

Assessing Opportunities for Commercial Greenhouse Development in Brunswick County

PREPARED BY: THE VIRGINIA TECH OFFICE OF ECONOMIC
DEVELOPMENT

Acknowledgements

This report was prepared by the Virginia Tech Office of Economic Development, www.econdev.vt.edu. The Office of Economic Development (OED) connects Virginia Tech faculty, companies, and communities in ways that help create, retain, and enhance the quality of jobs and opportunities around the Commonwealth. OED provides training, applied research, and technical assistance services to increase clients' abilities to prudently manage economic change and improve their quality of life. Examples of such services include completion of feasibility studies, economic impact analysis, industry and occupational analysis, strategic planning and community visioning, and performance management and benchmarking studies. OED faculty and staff who contributed to this report include Ebonie Atkins, Patrick Burke, Sarah Lyon-Hill, Frances Dowd, and Scott Tate.



The Brunswick County Industrial Development Authority commissioned the report and contributed input and assistance throughout the process. Numerous individuals and organizations contributed information, resources or assistance through survey responses and individual discussions.

Executive Summary

Brunswick County is interested in the feasibility of enhancing its economy through continued development of value-added commercial vegetable food production opportunities. The Brunswick County Industrial Development Authority (IDA) commissioned the Virginia Tech Office of Economic Development (OED) to conduct an opportunity analysis and preliminary feasibility report related to the potential for developing commercial greenhouse facilities in Brunswick County that create jobs, generate revenue, and result in positive returns on public investment.

While a commercial greenhouse venture could take a number of forms, OED identified three primary avenues through which the County might consider supporting commercial greenhouse venture development:

- 1.) Development of a smaller scale greenhouse facility or complex to support existing local producers and expand the capacity of the local and regional food system.
- 2.) Working with local investors/entrepreneurs such as Eco-Industries to develop a new business enterprise centered around an industrial-scale greenhouse facility.
- 3.) Identifying sites and conducting recruitment activities to attract an outside company to locate an industrial-scale greenhouse facility to the county.

OED collected quantitative and qualitative data to explore the viability of these approaches.

Pathway 1: Agriculture remains critical to the County's future economic vitality and there are signs of growth in the crop production sector. The increasing demand for locally grown and regionally identifiable food offers multiple economic opportunities for agricultural producers, associated industries, and entrepreneurs.

From OED's initial outreach to existing greenhouse operations in both Brunswick County and the larger region, there does not appear to be an existing greenhouse business with the current interest or capacity to shift into a higher growth mode and gradually develop into a larger-scale commercial operation. OED has also contacted a small number of regional local food system stakeholders. There does not appear to be a pressing need or active discussions concerning smaller-scale greenhouse facility development for strengthening the food system.

The study recommends that the IDA defer any further exploration of this option until a specific project is proposed by local stakeholder organizations or producers with a viable business plan. However, given the importance of agriculture to the County's economy, OED recommends conducting a county-based agriculture and local foods stakeholders meeting to identify current assets, challenges, and opportunities for enhancing the agriculture sector and the local foods economy.

Pathway 2: Virginia Eco Industries, LLC, is a county-based corporation that has proposed the construction of a large-scale greenhouse facility. The entity's principals have invested time and resources in exploring development of 100 acres of modern, high-technology greenhouse structure and equipment. The nearest recent national comparable for that size in terms of required investment is Nature Fresh Farms in Ohio at 175 acres. The project generated 300 jobs and required a \$200 million investment. Red Sun in Dublin, Virginia is a state comparable with 18 acres in its Phase I project, creating 100 jobs, and requiring \$30 million in total investment.

Large-scale projects of the type envisioned by Virginia Eco Industries are capital intensive and necessitate large-scale private investment. Greenhouse ventures are considered high risk investments by lending institutions. The failure rate for new greenhouse ventures is high and mirrors the 80 percent failure rate (firms that fail to stay in business five years) of most start-up businesses. Eco Industries has not developed a detailed business plan and the proposal does not appear to include plans for operations, so it is less clear if Virginia Eco Industries is prepared to undertake the ongoing management and operations of a facility. In addition, construction capital and operating funds sources were not identified. It is unclear how much of their own capital would be invested in the project.

The report recommends deferral of any county-based support of the Eco-Industries proposal until such time as a business plan is produced that more precisely identifies sources and amounts of start-up capital and more specifically delineates an operating entity, and includes expenses and revenues projections. It is also suggested that the IDA help refer Eco-Industries to expert resources for business planning assistance.

Pathway 3:

Brunswick County has a number of assets that would make it an appealing location for an industrial-scale commercial greenhouse development including access to major transportation routes, abundant site options, and access to water. Both nationally and in Virginia, the trends appear to indicate a short-term expansion in facilities, production, and sales for greenhouse growers. Virginia has seen some recent, larger-scale commercial greenhouse operations developed by private operators and investment, but also supported by modest state and local government financial incentives.

Of the three avenues, this seems to offer the most promising returns for the County in terms of impact. Brunswick County IDA should consider identifying possible sites and conducting recruitment activities to attract an outside company to locate an industrial-scale greenhouse facility to the county. While this avenue is promising, the infrastructure and other associated costs may be substantial and the County should engage with VEDP or a consultant organization to conduct an ROI analysis on any proposed county investment for land, site improvements, infrastructure, and company incentives.

Introduction

In February 2015 the Brunswick County Industrial Development Authority (IDA) commissioned the Virginia Tech Office of Economic Development (OED) to conduct an opportunity analysis and preliminary feasibility report related to the existing utilization, market potential, and expected feasibility of county-based greenhouse ventures. Brunswick County is interested in enhancing its economy through continued development of value-added commercial vegetable food production opportunities.

A large-scale commercial greenhouse operation has been proposed as one option, specifically for the opportunities greenhouses provide in extending the growing season and enhancing the seasonal capacity of local agricultural production. Relatedly, one or more existing commercial greenhouse facilities already exist but may be underutilized. It is proposed that a county-based greenhouse venture may help expand the local economy.

This feasibility report includes the following five sections:

- *Agriculture overview (Supply & Contextual Analysis)* – Data overview of existing farming and crop-related production in the county and surrounding region.
- *Assessment of existing greenhouse operations* – inventory and survey of existing operations and their types in the county and surrounding region.
- *Market data* – an analysis of market potential for greenhouse vegetables, including national and global data.
- *Comparative Analysis* – a discussion of recent commercial greenhouse ventures in Virginia and the United States.
- *Considerations for proposed commercial greenhouse operations* – discussion of factors to consider when assessing new venture development and preliminary feedback on existing project proposals.
- *Conclusion and Recommendations* – concluding observations and recommendations related to development of commercial greenhouse facilities and their potential to contribute to positive economic growth in the County.

Brunswick County is the primary area of study and data collection included available information from the USDA Agriculture Census, the Bureau of Economic Analysis, as well as compiled data and proprietary data from a multiple sources available through Economic Modelling Specialist, Incorporated (EMSI). Attempts were made to contact all existing greenhouse operations in Brunswick County. OED also collected data from the adjacent counties in Virginia and North Carolina.

Section I: Agriculture and Economic Data Overview (County and Adjacent Region)

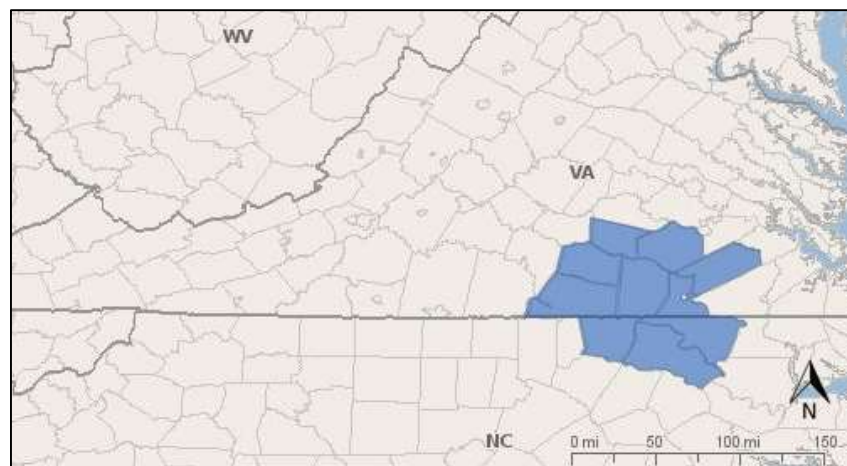
Rationale

The development of a commercial greenhouse venture in Brunswick County could take a number of forms ranging from a large-scale, technology-intensive facility spurred by private investors, to a more modestly sized enterprise operated by one or more local entrepreneurs, non-profits, or through some type of public-private partnership. In these instances, greenhouse facilities often support and complement the existing local and regional food system, offering opportunities for existing producers to extend their growing season or to offer a new specialty crop. The current agriculture economy matters and offers valuable context into potential supply concerns as well as the ways that greenhouse facilities may enhance or augment that larger picture and offer enhanced income potential.

Study Area

To fully capture conditions in the regional agricultural market, analysis was not limited to Brunswick County. OED selected a study area of 10 surrounding counties; seven within the state of Virginia and three along the southern border of the County in North Carolina. Specifically, the counties included in the study are the counties of Brunswick, Dinwiddie, Greenville, Lunenburg, Mecklenburg, Nottoway, and Sussex, in Virginia, and Halifax, Northampton, and Warren, in North Carolina. Due to limited data, OED omitted Emporia, an independent city within the boundaries of Greenville County, from the study area.

Figure 1: Map of Study Area



Employment Data

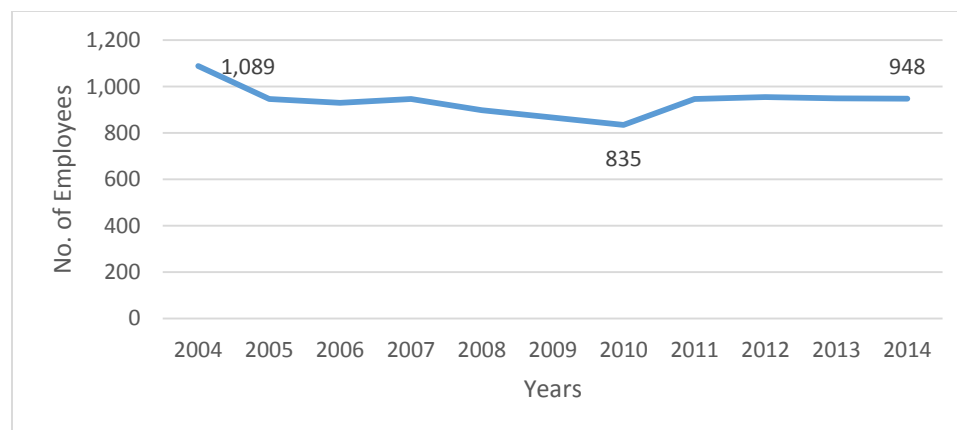
To be designated as part of the “nursery or greenhouse industry,” establishments must primarily grow flowers and crops under some type of cover, such as a greenhouse, cold frame, lath house, or cloth house. The industry is classified in the North American Industry Classification System (NAICS) as *NAICS 1114 Greenhouse, Nursery, and Floricultural Production*

within the larger umbrella industry *NAICS 1110 Crop Production*.¹ Employment figures for NAICS 1114 were unavailable; therefore this report highlights employment in the larger NAICS 1110 Crop Production industry. Greenhouse, Nursery, and floriculture production contributes a portion of the jobs in the industry group. Figure 2 depicts all crop production employment in the study area between 2004-2014. The crop production industry group consists of these subsectors:

- Oilseed and Grain Farming: NAICS 1111
- Vegetable and Melon Farming: NAICS 1112
- Fruit and Tree Nut Farming: NAICS 1113
- Greenhouse, Nursery, and Floriculture Production: NAICS 1114
- Other Crop Farming: NAICS 1119

Despite a decline in crop production jobs from 2004-2009, employment has remained stable from 2011-2014; at approximately 950 jobs. However, this figure is lower than employment in 2004.

Figure 2: NAICS 111 Crop Production Employment within the Study Area, 2014²



A breakdown of employment in the crop production industry by region shows that most jobs are in Halifax, NC; Mecklenburg, VA; and Northampton, NC. Mecklenburg, Brunswick and Lunenburg have the largest portion of crop production jobs among the Virginia counties in the study area. Less than 5% of crop production employment is found in Brunswick County.

