, their branch organisations and knowledge institutions to rethink their strategy. Agriculture, which includes horticulture, must become more local, sustainable, regenerative, and value based. The horticultural value chain will have to continue to adapt to be able to answer the needs of consumers regarding sustainability, quality, and availability. At the same time the way agriculture is financed is changing rapidly, with private equity moving into the industry and some companies going public with constructions like SPACs (Special Purpose Acquisition Company).⁶



Transactionele business versus verticale integratie

Figure 3 Traditional horticultural supply chain versus vertical integrations

There are several examples of companies making the shift from the traditional transactional model towards an integrated model creating value by 'owning' and taking control over the whole value chain. One of the examples is Pure Harvest Farms in the United Arab Emirates (see text box). These new companies will look at innovation and adoption of leading practices, digital tools, financial resources and business models to achieve this goal. Technology plays an increasingly prominent role as it provides opportunities for differentiation as the level of control over the environment and processes gradually increases in CEA. So called *AgTech* is a common denomination for technological innovations used across the value chain to improve efficiency, quality, profitability and/or sustainability. It involves all sorts of new technologies, systems and applications coming from hardware and software. There are many Agtech startups entering the arena that are attracting lots of attention and investment money as some of them may play a key role in shaping the future of agriculture. Just like this is the case with any innovation that requires investment, protection of IP is key for the AgTech industry. AgTech innovations and novel production systems used in vertical farming, in-store farms, and aquaculture could provide a bounty of local options to consumers, even in former 'food deserts'. A

⁶ <https://agfundernews.com/data-snapshot-2021-started-out-as-year-of-the-ag-spac-hows-that-going>

wide array of digital AgTech solutions will cause disruption in all areas of the value chain. We see large retailers making a play to integrate into these spaces to secure their supply and differentiation.⁷

Text box: Pure Harvest Farms in UAE

Sky Kurtz, CEO of Pure Harvest Smart Farms (PH) in the United Arab Emirates, explained his views in one of our sessions and expressed his advice to the companies involved.

According to Sky, there are both positive and negative changes occurring in the world that directly affect the prospects of 'operators' such as PH. On the one hand, you have the challenge of global disruption of supply chains, due to Covid-19 and the current geopolitical situation. On the other hand, governments are increasingly focusing on the CEA industry because of the food security objective, and funding is often made available to operators who can solve market challenges. On the whole, the industry is maturing and institutional capital is flowing into the sector with a few to global expansion of operations and operators with proven success. As a good example of this, PH is expanding beyond the GCC region and planning a new project in South-East Asia.

Governments also want to stimulate economic diversity and encourage entrepreneurs to buy their supplies locally. Companies must become active in the local market and adjust their business model to enable operators to get the ROI from the technology. Suppliers that fail to differentiate end up going into tendering processes where the winning proposition is to be the cost leader.

Agriculture Development Funds are available, but are starting to seek domestic sourcing and localization of expenditures, so Dutch and other international suppliers must localise (at least part of) their supply chains. Sky emphasised that traditional exports and transactional sales might not be the right strategy in the future.

Over the past fifty years, the Dutch horticultural technology sector has successfully innovated with the Dutch growers and research centres and exported their technology, cultivation methods, and business model mainly to NW/E-Europe and to N-America. New markets, like the GCC and Southeast Asia, are asking for a different approach. Today's customers are investment firms, real estate companies, developers of infrastructure for energy, water, and logistics, and moreover consumer goods companies. They are also focused on reducing Capex and risks. Especially today, with the disruption of global supply chains, rising energy prices, and the volatility of the Euro, investors that buy from the EU look extra carefully at their cost of supply.

Inspired by Frits Engelaer's white paper on Servitized Business Models,⁸ which he wrote for DLL in 2021, we see the analogy with the steps that he describes for the suppliers of technology and knowledge and extend the model towards food production which represents the customer segments of the suppliers. We can distinguish four levels from just producing a product towards a fully integrated business in which services are not just an added feature of the core business: services are the business. In this case the company is also the operator. This can be applied to both the solutions providers side as the food provider's side, and both can also be integrated in one company, hence the overlap. The model represents a logical framework to assess where a business is now and which choices you have to change your business model to serve the needs of your target customer (see Figure 4).

