

Research on CEA clusters in Ohio, Pennsylvania, Maryland, Virginia, North Carolina and Georgia in the perspective of improving Dutch-US cooperation on CEA technologies



Research report by Hillenraad Consulting, assigned by InnovationQuarter (IQ), Rotterdam Partners (RP) and the LVVN team in Washington

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Hillenraad.
Consulting

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1 Introduction

This research focuses on identifying the horticultural greenhouse CEA activity in 6 eastern states in US: Ohio, Pennsylvania, Maryland, Virginia, North Carolina and Georgia. The research project is carried out for, and in cooperation with, InnovationQuarter (IQ), Rotterdam Partners (RP) and the LVVN¹ team in Washington, D.C. InnovationQuarter has the objective to support (innovative) Dutch companies in their ambition to scale to the US. While previous US studies provided a high-level nationwide insight, showing a scattered CEA landscape throughout the US, this study provides a deep dive on the 6 specific states to create a more in depth understanding of the CEA activities, applied technologies and potential business matches with Dutch technology.

1.1 Objective of this research

This explorative research identifies the greenhouse CEA activities in the 6 states, trends and technology levels. The objective of this research is to understand US grower activities and needs, and the match between US needs and Dutch innovative technologies. With the practical view on future cooperation, this study also looks into state incentives for new business and potential cooperation partners for InnovationQuarter / LVVN.

1.2 Scope

This study investigates greenhouse horticulture, both vegetable- and ornamental greenhouses, and excludes Vertical Farming growing without daylight. Protected horticulture is a term generally used in the US and includes tunnels and other basic forms of coverage. This research focuses on the mid- and high-tech CEA greenhouses, both glass greenhouses and multispan polytunnel greenhouses, given that these greenhouses have sufficient level of technology, for example climate control (ventilation, heating and/or grow light) and greenhouse automation (moving benches and other transport systems).

1.3 The research team

The research is carried out by Hillenraad Consulting, with a local US consultant on the ground, and the founder of NLTOUS:

- Hillenraad Consulting is a business consulting firm, specialized in horticulture, from seeds and technology to retail, in EMEA (Europe, Middle East, and Africa) and broader North-America
- NLTOUS supports Dutch companies with their entry in US and with finding the right matching location for local presence

1.4 Approach

For each of the 6 states, we gathered general information and figures on CEA and identified the key horticultural companies, the growers, with a greenhouse area above 0,5 ha. To get a view on trends, CEA context and (grower) needs in each state we interviewed several organizations, such as agricultural universities and regional development agencies, as well as vegetable - and ornamental growers. We interviewed several Dutch companies to understand their view, needs and hurdles in the business with US.

¹ LVVN = Ministerie van Landbouw, Visserij Voedselzekerheid en Natuur; Department of Agriculture, Fisheries, Food Security and Nature

None of the information provided in this report is limitative. The accuracy and depth of the information in this report is subject to limitations in the size of the research assignment.

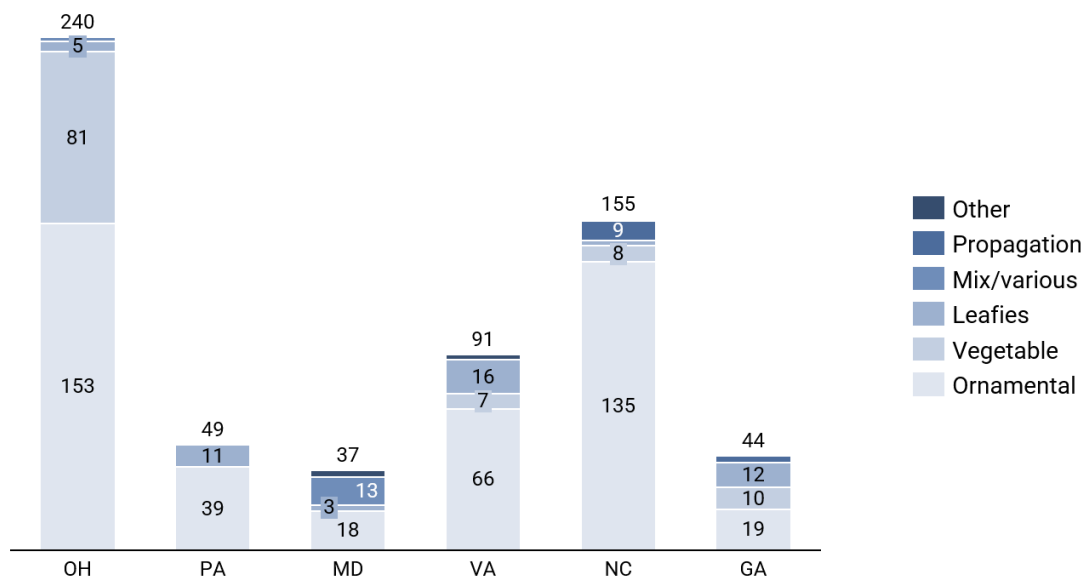
1.5 Research scope, focus on “qualifying” growers and acreage

In this research we focus on identifying those growers that have a good fit to Dutch technology. Typically these are the larger operations, using climate control and other technologies. Small ‘mum and dad’ growers in the 6 states would also benefit from technology advancement, but their greenhouse setups typically match less with the available Dutch CEA technologies and the small scale of operation is not sufficient to justify associated investments.

The growers on which this research focuses are hereafter referred to as “qualifying” growers (or more general as “qualifying” acreage). “Qualifying” includes poly clad multi-span foil houses and glass covered multi-span greenhouses with a certain level of control, with a acreage of more than 0,5 hectare.

In this research the qualifying growers have been identified and located across the 6 states. The acreage of these horticultural greenhouse operations adds up to a “qualifying acreage” of 617 hectares in the 6 states.

Chart: Hillenraad research area of qualifying CEA per state per type operation (in hectares)



2 General view on CEA in the 6 states

In most states there is an active interest to develop and stimulate CEA greenhouse horticulture. This interest is expressed by educational institutes, agricultural universities and local government. In some states governors are actively promoting CEA. CEA provides an answer to some of key issue topics in the states, like sustainability, water pollution through fertilizers and pesticides, food security, health benefits and labor. These are major themes for example in the large and environmental important Chesapeake Bay.

Of all 6 states, Ohio has the largest area of protected horticulture, in total 403 hectares and Maryland the smallest with only 89 hectares, according to the USDA Census 2022. There's a long history of ornamental greenhouse growing in all the states, mainly consisting of many small growers serving the local market or selling on-farm. The farmer's markets are a major share of the acreage.

Throughout the 6 states there are also several large ornamental operations (up to 80 hectares), especially in Ohio, North Carolina and Virginia. Typically these operations provide a broad mix range of potting- and bedding plants. Technologies range from low-tech tunnels to high-tech greenhouse operations. Especially the large-scale operations in the 6 states have a significant level of automation, not just on climate control, but also on internal greenhouse transport and the seed-to-ready plant process (e.g., seeding, transplanting). Production automation is the #1 investment goal for the large ornamental growers, according to the 2023 Grower's 100 Survey, mainly to improve efficiency and mitigate cost- and availability of labor.

While the ornamental CEA segment is large and stable, the CEA vegetable segment in the 6 states is overall smaller but growing. Multiple new high-tech greenhouse- and indoor facilities are (being) built for leafy greens and herbs in most of the 6 states, many with Dutch involvement. This is induced by the shift of the -water shortage threatened- California outdoor lettuce production, that is shipped from the west coast to the east coast, to CEA production on the east coast. Several new large scale fruit vegetable (mainly tomato) facilities are built and/or expanded especially in Ohio, besides that there are a large operation in Georgia and one in Virginia.

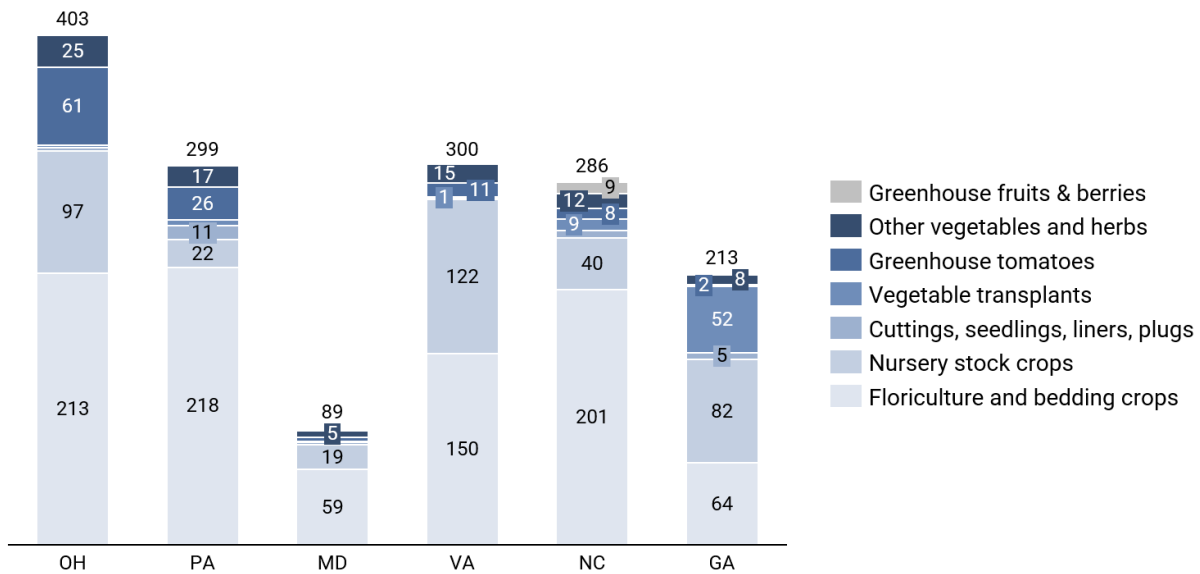
Current key challenges of most growers are labor and IPM (integrated pest management), threats headed by thrips and spider mites according to the 2023 Grower's 100 Survey. Foreign agricultural labor in the US, as needed for the greenhouse operations, is regulated by the H2-A program, making it far more costly in comparison with Canada and Mexico. For example, 2 top 100 growers in ornamentals, White's Nursey & Greenhouse (VA) and the Dan Schantz Greenhouses (PA, MD), announced closing their operation, citing high labor expense and high interest rates as main reasons.

2.1 USDA Census 2022 total greenhouse area (hectares)

The area of protected cultivation in the US is measured by the USDA in the Census 2022. This acreage count is based on a questionnaire amongst growers, small and large. It provides an indication of the state acreage per crop type and per technology.

According to USDA census 2022, the 6 states amount up to 1.600 hectares of greenhouse operations, mostly consisting of floriculture and bedding crops.

Chart: USDA Census 2022 Total greenhouse area per state (hectares)

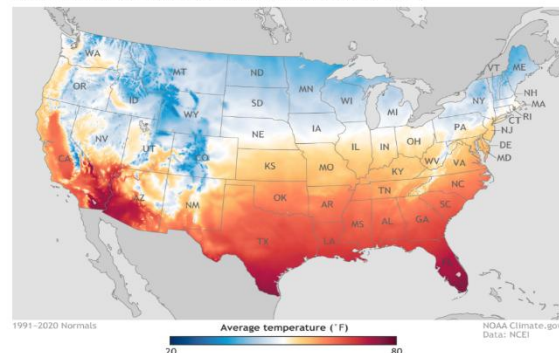


2.2 Climate in the 6 states and impact on horticulture

The climate towards southern states in this research is increasingly warm. As from Virginia downward the states have a humid subtropical climate (Köppen Climate Classification). This is a key factor determining the types of crops that can be grown and/or the feasible growing seasons, while not all crops can stand the high summertime temperatures. For example the southern states of this research scope have a challenging natural climate for year-round greenhouse CEA production of tomatoes. This can be (partly) offset by seeking the coolness of elevation terrain in the Appalachian mountains or by advanced greenhouse technology.

A greenhouse is a good way to manage climate conditions, e.g. with ventilation, heating and lights, however in essence within the upper boundaries of the outdoor temperatures. Though modern greenhouse technology is able to mitigate more extreme climate conditions, with for example cooling solutions, the key question is whether this is attractive and feasible in terms of growing, labor and transport costs, and in comparison with a location in a more moderate climate.

U.S. annual average temperature and precipitation (1991–2020)



Average temperature for each state during summer*

State	Avg °C	Avg °F
Pennsylvania	20,3	69
Ohio	21,6	71
Maryland	22,9	73
Virginia	22,9	73
North Carolina	24,3	76
Georgia	25,9	79

* The temperatures are based on data collected by weather stations throughout each state during the years 1971 to 2000 and made available by the NOAA National Climatic Data Center of the United States

2.3 Incentives and stimulation of horticulture in the US

In the US there are multiple incentive programs that apply to greenhouse CEA. Large programs on federal level are issued by the United States Department of Agriculture (USDA), other programs are dedicated on state level or even county level (not addressed in this research). The information in this research is not limitative on the incentives for greenhouse related activity.

Federal USDA programs

The [USDA](#) programs are available, also in the context of the Inflation Reduction Act, both on federal level and state level, incentivizing (food production) CEA. Programs are mostly focused on energy efficiency, food security (local US production), clean water, and to support (small) farmers. On the USDA website one will find an extensive set of incentive measures.

The USDA programs may apply to a subset of states or counties like the crop insurance program for CEA by the USDA Risk Management Agency (rma.usda.gov), which is available in selected counties in 25 US states, including Maryland, North Carolina, Ohio, Pennsylvania and Virginia.