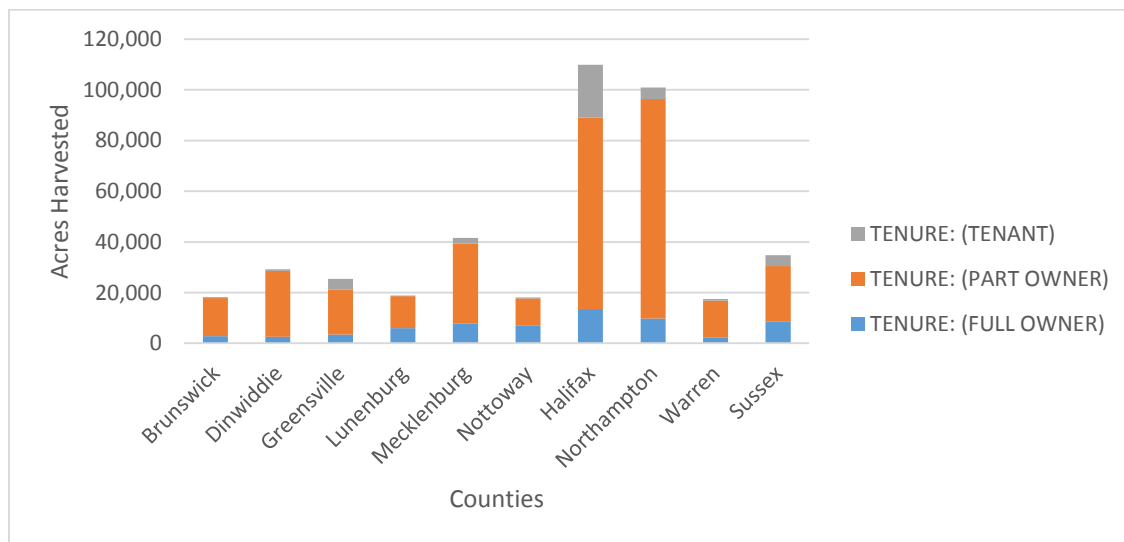
¹ <http://www.census.gov/econ/isp/sampler.php?naicscode=1114&naicslevel=4>

² Source: EMSI data based primarily on the Quarterly Census of Employment and Wages (QCEW) from the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA).

Table 1: Regional Breakdown of NAICS 111 Employment, 2004-2014

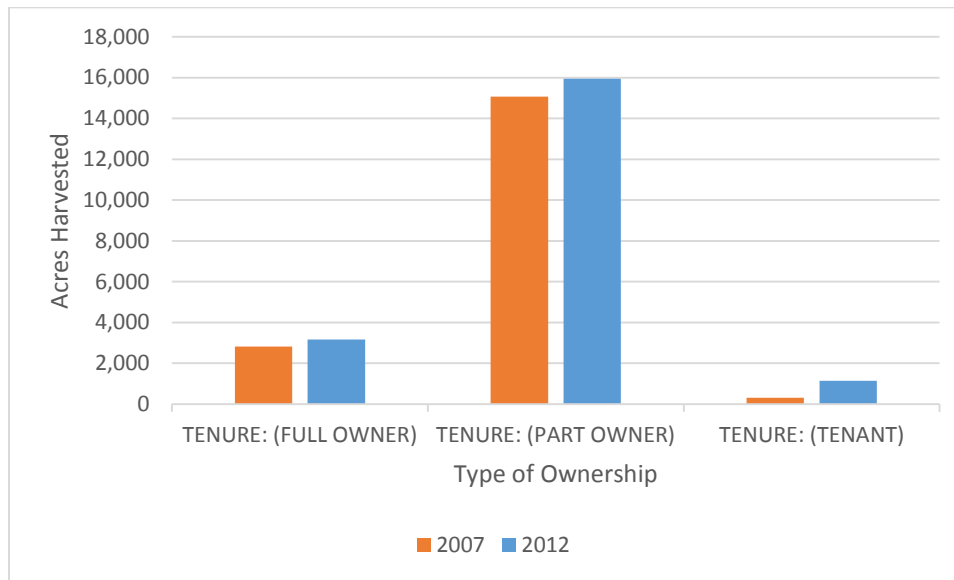
County	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Halifax, NC	368	312	303	287	283	273	284	297	278	264	260
Northampton, NC	167	167	164	163	144	135	138	149	147	150	150
Warren, NC	163	114	116	115	112	133	106	114	115	131	125
Brunswick, VA	37	39	36	37	38	40	44	49	58	58	56
Dinwiddie, VA	26	29	28	19	22	25	15	20	38	34	42
Greensville, VA	23	25	21	16	19	18	15	<10	12	12	10
Lunenburg, VA	29	32	31	36	31	27	28	35	38	42	34
Mecklenburg, VA	276	228	229	273	249	215	205	271	271	263	270
Nottoway, VA	0	0	0	0	0	0	0	0	0	0	<10
Sussex, VA	0	0	0	0	0	0	0	<10	<10	<10	0
Total	1,089	947	930	946	898	866	834	944	960	956	949

Halifax and Northampton Counties in North Carolina have the most acres of land dedicated to farming. Total farmland harvested in these two counties surpasses the number of acres harvested in the rest of the study area combined.

Figure 3: Farm Size by acres harvested for all counties, 2012

As depicted in Figure 4 below, total farmland harvested in Brunswick County increased by 11% between 2007 and 2012. In 2007, the harvested farmland totaled 18,202, increasing to 20,255 acres in 2012.

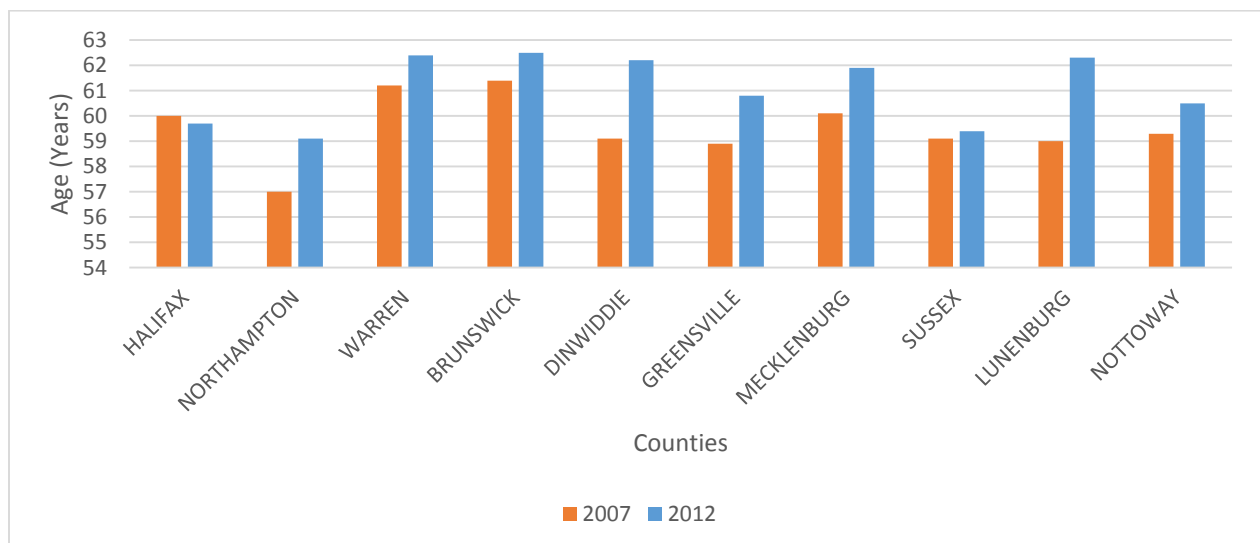
Figure 4: Farm Size by acres harvested for Brunswick County, 2007 and 2012



Average Operator Age Data Overview

This data is measured by average age in years for the principle farm operator per county. Overall, the average age is close to sixty. There are no clear outliers for this data as all counties are similar in age for operators. Cumulatively, the average operator age has increased slightly. In 2007, the average age for the study area was 59.51 years and increased to 61.08 years of age by 2012.

Figure 5: Average Age for All Counties in Study Area



Northampton County has the youngest average operator age of 59.1 years in 2012. Brunswick had the oldest average operator age of 62.5 years, closely followed by Warren County, NC, with an average operator age 62.4 years. Between the years of 2007 and 2012, the largest growth in average operator age was in Lunenburg, with an increase of 3.3 years over the 5 year period. Halifax County decreased in average age over the five year period by 0.3 years.

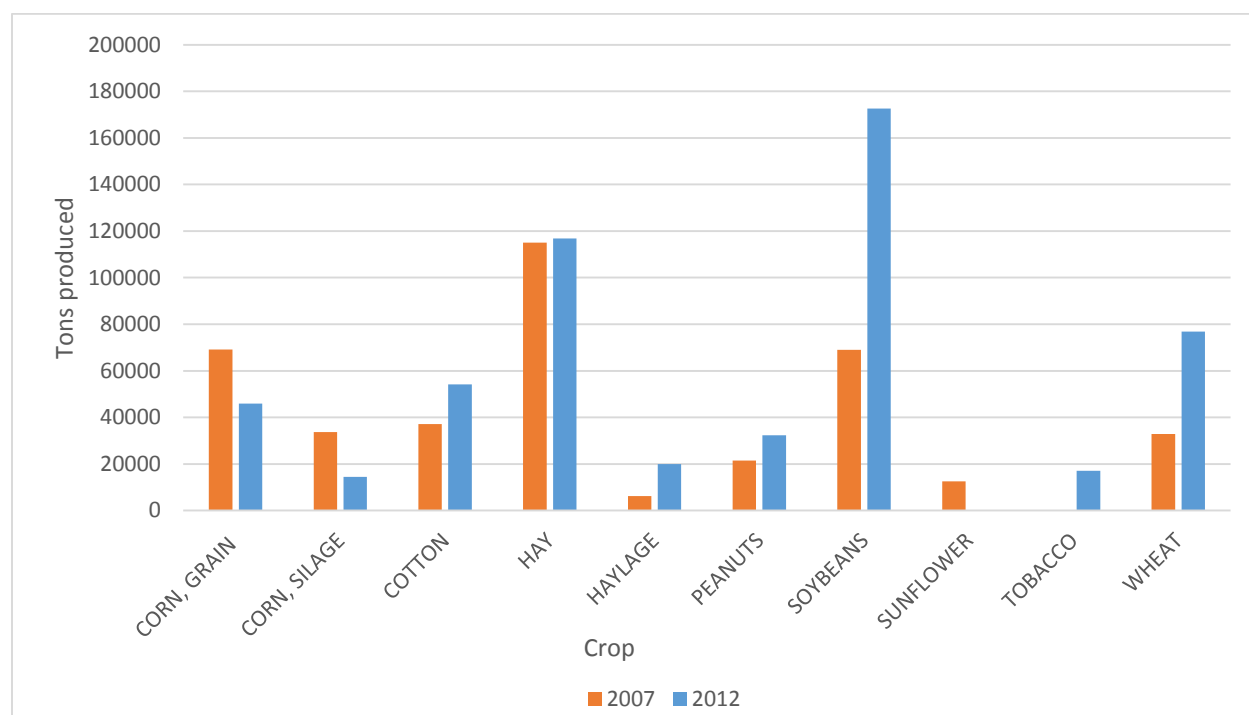
Table 2: Average Age for Principle Operators (Years)

County	2007	2012	Difference
Halifax, NC	60	59.7	-0.3
Northampton, NC	57	59.1	2.1
Warren, NC	61.2	62.4	1.2
Brunswick, VA	61.4	62.5	1.1
Dinwiddie, VA	59.1	62.2	3.1
Greensville, VA	58.9	60.8	1.9
Mecklenburg, VA	60.1	61.9	1.8
Sussex, VA	59.1	59.4	0.3
Lunenburg, VA	59	62.3	3.3
Nottoway, VA	59.3	60.5	1.2
Total average	59.51	61.08	1.57

Crop Production Data Overview

Crop production data from the U.S. Census of Agriculture was collected in various units (bushels, pounds, tons, etc.), then converted to tons using the Rayglen Commodities, Inc. conversion calculator.³ Pounds were converted into short tons.

³ http://www.rayglen.com/grain_conversion_calculator/

Figure 6: Crop Production for All Counties

For all counties, in the years between 2007 and 2012, production of corn silage and corn grain decreased while production of soybean, cotton, and wheat crops increased. Hay production increased only slightly over the past five years.

