The Economic Impact of Virginia's Agriculture and Forest Industries

Terance J. Rephann, Ph.D.

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Weldon Cooper
Center for Public Service
University of Virginia

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PREFACE

This study was commissioned by the Virginia Secretary of Agriculture and Forestry to estimate the contribution of the agriculture and forestry-related industries to Virginia's economy. It updates two previous studies, one conducted in 2008 and another in 2013, and utilizes the same methodology and data sources. Estimates of economic impact are provided for agriculture and forestry-related industries, industry groupings arranged by level of dependency on raw materials originating within the state, international exports, the six leading agricultural commodities, and localities. These varied estimates provide a comprehensive picture of the contribution that agricultural and forest natural resources make to the economy of the Commonwealth of Virginia.

The author would like to thank many people who participated in the planning and improvement of this study. Former Deputy Secretary of Agriculture and Forestry Samuel Towell organized industry stakeholders for a wide-ranging discussion of agricultural and forestry issues at the beginning of the study. Virginia Department of Agriculture and Consumer Services (VDACS) staff, Virginia Department of Forestry staff, and agricultural and forestry industry representatives participated in this forum. Participants included Martha Moore of the Virginia Farm Bureau, Brent Hunsinger of the Virginia Nursery and Landscape Association, Jason Carter of the Virginia Cattlemen's Association, Eric Paulson of the Virginia State Dairymen's Association, Katie Hellebush and Ben Rowe of the Virginia Grain Products Association and Virginia Wine Council, Ron Jenkins of the Virginia Loggers Association, Paul Howe and Shannon McCabe of the Virginia Forestry Association, Susan Jennings of the Virginia Forest Products Association, Charles Becker of the Department of Forestry, and Charles Green, Kent Lewis and Mike Hutt of VDACS. Former Deputy Secretary Cassidy Rasnick, Charles Becker of the Department of Forestry, and Katie Frazier of the Virginia Agribusiness Council provided extensive comments and recommendations on study drafts. Deputy Secretary Megan Seibel organized a final study review session.

Steve Kulp assisted with document preparation. Eric Cross designed the cover. Any errors or omissions are the responsibility of the author.

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STUDY HIGHLIGHTS

Agriculture and Forestry

- The total economic impact of agriculture and forestry-related industries in Virginia was over $91 billion in total industry output in 2015, the base year used for this study. The total employment impact was 442,260 employees, representing 8.7 percent of total state employment. The total value-added impact was $45.5 billion, which made up 9.5 percent of state gross domestic product.

- Every job created in agriculture and forestry-related industries results in another 1.7 jobs in the Virginia economy. Every dollar generated in value-added results in another $1.15 value-added in the Virginia economy.

- The impacts of agriculture and forestry-related industries are felt throughout Virginia's economy. The largest effects are in the directly affected agriculture, forestry, and manufacturing industries. However, agriculture and forestry stimulate activity elsewhere in the economy through the effects of industry purchases and subsequent rounds of indirect and induced spending. Through these cumulative effects, agriculture and forestry-related industries affect every sector.

- Every Virginia locality is touched by agriculture and forestry industries. Total employment impacts exceeded 1,000 jobs for sixty-two localities. Agricultural economic impacts were geographically diffuse. The largest clusters of agricultural-related industry employment impact were located in the Shenandoah Valley, Northern Virginia, and Central Virginia. The largest forestry-related economic impacts tended to be somewhat more geographically concentrated in the Southside region and communities with pulp and paper mills such as Alleghany County and Covington City.

- The total economic impact of agriculture and forestry-related industry exports is approximately 47,000 jobs, $4.6 billion in value-added, and nearly $9 billion in total output. One in nine Virginia farm jobs can be attributed to these international exports.

- Results drawn from other recent studies indicate that Virginia agritourism and forest recreation are important components of the state's tourism spending and economic impact, accounting for millions of visitors and billions of dollars of tourism-related spending and economic impact each year.

- Agriculture and forestry landscapes provide substantial environmental and other societal benefits. Forests improve air and water quality, mitigate flood vulnerability, provide wildlife habitat, and aid biodiversity. Rural landscapes provide scenic amenities that contribute to the quality of life. The value of air and water environmental services provided by farmland and forestland likely amounts to at least several billion dollars each year.

Agriculture

- The total impact of agriculture-related industries was approximately $70 billion in total industry output, 334,300 jobs, and $36.2 billion in value-added.

Forestry

- The forestry sector had a total impact of over $21 billion in total industry output, approximately 107,900 jobs, and $9.3 billion in value-added.

EXECUTIVE SUMMARY

Virginia's agriculture and forestry industries have played a significant role in the growth and development of Virginia's economy. They are still major contributors and their economic impacts can be felt far and wide, encompassing much more than the farms and forests with which they are most closely identified. The sectors affected include processing and manufacturing industries such as food and beverage processing, textile manufacturing, wood products manufacturing, pulp and paper mills, and furniture manufacturing, which often utilize Virginia farm commodities and timber. Distribution firms such as grain elevators and raw commodity warehouses rely on supplies of Virginia farm and forest products as well. These production, manufacturing, and distribution sectors purchase material and service inputs, labor, and value-added services from Virginia-based businesses and households. These purchases generate a multiplier effect that ripples through the Virginia economy. In this way, Virginia agriculture and forestry activity affects every industry and region of the state to varying degrees.

Virginia's agriculture and forestry sectors have emerged from the recent recession and significant restructuring induced by international competition and are growing once again. The agricultural sector is benefitting from increased international exports, rapid growth of traditional poultry and beef product markets, the expansion of specialty industries that range from craft beverage producers to shellfish aquaculture, and reduced drag from tobacco and textile industry decline. A slow but steady recovery in the housing market, increasing international exports of lumber and other wood products, and new markets for wood-based fuels such as biomass and wood pellets are contributing to a revival in the forestry sector. The Commonwealth of Virginia has also taken an active role in promoting industry expansion through a new economic incentive program called the Governor's Agriculture and Forestry Industries Development (AFID) program, ensuring that agriculture and forestry continue to play an important role in the Virginia economy in the future.

Virginia's farm cash receipts grew rapidly over the period 2009 to 2015 in tandem with a general boom in commodity prices. Real cash receipts increased 40 percent from 2009 to the peak year of 2014 before decreasing 10 percent in 2015. This growth corresponded with a rebound in state farm employment from 50,570 in 2009 to 54,842 in 2014 before easing to 52,406 in 2015. Farmland area was unchanged from 2009 to 2015 at an estimated 8.1 million acres.

Virginia's agricultural commodity mix has also changed in recent years. Recent farm sales growth has been driven largely by the cattle and poultry (broilers and turkey) sectors. Among crops, corn and soybeans have also enjoyed significant growth. The largest absolute decline occurred in dairy production. Dairy prices peaked in 2014 and experienced a substantial decline in 2015. Greenhouse and nursery product sales experienced only marginal growth despite a pickup in housing construction and slow improvement in median household incomes over the period. Although much smaller than the other sectors, the aquaculture industry is also rapidly growing.

Virginia's food, beverage, and fiber processors and manufacturers are the largest purchasers of Virginia agricultural commodities. The growth of these industries has been steady but slow since the end of the recent recession. Continual investment in manufacturing automation is one factor constraining employment growth. Another factor is the continued erosion in some historically significant industries such as tobacco products and textiles and apparel industries. However, the rate of decline for these now smaller industries has slowed significantly and now exert less overall effect on the headline numbers. One area that has experienced dramatic growth is the specialty beverage industry. Craft beverage firms have continued to expand their presence in the state, including wineries, breweries, and distilleries.