Another example -from the USDA Agricultural Marketing Service- is the (national) Specialty Crop Block Grant Program ([SCBGP](#)), that was initiated as part of the Specialty Crops Competitiveness Act of 2004 to enhance the competitiveness of high value specialty crops. Specialty crops are defined as "fruits, vegetables, tree nuts, dried fruits, horticulture, and nursery crops (including floriculture): Farm Bill (10.170) Grants to eligible State departments of agriculture to carry out projects that enhance competitiveness of specialty crops. The program aims to support projects that would benefit the specialty crop industry through initiatives such as research, marketing, education, pest and disease control, and food safety improvements. The goal is to boost the economic vitality of the specialty crop sector and address challenges unique to these crops.

Under the USDA Farm Loan Programs, the Farm Service Agencies offer loans to help farmers and ranchers get the financing they need to start, expand or maintain a family farm. This also includes funding of (technical) solutions to support "climate-smart agriculture and forestry", "Smart Agriculture and Nutrient Management", but also to create climate change resiliency. The main goals of climate-smart agriculture are to:

- Increase or maintain productivity and yield
- Enhance resilience to environmental changes
- Reduce greenhouse gas emissions

State incentive programs

On state level there are multiple, mostly general, incentives that are also applicable for CEA Horticulture, including customized incentive packages with tax credits, low-interest loans, grants, and labor sourcing- and training support. In the individual state chapters hereafter, some of these incentives are discussed.

2.4 Local regulations for (CEA) horticulture

There are multiple regulations on greenhouse growing in the 6 states, some are state specific, others are more general to the US. This report provides a first view on this topic, the information is not limitative nor depth full researched on accuracy. Details and applicability would be subject to

further in depth case specific research. The mentioned regulations hereafter may apply to a more of lesser extent depending on the state involved.

Typical regulations for CEA (may) include Local Zoning requirements, Business License (Sales and Use Tax License) and a Water Appropriation Permit. Many other licenses and permits are/may be required for greenhouse growing such as the Nutrient Management Plan, Pesticide Applicator License, Nursery Inspection Certificate (for nurseries), Spotted Lantern Fly Permit. States may require a Certificate of Quarantine Compliance for Spotted Lanternfly, Japanese Beetle, and Spotted Moth when products are shipped to (or through) the state. A new pest that may need compliance for 2025 is the Box Tree Moth.

More general regulations may apply such as Corporate Income Accounts with neighboring states if you sell your products there, UCR Account with neighboring states you transport your products through.

2.5 Drivers driving development of CEA in the US

Looking into CEA in the US there are several drivers that accelerate growth of CEA in 6 states and others that inhibit growth.

Competition Canada & Mexico

The decision-making on new US investments in greenhouse CEA is strongly related to the perceived competitive position of US greenhouse vegetable produce versus import from Canada (Ontario) and Mexico on costs, quality and freshness. Being able to label produce as 'local US' is a trade-off versus lower costs of Canadian produce, with cheaper foreign labor and favorable exchange rate, and cheaper Mexican produce. Some of the growers built their US facilities to produce counter-season versus their Mexican production premises.

Demand from major retailers

Due to the US market structure, new large-scale high-tech greenhouse investments require a solid sales connection to one of the major supermarkets to align the demand, quality and volume. Some opportunistic new US (indoor) farms suffered lack of a sound business case/plan and sales channel, resulting in ceasing operations. East coast retailers increasingly demand east coast "nearby" produce, which together with the water shortage for outdoor Californian lettuce, also created the steep growth of lettuce facilities on the east coast.

Proximity, landscape & infrastructure

The site selection for new projects is mostly related to its proximity to local markets in eastern US, the local climate, available infrastructure, flat terrains and efficient logistics rather than the presence of an existing horticultural cluster. This east coast proximity applies to all the 6 states. Established growers prefer to reach sufficient scale at their locations while focusing on boosting their technology.

Local climate conditions

The local climate determines the necessary investments in climate control installations and the related annual costs for operation. Since heating a greenhouse is easier than cooling a greenhouse, due to the influx of solar power concurrent with the need for light, summer high temperatures finally

determine the possibilities for year-round production of a crop and thus the spread of all costs over the production season. In most of the east coast states the (too) high summer temperatures reduce the options in crop selection and year-round production.

Local resources

Local resources like labor, energy and water have a big impact on business opportunities. The costing factors play a decisive role in the site selection and location in any specific state. The H2-A labor program in US for hiring foreign labor drives high labor rates, this is a struggle for small scale farms and for large farms.

Incentive programs

Incentive programs, like mentioned in the previous chapter, are generally for growers not the most dominant factor for their decision on the growing location, while growers merely lean on long term business drivers, including market connection and climate suitability. The incentive programs should come into play in the decision when locations are equally suitable.

Funding

Where traditionally accumulated profits of companies and bank loans were the key sources of funding to enable an investment, today large private investment funds from private equity players and AgTech investors have come into play for a new CEA investments. The investor interests include new greenhouse developments, growers and technology companies.

Cannabis

Commercial production of cannabis has rapidly grown in the past years in some of the US states. Throughout the US, the states have different legislation on production of cannabis. In the 6 states of this research, commercial (large scale) cultivation of recreational cannabis is not allowed. In some states, for example in Maryland, one- or a small selection of grower(s) is licensed to grow medical cannabis. The cannabis market and its outlook are not in scope of this report.

3 Takeaways from the interviews on the 6 states

As part of this research several interviews were carried out with US organizations, US growers and Dutch companies to understand trends and needs both for the states and from technology perspective.

Good technology alignment

The high level of automation and the technology ambitions of the major mid- and high-tech growers in the 6 states in ornamentals, lettuce- and vegetable (mainly tomatoes) production, align well with Dutch –innovative- technologies, as recorded in interviews with both US growers and Dutch innovative technology companies. The Dutch innovative technologies, as recorded from the interviews, include autonomous climate control solutions, innovative pest management solutions, smart cameras, robotization, fully automated lettuce growing solutions to adaptive LED technology, fully automated internal transport and automated quality control and many more.

Positive interest for Dutch technology *and* knowledge

In the US interviews, most organizations and companies expressed their positive interest in Dutch technology and its benefits to the US. A large part of current US facilities have Dutch technologies installed. Some organizations and growers show a preference for local US -and Canadian- suppliers providing technologies and innovations.

Interviews with US organizations show there is a clear interest in Dutch technology, however there is even more interest in Dutch knowledge: One of the interviews suggested the ideal model of cooperative partnerships between Dutch- and US companies would be one beyond the traditional supplier role, a joint venture approach, to sustainably secure knowledge transfer to US and at the same time for Dutch companies to benefit from the opportunities in the US (“Dutch knowledge is at a premium right now”).

Dutch challenges in doing business in US

Dutch companies consider US very interesting both for sales and for its capital investment market for now and on the long term. In the interviews with Dutch technology companies, the potential legal liability and claim risk is considered a big hurdle for entering the US, both in delivering products and services, and in relation to breach of US patented Intellectual Property Right. Data policies in US are another issue that can have significant consequences.

Whereas US growers are organized differently than in the Netherlands, the ‘How-to commercially address US growers’ is a major sales approach question for Dutch companies starting in the US.

Given the large geographical spread of the US CEA and lack of sizeable clusters in the 6 states, it is a challenge for technology equipment providers to build an effective and cost-efficient local service organization.

Keep up the good Dutch reputation

Bringing technology to US though also requires intensive training and support, particularly for AgTech-money funded greenhouses without a growing history. Just a good technical facility doesn’t make a successful greenhouse operations. Unsuccessful projects may have impact on the reputation of- and trust in Dutch technology, as recorded from the Dutch interviews.



4 CEA horticulture in Ohio

4.1 Summary

CEA trends

Ohio is generally well known on the greenhouse CEA map of the US and home to the Cultivate event. With over 240 'qualifying' hectares of CEA greenhouses and a greenhouse total acreage of over 400 hectares according the USDA Census 2022, Ohio has the largest portion of greenhouse horticulture of all investigated 6 states:

- The ornamental segment is historically dominant in Ohio, with several large scale -modern and automated- operations. The traditional small local ornamental growers are under pressure. The big growers are doing well and expect the market to further consolidate;
- In the recent years, Ohio welcomed 3 of the top 10 largest US/Canadian vegetable growers, some of them Ontario based coming from across lake Erie, building and expanding new large facilities in Ohio. In line with the more general trend in the 6 states, several new leafy greens facilities were recently built, both greenhouse and indoor.

From a technology perspective, though subject to crop types and needs, most facilities are typically well equipped with heating, screens and (LED) lights, also having an up-to-date process automation in the greenhouse area as well as in the logistics around it.

Specific for Ohio is JobsOhio. JobsOhio has a broad incentive program mostly focused to create new jobs and/or attract R&D. JobsOhio also supports companies, both foreign and US based, in organizing their local presence with human resourcing and practical aspects like permits and utilities.

Opportunities for cooperation

Many Ohio growers are testing with new technologies. There is a clear interest of Ohio growers for Dutch technology.

- Large ornamental growers expressed their interest in Dutch technology for further mechanization and smart (AI) controls, e.g. vision based quality control. Also Integrated pest Management (IPM) and beneficial insects are key topics amongst them.
- The new vegetable grower facilities are well equipped. Major opportunities for cooperation are autonomous greenhouse controls, to support the growers, and robotization to reduce (the costly H2-A) labor. In this field we also see several US based technology companies finding their way in trials with the large growers.
- Whereas leafy greens facilities are generally designed and right from the start built with high level of automation and technology, the technology opportunity in these facilities is mainly on either smart (AI) controls or new fully automated leafy green farms.
- At smaller traditional farms there is a clear need for solutions on irrigation, greenhouse design, IPM and technology, though this requires different types of solutions that are applicable and feasible for small scale (retro-fit) application.

4.2 About Ohio

Tradition of skilled workforce and innovation

Ohio is often referred to as the "Nation's Industrial Capital" due to its significant historical and contemporary contributions to the industrial sector in the United States. Geographically it is well connected to inland- and water transport routes. The abundant natural resources, such as coal and iron, historically induced heavy (steel) industries and later automotive, machinery and aerospace. It is said to have a skilled workforce and a long tradition of innovation.

Preserving its environment

Stretching from the banks of Lake Erie in the north to the Appalachian Mountains in the south, Ohio boasts a diverse natural landscape. The state's major cities include Columbus, its capital, along with Cincinnati and Cleveland. The Ohio River forms part of the state's southern border, while the northern border is defined by Lake Erie. Its state parks and natural resources are a testament to the state's commitment to preserving its environment.



Climate

On a typical July-day, the temperature will rise to about 30 °C, while in January typically down to about -7 °C. The state is open to cold, dry fronts from Canada and warm, moist fronts from the Gulf of Mexico, the frequent meeting of these fronts causes the considerable state's precipitation. Ohio occasionally experiences mild earth tremors and destructive tornadoes (for example causing the destruction of a high-tech Wapakoneta greenhouse in April 2023).

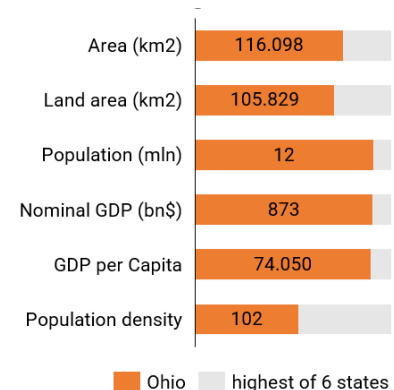
Main agricultural crops

Ohio's main crops are soybeans and corn. Also important are wheat, oats, hay, fruit, feed, vegetables, livestock, poultry, and dairy products, however the ornamental horticulture is also quite present.

4.3 CEA horticulture in Ohio

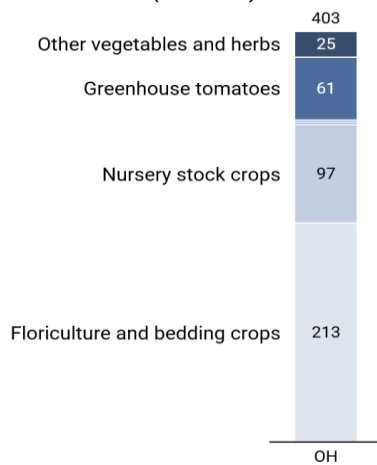
Historically Ohio is known for its ornamental horticulture, however in the recent years this is getting more balanced between vegetable production and ornamental horticulture with the addition of a few big high-tech operations by companies such as Nature Fresh Farms, Mastronardi Produce and Mucci Farms. Ohio has a full horticultural ecosystem of suppliers and technology companies, and proximity to even more in Ontario.

In recent years especially large-scale vegetable greenhouses have been installed and/or expanded. Several 30-40 hectares sites of high-tech Venlo type greenhouse operations have been built. As a result, contrary to other states in this research, the cumulative acreage of large scale vegetable greenhouses is the biggest in Ohio.