Table 3: Crop Production (Tons) for All Counties

Crop	2007	2012
Barley	620	362
Corn, grain	69203	45871
Corn, silage	33717	14455
Cotton	37135	54184.65
Grasses, fescue, seed	48.6	0
Hay	115011	116809
Hay & haylage	141050	140039
Haylage	6200	19911
Oats	954	260
Peanuts	21531	32384
Rye	157	931
Sorghum, grain	77	4076
Sorghum, silage	0	4277
Soybeans	76,361	172659
Sunflower	13,868	0.6
Tobacco	0	17116
Wheat	36,409	76816

In Brunswick County, hay is the largest crop produced, with a slight decrease between 2007 and 2012. Soybeans, tobacco, and wheat have increased in production, while total production for other crops remained minimal. Cotton, peanuts, and sunflowers, while common in surrounding counties, are not major crops produced in Brunswick

Figure 7: Crop Production (Tons) for Brunswick County

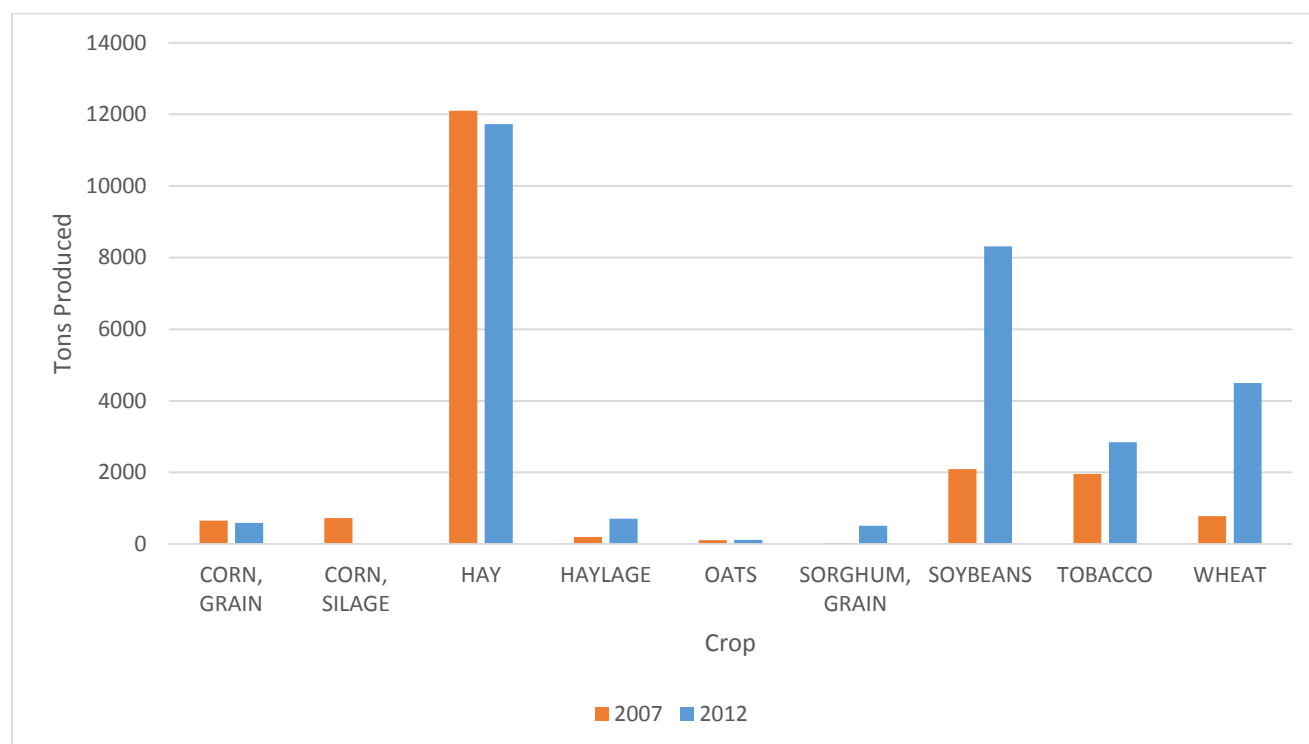


Table 4: Crop Production for Brunswick County (Tons)

Crop	2007	2012
Corn, grain	656	589
Corn, silage	726	0
Hay	12,103	11,729
Hay & Haylage	12,202	12,083
Haylage	200	711
Oats	106	121
Sorghum, grain	9	514
Soybeans	2,092	8,315
Tobacco	1,956	2,845
Wheat	779	4,494

Area Harvested

“Area harvested” refers to the number of acres harvested in order to produce a certain crop. Soybeans require the largest area harvested, followed by cotton and hay. In 2012, soybeans reached over 160,000 acres harvested for the study area. There is a large disparity in acres harvested between the top three crops (Among the top 10 in terms of area harvested) and the bottom three crops.

Figure 8: Area Harvested for All Counties in Study Area

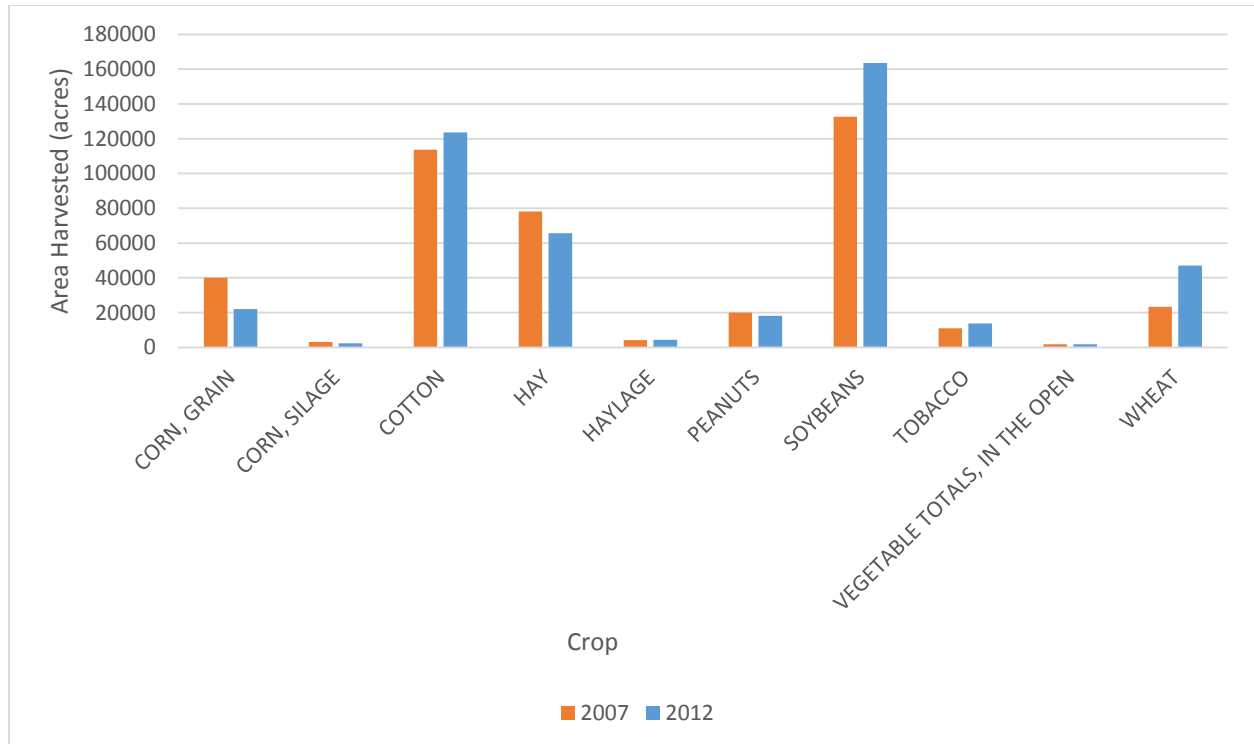


Table 5: Area Harvested (Acres) for All Counties

Crop	2007	2012
Asparagus	0	2
Barley	467	227
Beans, green, lima	15	2
Beans, snap	150	67
Blackberries (incl dewberries & marionberries)	1	13
Blueberries, tame		9
Cabbage, head	4	2
Corn, grain	40037	22111
Corn, silage	3084	2345
Cotton	113734	123716
Cucumbers	72	5
Eggplant	0	1
Field crops, other	45	0
Grasses & legumes totals, seed	104	0
Grasses, fescue, seed	104	0
Greens, collard	1	2
Greens, mustard	1	2
Hay	78274	65760
Hay & haylage	81735	69307
Haylage	4207	4307
Melons, cantaloupe	90	30
Melons, watermelon	189	31
Oats	1067	321
Okra	0	2
Onions, dry	1	1
Peanuts	19952	18224
Peas, green, southern (cowpeas)	34	
Peppers, bell		1
Potatoes	78	13
Pumpkins	8	
Raspberries	0	3
Rye	261	1755
Sod	0	232
Sorghum, grain	341	3078
Sorghum, silage		516
Soybeans	132738	163560
Spinach	1	0
Squash	13	3
Strawberries	0	4
Sunflower	0	12
Sweet corn	123	84
Sweet potatoes	30	36
Tobacco	11082	13808
Tomatoes, in the open	35	20
Vegetable totals, in the open	1808	1750
Vegetables, other	2	9
Wheat	23412	47148

In Brunswick County, hay and soybeans production requires the largest amounts of area harvested. This is similar to the rest of the study area although Brunswick does not produce any cotton, which was the second-highest acreage harvested in the region.

Figure 9: Area Harvested for Brunswick County, 2007 and 2012

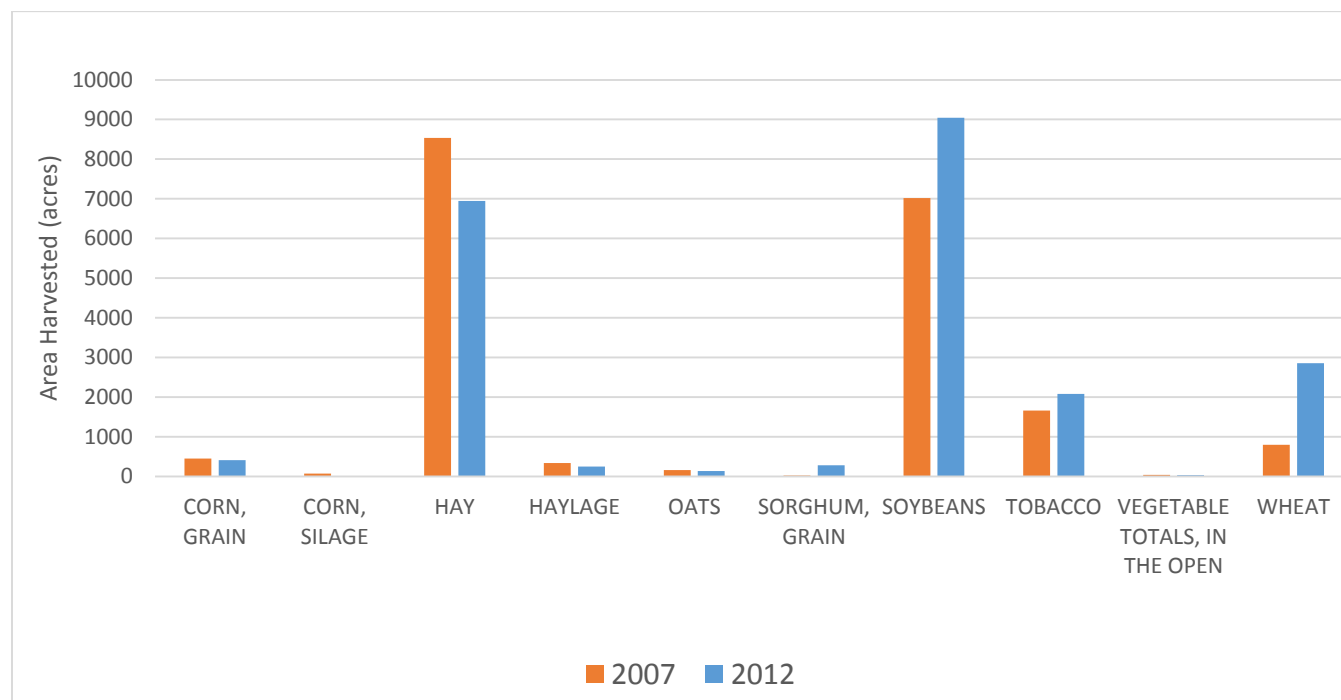


Table 6: Area Harvested for Brunswick County (Acres)