Virginia's forestry-related employment has bounced back since 2011. The sector is much more sensitive

to the business cycle and housing market activity; thus the gradual improvement in economic and housing construction activity has boosted production and employment. Increasing international exports of roundwood and wood products have provided additional stimulus. Timber harvesting shows significant improvement, reaching an all-time high of $388 million in FY2015 before dropping back to $336 million in FY2016. Forest products employment has modestly recovered to 31,323 jobs from a low point of 29,877 jobs in 2011. However, this total is still a far cry from the pre-recessionary level of 51,597 jobs in 2006 when national housing construction activity was at its peak. The vast majority of growth since 2011 has occurred in wood products manufacturing, reflecting improvement in the housing market since that time. Furniture manufacturing and pulp and paper manufacturing, in contrast, have experienced little change. This new equilibrium is a significant improvement over the steady atrophy of jobs that characterized the last decade, and reflects growth in consumer demand in the current recovery as well as industry restructuring that has restored global competitiveness.

Virginia's agriculture and forestry production sectors have been assisted in recent years by the introduction of a new economic incentive program that aims to stimulate purchases of Virginia-grown commodities by value-added companies: the Governor's Agriculture and Forestry Industries Development Fund (AFID). The AFID program was adopted by the General Assembly and signed into law by the Governor in 2013. The AFID facility grant requires value-added enterprise grant recipients to source a minimum percentage (30 percent) of raw agricultural and forestry inputs from Virginia while promoting employment creation and geographic diversity. Total appropriations for the program from FY 2013 to FY2016 were $5 million with a project-level cap of $250,000. Since 2013, the program has awarded 38 grants that are expected to create 1,666 jobs, $341.8 million in capital investment, and $543.3 million in purchases of Virginia agricultural and forestry products.

Virginia's agriculture and forestry sectors continue to play an important role in the commonwealth economy. Using the same methodology adopted in two previous studies (*The Economic Impact of Agriculture and Forestry on the Commonwealth of Virginia* in 2008 and *The Economic Impacts of Agriculture and Forest Industries in Virginia* in 2013), we gauge the magnitude of that economic contribution or "economic impact." Agriculture and forestry-related industries are disaggregated into four components: production, "core" processing, "extended" processing, and distribution, reflecting different positions in the value chain and degree of dependency on Virginia's agriculture and forestry natural resources. "Production" activities are those industries associated with growing and harvesting basic farm, commodities timber, and non-timber commodities. "Core" industries are manufacturing industries that are heavily dependent on state commodity inputs for production and are unlikely to exist within the state if the state did not produce the commodity. "Extended" processing industries are those agriculture and forestry industries that rely heavily on other inputs or imported inputs. In many instances, these industries' location choices are influenced by consumer market proximity, labor availability, or other factors rather than distance to agricultural commodity or timber inputs.

This study uses input-output analysis to perform the economic impact analysis. Input-output analysis produces industry-specific multipliers that show how economic activity in one sector of the economy affects the overall state economy.

For this study, we are interested in how changes in agricultural and forestry-related activity affect the state economy. The total impact of agricultural and forest-related activity consists of three parts, a "direct effect," "an indirect effect," and an "induced effect." The *direct effect* consists of the injection of economic activity or expenditure into the region, namely the sales of agricultural and forestry-related industries located in Virginia. This direct expenditure then causes a "ripple effect" on the state economy when money is re-spent. For instance, Virginia businesses provide supplies and services to farms such as seeds, fertilizer, veterinarian services, utilities and insurance. These businesses spend a portion of their sales revenues on purchases of supplies and

services from other state firms who, in turn, purchase a portion of their supplies and services from other resident firms. This cascading sequence of spending continues until the subsequent rounds of spending dissipate due to leakages in the form of spending outside the state. The cumulative effect of these cascading rounds of inter-industry purchases is referred to as the *indirect effect*. The final component of total impact (the *induced effect*) is attributable to the spending of households and other economic agents. For instance, businesses pay households for their labor services. These households then purchase goods and services from Virginia firms who in turn receive a portion of their labor, material and public service inputs from within the state. Again leakages occur at each round due to purchases of goods and services outside the state. The induced effect is the sum of the impacts associated with these household purchases

This study makes statewide economic impact estimates for agriculture and forestry- related industries. Economic impacts are evaluated using three different measures: total industrial output, employment, and value-added. The study also disaggregates the economic impacts in various ways including the four different industry components described earlier: production, core processing, extended processing, and distribution. The study estimates the statewide economic impact of Virginia's agricultural and forestry-related international exports. It also provides economic impact estimates for each of Virginia's six leading agricultural commodities (i.e., poultry, beef, dairy, grains, greenhouse and nurseries, and soybeans). These six industries account for nearly 84 percent of Virginia's total farm cash receipts. Lastly, it furnishes economic impact estimates for each of Virginia's localities.

In 2015, the direct effect of Virginia agriculture and forestry-related industries accounted for $52 billion in total output, approximately 164,700 employees, and over $21 billion in value-added. Agriculture production is the largest component in terms of employment at nearly 33 percent. However, the category of agriculture extended processing accounts for nearly 45 percent of output and 60 percent of value-added.

The total economic impact (including direct, indirect, and induced effects) of agriculture and forestry-related industries was over $91 billion in total industry output or sales. The value-added impact was approximately $45 billion dollars, which constitutes approximately 9.5 percent of Virginia gross domestic product (GDP). The total employment impact is approximately 442,000 employees or 8.7 percent of total state employment.

The impacts of agriculture and forestry were felt in every sector of the economy. The largest effects were in the manufacturing and agriculture and forestry industries where direct effects were dominant. However, agriculture and forestry stimulated trade, services, government and other sectors as well through the effects of industry, household, and government purchases and subsequent rounds of spending.

The economic impacts were distributed unevenly among agriculture and forestry sectors and among production, core processing, extended processing, distribution, and government payments components. Agriculture-related activities account for over 75 percent of total agriculture and forestry-related output, employment and value-added impacts with forestry-related activities making up the remainder. Relative to the state economy, agriculture-related industry impacts represent approximately 7.5 percent of Virginia's GDP. Forestry-related industry represents 2 percent.

Among the industry components, production industry impacts make up 19 percent of the total employment impact but a considerably smaller share, 7 percent, of value-added. This partly reflects the presence of many part-time farmers and seasonal employees in the sector. Core processing makes up 25 percent of employment and 24 percent of value-added. Extended processing is the largest economic impact category, representing 44 percent of employment and 61 percent of value-added. Distribution and power generation activities account for 12 percent of employment and 8 percent of value-added.

Results for Virginia's localities show that every single Virginia locality is touched by agriculture and forestry. Employment impacts exceeded 1,000 jobs in 62 separate localities. Agricultural economic impacts were geographically diffuse. The largest clusters of agricultural-related industry employment impact were located in the Shenandoah Valley, Northern Virginia, and the Richmond City area. The largest forestry-related impacts tend to be somewhat more geographically concentrated in the Southside region and communities with pulp and paper mills such as Alleghany County and Covington City.

International exports are a significant source of agriculture and forestry-related industry economic impacts. The total impacts of agriculture and forestry-related industry exports are approximately $9 billion in total output, 46,600 jobs, and nearly $4.6 billion in value-added. Therefore, about 10 percent of the total output, employment, and value-added impacts can be attributed to international exports. Forestry-related industries account for 32 percent of the export output impact, 34 percent of the export employment impact and 29 percent of the export value-added impact. The total employment impact of international exports on the farming sector is 5,693 jobs out of a total 52,406 farm jobs in 2015. Therefore, one in nine Virginia farm jobs is dependent on international exports.

Among Virginia's agriculture-related industries, the largest economic impact in terms of total output ($6.8 billion) and value-added ($2.3 billion) is the poultry industry. The largest industry in terms of employment impact (37,450) is the beef cattle industry, which reflects partly the role of nearly 15,000 cattle farmers and farm employees. The dairy industry also has a sizeable economic impact, including over 16,000 jobs, approximately $4.3 billion in total output, and $2.2 billion in value-added. The economic impacts in these sectors are amplified because of the importance of local supply chains in production and the presence of sizeable value-added manufacturing activities connected to the sector. Smaller in size, but still economically significant, are the grains, greenhouse, and soybeans industries.