Note: The state figures are in orange bar, grey bar represents the highest figure of all the 6 states as reference. In case bar is totally orange, the state has the highest figure

Chart: USDA 2022 Total Ohio greenhouse area (hectares)



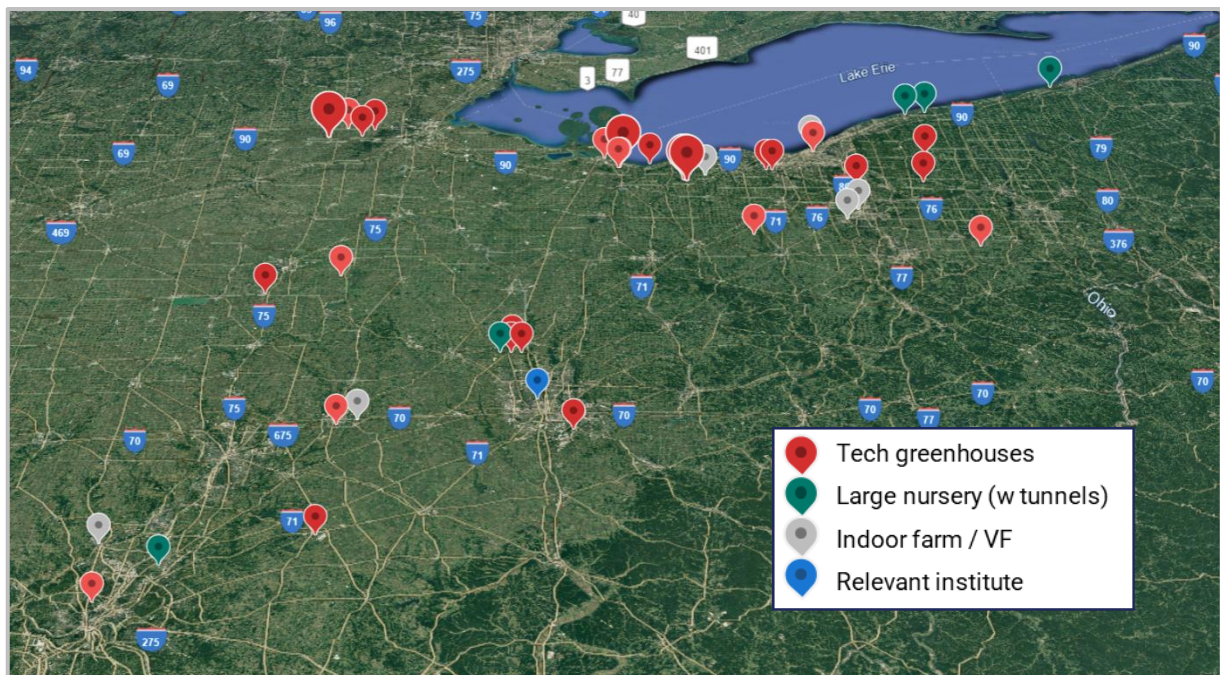
Ohio still houses many small ornamental operations and farms shops, having own propagation and retail sales of potted plants, annuals, perennials, and other plants.

The small/medium farms are under pressure, struggling with profitability. Though solutions like irrigation and more advanced nutrients management would be benefits these operations, their technology setup does not align well with (typical) Dutch technologies.

Like in the other states, labor costs is a real issue. Electricity is affordable with 4ct/kWh (rate is negotiable).

4.4 CEA acreage and crops in Ohio

The choice for Ohio by the large Ontario based vegetable growers that seek production locations in US is logic, whereas Ohio is just opposite Ontario across lake Erie. Although Ohio is nearby Ontario, the climate is slightly different than Ontario due to the default wind directions. Most high-tech large-scale operations are clustered alongside lake Erie, facing the north side of Ohio.



Ohio houses a number of large-scale high-tech vegetable operations, as well as a few large-scale ornamental greenhouses adding up to 240 hectares of “qualifying” CEA (see chapter 1.5 for explanation):

- 5 ha comprising leafy greens, 3 modern operations across the state;
- 155 ha of ornamentals, 19 large scale operations mostly glass- or poly greenhouses, with a high level of automation and technology;
- 81 ha of vegetables in 5 large-scale, high-tech, mostly recently built greenhouse operations of salad vegetables. 3 of the top 10 US/Canadian growers has a greenhouse operation in Ohio.

Besides the 3 large modern leafy greens greenhouses, there are several indoor farms in Ohio, like 80 Acres. Most of them are established in existing (storage/industry) buildings.

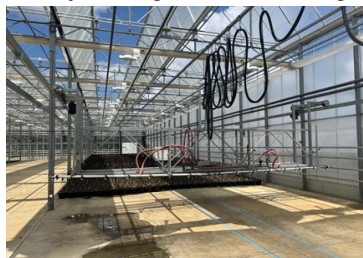
4.5 Greenhouse Technology in Ohio

Ohio CEA trends and technology

The large-scale greenhouses in Ohio have state-of-the-art technology and are constantly testing new technology (innovations), ranging from mechanization such as internal transport systems, robotization for example for harvesting, or UV-C treatment, to predictive intelligence on climate control, yield forecasting, IPM, and new sources for carbon dioxide. The general largest challenge is labor and the (H2-A) related labor costs. Other relevant themes in Ohio are (predictive) irrigation steering, nutrients management and improved greenhouse design to match US climates.

Broad application of various techniques

The big greenhouses are equipped with heating pipe rails and almost all have LED/HPS lighting. Latest new technologies include UV-C treatment via pipe rail trolleys in the nights, for example against powdery mildew, and ETFE as glass substitute. The application of beneficial insects in ornamentals is strongly growing and of major importance, while consumers ask for it and the government/legislators is continuously taking out various agrochemicals.



Examples: Ohio ornamental growers have a broad product range, but are in general technology intensive operations

Consolidation amongst ornamental growers

Large ornamental growers typically grow a wide range of plants in different greenhouse sections, flowering and foliage plants, both on the ground, on tables as well as hanging baskets, all in open vented Venlo greenhouses. The operations are tech savvy and technology needs are similar as large-scale Dutch ornamental growers. While the ornamental greenhouses are mostly automated, the next step would be AI and further advanced mechanization. The big ornamental growers expect the market to grow and at the same a consolidation of the number of growers.

Small scale growers missing technological connection

Opposite to the large growers, the many small greenhouses farms operations have general lack of Dutch technology fit, though especially these farms would need the benefits of new technologies

to remain competitive. The different greenhouse types do not have a heating pipe rail setup in place for mechanization, neither they can afford full scale climate controls.

4.6 Horticultural institutions and organizations

Ohio State University (OSU), Columbus, Department of Horticulture & Crop Science

The department of Horticulture & Crop Science is a leading research institute for horticulture and greenhouse growing, not only limited to Ohio, but even nationwide. OSU is well connected to the Ohio horticultural companies and supporting both the large and small operations with both fundamental and practical research and education.

Ohio Controlled Environment Agriculture Center (OHCEAC)

The Ohio Controlled Environment Agriculture Center (OHCEAC) has a research focus spanning across the controlled environment agriculture (CEA) industry, including greenhouse engineering, food safety, plant pathology and entomology for various crops of both vegetables and flowers. OHCEAC is committed to promoting interdisciplinary collaboration and to respond to the needs of the CEA industry in Ohio & beyond. The OHCEAC consortium members / collaborators are both growers, suppliers, associations, and education in states.



CEARC – Controlled Environment Agriculture Research Complex

The OSU department of Horticulture & Crop Science and OHCEAC organize an annual conference -see below- and are well connected, also to Dutch knowledge centers like Wageningen University & Research. This brings together academic knowledge, but OHCEAC/OSU also provides a route for new innovations to reach the Ohio growers.

4.7 Horticultural events

Cultivate

Ohio is well known for the annual Cultivate event, a trade show for horticulture held in July.(equivalent to GreenTech/IPM Essen)

OHCEAC Annual Conference

The Ohio State University College of Food, Agricultural, and Environmental Sciences(CFAES) and Ohio Controlled Environment Agriculture Center (OHCEAC) organize annually the 'Advancement in CEA Automation and Crop Management' (July timeframe)

4.8 Incentives and regulations in relation to greenhouse CEA

Incentives for CEA horticulture (not limitative)

Incentives and support services for undertaking business in Ohio are coordinated by JobsOhio. JobsOhio is a private non-profit corporation designed to drive job creation and new capital investment in Ohio through several business attraction-, retention-, and expansion efforts.

Ohio has a variety of incentives that are also applicable for CEA Horticulture, including customized state level incentive packages, consisting of tax credits, low-interest loans and grants.

Besides financial incentives, JobsOhio provides support to ease the start of local Ohio business activities and/or realizing a new greenhouse facility. Support includes assistance with permits, introduction to service providers & utility companies, site selection services, as well as talent acquisition services, from sourcing, pre-screening to training.

Grants are mostly related to job creation and to establishing R&D in Ohio, such as:

- JobsOhio Economic Development Grant, for job creation, focuses on fixed-asset and infrastructure investment
- Research & Development (R&D) Center Grant, for R&D job creating, providing grant for R&D costs and investments
- JobsOhio Workforce Grant, for job creation, focuses on training costs
- Job Creation Tax Credit (JCTC)

Local regulations for (CEA) horticulture (not limitative)

No particular local regulations come across for CEA horticulture in Ohio. Please refer to the introductory section on regulation; some regulation may apply for Ohio in relation to nutrients disposal and pesticides.

New location

NatureFresh Farms

(about the subsequent expansion)
"This strategic move helps us to simplify logistics while providing more efficient service taking our existing customer service to the next level. We are looking forward to the extension of our organic program! With organic attributes already strongly impacting the market today, we will see it continue to grow in the future."

John Ketter, Vice-president.

INCENTIVES OFFERED AT STATE LEVEL:

JobsOhio Growth Fund Loan	\$ 2,500,000
JobsOhio Economic Development Grant:	\$ 100,000
TOTAL:	\$2,600,000



5CEA Horticulture in Pennsylvania

5.1 Summary

Summary CEA trends

According the USDA census 2022, Pennsylvania has 299 hectares of greenhouses. Contrary to Ohio most greenhouse operations are small and serving local markets, mostly for ornamentals and vegetables, or even a combination of both. Researching the 'qualifying' greenhouse activities in Pennsylvania, approximately 50 hectares of qualifying greenhouses was found, mostly ornamentals. Two new lettuce/leafy greens facilities were established, such as the Brightfarms Pennsylvania greenhouse. There are also a few small scale indoor leafy greens vertical farm operations mainly in existing buildings, though one of them (Fifth Season) already stopped operating. The hilly terrain of Pennsylvania makes it more difficult to find a suitable spot for large scale greenhouse operations.

The biggest (ornamental) operation – the Dan Schantz Greenhouses, which ranked #49 on Greenhouse Grower's 2023 Top 100 Growers list, is shutting down per end of 2024, mentioning both high interest rates and increased cost of labor as the main reasons for shutting down.

Interest for CEA greenhouses is on the rise, on the educational side (the Center for Agricultural Research at Harrisburg University of Science and Technology) and from the governor's office, focuses on improving both the current agricultural/horticultural small-scale farms as well as attracting large-scale CEA. Most governmental incentives focus on strengthening the local (small scale) farms and farms shops.

In order to protect nature and water (especially in relation to the Chesapeake Bay area water quality issue) Pennsylvania has a regulatory framework in place, like other states such as Maryland and Virginia, regulating the use/disposal of nutrients (disposal) and pesticides.

Opportunities for cooperation

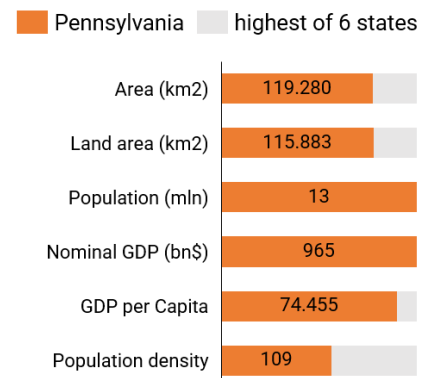
The overall CEA greenhouse activity and perspective for Pennsylvania is relatively limited in the context of the 6 states. Like other states, there is an opportunity on the leafy greens and in engagement with the Center for Agricultural Research at Harrisburg University of Science and Technology. The latter is highly interested to discover the possibilities for Dutch technologies in Pennsylvania.

5.2 About Pennsylvania

Most populated and the biggest economy of the six

Pennsylvania is the fifth-most populous state in the United States, with around 13 million residents. The largest metropolitan area is the southeastern Delaware Valley, which includes and surrounds Philadelphia, the state's largest and nation's sixth-most populous city. The second-largest metropolitan area, Greater Pittsburgh, is centered in and around Pittsburgh. The state capital is Harrisburg.

Pennsylvania's geography is highly diverse. The Appalachian Mountains run through the center of the state; the Allegheny and Pocono mountains span much of Northeastern Pennsylvania; close to 60% of the state is forested. While it has no ocean shoreline, it has 140 miles (225 km) of waterfront along Lake Erie and the tidal Delaware River.



Large rural community

Pennsylvania has one of the largest rural populations in the United States, and nearly one-third of the state is under cultivation. Livestock—including dairy and beef cattle, hogs, and sheep—and livestock products are the major components of farm income. Pennsylvania is a major producer of milk, eggs and poultry, fruits, including peaches, grapes, cherries, and apples, hay, corn (maize), mushrooms and Christmas trees. Pennsylvania is the leading producer of mushrooms, organic as well as conventional, in the United States, followed by California.



Climate

Pennsylvania's diverse topography produces a wide variety of climates, though the entire state experiences cold winters and humid summers. Pennsylvania has two major climate zones. Most of the state, except for the southeastern corner, has a humid continental climate. The southeastern portion of the state, including Philadelphia, has a humid subtropical climate. The state may be subject to severe weather

conditions from spring through summer till fall. Tornadoes occur annually in the state, sometimes in large numbers, such as 30 recorded tornadoes in 2011; generally speaking, these tornadoes do not cause significant damage.