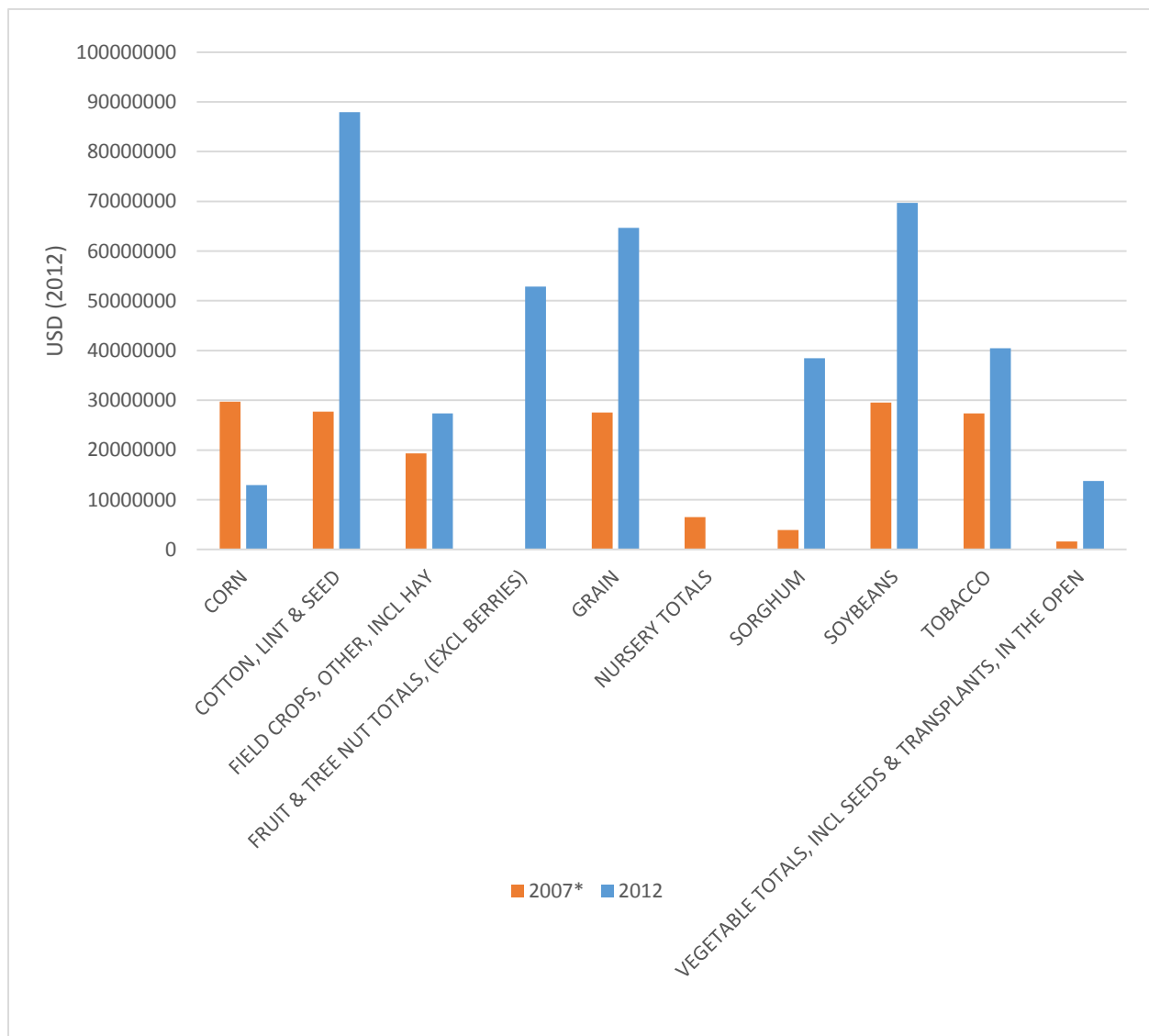
Crop	2007	2012
Corn, grain	449	412
Corn, silage	73	0
Greens, collard	0	2
Hay	8,538	6,943
Hay & Haylage	8,738	7,107
Haylage	333	250
Melons, watermelon	0	1
Oats	162	137
Potatoes	0	2
Raspberries	0	2
Sorghum, grain	17	282
Soybeans	7,020	9,047
Squash	0	1
Sweet corn	0	8
Sweet potatoes	30	11
Tobacco	1,660	2,078
Tomatoes, in the open	0	1
Vegetable totals, in the open	35	28
Vegetables, other	0	1
Wheat	797	2,851

Sales Data

This data is measured in dollars (USD 2012) and is based on the sales of produced crops. The sales vary from crop to crop, as does what crops are produced from county to county. Compared to surrounding county crop sales, the most significant crop sold in Brunswick was tobacco from 2007 to 2012.

Figure 10 shows the top ten crops by sales in the region in 2012. Of this list the top three crops were cotton, soybeans, and grain. The least amount of sales came from corn and vegetables, including seeds and transplants, in the open. In 2007, sales were more evenly distributed and about half as high as they were in 2012.

Figure 10: Crop Sales (USD 2012) for all Counties



*Adjusted for 2012 values

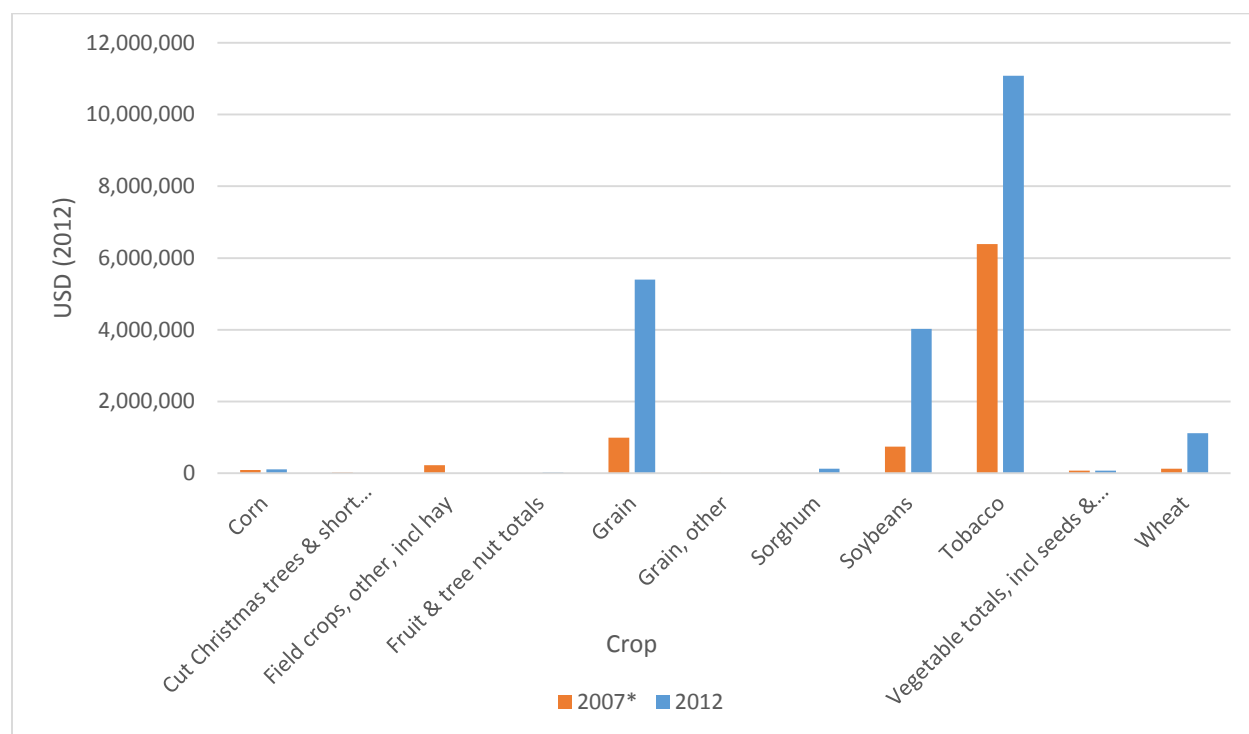
Table 7: Sales (USD 2012) for all Counties

Crop	2007*	2012
Barley	2694110	68000
Bedding plant totals	0	223204
Berry totals	0	1150000
Corn	29693900	12918000
Cotton, lint & seed	27680792	87914000
Cut Christmas trees & short term woody crops	18824	0
Cut flowers & cut cultivated greens	6134851	314840
Field crops, other, incl. hay	19350421	27329000
Floriculture totals	0	3883718
Flowering plants, potted, indoor use	0	3600
Fruit & tree nut totals	3385078	238240
Fruit & tree nut totals (excl. berries)	0	52835000
Grain	27543484	64680000
Grain, other	4794697	6375000
Horticulture totals (excl. cut trees & vegetable seeds & transplants)	1789429	1668000
Nursery totals	6526546	0
Sod	0	579750
Sorghum	3885587	38452000
Soybeans	29514515	69703000
Tobacco	27335611	40444117
Transplants, commercial, tobacco	1412941	815825
Transplants, commercial, vegetable & strawberry	0	38400
Vegetable totals (incl. fresh cut herbs), under protection	0	68360
Vegetable totals (incl. seeds & transplants), in the open	1583468	13780000
Wheat	2799306	9063000

*Adjusted for 2012 values

From 2007 to 2012, Brunswick had a 50% increase in tobacco crop sales, along with a slightly larger increase in grain and soybean crop sales.

Figure 11: Sales (USD 2012) in Brunswick



*Adjusted for 2012 values

Table 8: Sales (USD 2012) for Brunswick County

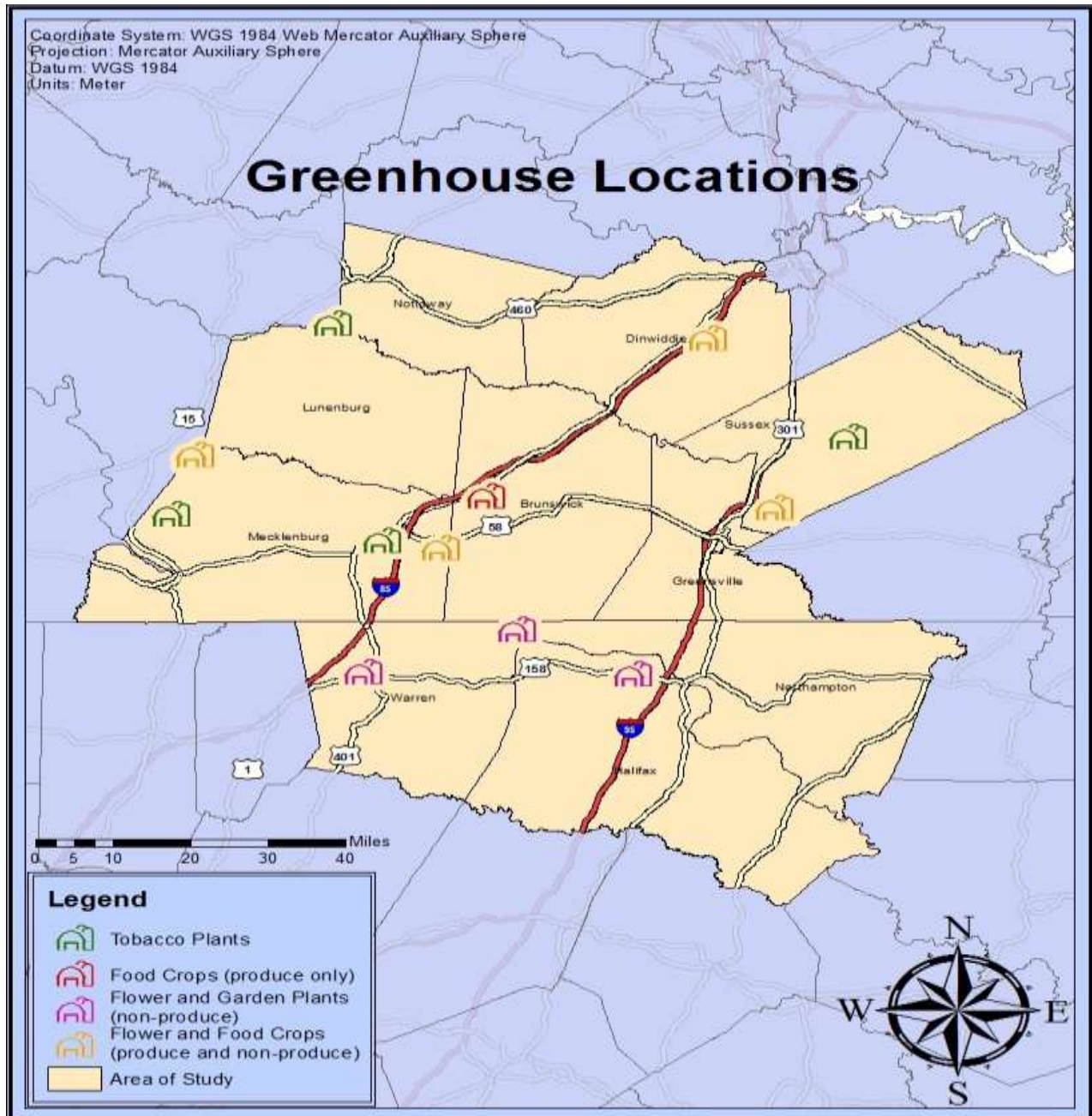
Crop	2007*	2012
Corn	93,015	114,000
Cut Christmas trees & short term woody crops	18,824	0
Field crops, other, incl hay	227,001	0
Fruit & tree nut totals	0	19,000
Grain	991,052	5,403,000
Grain, other	14,395	0
Sorghum	0	124,000
Soybeans	743,012	4,024,000
Tobacco	6,388,131	11,079,000
Vegetable totals, incl seeds & transplants, in the open	77,512	76,000
Wheat	130,664	1,122,000

*Adjusted for 2012 values

Section 2: Assessment of Existing Greenhouse and Nursery Businesses

OED conducted a survey of existing greenhouse and nursery businesses in the study area. Analysis consisted of phone calls to businesses that possibly grew and sold products grown in greenhouses. Figure 12 depicts greenhouse operations and types in the study area.