Virginia's agriculture and forestry industries generate economic impacts and other social benefits that are not represented in the economic impacts presented here. For example, the study does not capture the economic activity linked to corporate and regional offices, research and development, and other operations of agribusiness manufacturing firms. Virginia hosts agribusiness-related headquarters for Fortune 500 companies such as Altria and WestRock and other notable companies such as Smithfield Foods, Universal Corporation, Mars, Inc., American Woodmark, and Southern States Cooperative. The study also does not measure the economic impacts of on-farm recreational service or value-added product sales and off-farm agritourism and forest recreation, such as spending on hotels, restaurants, and retail establishments. These activities include freshwater fishing, hunting, hiking and backpacking, camping, wildlife watching, equine events and horseback riding, winery, brewery, and distillery visitation, and other agritourism. Studies of these activities conducted in recent years suggest that visitors can be counted in the millions and that economic impacts sum to several billion dollars. Thus, the commonwealth's agricultural and forest resources are also vital assets for Virginia's tourism industry.

Virginia's farm and forest landscapes provide important environmental benefits to the commonwealth. These benefits include improved water and air quality, flood risk mitigation, and wildlife habitat conservation. Open space preservation can also limit urban sprawl and lower the public costs of development such as the provision of public infrastructure, pollution and traffic congestion. Farm and forest open space preserves scenic beauty and helps maintain a sense of place. Quantifying the value of water and air quality improvements using environmental benefit parameters from scientific studies allows us to estimate conservatively that that the commonwealth receives approximately $184 million in value each year from agriculture and $6.7 billion in value from forestry in these areas alone.

INTRODUCTION

Virginia's agriculture and forestry industries have played a significant role in the growth and development of Virginia's economy. They are still major contributors and their economic impacts can be felt far and wide, encompassing more than the farms and forests with which they are most closely identified. The sectors affected include processing and manufacturing industries such as food and beverage processing, textiles manufacturing, wood products manufacturing, pulp and paper mills, and the furniture manufacturing industry which often utilize Virginia farm and timber products supplies. Distribution firms such as grain elevators and raw commodity warehouses rely on supplies of Virginia farm and forest products as well. These production, manufacturing, and distribution sectors purchase material and service inputs, labor, and value-added services from Virginia-based businesses and households. These purchases generate a multiplier effect that ripples through the Virginia economy. In this way, Virginia agriculture and forestry activity affects every industry and region of the state to varying degrees.

This study updates two earlier studies on the economic impact of Virginia's agriculture and forest industries (Rephann 2008, 2013) and preserves many features of those studies. It uses the same input-output methodology as the studies, and defines and disaggregates the industry in a similar manner. Agriculture and forestry-related industries are disaggregated into four components: production, "core" processing, "extended" processing, and distribution, reflecting different positions in the value chain and degree of dependency on Virginia's agriculture and forestry natural resources.

This study also expands on the presentation of the previous studies. Those studies provided statewide economic impact estimates, county-specific economic impact estimates, and international exports economic impact estimates. This study provides economic impact estimates of each of Virginia's six leading agricultural commodities (i.e., poultry, beef, dairy, grains, greenhouse and nurseries, and soybeans). These six industries account for nearly 84 percent of Virginia's total farm cash receipts. As in the previous studies, this study describes and quantifies other social and economic contributions of agriculture and forestry to Virginia, such as beneficial environmental effects, agritourism and forest recreation impacts, and other economic effects.

The study consists of five sections. The first section examines characteristics of the agriculture and forestry production, manufacturing, and distribution sectors in Virginia. It also examines recent industry fluctuations and trends. The second section describes the data and methodology used in the study. It describes input-output analysis and the computer model (IMPLAN) used, the method of delineating the industry, and the date sources used in estimation. The third section presents the results. The fourth section describes other economic impacts and social benefits of agriculture and forestry in Virginia that are not captured in the economic impact analysis. The final section is a summary and conclusion.

SECTION 1
VIRGINIA'S AGRICULTURE AND FORESTRY INDUSTRIES

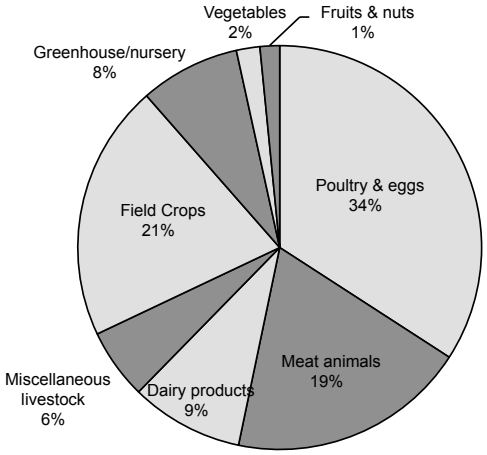
Virginia's agriculture and forestry sectors have emerged from the recent recession and significant restructuring brought on by international competition and are growing once again. A slow but steady recovery in the housing market, increasing international exports of roundwood and other wood products, and new markets for wood-based fuels such as biomass and wood pellets are contributing to a revival in the forestry sector. The agricultural sector is also benefitting from increased international exports, rapid growth of traditional poultry and beef product markets, the expansion of specialty industries that range from craft beverage producers to shellfish aquaculture, and reduced drag from tobacco and textile industry decline. The Commonwealth of Virginia has taken an active role in promoting industry expansion through economic incentive programs such as the recently established Governor's Agriculture and Forestry Industries Development (AFID) program, ensuring that it continues to play an important role in the Virginia economy. This section examines in greater detail the characteristics of Virginia agricultural and forestry production and related value-added industries, describes changes that have occurred in recent years, and outlines developments that may influence the trajectory of future growth.

Agriculture

Virginia's farms produce a wide variety of products. Livestock account for over two-thirds of farm cash receipts, with poultry, beef, and dairy constituting the largest products (see **Figure 1.1**). Crops make up the difference—grains (corn, wheat) and soybeans are the most significant field crops. Greenhouse and nursery products are also important. Virginia is a top 10 producer of several agricultural commodities. In 2015, the state ranked first for hard clam production, fourth for tobacco, sixth for turkeys, seventh for apples, eighth for grapes and peanuts, and tenth for tomatoes and trout aquaculture.

Virginia's farm cash receipts have grown rapidly in the last six years with a general boom in commodity prices (see **Figure 1.2**). Real cash receipts increased 40 percent from 2009 to the peak year of 2014 before decreasing 10 percent in 2015. This growth has been fueled by increased commodity prices driven by increased international demand. The recent growth has corresponded with a rebound in state farm employment from 50,570 in 2009 to 54,842 in 2014 before easing to 52,406 in 2015. Farmland area was estimated to be at the same level of 8.1 million acres (see **Figure 1.3**).