5.3 CEA horticulture in Pennsylvania

Pennsylvania typically houses many small low/mid-tech greenhouses, mostly in conjunction with mixed farm open field production. In the ornamental segment, there many local greenhouse-markets growers, that produce and sell their own plants to consumers.

Greenhouses in Pennsylvania are used to extend growing seasons and improve crop yields for both vegetables and ornamental plants, supporting local food production and horticultural businesses. Due to the small-scale operations of most greenhouses (<1 ha) they will most likely not be upgraded with advanced heating and lighting systems.

The 4 major regions in Pennsylvania:

1. Lancaster and Chester Counties

These counties mainly accommodate small scale vegetable greenhouses and multi-span greenhouses. Lancaster and Chester Counties have a strong (open field) agricultural base.

2. Philadelphia Area

The Philadelphia area mainly houses floriculture greenhouses and nursery greenhouses. Urban centers like Philadelphia have numerous floriculture and nursery greenhouses catering to the local demand for ornamental plants and young seedlings. These greenhouses support both retail and wholesale markets.

3. Pittsburgh Area

The Pittsburgh area also accommodates mainly floriculture greenhouses and nursery greenhouses.

4. Rural Areas Across Pennsylvania

Typically, small scale single-span greenhouses for a mix of vegetable, fruit, nursery greenhouses.

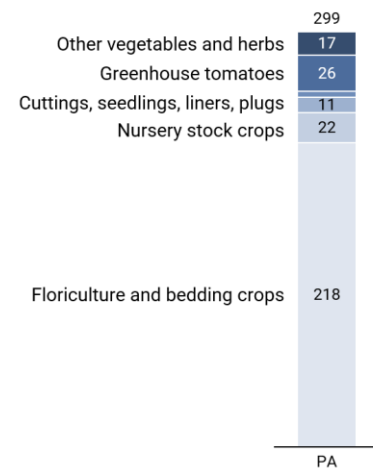
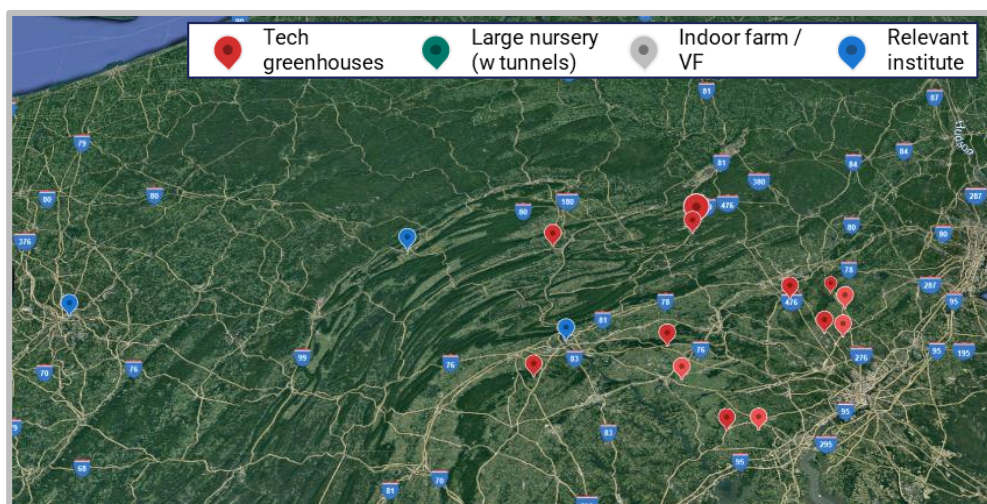


Chart: USDA 2022 Pennsylvania
Total greenhouse area (hectares)

5.4 CEA acreage and crops in Pennsylvania

Pennsylvania typically has hilly landscapes which limits the options for large-scale greenhouse operations that require flat terrain. There are many (very) small scale greenhouse (tunnel) operations growing ornamentals and vegetables. This aligns with the view from the interviews that greenhouse operations is seen as complementary to agricultural farms with a small scale production of high value products.



The qualifying greenhouses add up to below 50 ha, all located in the southeastern part of Pennsylvania. Main CEA operations include:

- 11 ha – Leafy greens – being 2 modern (recently installed) operations
- 39 ha - Ornamental plants: potted plants and bedding plant, merely mid-scale high-tech operations. From the 11 operations there are 5 larger ones in the range of 5-7 hectares, in some cases complemented with outdoor growing area. The biggest operation – the Dan Schantz Greenhouses (together 11 ha in PA), which ranked #49 on Greenhouse Grower's 2023 Top 100 Growers list, is shutting down per end of 2024 (i.e., for sale).

There are a few indoor (lettuce) farms in operation (in existing buildings), however others already stopped operating, like the Fifth Season, in what they call the “correction phase for the industry”.

5.5 Greenhouse technology in Pennsylvania

Being an outdoor farming and mushroom state (see introduction), Pennsylvania has the ambition to extent CEA. The number of mid/large-scale CEA greenhouse operations is still small. The 2 large-scale leafy greens farms are newly built, high-tech Venlo greenhouses including lettuce grow systems, grow lights, etc. The ornamental greenhouse locations are generally a mix of conditioned multispan polytunnel greenhouses and partially older as well as modern glass greenhouses. On the educational side there is a clear expressed interest to grow the application of CEA, in a broader context including a focus on aquaponics. On the technology supplier side we find in Pennsylvania Four Growers, a company in (tomato) harvesting robots.

5.6 Horticultural institutions and organizations

Greenhouse Controlled Environment Agriculture is overall a small part of the horticultural focus in Pennsylvania. Merely all activities, associations (like the PHS, SHAP, PLNA), events and research relate mostly to ornamental and to the broader definition of horticulture, including floriculture, gardening, orchards, nurseries up to landscaping etc., rather than to greenhouse CEA.

Penn State

The Pennsylvania State University (PSU), commonly referred to as Penn State, is a public state-related land-grant research university with campuses and facilities throughout Pennsylvania. It was founded in 1855 as Farmers' High School of Pennsylvania. Penn State College of Agricultural Sciences Horticulture Program provides a minor program in greenhouse horticulture.

The *Penn State Extension* is an educational organization dedicated to delivering science-based information to people, businesses and communities. PSE provides access to both face-to-face and online education to customers—when they want it, where they want it, and how they want it—to help them address problems and take advantage of opportunities for improvement and innovation. Funded by federal, state, and county governments.

The Center for Agricultural Research

The Center for Agricultural Research at Harrisburg University of Science and Technology, focuses on the commercialization of the CEA Industry and technology, a practical educational and applied technology approach rather than fundamental research. Soon building a tech/training facility: a “training center” for CEA to learn and fully understand the systems of growing and apply the knowledge to productive, efficient, and profitable CEA structures in the US. There’s a clear link between the center’s ambitions and the valuable of Dutch technology, a business opportunity for Dutch companies.

York College

The York College of Pennsylvania prepares for High-Demand Jobs in Plant Science, Production, and Design. The Appell Environmental Horticulture Program (Bachelor of Science) immerses students in the science and the business of growing and using plants while responsibly caring for the world’s soil, air, and water resources. A new horticulture center is under construction on York College of Pennsylvania’s campus. The college is building an education center on its campus and Urban Farm shop with Dutch knowledge and materials to accommodate its Environmental Horticulture program.

5.7 Horticultural events

MAFVC – convention (Hershey Lodge in Hershey, PA, January)

Attended by about 2,200 fruit and vegetable growers and other industry persons from the mid-Atlantic region and beyond. The program covered nearly every aspect of fruit, vegetable, potato, berry, cut flower, and greenhouse production and marketing. The Convention has been jointly sponsored by amongst other the State Horticultural Association of Pennsylvania, the Pennsylvania Vegetable Growers Association, the Maryland State Horticultural Society, and the New Jersey State Horticultural Society.

5.8 Incentives and regulations in relation to greenhouse CEA

Incentives for CEA horticulture (not limitative)

Through the Pennsylvania Department of Community and Economic Development there are several grants and loans available for wide variety of purposes, some of which might be applicable to CEA or new CEA technology companies. For example:

- PA Life Science Greenhouse Initiative, that incorporates business models of effectiveness and efficiency. They capture the innovation potential of the life sciences industry and nurture that potential with critical early-stage funding and sector-specific business expertise. Funding is administered through the Life Science Greenhouses to qualifying businesses that support the accomplishment of the mission of the LSG program. This support may be in the form of grants, loans, equity investments, royalty/payback agreements, or other forms of financial support. \$3 million is made available through 3 designated LSG organizations

Pennsylvania Department of Agriculture

The Farm Bill has 6 themes of which especially the “Removed Regulatory Burdens, Strengthen Ag Business Climate in PA” describes the ambition to develop the technology intensive greenhouse

sector. However no specific grants and loans are mentioned in relation to greenhouse CEA itself. Most grants/incentives are related to support the agricultural community with fairs, education and knowledge, or mostly outdoor crop focused, like the Specialty Crop Block Grant Program, that invests in priority Pennsylvania crops such as hardwoods, hemp, and hops.

Though not mentioning greenhouse CEA, Pennsylvania is intensifying technology advancement in agriculture, with reference to the September 2024 announcement of Governor Shapori: "Governor Shapiro's 2024-25 budget signed this summer makes vital investments in Pennsylvania's \$132 billion agriculture industry, including \$10 million dedicated to agricultural innovation – the first-of-its-kind in the nation – supporting farmers and helping them adopt new technologies to advance the industry".

Most grants apply especially to small-scale farmers and local farms shops, like demonstrated by the 2/11/2023 news items by Hortidaily "US (PA): Shapiro administration tours Pittsburgh urban farm to announce \$736,000 investment in 26 projects \$736,145 in grants to support projects that will increase capacity to produce fresh food and create economic opportunity in urban Pennsylvania neighborhoods. Funding through the Pennsylvania Farm Bill's Urban Agriculture Infrastructure Grant Program and a \$200,000 donation from The GIANT Company will support 26 projects in 11 counties across the state."

Local regulations for (CEA) horticulture (not limitative)

To protect nature and water, for example in relation to the Chesapeake Bay area water quality issue, Pennsylvania has a regulatory framework in place, like other states (with reference to the introduction section), that regulates the use/disposal of nutrients (disposal) in waste water and pesticides.



6 CEA Horticulture in Maryland

6.1 Summary

Summary CEA trends

Maryland is the smallest, most wealthy (measured in GDP per capita) and densely populated state of the 6 states. According to the USDA Census 2022, Maryland counts 89 hectares of horticulture, mostly floriculture and small sized greenhouses. The Hillenraad research adds up to 40 'qualifying' CEA hectares. The ornamental operations are mostly small size operations up to 11 hectares of modern High Tech greenhouses. Several lettuce facilities have been built recently, part of them are greenhouses, others indoor farms.

Incentives in Maryland are focused on competitiveness of specialty crops (though most agricultural crops) and on small local farms, stimulating local for local produce and adhering to the increasingly popular 'farm-to-table' trend in Maryland. Other incentives are related to energy efficiency (including grant award for LED in greenhouses).

Maryland has several permits and practices in place in relation to water, nutrition rich wastewater discharge and use of pesticides, to protect nature, including the Chesapeake bay area. Environmental topics to which greenhouse CEA has a solid answer.

Unfortunately, overall wages are higher than surrounding states creating a competitive disadvantage for CEA production. Maryland has sufficient flat terrain.

Of the limited number of greenhouse operations in Maryland, some are high-tech and recently built/expanding, operating with advanced level of technology.

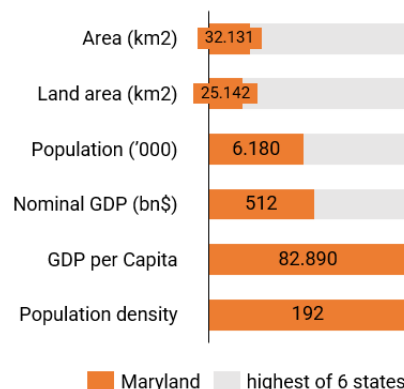
Opportunities for cooperation

Opportunities for business cooperation are relatively limited, given the limited presence of CEA greenhouse operations in Maryland. There are no active policies or incentives to attract sizeable CEA greenhouse operations, on the other hand CEA could provide an answer to some of the environmental challenges in Maryland.

6.2 About Maryland

Wealthy

Maryland lies at the center of the Eastern Seaboard, amid the great commercial and population complex that stretches from Maine to Virginia. Of all 6 states in this research Maryland is the smallest, but most densely populated and few miles from Washington D.C. It is a wealthy state with the highest GDP per Capita of all 6 states. It is home to several federal agencies.



Mostly flat landscape

The Eastern Shore, the area east of Chesapeake Bay, is flat with extensive wetlands. The maximum elevation there is 100 feet (30 meters) above sea level. The area west of the Chesapeake, the Western Shore, is mostly flat. Most of the Coastal Plain is farmland with small rural communities, except for the urban areas of Baltimore, Washington, D.C., Salisbury, and Ocean City.

Water pollution in the Chesapeake Bay is a key issue, although water quality is improving because of new regulations: all agricultural firms need to provide a Nutrient Management Plan and Pesticide Applicator License, in order control pesticide use as well nutrient- and waste discharge upstream of Chesapeake Bay.

Climate



Maryland has two climates. It is continental in the highland west, with temperature records from -40°C to more than 38°C . Average temperatures in western Maryland are 18°C in July and -2°C in January. The East has a humid subtropical climate strongly influenced by Chesapeake Bay and the Atlantic Ocean, both of which moderate the weather; summer calms can produce high temperatures up to 42°C , with nearly 100 percent relative humidity. Average temperatures in

eastern Maryland are 24°C in July and 2°C in January.