Figure 12. Greenhouse operations and types in the study area



The 2012 Census of Agriculture estimated a total of 62 greenhouse and/or nursery establishments in the region. Information from Virginia Labor Market Information, the North Carolina Department of Commerce, and web search provided the names of 69 greenhouse businesses in the study area. Phone contact information was found for 60 establishments. Of the 60 establishments:

- Twelve locations confirmed they were greenhouses, nine of which consented to full interviews. (NOTE: the image above depicts the location and type of those twelve operations).
- Eighteen operations stated they did not use greenhouse technology
- Thirty businesses did not answer the phone, refused an interview, were out of business, or their phone was out of service.

The 12 locations mapped in the chart above include:

County	Business Name	Address
<i>Brunswick County, VA</i>		
	Dogwood Grove Greenhouse	370 Meredith Mille Rd Brodnax, VA 23920
<i>Dinwiddie County, VA</i>		
	Willows Bend Farm	20413 Carson Rd Dinwiddie, VA 23841
	Old Hickory Farms Inc	26819 Courthouse Rd, Stony Creek, VA 23882
<i>Greensville County, VA</i>		
	Pine View Greenhouses	11510 Lebanon Church Rd Jarratt, VA 23867
<i>Lunenburg County, VA</i>		
	Lynn Vaughan Farm	3886 Bethel Church Rd Green Bay, VA 24392
<i>Mecklenburg County, VA</i>		
	Brankley Farms Inc.	599 Brankley Rd Skipwith, VA 23968
	Cabbage Farms	1020 Regional Airport Rd Brodnax, VA 23920
	Huston R. Hart Farms	338 Tobacco Ln South Hill, VA 23970
	Wootton Bros. Greenhouse	868 Greenhouse Rd Chase City, VA 23924
<i>Nottoway County, VA</i>		
	None	
<i>Sussex County, VA</i>		
	None	
<i>Halifax County, NC</i>		
	Roanoke Nursery-Garden Center	1165 US-158 Roanoke Rapids, NC 27870

Northampton County, NC

Wildwood Nursery & Garden Center

847 Lizard Creek Road, Henrico, NC
27842

Warren County, NC

Hundley's Greenhouse Inc

305 Terrell St Norlina, NC 27563

Of the nine greenhouses interviewed more fully, six were **farms with greenhouse** components, ranging from as little as 5% of greenhouse crop production to as high as 100%. The remaining three identified themselves solely as **greenhouse businesses**.

Only one location operated year-round while all others operated seasonally. All of the greenhouses operated from March to June, while three others continued into June and finished operations in October or November. One farm had two operating seasons, March to June and August to October.

The average operator age for the greenhouse businesses was just under 22 years, while farms with greenhouses averaged just over 29 years of age. The average size for each greenhouse operation was about 11,400 square feet, ranging from as little as 2,000 to as high as 28,000 square feet. A single greenhouse building ranged from 2,000 to 6,000 square feet. Free-standing and Quonset greenhouses were the most common style among those interviewed.

Quonset-style greenhouses are typically lightweight prefabricated structures of corrugated galvanized steel having a semicircular cross-section, such as those in the image below:



Photo: Virginia Tech Horticulture Department

One producer used a gutter-connected greenhouse. These structures usually consist of a galvanized steel, bolt-together frame with multiple arches, separated by gutters at the side and mid-columns.

Another respondent used a gothic-style greenhouse. These structures are similar to the Quonset-style but with a more sharply angled roof structure, as in the image below:



Photo: Washington State University Extension

Most of the respondents reported that their greenhouse structures had polyethylene siding/sheets with polycarbonate ends. Most also utilized a shading sheet. None of those surveyed used any type of open roof structure. All respondents used fans to maintain temperatures and circulate air and some also had curtains, shade clothes, or windows that operated automatically. Five respondents said they heated their greenhouses using propane gas.

While producers were often both retail (with direct product-customer sales) and wholesale (suppliers to retail outlets), the three greenhouse businesses surveyed rely more on retail and the six farms with greenhouses are mostly wholesalers. Four of the farms with greenhouses were primarily tobacco growers. The remaining five locations produced flowers and a variety of produce, which included:

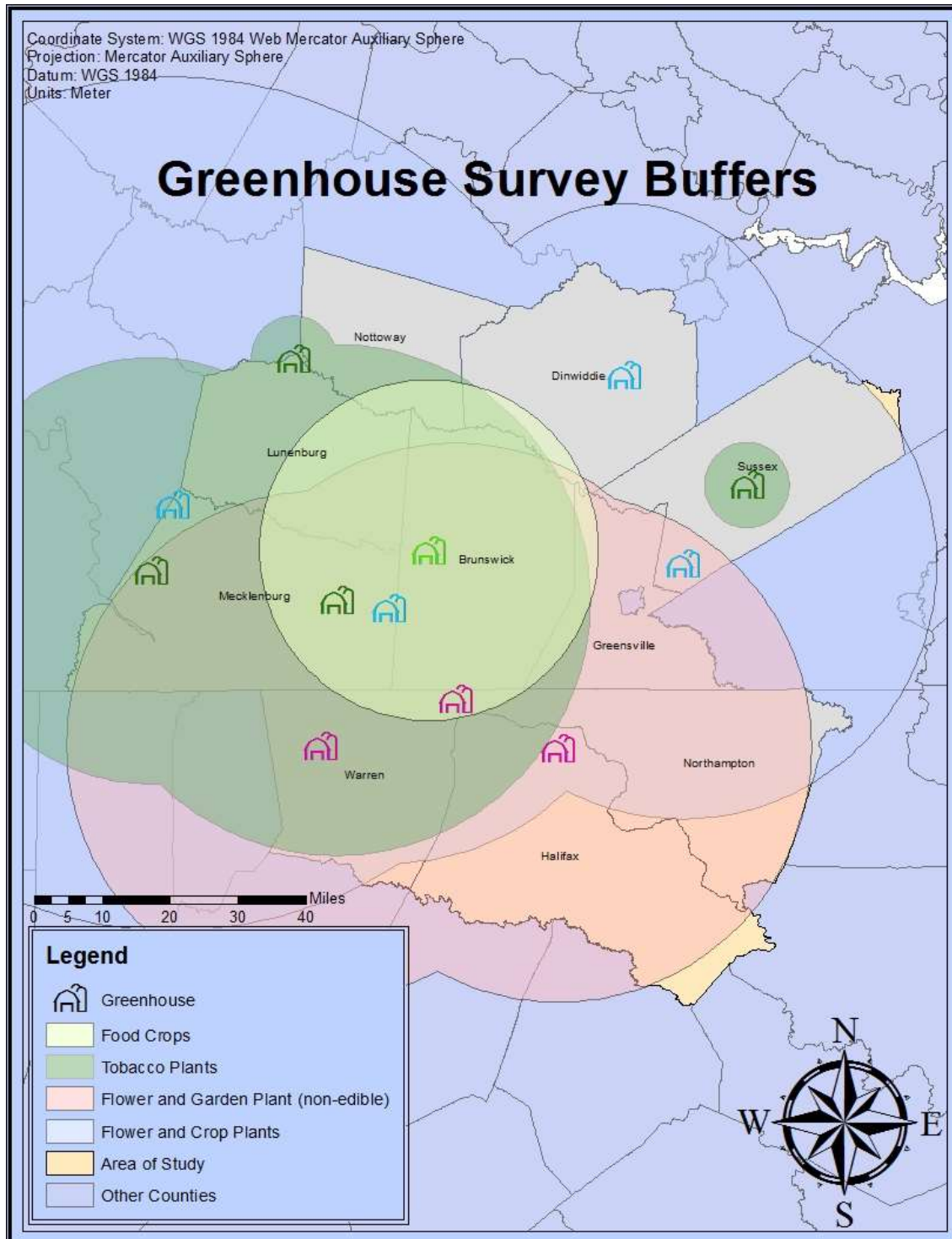
- Bedding plants, including perennials
- Cucumbers and sweet bell peppers
- Heirloom and a large variety of other tomatoes
- Grow-to-order vegetables

None of these locations grew organic-certified products, although many claimed to use organic practices or abstain from using pesticides. According to survey responses, the biggest barrier to growing organically-certified produce was the production costs, presumably due to the labor intensive practices and the decreased produce output. Most said that if there was a lower cost of production, they would switch to organic-certified produce.

Clientele varied from one producer to the next. Most farms with greenhouses sold to companies within a 30 to 40 mile radius or to nearby farmers. The three greenhouse businesses sold to locals who were interested in freshly-grown produce; depending on the business,

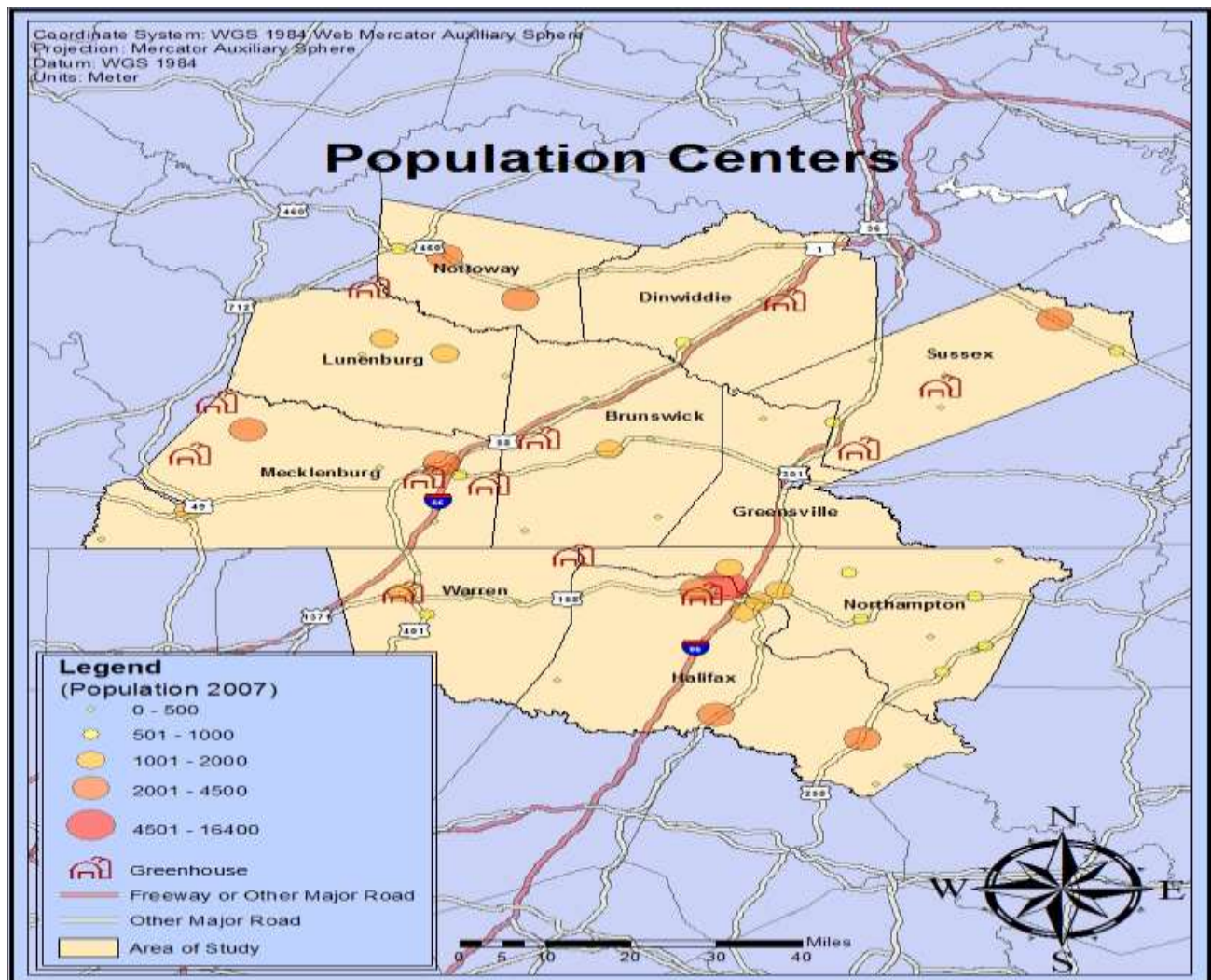
however, their “local” market ranged from 15 to 50 miles away. Figure 13 graphically depicts this market radius.