Figure 1.1 Cash Receipts by Commodity, Virginia, 2015

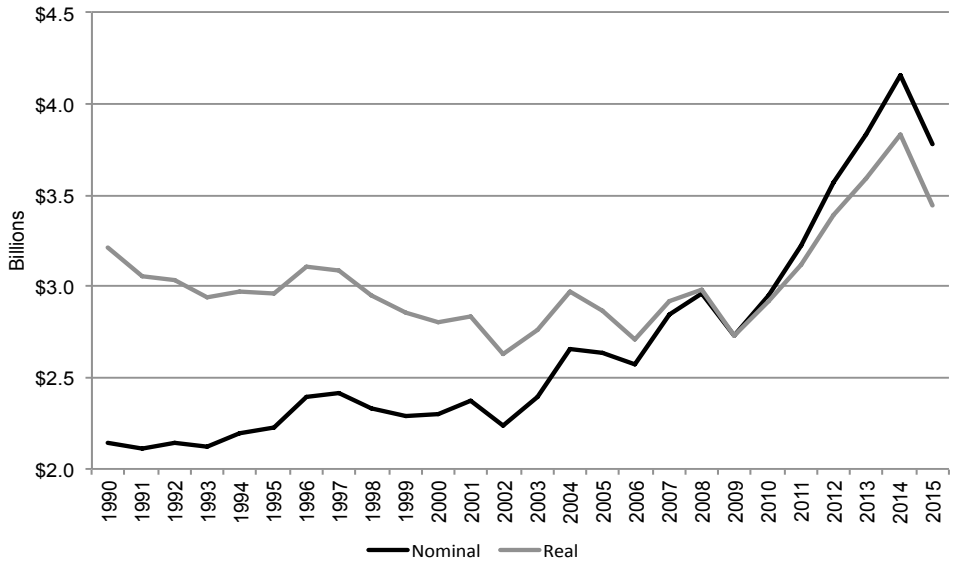


Source: U.S. Department of Agriculture, Economic Research Service (2016a)

The value of Virginia's agricultural commodity mix has also changed in the recent years. These changes are illustrated for major commodities in **Figure 1.4** for the period 2011-2015. The figure shows the degree of Virginia commodity concentration[1] versus the change in state nominal commodity sales on the horizontal axis. The relative size of state commodity sector sales is indicated by bubble size. Recent farm sales growth has been driven largely by the cattle and poultry (broilers and turkey) sectors. Among crops, corn and soybeans have also enjoyed

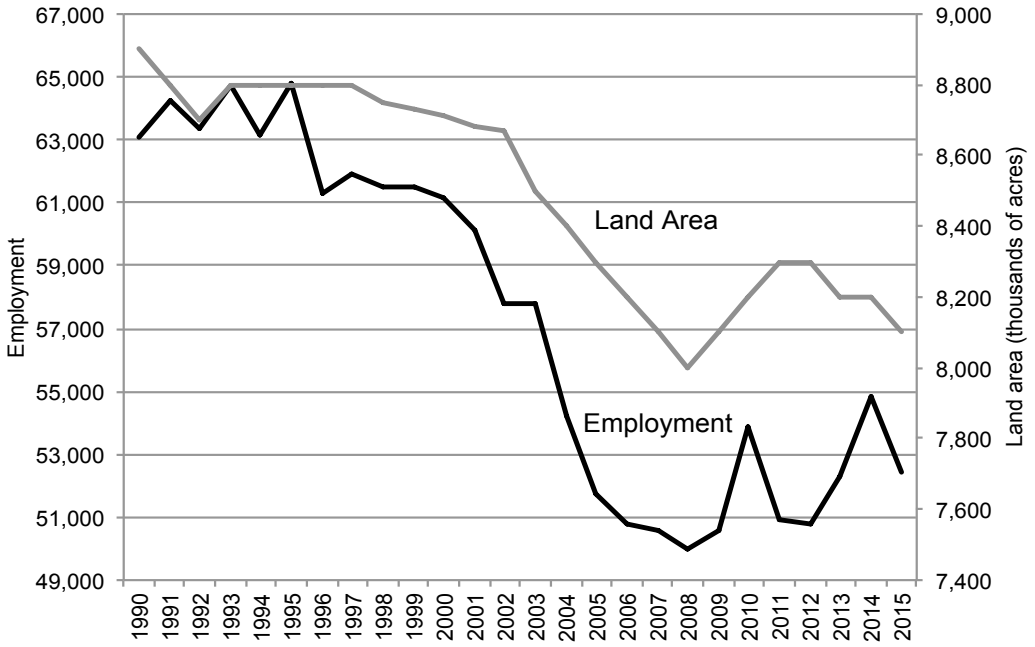
1 The location quotient measures state concentration in a given farm commodity relative to the nation. A location quotient greater than one indicates a higher concentration of the commodity in Virginia.

Figure 1.2 Virginia Agricultural Nominal and Real (2009 Dollars) Cash Receipts, 1990-2015



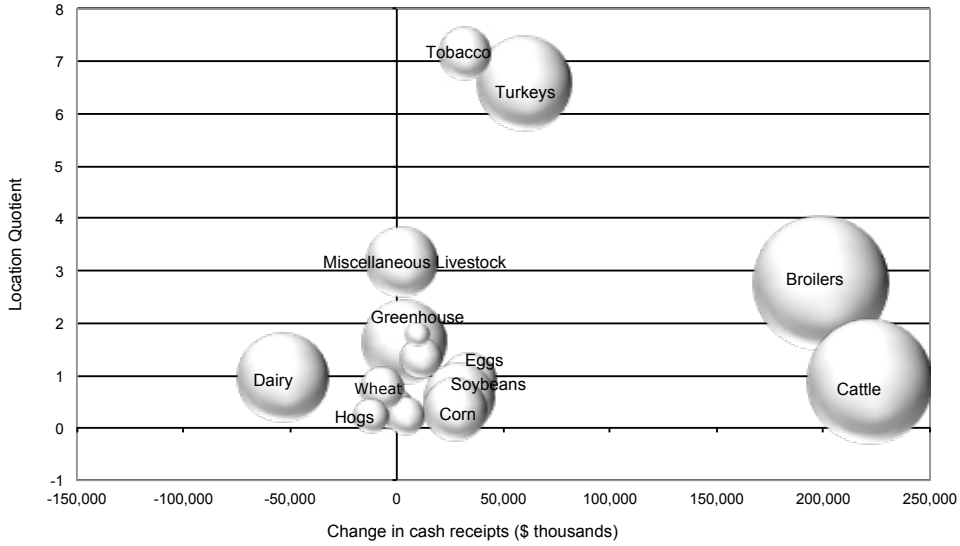
Source: U.S. Department of Agriculture, Economic Research Service (2016a)

Figure 1.3 Virginia Farm Employment and Land Area, 1990-2015



Source: U.S. Department of Commerce, Bureau of Economic Analysis (2016) and U. S. Department of Agriculture, National Agricultural Statistical Service (2016)

Figure 1.4 Change in Virginia Farm Commodity Sales by Size and State Specialization,2011-2015



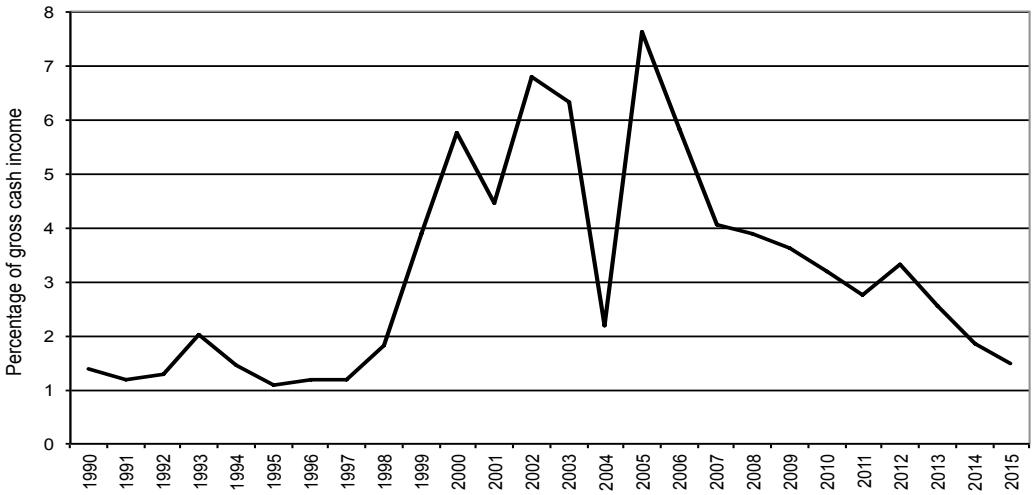
Source: U. S. Department of Agriculture, Economic Research Service (2016a)

significant growth. The largest absolute decline occurred in dairy production. Dairy prices peaked in 2014 and experienced a substantial decline in 2015. Greenhouse and nursery product sales experienced only marginal growth despite a pickup in housing construction and slow improvement in median household incomes over the period. Although difficult to detect in the graph because it is subsumed in the "miscellaneous livestock" category, Virginia aquaculture industry is also rapidly growing. Shellfish aquaculture generated an estimated $48.3 million in 2015 ($32.3 million for hard clams and $16.0 million for oysters), up 48 percent from $32.7 million in 2011 (Hudson and Murray 2016; Murray and Hudson 2012).