This era is characterised by the rise of companies that bring together the entire or a large part of the value chain, (novel) technological concepts and systems, all meant to provide maximum predictability, scalability and invest ability. Whether you are one of these companies, integrating with them or serving them, you need to make profound strategic choices.

⁷ https://www.ey.com/en_us/consumer-products-retail/how-vertical-integration-is-impacting-food-and-agribusiness

⁸ <https://dll.nl/fi/en/-/media/Project/DII/Global/Documents/Servitization/DLLServitizedbusinessmodels.pdf>

Company mindset	Service as a necessity	Services as added value	Services as a business	Services are the business
Operate				✓
Improve			✓	✓
Enhance		✓	✓	✓
Maintain	✓	✓	✓	✓
Asset	✓	✓	✓	✓



Figure 4 Vertical integration levels, towards servitisation where services are the business (adapted scheme from DLL Group: source see footnote 8)

Examples of integrated providers/companies

InFarm is an example of a vertically integrated AgTech enterprise. They are the first European unicorn⁹ in Agtech. They and several others in for example North America deploy a business model based on local or even hyper-local production, a substantial technology and IP portfolio, and dedicated marketing, sometimes even in-store marketing. This is becoming a global trend. Driscoll's is an example with a solid foundation in IP and commerce. They license their genetics to growers and take control over the marketing and sales of the produce. Vertical farming scale-ups such as Aerofarms, InFarm, PlantLab, Growy, Planet Farms and 80 Acres boast their unique technology to create a new product category for the leafy vegetables and herbs shelves in markets that offer opportunities for differentiation. The same goes for their 'horizontal' farming counterparts like AppHarvest, PureHarvest Farms, Local Bounti and Bright Farms. These players are looking for partners rather than suppliers.

This does not mean the traditional model is rapidly becoming obsolete. The traditional model does also offer options for innovating the business model, for example by offering servitisation to unburden the operator or investor for the particular part of the production system a company delivers. Especially the new entrants apply strategies that intend to take control over key resources and activities, to comprise the entire production system and vital parts of the supply chain, stepping into the opportunity to servitise or vertically integrate everything that's required to produce and sell fresh produce. Predominantly, non-agricultural investors provide vast amounts of money to support these companies' ambitious and aggressive plans for growth.

However, the expert group expects that some will fail to do so in the near future, but that won't stop the trend. Beware that most of these companies have yet to perform, prove their value and sustainability, let alone scale their business. Both models will coexist, but the new one is attracting substantially more capital (which is required), is considered more investible because it promises better scalability because all key activities and expertise is integrated to serve the comprehensive business model, which is moving towards food manufacturing and marketing.

We expect that the new model will gradually displace the old model, starting in the vertical farming industry. Inevitably the existing industry based on other cultivation systems will follow but the question is who will be the financiers: existing actors or the new entrants with their deep pockets?

⁹ Unicorn is the term used in the venture capital industry to describe a start-up company with a value of over \$1 billion. (source Wikipedia)

Retail companies such as IKEA will also be major drivers of the change. Retail companies know how to create value in fresh produce, they have the capital to invest and believe in innovation that drives sustainability and food security. Thus, it is crucial to keep track of what's going on in that market and connect with these actors to stay on top of the game. Actors in the cluster must decide how they can serve the needs of both segments.