Figure 13. Market radius of greenhouse operations in the study area



Survey respondents were somewhat reluctant to share business financial information. However, some respondents did provide limited revenue and employee data. Three businesses were operated by the owners with help from family members, while three were managed by the owners who also hired full- and part-time staff depending on market demand. One location enlisted volunteers or interns (presumably unpaid) to help during growing seasons. One tobacco farm had 25 employees annually and a second greenhouse farm respondent had a similar revenue (\$2-4 million annually), and likely a similar number of workers. One greenhouse business reported annual earnings of \$150,000, while farms with greenhouses stated annual earnings ranging from \$24,000 to \$40,000. However, when asked whether their business had expanded in recent years, three replied that they had not tried to expand within the past five years and one stated they had cut staff production due to financial constraints. Three responded that they have grown within the past five years. Figure 14 illustrates proximity of existing operations to area population centers.

Figure 14. Proximity of existing greenhouse operations to area population centers



Section 3: Market Data

Both nationally and in Virginia, the trends appear to indicate a short-term expansion in facilities, production, and sales for greenhouse growers. The industry publication, *Greenhouse Grower*, conducts an annual survey of greenhouse operators in the United States.⁴ The 2015 State Of The Industry Report collected survey responses from 253 growers, including wholesale growers, grower-retailers, and young plant growers of all sizes from across the industry.



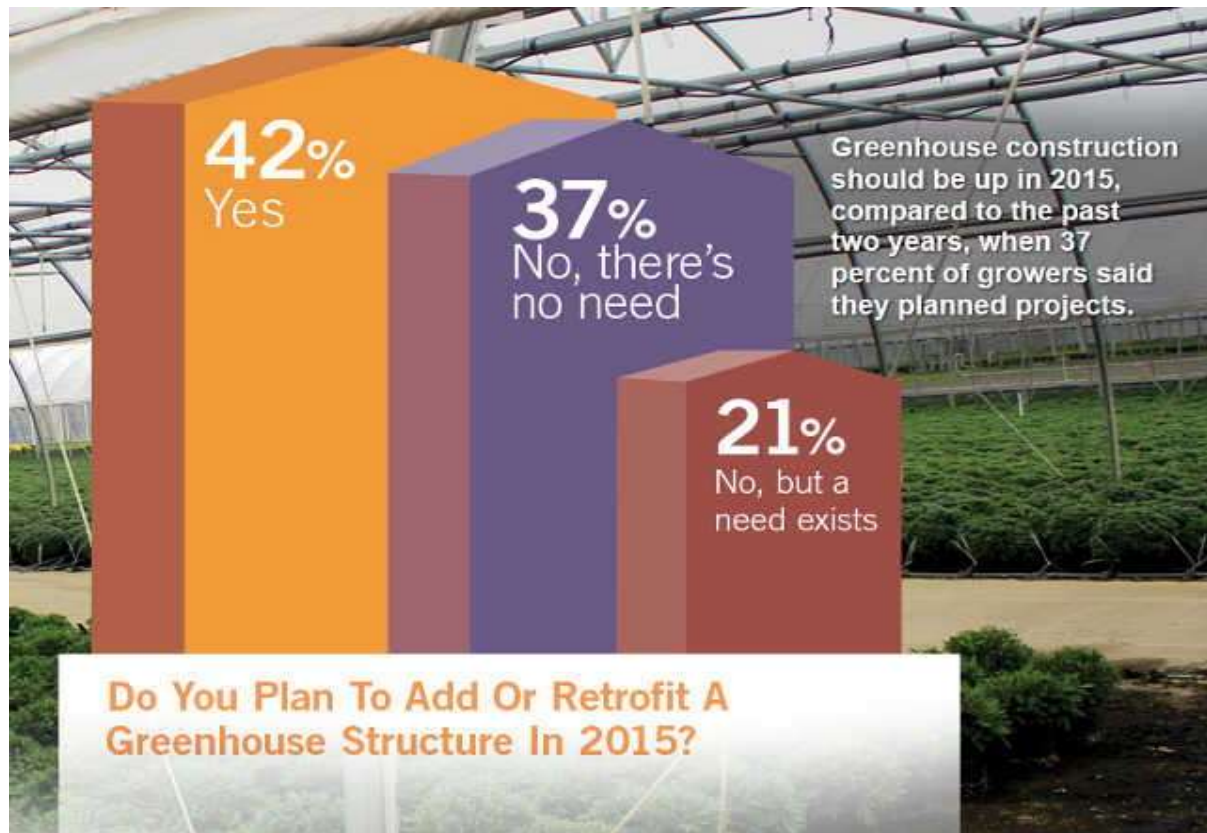
Seventy-one percent of the grower respondents reported their 2014 sales grew from 2013 levels.



Sixty-three percent of growers reported they expect to increase production volume in 2015 while 30 percent anticipate their production volume will remain the same.

⁴ 2015. *Greenhouse Grower's State of the Industry Report*. Accessible at <https://s3.amazonaws.com/files.greenhousegrower.com/pdf/2015/2015+SOI+Whitepaper.pdf>

The survey also indicates that greenhouse construction and expansion is expected to increase, as 42% of growers reported plans to add a new greenhouse structure or to retrofit an existing greenhouse structure in 2015.



Hydroponic growing refers to methods requiring water and nutrients, but not soil. Globally, the hydroponics vegetable market is projected to expand significantly over the next five years, comprising a new domestic market of over \$8.5 billion and a global hydroponics industry of \$28 billion by 2020.⁵ In commercial greenhouse operations, hydroponic systems require high technology and are therefore more capital-intensive. Technological equipment is needed to control air and root temperature, light, water, and plant nutrition. The yield, however, is approximately ten times more than obtained through soil based farming.

Worldwide, the key crops grown hydroponically include tomatoes, cucumbers, peppers, and lettuce, among others, with tomatoes constituting the largest portion of the market. It is estimated the hydroponics production in North America will grow at an annual rate of 9-10%

⁵ 2015, March. Hydroponics Market by Crops (Tomato, Lettuce, Cucumber, Pepper, Marijuana & Others): A Global Insight Through 2015 to 2020 with Special focus on the U.S. & India Market. Research and Markets. Available at: <http://www.researchandmarkets.com/reports/3143729/hydroponics-market-by-crops-tomato-lettuce>

through the next five year period.⁶ The USDA projects the farm value of vegetables and pulses (including melons) to increase to \$25.8 billion in 2024, up from \$21.7 billion in 2014—an average growth rate of 1.8% per year⁷.

Tomatoes represent a large share of the commercial vegetable market:

“In terms of consumption, the tomato is the Nation's fourth most popular fresh-market vegetable behind potatoes, lettuce, and onions. Although stabilizing in the first decade of the 2000s, annual average fresh-market tomato consumption remains well above that of the previous decade. Over the past few decades, per capita use of tomatoes has been on the rise as a result of the enduring popularity of salads, salad bars, and bacon-lettuce-tomato (BLT) and submarine (sub) sandwiches. Perhaps of greater importance has been the introduction of improved tomato varieties, heightened consumer interest in a wider range of tomatoes (such as hothouse tomatoes, grape tomatoes, and specialty/heirloom varieties), a surge of new immigrants who eat vegetable-intensive diets, and expanding national emphasis on health and nutrition.”⁸

Tomatoes may be grown in field or under cover in a “protected-culture system”, which refers to some type of covering or structure to shelter the plants. The protected-culture systems range from low-tech hoop houses, to state-of-the-art automated greenhouse structures. The North American protected-culture tomato industry began in the late 1990s. In 2005, American, Mexican, and Canadian growers produced nearly equal amounts of protected-culture tomatoes for the U.S. market. Since then, production has increased in all three countries, but Mexico has emerged as the dominant protected-culture tomatoes supplier to the United States, producing 62% of the volume in the U.S. market in 2011.⁹ New technologies developed in protected-culture opened the door for additional tomato production, especially from areas where field seasons were previously limited. For example, Canada is now a major producer in protected-culture tomatoes but not in field tomatoes. In contrast, Florida, a major field producer, has not developed a protected-culture industry.

⁶ 2015, March. Hydroponics Market by Crops (Tomato, Lettuce, Cucumber, Pepper, Marijuana & Others): A Global Insight Through 2015 to 2020 with Special focus on the U.S. & India Market. Research and Markets. Available at: <http://www.researchandmarkets.com/reports/3143729/hydroponics-market-by-crops-tomato-lettuce>

⁷ 2015, May. Longrun Outlook: Projections for Vegetable and Pulse Markets. USDA: Economic Research Service.

⁸ Thornton, S. (2012). Tomatoes Outlook. USDA: Economic Research Service.

⁹ USDA, Economic Research Service

Over the past decade, greenhouse/hydroponic products have made significant inroads into the U.S. fresh-tomato retail market. Imports from Canada's hothouse tomato industry peaked in 2005, but have weakened with rising competition from Mexico. The country has invested heavily in protected-culture of vegetables, resulting in a larger share of the U.S. import market. Mexico now accounts for 71% of the U.S. import market for greenhouse tomatoes, while Canada's share has been reduced by half to 27%.

In Virginia, the greenhouse and nursery industry is the fifth largest agricultural sector in the Commonwealth and generates \$272 million in farm sales, representing nearly 8% of the state's distribution of cash receipts for agricultural commodities.

Section 4: Comparative Analysis

Virginia has seen some recent, larger-scale commercial greenhouse operations developed by private operators and investment, but also supported by modest state and local government financial incentives.

For example, Red Sun Farms opened one of the largest hydroponic, high-technology greenhouses in North America in Pulaski County in 2014, investing \$20 million in the project. Shenandoah Growers, Inc. is constructing a new 78,000 square foot nursery greenhouse in Rockingham County to expand its organic herb growing operation. The state and county each provided \$100,000 in funding support, with the company investing \$8.7 million for the greenhouse as well as to develop new warehouse facilities, expand office space, and upgrade equipment.

Assessing the potential feasibility of a commercial greenhouse venture in Brunswick County is complicated by a number of factors. The central challenges include:

- Identifying an ideal scale, purpose, and target markets for a greenhouse venture in the county
- Absence of an existing greenhouse operation with clear plans for expansion
- Absence of a plan for recruiting a commercial greenhouse business to the County.
- Lack of an identified lead organization or entrepreneur to start and operate a commercial greenhouse experience and/or investment capital.

Greenhouses can encompass a variety of purposes and sizes. For example, a greenhouse could be structured to augment the local food system, extend a short growing season, or provide an alternative revenue stream for existing producers. Each different purpose calls for different considerations in development. Also, the focus, requirements, and considerations of small-scale greenhouse are much different than larger-scale, technology-intensive greenhouse operations that may target larger wholesale markets.

For instance, Lynchburg Grows, in Lynchburg, Virginia, was established in 2003 as a non-profit to help disadvantaged persons learn about gardening and enjoy access to healthy foods. The organization has constructed 70,000 square feet of greenhouse space in nine different structures, each with a differing focus. Two greenhouses are used as mainly vegetable production areas as well as for hosting education groups. A third greenhouse structure is devoted to roses. Two facilities are used for cut flowers and grafting, while another structure is devoted to aquaponics (utilizing fish and fish waste to provide plant nutrients). Lynchburg Grows uses the remaining three structures in partnership with other non-profits to provide food for vulnerable populations or to explore experimental growing methods. Lynchburg Grows began with a core mission to engage disadvantaged populations, enhance food security, and strengthen the local food system. The non-profit purchased an abandoned rose farm with some existing greenhouses in downtown Lynchburg and increased capacity over time. The organization also generated extensive support resulting in widespread community involvement and partner engagement. Lynchburg Grows' operating model and fiscal considerations, are very different from a larger-scale, high technology, more commercially focused, private greenhouse operation.