Technology savvy

Besides many federal agencies, Maryland is known for its biotechnology, aerospace, information technology, and other high-technology industries that made it one of the leading states in the knowledge- and information technology-based “new economy” of the late 20th and early 21st centuries.

6.3 CEA horticulture in Maryland

Historically there is mostly open field agriculture with large commodity crops like corn and soybeans, but also growth of strawberries and for example vineyards. Subsidies to stop tobacco made the Amish and Mennonite community in the southeast of Maryland to convert to vegetables using high tunnels.

As a small but wealthy densely populated state with sufficient flat terrain with a challenge on abundant clean water, Maryland is eligible for water efficient greenhouse CEA. However, Maryland has a quite ‘southern climate’, creating a summer challenge for some types of vegetable growing. Only up north-west of Maryland in the Apalachin mountains climate is cooler. Here one finds a major apple production area.

Like in other states, also in Maryland several new lettuce facilities have been built more recently (as from +/- 2019), both the greenhouse type and the indoor VF.

Labor is expensive in Maryland, given the competition with many other industries in the region and due to the ‘expensive H2A’ rules, creating a hurdle for (vegetable) greenhouse CEA.

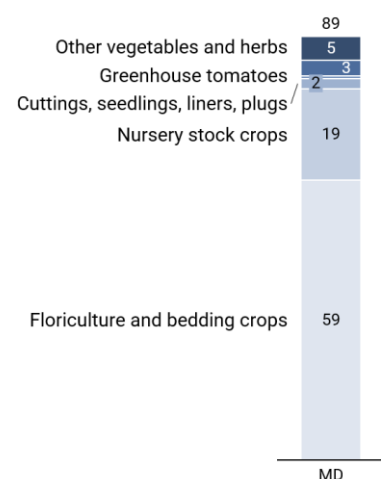


Chart: USDA 2022 Maryland
Total greenhouse area (hectares)

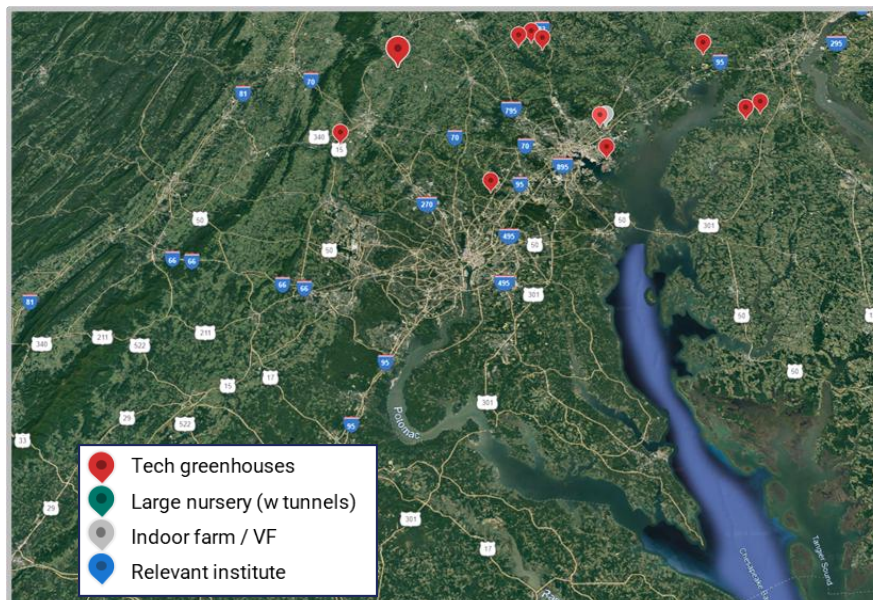
The 2022 USDA research update on protected horticulture in Maryland shows a similar view with total hectare adding up to 89 hectares for Maryland. The total protected area consists of many small growers and a few larger ones.

"Farm-to-table"

In Maryland there is an increased interest for local produce, the 'farm-to-table' is popular in restaurants and local markets. The "Maryland's Best" program helps that state's citizens find food products from local farmers and local seafood producers. It also acts as an educational tool where users can learn about the history and heritage of Maryland's agriculture and seafood industry. 96% of farms in the state are family-owned.

6.4 CEA acreage and crops in Maryland

The "qualifying" area of CEA in Maryland is limited. The few large growers are located in Maryland across the state. Several new facilities have been built as from 2019 for lettuce.



The qualifying greenhouses add up to approximately 40 ha. The main CEA production includes:

- 5 ha of leafy greens, herbs– 2 modern (recently installed) operations, 1 mid tech + high tech combined operation
- 29 ha Ornamental greenhouses, 8 operations: potted plants and bedding plant, mostly operations sizing up to 6 ha and one modern high tech greenhouse of 11 ha. Some of the facilities are also growing vegetables and herbs and/or are having an outdoor production area. The largest facilities are related to the van Wingerden family, leading the ornamental sector in multiple Eastern states.

There are a few large VF indoor operations (planned) for lettuce production, like Bowery.

6.5 Greenhouse technology in Maryland

The main crop trend is on lettuce, both high-tech greenhouse and indoor farming. How this will evolve is still a question mark, but there is a clear rationale of the lettuce production shift from outdoor California to indoor in the Eastern states, as elaborated in chapter 2. Another large-scale indoor farm (Infarm from Germany) was also planned, however may not be realized in the footlight

of its (partial) bankruptcy. Use of pesticides is a real hot topic as well as (genetic) research on resistances.

New environmental legislation may require the use of electrical energy for new equipment, banning fossil fuels. This may induce the need for new technologies.

6.6 Horticultural institutions and organizations

The Maryland organizations and events focus on horticulture in the broad meaning, there is no organization or dedicated education to greenhouse CEA.

University of Maryland

The University of Maryland's College of Agriculture and Natural Resources has 150 undergraduates' students and 59 graduate students in the Horticulture Department. One of the research area's is genetics and trans genetics on tomatoes.

The Maryland Nursery, Landscape, and Greenhouse Association (MNLGA)

MNLGA supports constituent groups of the horticulture industry, including landscape, garden centers, interior scape, soil maintenance, nursery, greenhouse, arboriculture, botanical gardens and other allied businesses. Since the start of MNGL in 1934 it did support, promote, and provide services and assistance to member businesses. The MNLGA also provides a unified voice of the industry, communicating to the public about the vital role of the green industry in its contribution to improving the quality of life. The members, over 300 people strong, enjoy the benefits of quality continuing education programs, publications, the Certified Professional Horticulturist Program, active lobbying program through the Maryland Green Industry Council (MaGIC), and much more.

Maryland Green Industry Council (MaGIC)

The Maryland Green Industry Council (MaGIC) is a coalition of associations, established in 2002, with the purpose to represent Green Industry interests in the legislative and regulatory processes in Maryland. These efforts include furthering the understanding of green industry issues among legislators, regulators, the governor's office, and consumers through education, promotion, expert advice and testimony.

6.7 Horticultural events

MANTS - Mid-Atlantic Nursery Trade Show. The Mid-Atlantic Nursery Trade Show (MANTS), held annually at the Baltimore Convention Center, is a horticulture industry event that focuses on nurseries. It is known as the "Masterpiece of Trade Shows" for the horticulture industry, showcasing plants, supplies, and technology. MANTS welcomes almost 1.000 exhibiting companies and over 11.000 paying visitors. It is hardly attended by Dutch technology exhibitors, while the many nurseries are predominantly outdoor operations.

6.8 Incentives and regulations in relation to greenhouse CEA

Incentives and regulations in relation to greenhouse CEA in Maryland support the local farm-to-fork and are there to protect nature.

Incentives for CEA horticulture (not limitative)

Maryland can also benefit from several federal and national grants and incentives, like the Specialty Crop Block Grant Program (SCBGP), however not necessarily dedicated to CEA. Some of the incentives may apply to CEA, for example those focused on energy efficiency (e.g., grant awarded for LED light in CEA).

In the context of “Farm-to-fork”, Maryland supports very small growers with very small amounts (up to \$1,000 per growing season): Governor announces launch of cover crop program supporting urban agriculture (09-2022), the Small Acreage Cover Crop Program. “Interest in small-scale and urban agriculture is on the rise, both nationally and here in Maryland,” said MDA Secretary Joe Bartenfelder (article Hortidaily). “In recent years, the department has seen a high demand for fresh, safe, locally grown food in communities statewide.”

Local regulations for (CEA) horticulture (not limitative)

There are multiple regulations on greenhouse growing in Maryland. Local Zoning requirements, Business License (Sales and Use Tax License) and a Water Appropriation Permit on well water using over 10,000 gallons per day. Many other licenses and permits are required such as Nutrient Management Plan, Pesticide Applicator License, Nursery Inspection Certificate, Spotted Lantern Fly Permit (required in most counties), Corporate Income Accounts with neighboring states if you sell your products there, UCR Account with neighboring states you transport your products through. If you are shipping outside of Maryland there are a few states that require a Certificate of Quarantine Compliance for Spotted Lanternfly, Japanese Beetle, and Spongy Moth. A new pest that may need compliance for 2025 is the Box Tree Moth. New environmental legislation may require the use of electricity on new equipment (ban on equipment using fossil fuels). New laws have been passed on the prohibition on growing various plants that may be considered invasive in Maryland. The use of various pesticides is a hot topic in Maryland.



7 CEA Horticulture in Virginia

7.1 Summary

Summary CEA trends

Virginia has the clear ambition to attract new CEA greenhouse operations and the VEDP (Virginia Economic Development Program) actively supports CEA (-related) companies to start operations/activities in Virginia. The 2022 USDA census adds up to 300 hectares mostly floriculture, bedding plants and nurseries. This research identified 90 hectare of qualifying operations, mostly large scale high-tech ornamental operations as well as a significant amount of new (high-tech) leafy greens greenhouse operations and indoor facilities. Most of the greenhouse activity is in the north-eastern part of Virginia (just below Washington D.C.). The climate of Virginia is not suited for conventional greenhouse tomato growing, unless the operation is located in the elevated area of the Appalachian mountains or the climate is mitigated with advanced greenhouse technology. Like all other states, availability of affordable labor is an issue.

In the view of Virginia, CEA provides a clear answer to environmental challenges in agriculture (clean water, pesticides). The other key CEA topics are sustainable substrates (instead of the synthetic foam oasis type of substrate), beneficial insects (in relation to the pesticide challenge) and clean renewable energy. Several incentives, grants, tax credits and workforce incentives are specifically available for new CEA greenhouse operations as well as general incentives supporting the Virginia economic- and environmental goals. The (new) Institute For Advanced Learning and Research (IALR) in Danville underlines the CEA ambition of Virginia.

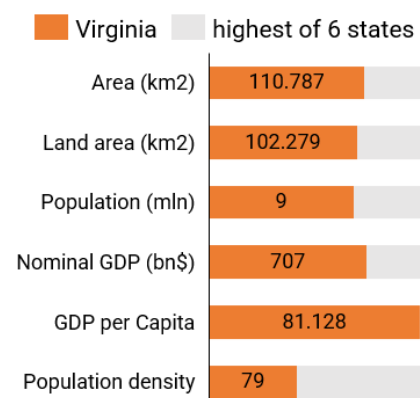
Opportunities for cooperation

There are several high-tech greenhouse operations in Virginia, especially on ornamentals and greens, matching the profile for a clear business fit with Dutch innovations. The active role of the VEDP and government creates an attractive environment for new greenhouse CEA operations. The VEDP actively links businesses (Dutch and US) for cooperation.

7.2 About Virginia

Centrally located

Virginia, officially the Commonwealth of Virginia, is a southeastern U.S. state, that stretches from the Chesapeake Bay to the Appalachian Mountains, with a long Atlantic coastline. 6,2 million of the 8,7 million people (71%) live in the North-East triangle area from Northern Virginia – adjacent to Washington D.C., Richmond and coastal counties of Hampton Roads. Virginia is near the major metropolitan areas in the eastern part of the US. From the 6 states in this research, Virginia has second highest GDP, after Maryland.



Economy

Virginia has several military bases, the CIA headquarters and the Pentagon. Virginia has a large technology sector. Computer chips became the leading export product from Virginia in 2006, surpassing tobacco and coal combined.

Agriculture occupied 31% of Virginia's land and provided about 381,800 jobs (VDACS, 2024). There were about 41,500 farms in the state, which occupied an area of about 8.1 million acres. Though the number of farms declines, the overall production increases. The main agricultural products in this state include poultry (broilers and turkeys, largest by far), cattle, dairy products, feeds and grains. Virginia is home to one of the leading turkey-raising operations in the country. Agricultural wastewater is a huge problem – with far too many nutrients/nitrates in the water.



Climate

Virginia has a humid climate with very warm summers and moderately cold winters. There is substantial regional variation in climate due to the state's diverse geographic elements. As a result Virginia has five distinct climate regions: Tidewater, Piedmont, Northern Virginia, Western Mountain and Southwestern Mountain.

7.3 CEA horticulture in Virginia

Virginia has a large outdoor agricultural industry, including 890 hectares of fresh market (open field) tomato production.

Most of the protected cultivation is ornamental, mainly consisting of many small-scale growers. Most of the protected cultivation is in foil tunnels according to USDA 2019, however there are a few large-scale high-tech modern ornamental greenhouses in Virginia. Virginia recently welcomed several lettuce facilities both greenhouses and indoor farms.

Significant part of the greenhouse vegetable production (tomatoes, herbs and others) is also small scale (USDA 2019): 45% of the operations -measured in hectares- are below 0,37 ha (40.000 sq ft).