Federal farm programs have transitioned in the last decade. The peanut and tobacco quota buyout programs that accounted for a rising share of payouts to Virginia farmers in the 1999-2007 period have now expired. In addition, the federal government has phased out price support, direct payment, and counter-cyclical payment programs in favor of a risk management approach. Conservation programs such as the Conservation Reserve Program (CRP) are also relatively more important. Because of a different product mix, Virginia farmers are much less dependent on federal farm program subsidies than farmers nationwide. Government payments shrunk from a high of 7.6 percent of gross farm income in 2005 to 1.5 percent in 2015 (see **Figure 1.5**). This figure compares to 2.5 percent nationwide in 2015.

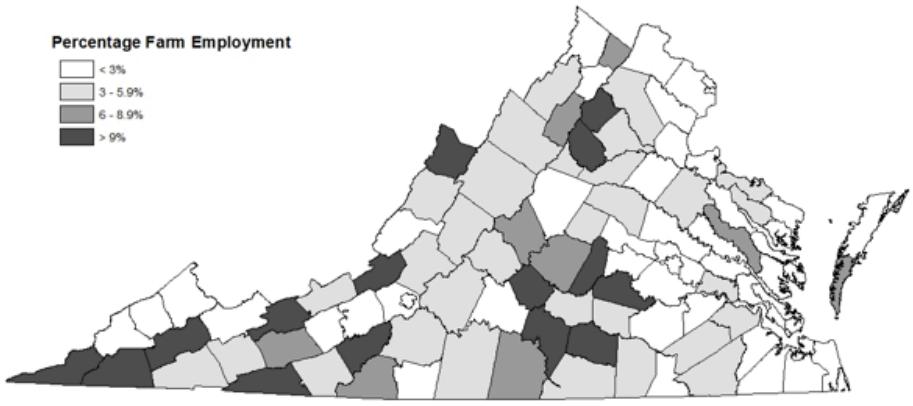
Farm production occurs throughout the commonwealth, but several significant geographical concentrations are found. Rockingham County (2,645) boasts by far the highest farm employment, including a large number of poultry, beef, and dairy producers that support a substantial agribusiness processing industrial cluster. Other high employment localities include Augusta County and Waynesboro and Staunton cities (1,944), Loudoun County (1,760), Washington County (1,625), and Pittsylvania County (1,553). Seven other localities had more than one thousand employees in the farm sector. The geographical pattern of farm employment as a share of total employment has changed little since 2010. Farm employment share is generally greater in the southern and western parts of the state (see **Figure 1.6**). Strong rural-urban differences also persist. Farm employment makes up 4.6 percent of total employment in Virginia's 53 nonmetropolitan localities versus 0.7 percent of total employment

Figure 1.5 Government Payments as Percentage of Virginia Farm Gross Cash Income, 1990-2015



Source: U. S. Department of Agriculture, Economic Research Service (2016a)

Figure 1.6 Farm Employment as Percentage of Total Employment by Locality, 2015



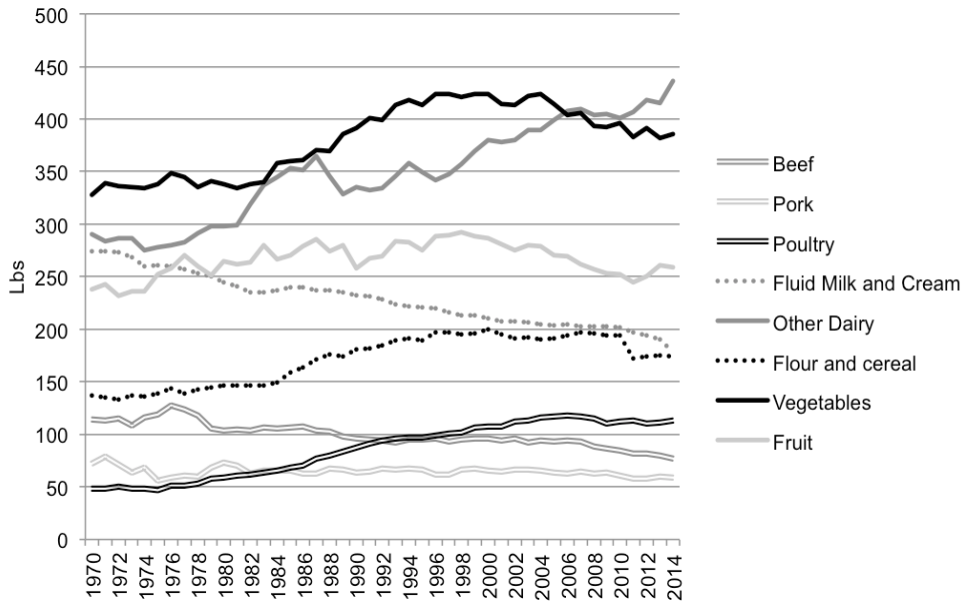
Source: U.S. Department of Commerce, Bureau of Economic Analysis (2016)

in metropolitan areas. As illustrated in Rephann (2013), the Commonwealth also exhibits sometimes pronounced regional specializations. Poultry production is important in the Shenandoah Valley and the Eastern Shore. Crop farming forms a bigger proportion of farming activities in the eastern half of the state where terrain is flatter while livestock farming is more common in the more mountainous west.

Virginia's farm economy continues to survive and often thrive because of a number of factors. The state provides a favorable climate for growing a variety of crops and sheltering livestock. It has an ample supply of fertile farmland. It is ideally located in close proximity to major growing northeastern urban markets. It has ready access to quality multimodal transportation, including the east coast's deepest-water seaport, inland intermodal container transfer facilities in Richmond and Front Royal, and excellent highway and rail infrastructure. The state is also rated highly on many business climate metrics that evaluate the cost of doing business in the state such as tax levels, regulatory burdens, labor costs, and energy costs. The state's land-grant universities at Virginia Tech and Virginia State University and Virginia Cooperative Extension provide a wide range of educational, farm assistance, research and development, and technology commercialization services for the farm and forestry sectors. State public policy has also been very supportive. These policies include a Secretariat of Agriculture and Forestry that oversees progress in the state agribusiness sector, marketing and export assistance, land preservation policies that protect valuable open spaces and farmland, land use value taxation and agricultural and forestry districts that decrease the costs of farm operation, and a newly created industrial incentive program (Governor's Agriculture and Forestry Industries Development) that supports the attraction and expansion of agribusiness enterprises that purchase Virginia grown farm and forestry commodities.

Domestic food demand has grown with the general increase in the population. However, demand for particular commodities has fluctuated because of changing consumer tastes and demographics, including increasing ethnic diversity and population aging (Davis and Lin 2005). Per capita domestic

Figure 1.7 Food Consumption Per Capita in U.S., 1970-2014



Source: U.S. Department of Agriculture, Economic Research Service (2016b)

demand for red meat such as beef and pork products has been trending downward while poultry consumption has increased (see **Figure 1.7**) due to dietary changes and price factors.[2] Demand for fluid milk products has been in long-term decline, while demand for other solid dairy products such as cheese and yogurt has increased. Public health advocates and U.S. dietary guidelines are prodding consumers to reduce their consumption of meat and add more fish and vegetables to their diets. Although increased consumption is not yet evident in overall fruit and vegetable consumption figures, growth in the consumption of fresh fruits and vegetables has occurred.