Larger-scale commercial greenhouse operations could be a source of employment and revenue to the County. The most likely source of capital and expertise for the development of a larger-scale commercial greenhouse in Brunswick County would be an existing operation with the capacity to expand or an outside business that could be attracted to locate in the County.

Red Sun Farms and Shenandoah Growers represent examples of private company site locations or possible existing business expansions. Metrolina Greenhouses in Charlotte, North Carolina is an existing, family owned business that expanded over time into a modern and expansive greenhouse operation. Founded in 1972, Metrolina Greenhouses now contains an automated, technology intensive, 162 acre structure comprising the largest single-site heated greenhouse in the United States.¹⁰ The company employs 725 year-round workers, and an additional 600 seasonal employees.

From OED's initial outreach to existing greenhouse operations in both Brunswick County and the larger region, there does not appear to be an existing greenhouse business with the current interest or capacity to shift into a higher growth mode and gradually develop into a larger-scale commercial operation.

¹⁰ Retrieved from <http://www.metrolinagreenhouses.com/Pages/About-Our-Company.aspx>

Table 9 provides a glimpse at some of the more recent, larger greenhouse facility construction or expansion projects in the United States:

Table 9. Recent Greenhouse Facility Projects in the United States

Company	State	Product(s)	Size	Jobs	Investment	Unique Features
Preferred Produce	New Mexico	Vegetables including greens, tomatoes, squash, cucumbers	45,000 sq. feet			High-tech, fast-to-market, 100% waste recycle, biomass. Also has orchard and tilapia and shrimp operation
Houweling's Tomatoes	Utah	Tomatoes		280 jobs	\$79 million	Will use heat and Co2 from industry partner.
Toigo Organic	Pennsylvania	Tomatoes	240,000 sq. feet	13-15 full-time jobs	\$1.8 million	Will collect 100% of water runoff
Red Sun	Virginia	Tomatoes	18 acres (Phase 1)	100	\$30 million	
Nature Fresh Farms	Ohio	Non-GMO produce	175 acre facility	300 jobs	\$200 million	Will utilize Co2 & waste heat
Bloomaker	Virginia	Flowers		98 new jobs	\$2 million	New patented technology for long-lasting flowers
Shenandoah Growers	Virginia	Organic herbs	78,000 sq. feet	15 new jobs	\$8.7 million	Technology-intensive; new finishing system

Finally, the lack of an identified organization or entrepreneur with commercial greenhouse experience who can operate and manage a larger-scale, newly created greenhouse operation is a critical missing component in Brunswick County. The failure rate for new greenhouse ventures is high and mirrors the 80 percent failure rate (firms that fail to stay in business five years) of most start-up businesses.¹¹

¹¹1999. Robbins, J. *Starting a Greenhouse Business*. University of Arkansas.

Section 5: Feasibility Considerations for a Proposed Facility in Brunswick County

Virginia Eco Industries, LLC, is a county-based corporation that has proposed the construction of a large-scale greenhouse facility. The entity's principals have invested substantial time and resources in project development work that has included:

- Initial conversations, including the exploration of a partnership with an existing industry.
- Commissioning a preliminary analysis to explore the utilization of waste heat from industry partner operations to heat a proposed greenhouse using water circulated through a heat exchanger.
- Preliminary site analysis of a possible location that examined water availability, infrastructure accessibility, and proximity to industrial partner.
- Incorporating as Virginia Eco Industries, LLC to pursue the development of the greenhouse concept.
- Preparing funding proposals to assess the feasibility of the concept.

This report does not directly explore the feasibility of the Virginia Eco Industries project, as the Brunswick County IDA commissioned a more broadly focused study, exploring more generally the opportunities and potential for commercial greenhouse ventures in the region.

However, the Eco Industries proposal does not appear to include plans for operations, so it is less clear if Virginia Eco Industries is prepared to undertake the ongoing management and operations of a facility. In addition, construction capital and operating funds sources were not identified. It is unclear how much of their own capital would be invested in the project. As seen from the recent Virginia examples above, public funding may incentivize and support such a venture but only minimally.

Large-scale projects of the type envisioned by Virginia Eco Industries are capital intensive and necessitate large-scale private investment. Greenhouse ventures are considered high risk investments by lending institutions. Lenders are reluctant to finance large operations. Smaller operations carry higher probability of obtaining financial support from a lending institution than larger operations. An excellent relationship between the client and the financial institution is normally an essential requirement in obtaining financing. If a loan is available, most lending institutions are reluctant to provide more than a 50%-80% of the capital requirement. As a result, the use of equity or venture capital is the most common means of financing greenhouse operations.

Eco Industries identified possible greenhouse uses to include hydroponic vegetable production, potted plants, algae for animal feed production, proprietary algae production as well as large scale aquaculture. Eco Industries has proposed 100 acres of greenhouse structure.

Changes in the greenhouse industry during the past ten to twenty years have significantly increased greenhouse construction and operation costs. One consequence of this costs

increase is that newer facilities should carefully plan the overall initial design in order to avoid costly retrofits at a later stage. New Jersey Cooperative Extension recommends a comprehensive master plan be developed that reflects how the owner/operator intends the completed facility to function. The plan should identify the careful integration of all the systems and buildings comprising the entire greenhouse operation including consideration of system inputs and outputs, as illustrated in Table 10.

Table 10. Greenhouse inputs and outputs important for facility design.¹²

Inputs	Outputs
Seeds, cuttings, plugs, etc.	Finished plant material
Growing media	(Plant) Waste
Energy (heating fuel and electricity)	Heat (loss to air and conduction to subsoil)
Light	Stray light from supplemental lighting
Carbon dioxide	Oxygen
Water	Runoff
Fertilizer	Leachate
Labor	
Disease and pest management	

For this assessment, OED does not propose a specific structural model but provides a general discussion below of some of the additional key considerations for greenhouse feasibility:

Market Considerations

Greenhouse vegetables are a perishable crop. Consequently, growers should craft a marketing strategy that ensures their produce has timely access to the retail markets. The majority of greenhouse vegetables are marketed to consumers through retailers. The retail market is accessed primarily through wholesalers. Large retailers deal almost exclusively with wholesale buyers. Growers hoping to access the retail or foodservice market through wholesalers must be able to prove their ability to provide a quality product on a reliable basis at a competitive price.

Marketing the crop is another area in which greenhouse operators experience challenges. It is critical to identify the available marketing avenues, which may include wholesalers, retailers, roadside or farm stands, and door-to-door routes.

Wholesalers require a steady and reliable product supply and individual greenhouse growers cannot guarantee this. Greenhouse operators are increasingly marketing relatively small amounts of produce directly to consumers either from retail outlets that are part of the

¹² Both, A.J. (2005) Creating a Master Plan for Greenhouse Operations. Rutgers Cooperative Research and Extension.

greenhouse facility or through nearby, or on-site, farmers' markets. However, marketing greenhouse vegetables through retail outlets located at the greenhouse is a relatively small market for greenhouse growers.

Moreover, in considering this method, sales costs should be considered, both in real terms, and in lost opportunity time for other endeavors. Producers can pursue multiple sales outlets, but need to consider the additional costs associated with selling, such as transportation, time and any storage required.

Tomatoes, cucumbers and peppers comprise the largest segment of greenhouse-grown vegetables, with tomatoes representing nearly 50% of the supply.¹³ According to Virginia Cooperative Extension, potential greenhouse operators must consider and prepare for market fluctuations based on demand influenced by seasonal considerations and other factors. Greenhouse production is also subject to seasonal fluctuations due to decreased light conditions during the mid-winter period.

The market demand for greenhouse vegetables has increased, but the increases may be associated with population expansion, rather than increased individual vegetable consumption. Market analysts suggest this means that greenhouse vegetables are characterized by a relatively elastic demand curve with a high potential to remain on the shelf if the price is too high or if similar quality substitutes are available.

Site Selection and Access

Brunswick County has a number of assets that would make it an appealing location for a commercial greenhouse development including access to major transportation routes, abundant site options, and access to water. Eco-Industries has proposed a specific site location and provided an initial site assessment of that site. It is unclear whether they currently own the site, but site ownership may be a significant indicator of their interest and commitment to the project. Beyond that, the Brunswick County IDA may find it worthwhile to assess this and similar sites for potential industrial attraction of larger-scale greenhouse ventures.

In general, site considerations should include factors such as

- proximity to markets
- slope of the land and exposure to the sun
- access to adequate amounts of good quality water
- access to utilities
- access to a main transportation corridor
- access to labor
- room for future expansion

¹³ Source: Virginia Cooperative Extension. See <http://www.ext.vt.edu/topics/agriculture/commercial-horticulture/greenhouse-nursery/index.html>

- zoning requirements or limitations
- potential environmental hazards such as, industrial pollution and contaminated water

Water

Factors such as the crops being produced, area to be watered, light intensity, growing medium and time of year all influence the water requirements of a greenhouse operation. A typical greenhouse operation requires 800 cubic meters of water per 100 square meters of growing space per year. The irrigation system and pump need to be designed to deliver adequate water to individual plants during peak consumptive periods.

Water with high levels of soluble salts is considered to be of poor quality for greenhouse vegetable crops. Electrical conductivity (EC) and the sodium absorption ration (SAR) are used to measure the quality of water. Water with a SAR of four or less and an EC of 0.8 is considered to be good quality water. If the SAR is greater than four and EC greater than 0.8, special management practices are required.

Eco Systems projected the availability of water from discharge from the industrial partner at 700,000 gallons per day and cited the presence of a nearby river for which the County has a withdrawal permit as a possible source. It is not verified as to the nature of the permit, the quality of the water, nor the costs associated with directing any available water to the site.

Design and Facility Considerations

The greenhouse facility must provide an ideal environment for production and a layout that allows for the efficient use of labor and equipment in the handling of crops. When developing a new greenhouse facility producers need to consider the following issues:

- size of the greenhouse
- orientation of the greenhouse
- greenhouse design
- type of glazing material
- heating requirements and heating system
- cooling and ventilation requirements
- space requirements for storage, work area and production area
- production equipment
- water system

Materials and Costs

The materials requirements and construction costs for a new greenhouse facility may vary widely based on scale, technology, function, and other factors.

University of Nebraska extension researchers looked at the construction costs for a relatively low-cost Quonset-style greenhouse system. Double polyethylene Quonset-style greenhouses offer growers and farmers a more cost-effective alternative to the glass- or acrylic-covered structures for growing plants off-season. The greenhouses are especially useful for producing high value, off-season crops such as fruits and vegetables for local markets. The report estimated a total capital investment of \$22,000-\$26,000 for a 24 by 72 feet structure or between \$13.09 and \$15.32 per square feet.¹⁴

Economists at Texas A&M conducted a study of greenhouse vegetable considerations in the southeastern United States, which included greenhouse grower surveys and interviews. Sixty-five percent of the respondents were using houses with double layers of ultraviolet protected plastic over either high carbon steel pipes or aluminum frames. Fifteen percent were using fiberglass over a wood frame. The remainder were using glass houses or a combination of thin wall tubing, wood, single layer plastic and fiberglass. In Europe, most houses are covered with glass. Europeans continue to prefer glass due to its permanency, but many new houses are being covered with double layered plastic panels. A comparative analysis of construction costs was conducted separately. It was found that the double layer plastic with ultraviolet light protection treatment over a metal frame (steel pipe or aluminum) was both the least expensive and most durable in the long run.

The study also disclosed that construction costs to establish a complete economic unit, to include required equipment, varied from \$5,500 by a Louisiana grower, to over \$70,000 for a completely automated unit in Canada. Turnkey construction costs by competent greenhouse construction contractors were substantially higher than construction costs by an owner/operator who supervised construction and used subcontractors.

The average construction costs varied from \$4.00 to over \$30 per square foot, not including the cost of land. Construction costs were found to be highly variable, due partly to fluctuations in labor and materials costs. The analysts extrapolated a weighted average cost of \$6 per square foot from the survey assuming that a new entrant to the industry would supervise contractors of major components and use hired labor for the finishing tasks.

The construction of a complete greenhouse includes:

- Site Preparation
- Structure
- Heating/Cooling Equipment
- Thermostats and Controls

¹⁴ Lambe, D., S. Adams, & E. Paparozzi. (2012). Estimating Construction Costs for a Low-Cost Quonset-style Greenhouse. University of Nebraska Extension.