Virginia Governor Youngkin as well as the Secretary of Agriculture and Forestry Matt Lohr are very much in favor of developing CEA in the state.

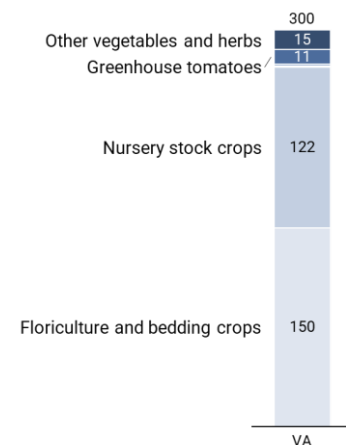
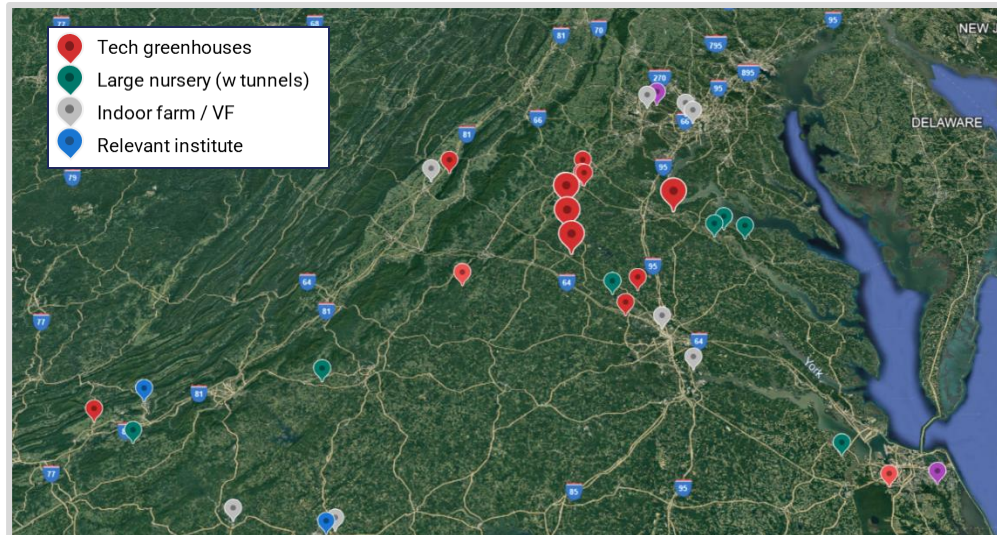


Chart: USDA 2022 Virginia Total greenhouse area (hectares)

7.4 CEA acreage and crops in Virginia

Virginia provides a mix of climates to accommodate different types of horticulture. With 'cooler' elevated flat land at the edge of the Appalachian Mountains and the warm southern part of Virginia to the coastal area.



The qualifying greenhouses add up to over 90 ha, of which most are in the upper part of Virginia. Main CEA production includes:

- 16 ha leafy greens – 6 operations typically up to 5 ha and mostly in northern part of Virginia
- 7 ha fruit vegetables (mainly tomatoes, some cucumber, peppers), in the mountain area due to the climate, the Red Sun Farms greenhouse (2014) on 650 m altitude
- 66 ha in 6 large operations – up to 20 ha - producing ornamental plants: potted plants and bedding plant, including large-scale high-tech operations like Bloomia and Costa Farms (former Battlefield Farms)
- 3 ha of seed growers
- Besides there are several new indoor farms, mostly leafy greens, like AeroFarms in Danville, and Babylon and Plenty near Richmond

7.5 Greenhouse technology in Virginia

Virginia has a rapid growth of especially the leafy greens production both in modern greenhouses and vertical farms. Several new (leafy greens) sites are recently being built (like Better Future Farms) or planned (amongst others like Sunny Farms). At the same time Whites Nursery & Greenhouses has been in the process of liquidating all its assets (mid/high tech) via auction running until July 1, 2024. Current (technology) topics in Virginia are diversification on varieties (micro tomato), replacement of oasis substrates (substrate waste), minimization of wastewater disposal (fertilizer waste), beneficial bacteria, and labor shortage/costs. Most topics are also relevant in the context of the Virginia Clean Economy Act (VCEA).



Example: Better Future Farms

7.6 Horticultural institutions and organizations

Virginia Tech

Within Virginia Tech, the School for Plant and Environmental Sciences combines several disciplines: horticulture, crop and soil environmental sciences and plant pathology, physiology, and weed sciences. Like other state universities, VT has the Virginia Cooperative Extension, providing research, support and training to the local agricultural communities.

IALR

The Institute for Advance Learning and Research (IALR) is a R&D partner for CEA companies. IALR, located in Southwest Virginia, is the only publicly funded CEA research and development facility in the U.S. that is not affiliated with a university. This provides the CEA industry access to high quality, customized research. Examples of Support Services include Plant Pathogen Services and Support, Bio-Stimulant Development, Contract Research, ISO Analytical Chemistry Services and Support.



IALR recently partnered with Virginia Tech to launch a Controlled Environment Agriculture Innovation Center (CEA-IC), utilizing technology and research to accelerate advancements, economic development, and regional participation in indoor farming.

7.7 Horticultural events

CEA Summit East

Ag-Con and the CEA-IC partnered to host the first annual CEA Summit East in October 2022 in Danville. The summit is designed to bring CEA industry leaders and academia together to build relationships, brainstorm business strategies, and share research to strengthen the industry. The summit is meant to serve as a conference, networking event, and business generator for individuals across the CEA industry.

7.8 Incentives and regulations for greenhouse CEA

Incentives for CEA horticulture (not limitative)

Virginia provides a broad range of state incentives applicable to CEA and focusing on creating jobs. A subset of relevant programs is listed hereafter:

Grants

- Governor's Agriculture and Forestry Industries Development Fund (AFID): AFID grants focus on new Virginia-grown agriculture. Grants may be used for a broad variety of purpose from site-acquisition to training.
- The Tobacco Region Opportunity Fund (TROF) focuses on revitalizing former tobacco regions (in South (West) Virginia), focusing on attracting new jobs and investments.
- The Commonwealth's Development Opportunity Fund (COF) is a fund used at the Governor's discretion to secure a company location or expansion in Virginia, with the objective of job creation and capital investment in return.

Tax incentives

- Virginia's corporate income tax is 6% and no unitary tax is levied on Virginia companies' worldwide profits.
- Tax incentives include: the New Company Incentive Program for a new company presence in Virginia providing modified state income tax; Agricultural Materials and Equipment Sales & Use Tax Exemption being available for tangible property to produce agricultural products (applicable for CEA equipment, facility, etc.); Major Business Facility Tax Credit incentivizing new FTE-job creation; R&D Expenses Tax Credits; Worker Training Tax Credit; Property Tax incentives.

Workforce incentives

- The Virginia Talent Accelerator Program, delivered by VEDP in partnership with the Virginia Community College System, provides training and recruitment solutions that are fully customized to a company's unique operations, equipment, standards, and culture. All program services are provided at no cost to qualified new and expanding companies as an incentive for job creation. The Virginia Talent Accelerator Program accelerates facility start-ups and expansions by expediting recruiting and shortening the new-hire learning curve.
- The Virginia Jobs Investment Program (VJIP) is a discretionary program that provides funding to companies creating new jobs or experiencing technological change to reduce the human resource development costs. It is available for new companies, expanding companies, and companies retraining their employees. Funding for each net new full-time job created or full-time employee retrained is based on a customized budget determined by an assessment of the company's recruiting and training activities, as well as the project's expected benefit to the Commonwealth. It is subject to approval by the Secretary of Commerce and Trade.

Local regulations for (CEA) horticulture (not limitative)

To protect nature and water, for example in relation to the Chesapeake Bay area water quality issue, Virginia has regulations in place on use/disposal of nutrients (disposal) in waste water and pesticides, administered by the DCR (Virginia Department for Conservation and Recreation. Please refer to introduction section on regulations.



8 CEA Horticulture in North Carolina

8.1 Summary

Summary CEA trends

With a long history in ornamentals, North Carolina is the second largest ornamental state after Ohio. Most of the 286 hectares (USDA Census 2022) is dedicated to floriculture and bedding plants. The many small farms in North Carolina are under pressure by severe competition from the few large-scale high-tech operations. From the 155 hectares of qualifying greenhouses, 135 hectares is dedicated to a few large-scale ornamental growers. Metrolina Greenhouses is heading the ornamental playing field in NC with over 80 hectares of high-tech highly automated greenhouse operation. The ornamental competition game is played on innovation, efficiency technology/automation and retail connection.

All greenhouse operations in North Carolina are clustered around Asheville, on an elevated plateau with a 630m altitude, and around Charlotte. There are only a few non ornamentals high-tech (new) operations, one growing leafy greens, one growing tomatoes, one growing strawberry plants (who recently took over the 7 ha brand-new bankrupt Lakeside Produce facility), while the remaining others are specialty operations on biotechnology and specialty grafted plants.

Despite the lack of dedicated CEA greenhouse (technology) incentives, the general incentivization in North Carolina on energy efficiency and economic development may also apply to greenhouse CEA solutions and technology. There is an incentive to attract biotech.

The CEAg event (August) in Raleigh brings together CEA tech-suppliers including several from the Netherlands.

Opportunities for cooperation

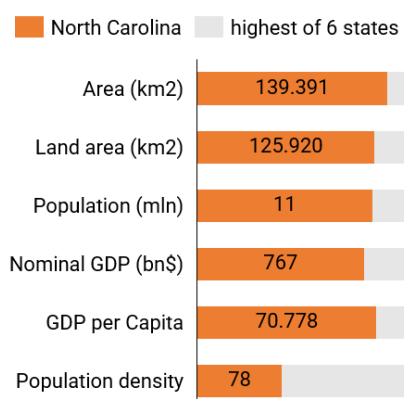
Advanced technology is a major theme in North Carolina since ornamental growers focus on effective sales and efficiency operations investing in high-tech facilities. The link with Dutch technology ranges from greenhouse automation to irrigation booms, end-to-end process automation, innovative pest management, and for example the application of vision technology in the different aspects of growing and selecting.

8.2 About North Carolina

Broad based economy

North Carolina, located in the southeastern United States, has a diverse geography that ranges from the Atlantic Ocean coastline in the east to the Appalachian Mountains in the west. The state's topography includes coastal plains, rolling hills of the Piedmont region, and mountainous areas, providing a variety of landscapes.

Many industries and abundant natural resources characterize North Carolina's economy. The state's major sectors include manufacturing, agriculture, technology, finance, healthcare, and tourism. Manufacturing is a key



industry in North Carolina, with the aerospace and defense, automotive, biotechnology, textiles, and furniture industries being significant contributors.



Climate

The climate in North Carolina varies significantly across its regions. The coastal areas experience a humid subtropical climate, characterized by hot, humid summers and mild winters. In contrast, the mountainous regions have a more temperate climate, with cooler summers and colder winters. There, in the area around Asheville is an elevated plateau on around 630 meter of altitude housing multiple greenhouse

operations. East of the route 95 there is an increased risk of hurricanes.

Century family farms

The agricultural sector is a firm but small part of the state's economy. Most of the farms in the state are owned by families. More than 1,600 farms throughout North Carolina are considered "century farms," or farms that have been owned by the same family for more than 100 years. North Carolina is the leading grower of sweet potatoes, tobacco, beans, poultry, and pork.

8.3 CEA horticulture in North Carolina

North Carolina has a strong history in ornamentals and after Ohio, North Carolina is largest in ornamentals, hosting a few large-scale high-tech greenhouse operations.

North Caroline is the home of one of the largest US ornamental grower families, the Van Wingerdens, with family branches having facilities all over eastern US.

Whereas the large scale high-tech ornamental operations serve the retail market with products from their professional automated efficient operations, the many "mom-and-dad" operations are struggling, not being able to compete with the big ornamental companies. Especially the increasing cost of labor imposes a continuity risk for these small farms.

Because of the above, a lot of consolidation is going on in the ornamental nurseries, fueled by the belief that overall the market for ornamentals will remain stable.

In addition to the high and mid-tech greenhouse operations in North Carolina, there are also several large scale outdoor/tunnel nursery operations.