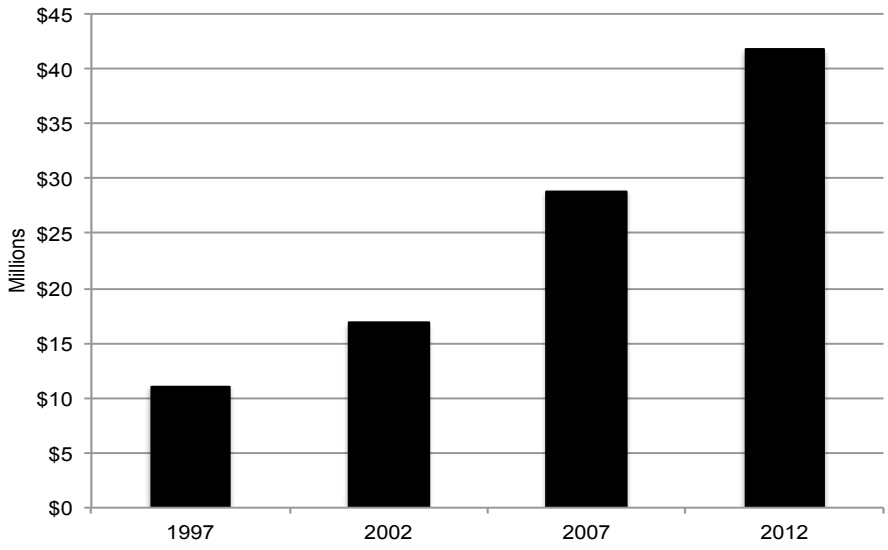
Another consumer trend is the growing popularity of local, organic, and natural (non GMO and antibiotic free) products. The growth of these products reflects increasing consumer concern about the quality, nutrition, and medicinal properties of foods and the social, environmental, and animal welfare impacts of their production processes. It also reflects the success of local food marketing efforts such as the Buy Fresh Buy Local campaign and Virginia Grown in the Commonwealth.

In Virginia, these trends can be seen in several indicators. The number of farmers markets doubled from 118 in 2009 to 237 in 2013. The volume of direct to consumer sales of Virginia farms increased from $11.1 million in 2002 to $41.7 million in 2012—1.1 percent of total farm sales (see **Figure 1.8**). In addition, 1,719 farms in 2012 sold through intermediated marketing channels (i.e., grocery stores, restaurants, and other regional distributions and retailers). Another indicator in this area is increased organic sales. One hundred and forty-five Virginia farms reported selling organic products worth $12.0 million in 2012. This represents a significant increase over $4.3 million in 2002.

Virginia farmers are also increasingly turning to international markets. An expanding middle class

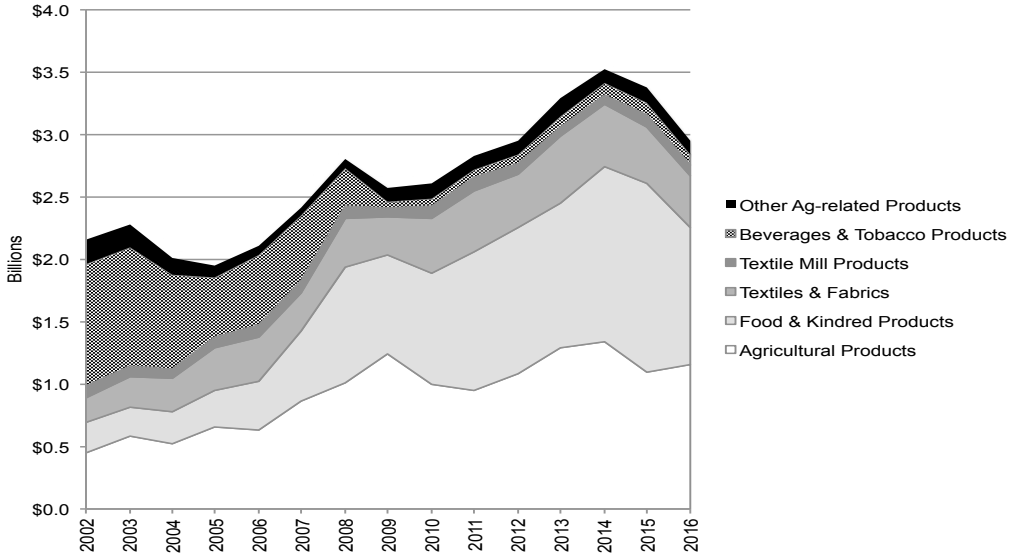
2 Food availability shows the food supply that is taken up by the food marketing system. It serves as a proxy here for food consumption.

Figure 1.8. Direct Sales of Agricultural Products, Virginia, 1997-2012



Source: U.S. Department of Agriculture, National Agricultural Statistics Service (2004, 2009, 2014).

Figure 1.9. Virginia Agriculture-Related Product Exports by Industry, 2002-2016



Source: U.S. Census Bureau (2017).
* Other agriculture-related products includes livestock and livestock products and leather and allied products

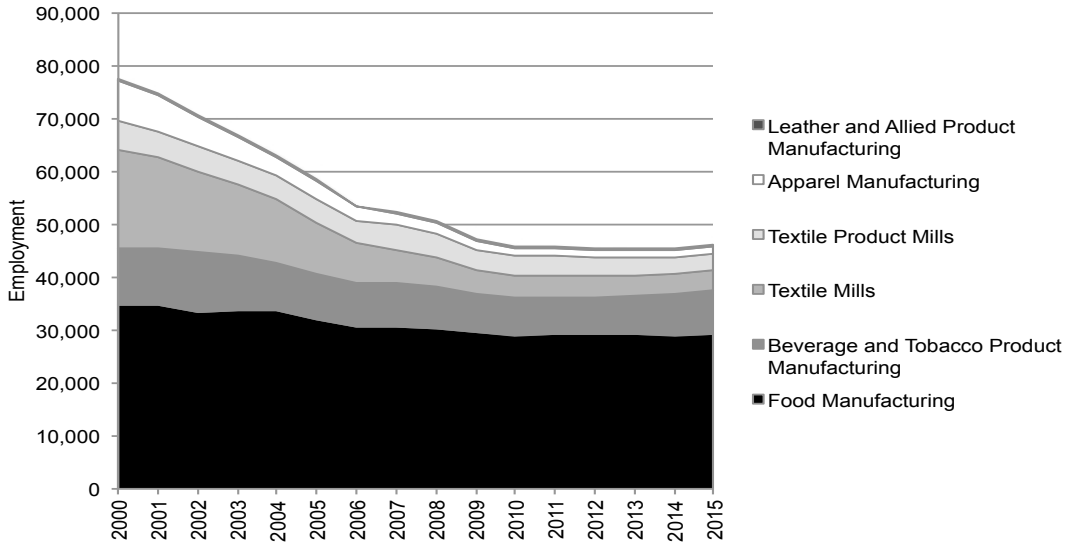
in rapidly growing developing countries has contributed to increasing international demand for U.S. food and fiber exports (see **Figure 1.9**). Virginia agriculture-related product exports increased from 2002 to 2014 by 62 percent. This increase was partly reversed by a 16 percent drop in exports between 2014 and 2016, due in large part to a higher dollar, slower global growth, and worldwide commodity glut that decreased demand for U.S. products. Consumer-oriented good exports such as food and kindred products, which are generally less sensitive to exchange rate fluctuations because of product differentiation by quality and branding (Cooke et al. 2016), have also decreased. The largest Virginia export products in 2016 were poultry products, soybeans, tobacco, wheat, dairy products, and beef.

Although starting from a relatively small base, agricultural feedstocks are increasingly being used to produce biofuel in Virginia. Five biofuel plants in Virginia produced biodiesel and ethanol in 2014. They produced 40 million gallons of biofuel, a substantial increase from 2.7 million gallons produced in 2012 (Virginia Clean Cities 2017).