- Irrigation System
- Nutrient Tank or Injector System
- Growing System

The study also relied on a set of assumptions for producers constructing a greenhouse for tomato production and arrived at the following investment costs for initial construction.

The initial investment for an operational greenhouse as described above, together with all the major components necessary to initiate operations, is estimated at \$18,788 as shown in Table 12 below. Equipment purchases are estimated at \$1,500 and would include a sprayer, dissolved solids meter, scales, timers and miscellaneous small tools.

Table 12. Estimate of Capital Requirements for Initial Construction for a 30'x 96'Greenhouse

	Total	Per FT ²	Per M ²
Greenhouse (2880FT ² x \$6/FT ²)	\$17,288	\$ 6.00	\$64.37
Other Equipment	\$ 1,500	\$.52	\$ 5.59
Total Capital Required	\$18,788	\$ 6.52	\$69.96
30% Down Payment	(\$ 5,638)	(\$1.96)	(\$21.00)
70% Loan	\$13,150	\$4.57	\$48.96

This equipment could support a moderately larger greenhouse operation. Equity capital requirements necessary to initiate financing are highly variable and depend on the loan agency, securities provided, borrowers' credit rating, and the relationship between the borrower and the lending agency. Small operators with good credit ratings can usually obtain 60-80% loans, however, lending agencies are reluctant to finance large operations. Financing with equity or venture capital appears as the most viable means of financing large operations.

The summary of the capital requirements shown above assumes a 70% loan. A grower interested in establishing a greenhouse would need initial funds of approximately \$1.96 per square foot to obtain a 70% loan of \$4.57 per square foot.

Other Production Considerations and Costs:

Growers should be aware of the tenuous costs/prices for greenhouse vegetables. According to the Texas A&M study, production costs have continued to increase steadily, while farm prices for greenhouse vegetables have remained relatively unchanged. The quantity and quality of field grown tomatoes during the winter months has increased substantially during the past few years. In response, greenhouse growers have tried to sustain positive net returns by minimizing

production costs and increasing yields. Some greenhouse vegetable producers have shifted away from constructing higher quality greenhouses that use glass and towards using the more economical polyethylene construction materials. Producers continue to seek ways to cut production costs since greenhouse tomatoes are highly vulnerable to product substitution at the retail prices.

Energy and Heating:

In considering energy options, the alternatives, as well as the potential costs, can be daunting. According to Virginia Cooperative Extension, energy and labor are the two largest cost areas for larger greenhouse operations. Commercial greenhouses must be maintained at a constant temperature of approximately 65°F to insure consistent plant growth. Various proven heating methods including centralized steam or hot water systems and localized forced air heating units are used to heat commercial greenhouses.

Eco Industries, in their early explorations of a proposed Brunswick County facility, have engaged a private consultant, with Advanced Process Solutions, to evaluate the prospects for using an industry-sourced waste heat to heat the facility using a circulated hot water system.

Average Energy Required to Heat Greenhouse¹⁵

Greenhouse Size (Acres)	January (BTU/hr)	April (BTU/hr)	July (BTU/hr)	October (BTU/hr)
100	69,600,000	20,700,000	292,500	21,035,000
200	139,200,000	41,400,000	585,000	42,070,000
500	348,000,000	103,500,000	1,463,000	105,200,000

The brief report from Advanced Process Solutions indicated that the industrial partner would have “substantial energy available on a constant basis” to meet these energy needs. According to the report, “The calculated greenhouse loads would represent only 3% (100 acres, January) to 15% (500 acres, January) of the available waste heat. For this reason, we believe utilization of the proposed industrial heat source is feasible.”¹⁶

However, the report’s author cautions that further study is required to fully evaluate the project. Moreover, anecdotal reports from other greenhouse facilities reliant on waste-heat from an industrial source such as a power-generation station indicate that the available waste energy may not be consistently present in every case. Some power-stations reduce operations for significant periods of time, ranging from days to weeks. Greenhouses require a constant source of heat. Therefore, a reliance on waste energy may still require the installation and as-needed utilization of back-up or redundant heat and energy systems.

¹⁵ 2014, September 19. Evaluation of Heating Commercial Greenhouses. Advanced Process Solutions.

¹⁶ 2014, September 19. Evaluation of Heating Commercial Greenhouses. Advanced Process Solutions.

For more conventional heating estimates, software such as the USDA's Virtual Grower tool may help calculate energy costs. Figure 16 is an example of the options that may be inputted.

Figure 16. Advanced design options in greenhouse construction

Advanced Design Options

Name:

Materials

Roof:

Floor:

Siding Materials

North:

South:

East:

West:

Knee Wall Material

North:

South:

East:

West:

Dimensions and Orientation

Number of Spans:

Length of Spans: feet

Width of Spans: feet

Roof Shape:

Kneewall Height: feet

Height on the Edge: feet

Height in the Middle: feet

Orientation:

Fuel Type

Fuel Type:

Fuel Price: per gallon

Heater Efficiency: percent

OK Cancel

Diagram labels: Height at Edge, Height of Middle, Width of Span, Number of Spans

Synthesis and Recommendations:

The key question motivating this project concerns whether there are viable pathways for development of commercial greenhouse facilities in Brunswick County that create jobs, generate revenue, and result in positive returns on public investment. There are three primary avenues through which the County might consider supporting commercial greenhouse venture creation:

1. **Expansion:** Development of a smaller scale greenhouse facility or complex to support existing local producers and expand the capacity of the local and regional food system.
2. **Creation:** Working with local investors/entrepreneurs such as Eco-Industries to develop a new business enterprise centered around an industrial-scale greenhouse facility.
3. **Attraction:** Identifying sites and conducting recruitment activities to attract an outside company to locate an industrial-scale greenhouse facility to the county.

The quantitative and qualitative data collected by OED and described in this report provide initial indications as to the viability of these approaches. Each of the efforts is summarized briefly in the sections below.

1. **Expansion**

The central issue here concerns whether existing producers, greenhouse operators, or local food entrepreneurs possess interest, capital, and capacity to partner with the County and other stakeholders in developing a new smaller-scale facility or significantly expanding and repurposing an existing structure. This option concerns a smaller-scale, Quonset or similar-type structure ranging from \$25,000 to \$75,000 in construction and equipment costs.

It is worthwhile to seriously assess the role that the Brunswick County IDA may play in strengthening the agriculture sector. Agriculture remains critical to the County's future economic vitality. There are some signs of growth in that sector as the land harvested in Brunswick County increased by 11% between 2007 and 2012.¹⁷ While the total number of crop production jobs in Brunswick County are low (55 in 2015), that number represents a 23.4% increase since 2010 and is 120% above the national average.¹⁸ Average earnings are slightly less than the national average at \$28,175. Still, those job increases in the agriculture sector generate positive spillover. The Virginia Food System Council has reported that for every job within the agricultural and forestry sector, another 1.5 jobs is supported as an indirect economic benefit and impact. Moreover, the increasing demand for locally grown and regionally identifiable food offers multiple economic opportunities for agricultural producers, associated industries, and entrepreneurs.

¹⁷ Source: 2012. U.S. Agriculture Census. United States Department of Agriculture.

¹⁸ Source: EMSI data based primarily on the Quarterly Census of Employment and Wages (QCEW) from the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA).

From OED's initial outreach to existing greenhouse operations in both Brunswick County and the larger region, there does not appear to be an existing greenhouse business with the current interest or capacity to shift into a higher growth mode and gradually develop into a larger-scale commercial operation. OED has also contacted a small number of regional local food system stakeholders. There does not appear to be a pressing need or active interest in smaller-scale greenhouse facility development. According to the Texas A&M grower report, the competitive position of smaller greenhouse operations remain at a disadvantage due to increased competition from alternate supply sources and increased production costs. Profitable operations require substantial managerial expertise and attention to marketing channels and production costs.

RECOMMENDATIONS IN THIS AREA:

- Defer any further exploration of this option until driven by local stakeholder organization or producer with a viable business plan.
- Conduct a county-based agriculture and local foods stakeholders meeting to identify current assets, challenges, and opportunities for enhancing the agriculture sector and the local foods economy. As a follow-up activity, OED is willing to provide facilitation and planning assistance to conduct this meeting.

2.) Creation

Virginia Eco Industries, LLC, is a county-based corporation that has proposed the construction of a large-scale greenhouse facility. The entity's principals have invested time and resources in project development work. Eco Industries identified possible greenhouse uses to include hydroponic vegetable production, potted plants, algae for animal feed production, proprietary algae production as well as large scale aquaculture. Eco Industries has proposed 100 acres of modern, high-technology greenhouse structure and equipment. The nearest comparable for that size in terms of required investment is Nature Fresh Farms in Ohio at 175 acres. The project generated 300 jobs and required a \$200 million investment. Red Sun in Dublin, Virginia has only 18 acres in its Phase I project, creating 100 jobs, and requiring \$30 million in total investment.

Large-scale projects of the type envisioned by Virginia Eco Industries are capital intensive and necessitate large-scale private investment. Greenhouse ventures are considered high risk investments by lending institutions. The failure rate for new greenhouse ventures is high and mirrors the 80 % failure rate (firms that fail to stay in business five years) of most start-up businesses.¹⁹ Eco Industries has not developed a detailed business plan and the proposal does not appear to include plans for operations, so it is less clear if Virginia Eco Industries is prepared

¹⁹1999. Robbins, J. *Starting a Greenhouse Business*. University of Arkansas.

to undertake the ongoing management and operations of a facility. In addition, construction capital and operating funds sources were not identified. It is unclear how much of their own capital would be invested in the project. As seen from the recent Virginia examples above, public funding may incentivize and support such a venture but only minimally. Eco-Industries has proposed a specific site location and provided an initial site assessment of that site. It is unclear whether they currently own the site, but site ownership may be another significant indicator of their interest and commitment to the project. Still, the size, scale, technical complexity, and relative inexperience of the company in this industry are all reasons for a more cautious approach to the Eco Industries proposal.

RECOMMENDATIONS IN THIS AREA:

- Defer any county-based support of the Eco-Industries proposal until such time as a business plan is produced that more precisely identifies sources and amounts of start-up capital and more specifically delineates an operating entity, and includes expenses and revenues projections. It is beyond the existing capacity of the County to develop this venture on its own or on behalf of a private entrepreneur.
- Refer Eco-Industries to expert resources for business planning. As a project follow-up, OED is willing to coordinate a one-time consulting session for Eco Industries with Dr. Richard (Dick) Daugherty. Dr. Daugherty is Director of Strategic Services at VT KnowledgeWorks. He helps emerging and evolving technology-based businesses assess, quantify and exploit their business opportunities, especially development of their business strategy and preparation of documents needed for investor discussions. Some of his typical projects involve gathering the data needed for a company to make an intelligent decision about a market opportunity, its competition, and the potential financial reward associated with a market opportunity. If Eco-Industries is able to develop a more targeted, numbers-driven plan, it may then be worthwhile for the County to consider some level of incentive, or matching funding.

3.) *Attraction:*

Brunswick County has a number of assets that would make it an appealing location for an industrial-scale commercial greenhouse development including access to major transportation routes, abundant site options, and access to water. Both nationally and in Virginia, the trends appear to indicate a short-term expansion in facilities, production, and sales for greenhouse growers. Virginia has seen some recent, larger-scale commercial greenhouse operations developed by private operators and investment, but also supported by modest state and local government financial incentives. As described in this report, Red Sun Farms opened one of the largest hydroponic, high-technology greenhouses in North America in Pulaski County in 2014, investing \$20 million in the project. Shenandoah Growers, Inc. is constructing a new 78,000

square foot nursery greenhouse in Rockingham County to expand its organic herb growing operation. Virginia Tech experts expect continued growth in the high tech organic and specialty product market, estimating that sales of organics account for 30 billion dollars in annual sales and are increasing at 10 % a year²⁰.

RECOMMENDATIONS IN THIS AREA

- Of the three avenues, this seems to offer the most promising returns for the County in terms of impact.
- Brunswick County IDA should consider identifying possible sites and conducting recruitment activities to attract an outside company to locate an industrial-scale greenhouse facility to the county.
- As a follow-up activity, OED is willing to organize a meeting between the IDA, Virginia's Growth Alliance, and Virginia Economic Development Partnership to discuss possible strategies in this direction.
- While this avenue is promising, the infrastructure costs may be substantial and the County should engage VEDP, OED, or another entity to conduct an ROI analysis on any proposed county investment for land, site improvements, infrastructure, and company incentives.

²⁰ Source: 2014. O'Rourke, M. Virginia Tech Department of Food Science. WVTF News.