For the leading seed breeders, many of them headquartered in the Netherlands, the disruption of the business model is coming from the world of data science and AI. Big data science on genomics is changing the rules of the game. Advances in genomics have started an explosion in biological information: first, the onset of sequencing the genomes of model organisms like Arabidopsis and, second, the rapid application of high throughput, or automated, experimental techniques to process and select genomic information. Through better tools, the time to field will be faster and it will become cheaper to develop new plant traits. It will also be performed by smaller labs with less infrastructure. More data will be made available and analysed through shared databases. Plant genomics innovation and cloud biology is empowering new and diverse start-up companies.¹⁰

Suppliers of technical solutions for CEA will be asked by their customers to co-invest and share the risk and profit in large-scale projects. They will have to supply locally, cooperate with local companies, develop and license their IP together, train local staff and even help with the marketing and sales. At the same time, they have to bear in mind the important social issues such as inclusiveness of the small existing entrepreneurs, creating meaningful jobs and enabling sustainable labour practices.

¹⁰ <https://agfundernews.com/how-big-data-is-disrupting-agriculture-from-biological-discovery-to-farming-practices5973>

Part III: Implications for the future of the cluster

Cooperation and competition go hand in hand

In the past, many predominantly small-sized companies and a few big ones coexisted in each element of the value chain. Today, as a result of consolidation and economies of scale a relatively small number of large companies are leading the cluster and form the face of the cluster in the international market.

On an everyday basis, these companies compete, but they join forces when it comes to non-competitive topics and unite in sector organisations and collective initiatives such as the Greenports, Seed Valley, Food Valley, Club of 100 (R&D), Hortivation, Dutch Greenhouse Delta, and other initiatives. Working together while competing at the same time can be regarded as one of the characteristics of a cluster according to Michael Porter.

The expanding increase in internationalisation of the players in the industry is also striking. The Dutch greenhouse industry has always been export-oriented, looking at the export of produce and flowers, but in the past 30 years almost all actors in the value chain have built an international presence. Seed companies and greenhouse technology providers are international companies. Their owners are also increasingly international investors. The largest growth markets for CEA crops are no longer in the Netherlands but in North America and Asia.

A government that supports the existence and growth of a CEA ecosystem by enabling the preconditions and general policies that favour its interests has been a crucial success factor. It goes without saying that the government must be aware and knowledgeable and closely connected to the key knowledge institutions and branch organisations to be able to implement the right policies for the industry. The support consists of:

- Tailored laws and regulations;
- Ensuring the quality of workers through good education at all levels (applied (low, medium and high) and academic);
- Funding and stimulating innovation and fundamental and applied research;
- Taking care of the infrastructure and availability of key resources;
- Helping to facilitate the workforce (of local employees and migrant workers).

Social debate in the Netherlands

Since about 1985 the focus of agricultural policy has changed from food security ('No more hunger', the post WW2 adagio of building food security) and economic impact through export, towards more value added, sustainable and socially accepted production. The current energy crisis due to the war in Ukraine means a huge increase in energy costs, and even possible restrictions on the availability of energy for greenhouse production in the coming winter. This contributes to the shift in focus and the horticultural sector has to adapt accordingly and rapidly. Key resources that were taken for granted have become volatile due to all kinds of unforeseen developments: today it is energy, the next moment nitrogen emissions, closed borders, Covid-19, container prices, blocked Suez Canal, etc.

As a CEA cluster, we no longer get away with simply stating the economic benefits of a strong horticultural cluster. The pitfall is to put too much emphasis on this narrative, without connecting to today's societal demands and trends. We must beware not to get distracted from the values, needs and expectations of the stakeholders around our industry. Public acceptance is the least we should achieve, preferably consumers would be turned into fans and enthusiasts.

As an industry we cannot avoid focusing on the social and environmental costs, but we also need to create, substantiate and promote social and environmental benefits: be transparent, proactive and contribute to a social debate on essential, substantial topics.

Consistent and validated information is needed on our sector's sustainability, the same goes for all improvements that are needed: for example, in the use of fossil fuel, chemical crop protection,

fertilisers, emissions to the environment that may affect the quality of surface water, but also on social and ethical standards such as the impact of migrant workers, the public image of greenhouse work or rather said the career opportunities in CEA. WUR is working on a Product Environmental Footprint (PEF) for ornamental plant cultivation and for vegetables,¹¹ based on a LCA approach. This EU-accepted standard method can provide reliable data that is also comparable. This is urgently needed.