Virginia's food, beverage, and fiber processors and manufacturers are the largest purchasers of Virginia agricultural commodities. The growth of these industries is steady if unspectacular since the end of the recent recession (see **Figure 1.10**). Investment in manufacturing automation is one factor constraining employment growth. Another factor is the continued erosion in some historically significant industries such as tobacco products and textiles and apparel industries, although the drag on total agricultural-related manufacturing employment exerted by the slowdown in these industries has lessened as they become smaller and the rate of decline slows. Employment in tobacco products manufacturing industry decreased approximately 8 percent from 2011 to 2015 while employment in textile and apparel industries decreased 10 percent. In contrast, these industries shrank by 49 percent and 29 percent respectively from 2007 to 2011.

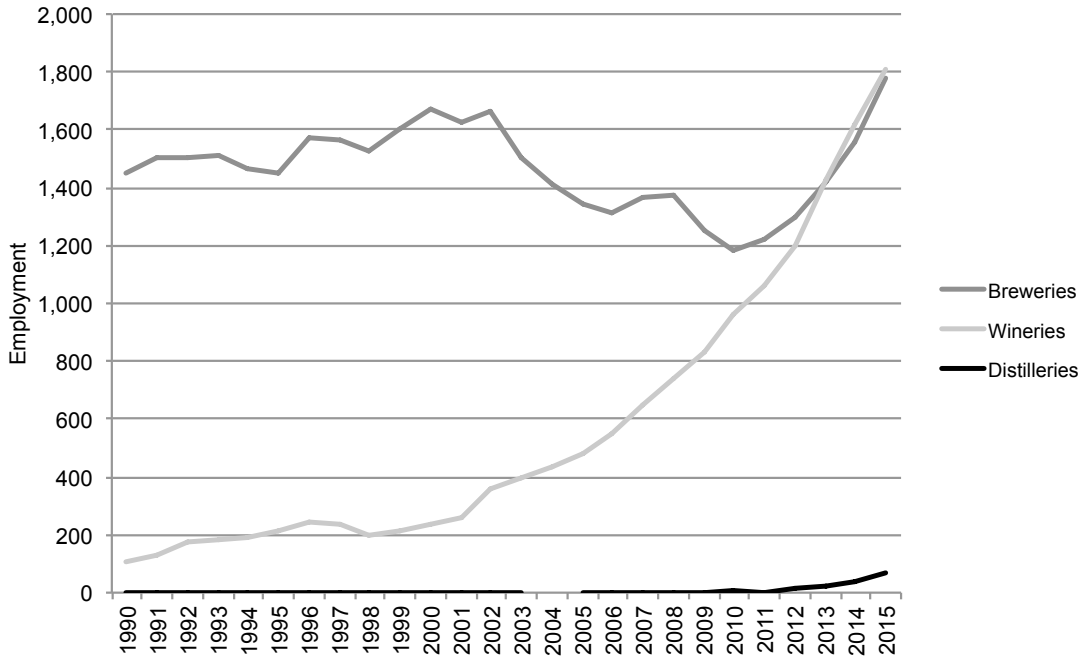
Hidden in the overall employment numbers are areas of substantial growth. Craft beverage firms have continued to expand their presence in the state. The Virginia wine industry grew from 193 winer-

Figure 1.10 Virginia Agriculture-Related Manufacturing Employment, 2000-2015



Source: Virginia Employment Commission (2016)

Figure 1.11 Brewery, Winery, and Distillery Employment in Virginia, 1990-2015



Source: Virginia Employment Commission (2016)

ies and 1,360 winery and vineyard workers in 2010 to 261 wineries and 2,785 winery and vineyard workers in 2015 (A Frank, Rimerman and Co. LLP 2017). There are were 68 brewing establishments in 2015 employing 1,776 workers in 2015 compared to just seven breweries, employing 1,316 workers in 2006 (see **Figure 1.11**). These totals numbers do not reflect new regional breweries announced by West Coast brewers such as Deschutes (Roanoke), Stone (Richmond), Ballast Point Brewing and Spirits (Botetourt County), and Green Flash (Virginia Beach) with a combined estimated employment of approximately 600 workers. Craft distilleries, an industry that barely existed a decade ago, consisted of 12 establishments employing 70 workers in 2015. Several new distilleries are in the pipeline.[3]

Virginia agriculture will continue to be shaped by changes in technology, consumer preferences, globalization, energy prices, and government policy.

New agricultural technology is transforming farm inputs, production practices and management, processing, and logistics and distribution. Farmers are increasingly substituting intermediate inputs such as improved seeds, pesticides, and herbicides for labor inputs (Wang et al. 2015). They are also using more specialized inputs and purchasing inputs through online platforms to improve farm productivity and lower costs. Supply chain vertical integration and increasing reliance on bilateral contracts have become common in certain farm sectors such as poultry (MacDonald 2014). Likewise, hog and dairy production are consolidating into increasingly larger farms with greater farm specialization in one stage of production to achieve economies of scale (McBride and Key 2013; MacDonald, Cessna, and Mosheim. 2016). These changes have affected Virginia livestock and poultry sectors differently; poultry production has been reinforced while hog production has expanded to other states.

Bioengineering advancements have resulted in seeds, feeds, feed enzymes, and growth hormones that have improved crop and livestock quality and output. Farms are also increasingly using data and automation in new ways. Precision agriculture tools allow crop farms to monitor crop yield and adjust seeding, fertilizer, pesticides, and herbicides in response to need. Livestock and poultry farms are also using more automation. For instance, it is increasingly common for dairy farms to use automated milking systems such as rotary or parlor milking systems, automatic feeding systems, and manure handling and bedding systems

Energy costs have decreased significantly in recent years with largely beneficial impacts on agriculture. Hydraulic fracturing and horizontal drilling have reduced natural gas and other energy prices. These price reductions have also decreased the cost of fertilizer and other chemicals used in agriculture (Marshall et al. 2015). Energy intensive crops (e.g., cotton and corn) have realized the greatest cost savings. There have been some areas of agriculture that have been negatively affected by these changes, including corn-based biofuels. Declining energy prices may also dampen demand for natural fiber products such as cotton due to the decreasing cost of petrochemical-based synthetic fiber product substitutes.

On the consumer side, changing demographics and preferences will continue to affect Virginia agriculture. Among the demographic factors are aging, more educated, and more culturally diverse consumers. Technological factors such as expanding communications media, including availability of smart phones, social media and access to global information, has contributed to the increasing consumer market fragmentation and growth of consumer market niches. Consumers have also generally grown more health conscious and place a higher priority on social and environmental issues. Thus, organic food, local foods, fair trade, and humane treatment of livestock are increasingly influencing consumer decisions. Consumers have also demonstrated increasing interest in boutique, artisan, and experiential food products and services. Virginia's close proximity to Northeastern populations centers is a key asset in catering to growing demand for many of these niche markets, including local foods, artisan foods, and agritourism.

3 The latest employment data from the Virginia Employment Commission Quarterly Census of Employment and Wages (QCEW) indicates that the numbers are still rising at a brisk pace. Ninety-one breweries reported 2,180 employees, and 15 distilleries reported 123 employees in the third quarter of 2016.

The agriculture sector remains vulnerable to the vicissitudes of government policy. Federal farm programs are a key element of government policy. But, Virginia is less reliant on farm programs payments than other states because of its agricultural commodity mix and the relatively small size of its farms. Tax, regulatory, trade, immigration, and monetary policy are also important.

Federal and state tax and regulatory policy affects Virginia farmers in several major ways. Virginia farmers have assumed a significant cost and regulatory burden for improving water quality such as the Chesapeake Bay Watershed region. Federal, state, and local regulations and taxes affecting food, beverage, and other products can also affect domestic demand with the most visible example being taxes and regulations used to discourage tobacco product use. Tax rates, depreciation rules, and other tax program parameters can affect farm profitability. Estate taxes have a disproportionate impact on farm estates and family farm succession. Policies to reduce air emissions such as carbon affect the farm sector as both producers of emissions and producers of biofuels and renewable energy. The rapid conversion of rural land to urban and non-agricultural uses has prompted a variety of land conservation tools to be used to preserve agricultural natural resources and protect the environment. They include land use regulations and incentive tools such as use value taxation, purchase of development rights (PDR), and tax credits.