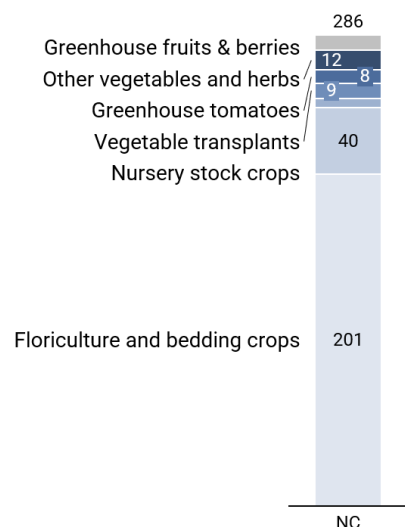
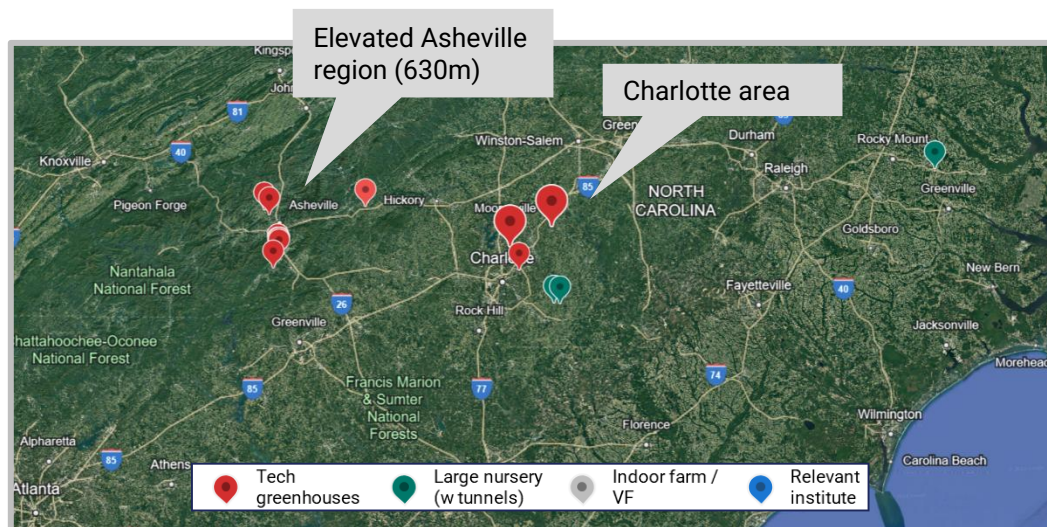


Chart: USDA 2022 North Carolina
Total greenhouse area (hectares)

8.4 CEA acreage and crops in North Carolina

Most of the qualifying greenhouses in North Carolina are clustered in the elevated area in the Appalachian mountains on an altitude of 600-700 m near Asheville and around Charlotte. The elevated Asheville / Mill River area qualifies for the high amount of sunlight during the winter months, mild summer temperatures and its central location for east coast shipments.



The qualifying acreage adds up to 155 ha:

- 3 ha Leafy greens – being 1 modern (recently installed) operation.
- 135 ha ornamental plants greenhouse operations, 6 key players, producing annuals, perennials, shrubs & trees. Large-scale high-tech operations are typically 10-20 hectares each, the largest is Metrolina with 80 ha, a high-tech operations that is innovative and leads the US floriculture industry in research & development, marketing, innovation and retail partnerships.
- 14 ha food related greenhouses consisting of 1 vegetable- and 1 berry operation. Nourse Farms, a berry plant propagator, has recently taken over the brand new 7 ha Lakeside Produce facility following its bankruptcy.
- 3 ha others: 0.67 biotech greenhouse, developing genetically-engineered potatoes and corn, and 2.2 ha specialty grafted plants.

8.5 Greenhouse technology in North Carolina

The large-scale ornamental farms are mostly well equipped. The Metrolina greenhouse for example is highly automated, with all the bells and whistles imaginable, from the seeding process to automated greenhouse transport systems. The route to compete for the large ornamental companies is on innovation and (further) automation technology, whereas labor costs is the biggest issue. There is an increasing interest in and application of beneficials.

8.6 Horticultural institutions and organizations

NCSU North Carolina State University (NC State)

NC State is a leading research institution. Through its Department of Horticultural Science and the JC Raulston Arboretum, NC State offers cutting-edge research, hands-on learning, and outreach initiatives, advancing sustainable practices and innovation in horticulture. NC ST currently has its highest undergraduate & graduate students' enrollment in Horticulture in the history of the university: 191 undergraduates and 62 graduate students.

North Carolina Cooperative Extension: This is part of North Carolina State University, it provides resources, workshops, and support for horticulture practices across the state. The Cooperative Extension also tests and introduces new tomato varieties to the state farmers.

North Carolina Biotech leads life science economic development for North Carolina. They help advance ideas from research to marketplace, overcoming all of the challenges in between, to transform businesses, technologies, professionals and whole sectors related to life science. They support with innovation, commercialization, education and business growth.

North Carolina Green Industry Council

The council promotes the interests of the horticultural and landscape industry in North Carolina through advocacy and education, though mostly focused on turf.

North Carolina Nursery & Landscape Association (NCNLA)

A professional trade organization dedicated to the advancement and enhancement of the nursery and landscape industry in North Carolina.

8.7 Horticultural events

CEAg World Conference Expo taking place on August 26-28, in Raleigh

The CEA World Conference and Expo took place August 26-28, 2024, in Raleigh, North Carolina, USA. The 2024 event was attended by several (advanced) Dutch technology providers. This new event will bring together the growing CEA ecosystem, with an event serving the broad spectrum of sectors around food production under cover, including traditional outdoor farms utilizing protected cropping systems (for example hoop houses, netting, and/or tunnels), greenhouses, vertical farms, urban agriculture ventures, aquaponic operations, and more.

8.8 Incentives and regulations in relation to greenhouse CEA

Incentives for CEA horticulture (not limitative)

North Carolina has various government incentives and programs to attract and support companies, also applicable to greenhouse horticulture. These incentives are designed to promote amongst others energy efficiency and economic development. Incentives and programs include:

- North Carolina Agricultural Development and Farmland Preservation Trust Fund (ADFPTF): This fund provides grants to support agricultural development and farmland preservation projects.
- North Carolina Department of Agriculture and Consumer Services (NCDA&CS) Grants: The NCDA&CS offers various grants and cost-share programs to support agricultural projects. Examples include the Specialty Crop Block Grant Program and the Agricultural Water Resources Assistance Program (AgWRAP).
- The Rural Economic Development Division (REDD) Programs: The North Carolina Department of Commerce's REDD offers several programs to support economic development in rural areas.
- Energy Efficiency Incentives: Programs such as the North Carolina Renewable Energy Investment Tax Credit (REITC) and incentives from utility companies like Duke Energy offer financial benefits, e.g. for implementing energy-efficient systems in greenhouses.
- North Carolina Biotechnology Center (NCBiotech) Grants: NC Biotech offers grants and loans to support biotechnology-related projects
- USDA Programs: Federal programs administered locally, such as the Environmental Quality Incentives Program (EQIP) and the Rural Energy for America Program (REAP), provide

financial assistance for implementing conservation practices and renewable energy systems

- Local Government Incentives: Various counties and municipalities in North Carolina may offer tax incentives, grants, and other support for agricultural businesses, including greenhouses. These incentives vary by location and may include property tax abatements and infrastructure support.

Local regulations for (CEA) horticulture (not limitative)

North Carolina regulations for CEA –besides the general business regulations on food safety, land use regulations, utilities, and (building) permits, worker permits), can include like other states regulations on water usage & rights, wastewater, storm water management, pesticide use, energy efficiency (especially for artificial light and heating/cooling) and for transportation of agricultural products.



9 CEA Horticulture in Georgia

9.1 Summary

Summary CEA trends

Georgia is the most southern state of the 6 states with a large agricultural sector. Greenhouse CEA in Georgia adds up to 213 ha according to USDA Census 2022, mostly small-scale floriculture and bedding plants operations and nurseries. Greenhouse propagators, producing transplants for vegetable growing, is a significant share of the Georgian greenhouse operations. Propagators are also promoted by the UGA Extension. Their extension programs are related to the state universities providing knowledge and education to local farmers.

Qualifying greenhouses in Georgia total 45 ha and are predominantly located in the northwest of Georgia in proximity of Atlanta. Most of the greenhouse acreage is used by ornamental operations with mixed mid- and high-tech greenhouses. Like other states, the large-scale ornamental operations have adequate technology to match the regional climate for year-round production. The biggest facilities have greenhouse equipment for seed-to-plant automation creating efficient operations.

Of all the states, Georgia has the most (new) leafy greens farms, in total 5 greenhouses and several indoor facilities. There is 1 large scale tomato grower in Georgia with 10 ha greenhouses, and a one leading vegetable propagator.

Incentives for business in Georgia include job tax credits, related to employment, and state tax exemption for high-tech companies. CEA might qualify for the USDA loans on “climate-smart agriculture”.

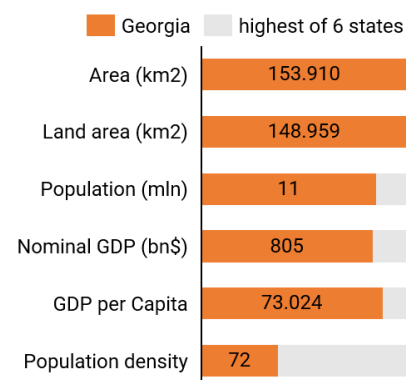
Opportunities for cooperation

New leafy greens facilities provide new business opportunities in horticulture, like the 4 ha BrightFarms facility built in 2024 by a Dutch greenhouse builder. The only vegetable tomato produce operation is state-of-the-art and the mentioned propagation facility uses automated benches, all together a suitable basis for further Dutch innovations. Overall, not too many CEA greenhouses, but still relevant for potential Dutch cooperation.

9.2 About Georgia

Powerful economy

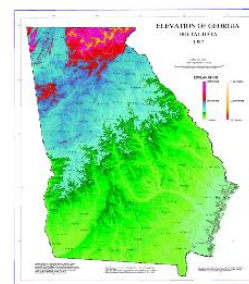
Georgia is the most southern state in this research. Typically, there's Georgia and there's Atlanta. There are 16 Fortune 500 companies with headquarters in Georgia, including Home Depot, UPS, Coca-Cola, TSYS, Delta Air Lines, Aflac, Southern Company, and Elevance Health. Georgia hosts the world's busiest airport Atlanta and the Port of Savannah is the fourth-largest seaport and fastest-growing container seaport in North America.



Still agriculture is the driving force for local economies across Georgia, headed by broilers and eggs, accounting for over 40% of the commodities by value, followed by– to a lesser extent- cotton, peanuts and timber. Leading industries include food processing as well as the production of textiles and apparel (historically large, but textile industry moved mostly overseas), paper and lumber.

Varied landscape

In the northwest corner of the state is the Appalachian Plateau. East and south of the Plateau region is the Valley and Ridge region, which has steep, rocky ridges above fertile valleys. In the northeast corner of the state are the Blue Ridge Mountains, with Georgia's highest peak soaring to 1,458m. The center of the state is the Piedmont region, with valleys, low hills, and forests full of oak, hickory, and poplar trees. To the south is the Atlantic Coastal Plain (colored green in the elevation chart on the side), with rivers, waterfalls, and beaches. It's also home to the 700-square-mile Okefenokee Swamp. Full of twisting waterways, cypress trees, and alligators, the swamp is the largest in North America.



Climate

Maritime tropical air masses dominate the climate in summer, but in other seasons continental polar air masses are not uncommon. The average January temperature in Atlanta are 6 °C, in August it is 26 °C. Further south, January temperatures average 12 °C, but in August the difference is only about +2 °C (28 °C). In northern Georgia precipitation is more evenly distributed throughout the season, usually

averaging from 1,270 to 1,524 mm annually. The east-central areas are drier, with about 1,118 mm, mostly in summer rains.

9.3 CEA horticulture in Georgia

Georgia has a large ornamental and outdoor vegetable sector (ranked 4 and 5 in commodity totals). Vegetables are headed by corn and onions, outdoor fruit, vegetables- especially bell pepper, and tomatoes and cucumber to a lesser extent. Georgia is a top five blueberry producer in the United States.

Greenhouse CEA presence is relatively limited. The far majority of the greenhouses is plastic film covered type or tunnel greenhouse, assigned to ornamentals, mostly in small operations. There are a few large nurseries across the state, in basic covered operations as well as high-tech greenhouses. Greenhouse propagation is getting more popular, promoted by the UGA Extension.

In the recent years several (large) new indoor facilities and greenhouses were built and several are planned or said to be built shortly. The indoor facilities

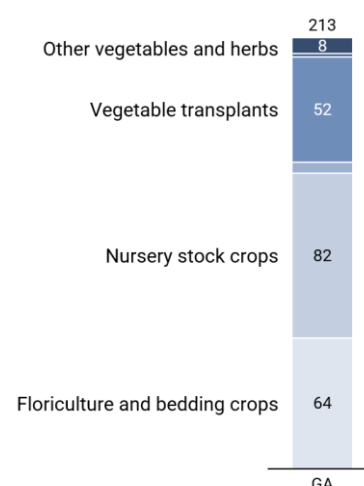


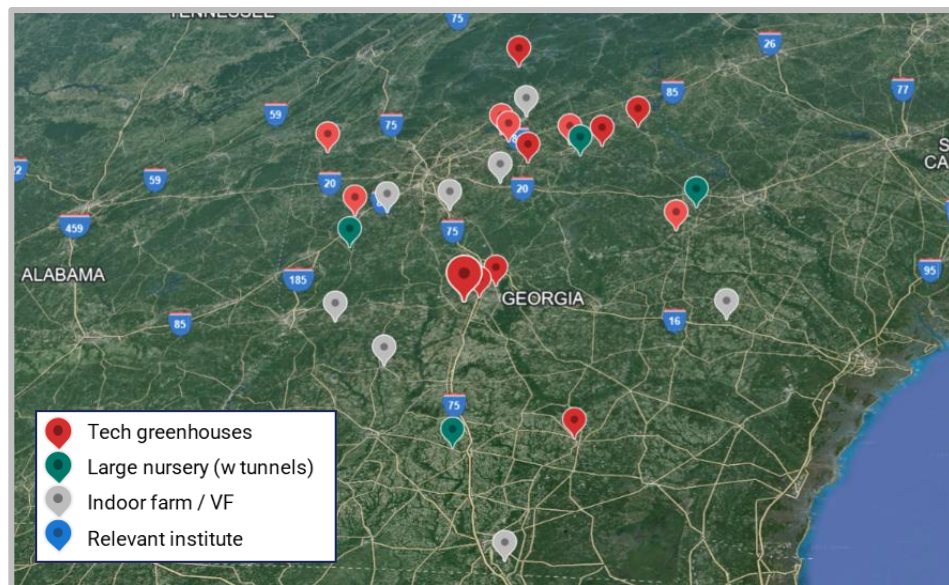
Chart: USDA 2022 Georgia Total greenhouse area (hectares)

comprise existing buildings and newly built production facilities, all dedicated to leafy greens and herbs.