We will also have to look at the substantiation of the benefits: what exactly are the benefits compared to outdoor cultivation? Who is benefitting? How do Dutch people perceive a strong CEA cluster? And what would they miss if it became smaller?

Does the horticultural cluster dare to listen to the critical voices? And translate that into new change concepts and communication messages? And what impact will that have on the European lobby? How do we get a sustainable and circular greenhouse horticulture and vertical farming entrepreneurs into the view of European policy makers that they are, among others, the Farmers of the Future?¹²

Societal debate internationally

Because the international demand for CEA crops is growing rapidly, these societal aspects also play an increasing role internationally. These days there is limited attention for this in the narrative towards the customer. Sometimes it is just a matter of making the customer more aware because they are often taken for granted. This raises questions for the Dutch cluster: Do we think this is important? Do we think we should play a role in this? Are we doing enough?

The following issues play a role in this:

- The definition of greenhouse horticulture in laws & regulations. In the Netherlands, greenhouse horticulture is considered an agricultural activity. In other countries it is seen much more as just another industrial activity which cannot simply be done in the countryside or under special conditions. An example is the US, where CEA is hardly present in agricultural policies. The question is how we can use Dutch knowledge and expertise to better substantiate the definition of greenhouses abroad.
- Economic diversity: The inclusivity of local entrepreneurs in the development of AgTech clusters. Now, large investors build large greenhouse facilities, but how can local entrepreneurs and society benefit from this? An example is AppHarvest in Kentucky, where a limited form of CEA did not exist previously.
This includes not only a technology push from low-tech to mid-tech to high-tech for local entrepreneurs (training, demos, financial incentives, etc) but also a market pull to ensure that they can sell their increased volumes of products at a better price. Examples include incentives for sales cooperation/collaboration (such as CMO from Europe, subsidising investments in quality management training, post-harvest management, branding, etc.). Technology push and market pull must go hand in hand. Another example is Silal in the UAE that supports their more than 1,000 entrepreneurs in technology innovation per entrepreneur, funded by the government.
- CEA is essentially a sustainable production method, highly efficient and resilient to climate change and water shortage (provided they use sustainable energy and have a firm grip on emissions) but other (low cost) cultivation systems can be meaningful and sustainable as well. Low-tech and mid-tech greenhouses can make substantial improvements when it comes to nutrient emissions because drain water is not yet recycled, or by the application of IPM with biological control. How do local entrepreneurs, who want to scale up from mid-tech to high-tech, start producing more sustainably with low investments and skip the period of the 70s and 80s in the Netherlands?

¹¹ <https://www.wur.nl/nl/onderzoek-resultaten/onderzoeksprojecten-lnv/expertisegebieden/kennisonline/methode-milieu-footprint.htm>

¹² https://www.europarl.europa.eu/cmsdata/232686/farmers_of_the_future_final_online.pdf

From Triple Helix to Multiple/Quintuple Helix

The current Dutch Triple Helix model, apparent in the Dutch Top Sectors approach, allows the three stakeholders government, private sector and knowledge sector to work together in R&D and innovation development. Annually about 15-20 million euros are invested by the government and an equal amount by the private sector in a joint public-private research programme of the Top Sectors Water, Agrifood and Horticulture & Starting Materials, based on the Knowledge and Innovation Agenda (KIA) Water, Food and Agriculture. According to the expert group, the private sector should have more influence on the programme and the selection of projects of the Top Sectors, aimed at creating more room for innovations with impact with larger budgets. The expert group proposes to expand the Triple Helix to a Multiple Helix, preferably a Quintuple Helix, including international financiers and social & environmental NGOs. Another advice is to break the sectoral boundaries of Top Sector silos. Crossover innovations between different Top Sectors are much needed.

Rationale

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