Increasing cost of labor is major issue in Georgia, especially in relation to the H-2A program. Whereas ornamental growing on a small scale is still profitable, small scale vegetable growers are under pressure.

9.4 CEA acreage and crops in Georgia

Georgia is typically an agricultural state, with limited greenhouse CEA presence. Qualifying greenhouse CEA is mostly concentrated around Atlanta, in the North-East part of Georgia and the cities of Macon, Tifton and Augusta.



The qualifying greenhouses add up to 45 ha. Main CEA production includes:

- 12 ha leafy greens – being 3 high-tech (recently installed, being installed) operations and 2 multi span operations.
- 19 ha ornamental greenhouses: 5 mid- / high tech operations with potted plants and bedding plant, ranging from 1 to 10 ha. Some of these facilities also grow vegetables and herbs. The largest facilities are related to the Van Wingerden family, leading the ornamental sector in multiple Eastern states.
- 13 ha of food greenhouses, 2 vegetable operations: one tomato growing (started operation 2019) and one high-tech propagator (vegetable & ornamental).

9.5 Greenhouse technology in Georgia

Recent leafy greens/lettuce farms are high-tech, having advanced- and latest available technologies. Most large leafy greens players have a facility in Georgia, like Revol Greens (former Living Fresh), BrightFarms (planned 2024), Gotham Greens (2023), Local Bounti. Besides a greenhouse farm setup, several indoor (vertical) farms are present or planned, in leafy greens or mushrooms (2023, Candler County), Bowery (2022/23), 80 Acres (2022/23), saying to build another 200,000 sq ft. indoor facility in Georgia in 2024, as well as the planned 31,200 m2 Hardy Fresh (Late 2024). The only tomato grower has a 10 ha high-tech Venlo greenhouse (built 2018), whereas the

3 ha vegetable & ornamental propagator has a glass covered greenhouse setup. The latter even has a moving bench internal transport system. Ornamental growers typically have a mix of polytunnel and some older glass greenhouses.

9.6 Horticultural institutions and organizations

The Georgia organizations and events below have a broad agriculture focus, not limited to greenhouse horticulture.

University of Georgia

The UGA main campus is located Athens. UGA has several locations, including Griffin and Athens. In Athens is the department of Horticulture, with topics including plant breeding, genetics, controlled environments, plant physiology, etc.

The Georgia Fruit and Vegetable Growers Association, GFVGA

The GFVGA provides programs and services to the “Southeast Specialty Crop Farmers” designed to increase production efficiencies, to provide educational opportunities, to promote new markets, to monitor legislation, to encourage applied research and to improve communications between GFVGA members and industry suppliers.

The Georgia Green Industry Association, GGIA

GGIA is the statewide umbrella association for the entire ornamental/environmental horticulture industry.

9.7 Horticultural events

The Southeast Regional Fruit & Vegetable Conference is a main fruit- and vegetable AG event. It is held in early January each year. Besides being mainly a trade show, the event also focuses on education “Anything that you need to know about what you’re supposed to be doing as a grower, you can learn here”.

9.8 Incentives and regulations in relation to greenhouse CEA

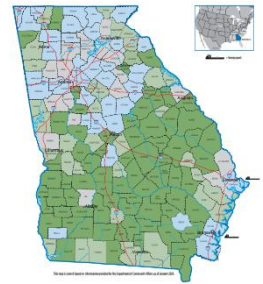
Most Georgia state incentive programs are focused on agriculture in broader context. Programs are facilitated by the Georgia Department of Economic Development / Georgia Center of Innovation.

Incentives for CEA horticulture (not limitative)

The Farm Service Agency in Georgia offers loans in the context of the Farm Loan Programs (USDA), described in chapter 2, to help farmers and ranchers get the financing they need to start, expand or maintain a family farm .

Besides the agricultural and USDA programs, the Georgia Department of Economic Developments provides several incentives to support doing business in Georgia, some examples:

- Low tax rate, and tax obligation is based on one factor: your sales inside Georgia.
- Job tax credits and other incentives, ranging per county, up to \$4,000.00(dark green area on chart)
- Georgia Tax Exemptions: high-tech companies qualify for state tax exemptions



Local regulations for (CEA) horticulture (not limitative)

Similar to the others states, regulations may apply especially in relation to water usage & rights, wastewater, storm water management and pesticide use. Other general permits and regulation as mentioned in previous chapters may also apply (for example building permits, business licensing and H2-A labor regulations).

10 Summary and conclusive remarks

10.1 Strong differences in CEA between the states

All six states differ significantly in scale and composition of the greenhouse CEA. There are large differences in the qualifying area of greenhouses, size of operations and technology level.

Ohio greenhouse CEA is reasonably balanced between ornamental and new vegetable greenhouses, and leading the 6 states in size with 240 qualifying hectares. Several nationwide large growers have large facilities in Ohio. Ohio CEA is technology savvy and a good match for Dutch technology. An interesting state to collaborate with/become involved.

Pennsylvania greenhouse CEA is modest with 50 ha. Most of the greenhouses operations are small, farm facilities and the scale are smaller than most other states. The opportunity for cooperation with Pennsylvania businesses is limited, though the Center for Agricultural Research at Harrisburg University is working to change this towards the future.

Maryland hosts several ornamental greenhouse facilities and smaller operations for leafy greens & herbs, adding up to 40 hectares. Labor is expensive in Maryland. The cooperation options with Maryland are limited.

Virginia is a state leader in the USA when it comes to cut tulips (Bloomia) and leafy greens. This state all together accommodates over 90 hectares of qualifying greenhouses. Virginia takes a very active and supportive role in attracting CEA greenhouse operations, also shown by the establishment of the new IALR institute. An interesting state to collaborate/become involved.

North Carolina is a top 10 horticulture state in sales revenue. North Carolina is home of Metrolina Greenhouses (84 ha site), an industry-leading wholesale greenhouse producer of ornamental plants. With in total 155 hectares, mostly ornamental, NC hosts an attractive and stable market for technology intensive greenhouses.

Georgia accommodates the largest acreage of leafy-greens & herbs farms of all investigated states, hosting most of the national leafy greens companies, both in high-tech greenhouses as well as in indoor farms. Although the overall qualifying greenhouse area of 45 hectares is modest, the recent settlement of the many leafy greens activities is interesting.

10.2 CEA clusters only near lake Erie and North Carolina

One of the research questions in the assignment was whether there are typical agglomerative clusters of CEA in the US. Contrary to typical clustering in some regions in Europe, we see in the US mostly isolated CEA operations. Three exceptions are the CEA cluster in Ohio near lake Erie, opposite Ontario, and the -mainly ornamental- clusters in North Carolina in Asheville and Charlotte.

Beyond these clusters, the distances between the CEA sites in US impose a different approach on hardware support services, generally driving greenhouses to have own spare parts of specialty components and service engineers being flown in.

10.3 Historically mainly ornamental, high-tech vegetable CEA growing

Historically the application of CEA greenhouses in the 6 states was mainly on ornamental horticulture, mostly mixed operations e.g. for the production of potting- and bedding plants, which is a large segment in the US. Vegetables, such as tomatoes and lettuce, used to be grown outside and, if in greenhouses, in Canada and Mexico.

Most large ornamental greenhouse operations have modern technologies installed and appetite to keep up with technology developments. This creates an interesting opportunity for US-NL cooperation.

In the past 10 years the amount of sizeable vegetable greenhouse operations has strongly increased in the 6 states, now consisting of several large scale tomato greenhouses and multiple greenhouse lettuce facilities. All these modern operations have a one-on-one technology fit with Dutch technology suppliers, making them attractive partners for US-NL cooperation.

10.4 Trend on 'local' east coast production with CEA

A large number of new high-tech greenhouse- and indoor facility are (being) built for leafy greens and herbs in most of the 6 states induced by shift of the -water shortage threatened- California outdoor lettuce production to CEA production locations on the East coast. Besides this 'climate' driven shift, "Farm-to-table" gains popularity. The "Maryland's Best" program is a good example connecting local producers to consumers.

10.5 Climate limitations on conventional year round produce southwards

Going southward along the east coast, the summertime temperatures increase. The states as from Virginia and southward have a humid subtropical climate (Köppen Climate Classification), with going south increasingly warm summers. This imposes limitations to conventional year round growing of some crops, like tomatoes, explaining the limited number of CEA salad vegetable growers going southward. On the other hand this can be an opportunity for the Dutch (closed and/or cooled) greenhouse technologies, when regional presence is crucial for growers.

10.6 Government incentives vary by state

There are several incentives for CEA growers to invest in technology advancement as well as for new businesses that want to open an office in one of the states, creating jobs. The incentives though strongly differs between the states, both on the level of the USDA programs, that target particular states or counties, but even more on state level, where regional state development organizations play a strong role. The incentives would not necessarily be the main driver to do business in a state, but can provide (additional) funding for new technologies.

10.7 What's the opportunity for Dutch companies – the Dutch Fit

In the 6 states, we see a recent increasing vegetable presence in CEA, both on lettuce- and salad vegetables (e.g. tomatoes). All 6 states are well connected to the large consumer metropolitan area's in east US. For Dutch business it is not necessarily the state that determines the attractivity, but mainly the leading entrepreneurs that generally operate across multiple states.

Reflecting on the full range of Dutch CEA technologies, the existing high-tech operations in the 6 states are interested in and open for Dutch innovations, technology and solutions. The same accounts for the large scale ornamental operations, currently mainly present in Ohio and North Carolina. The technology match includes for example greenhouse infrastructure, greenhouse automation, climate control, as well as technologies and solutions in the field of internal transport systems, AI based control, (harvest) robotization and new disinfection- and pest management solutions.

The current focus on new projects is mostly on indoor/greenhouse lettuce investments: In all cases it is relevant to review the customer's specific business model and retail connection. In cases where one of these two lacks, it is difficult to establish new businesses, as frequently mentioned in the conducted US interviews.

The CEA in US (and Canada) is increasing and matured over the past decade(s), also accommodating more domestic suppliers and technologies and becoming -technologically wise- more self-sustainable as a sector. This may impose a necessity for Dutch companies to adjust their business approach from a traditional export oriented supplier model to a more local engagement and presence, for example either with own (production/development) facilities or by cooperation with US horticultural technology companies. There is a strong US interest – as mentioned in the interviews - to secure sustainably knowledge transfer to US. This allows Dutch companies to stronger benefit from the opportunities in the US by establishing strong alliances with local technical partners ("Dutch knowledge is at a premium right now", but must be secured by long term knowledge accessibility).

10.8 Comparison table of the 6 states

In the comparison table on the next page, we compare the following elements to come to an 'attractivity' ranking from 1 to 6 for the states, where predominantly the amount of 'qualifying' hectares and overall tech level are considered most important for the business fit with Dutch companies:

- Greenhouse hectares (2022): USDA estimation of greenhouse hectares. This figure indicates the magnitude of CEA in the state, but includes many small greenhouses, in some states the far majority. It is not considered a good measure for the attractivity for Dutch technology cooperation.
- Hectares mid-/high tech: the number of 'qualifying' hectares, indicating the magnitude of greenhouse acreage eligible for cooperation.
- Number of qualifying companies and average size (hectares/company): similar to the 'qualifying' hectares, this provide an indication of the addressable greenhouse market.
- Share of ornamental: provides a view on the state mix of CEA differentiation between ornamental and vegetable produce.
- Overall tech level (1..5=high): provides a judgement score of the tech-savviness of the greenhouse companies.
- CEA focused state development programs (score 1..5=attractive): provides a judgement score of the pro-activity of the economic development agency and other organizations on developing CEA.
- Key drivers and key opportunities for Dutch growers: key takeaways from the research on each state.

Table: Comparison of the 6 states

							
State Greenhouse figures	OH	PA	MD	VA	NC	GA	Total
Greenhouse hectares (2022) ¹	403	299	89	300	286	213	1.590
Hectares mid-/high tech ²	240	49	37	91	154	44	616
Number of qualifying companies	27	13	11	14	12	12	89
Average size	8,9	3,8	3,4	6,5	12,9	3,7	6,9
Biggest mid/high-tech grower	Green Circle Growers	Little Leaf Farms	Catoctin Mountain Growers	Battlefield Farms, Inc	Metrolina Greenhouses	Pure Flavor	
Share of ornamental	64%	78%	49%	72%	87%	44%	70%
State comparison							
Overall tech level (1..5=high)	5	2	4	4	5	4	
CEA Focused state development programs (score 1..5=attractive)	4	3	1	5	2	4	
Key drivers for future development	Presence of leading growers and sizeable operations	Many small growers, limited attractiveness for large scale	Limited attractiveness: Labor in MD is even more costly than other states	Active VEDP, leading ornamental growers, many new leafy farms	Presence of leading ornamental growers competitive market	Many leafy & herbs farms (soon) in operation	
Key opportunities for dutch growers	In all segments, great appetite for technology	Opportunities in near future are limited	Opportunities in near future are limited	Mainly leafy and ornamental, VA is CEA focused: a state to watch	Ornamental competition is based on technology advantage	Mainly -high tech- leafy and ornamental	
RANK		6	5	3	2	4	