Trade and immigration policies are also important. The recently abandoned Trans-Pacific Partnership (TPP) deal involving 11 other nations that decreases tariff and non-tariff trade barriers for goods and services was seen by farm groups as an important tool for expanding agricultural markets. The American Farm Bureau estimated that enactment of the TPP would have resulted in an estimated increase of $46.9 million in net agricultural exports from Virginia and 350 farm jobs.[4] Renewed efforts to stem the arrival of immigrant workers in the U.S. will have a disproportionate impact on the farm sector. According to one estimate, illegal immigrants make up over half of the hired workforce for crop agriculture (Calvin and Martin 2010). While existing legal immigration programs such as the H-2A visa program could potentially be used to help alleviate any labor shortage, farm groups argue that the visa program is unwieldy because of administrative and compliance costs.

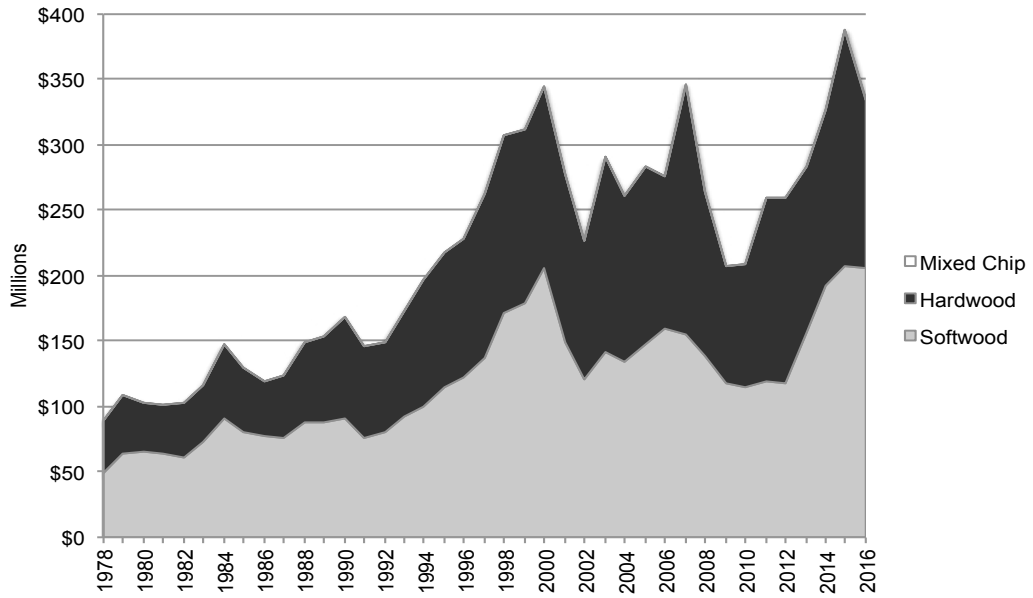
Federal Reserve interest rate policy also can have a significant impact on farming. After several years of extraordinary monetary policy (including various stages of quantitative easing) to address the 2008-09 financial crisis and recessionary aftermath, the Federal Reserve Board has begun to normalize interest rates. Rising interest rates can be expected to have a significant impact on farm capital equipment purchasing and debt serviceability.

Forestry

Virginia is a significant producer of timber. Hardwood species are the most common statewide, but the dominant removal species in the southeast and coastal regions are softwoods. Over the past two decades, harvested timber values have been roughly evenly divided between hardwoods and softwoods. Virginia produced approximately $388 million in stumpage (the sales value of standing timber) in FY2015, a new state record. However, it dropped back to $336 million in FY2016 in part due to a drop of international exports to China (see **Figure 1.12**). Forest Inventory Analysis (FIA) data indicates that timber growth continued to exceed removals and mortality from 2001 to 2014, particularly for hardwood species (Rose 2016). A study completed in 2015 using 2011/2012 forest resource data (Prisley 2015) raised concerns that softwood pulpwood size trees in Virginia were being harvested faster than they were growing and was leading to unsustainable removals of timber. However, more recent data shows that the state is growing more than it is harvesting. In response to sustainability concerns, the state has developed a forest sustainability plan to improve forest management and production (Virginia Department of Forestry 2015), hired pine sustainability foresters, supported tree improvement research, and fully funded the Reforestation of Timberlands program that provides additional technical and financial assistance for tree planting and landowner management.

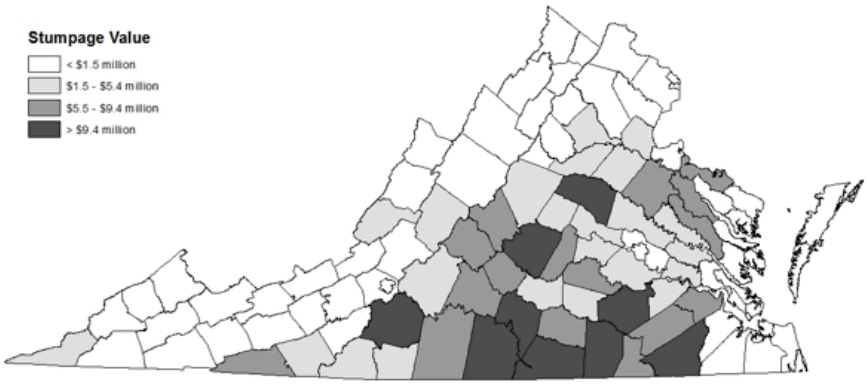
4 American Farm Bureau. 2017. http://www.fb.org/files/tpp/Virginia_TPP.pdf (Accessed March 21, 2017)

Figure 1.12 Virginia Stumpage Values, FY 1978-2016



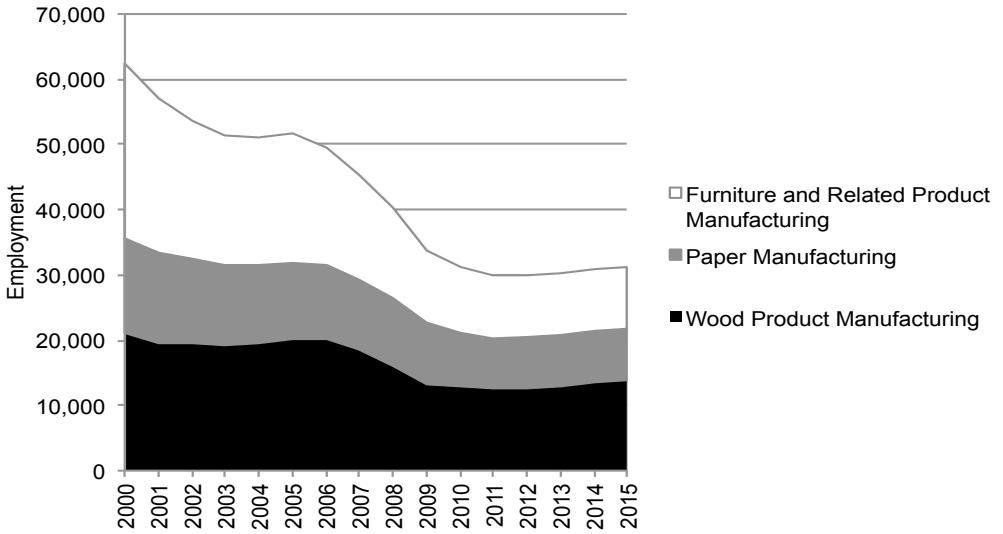
Source: Virginia Department of Forestry

Figure 1.13 Value of Virginia Stumpage by Locality, FY 2016



Source: Virginia Department of Forestry

Figure 1.14 Virginia Forest Product Manufacturing Employment, 2000-2015



Source: Virginia Employment Commission (2016)

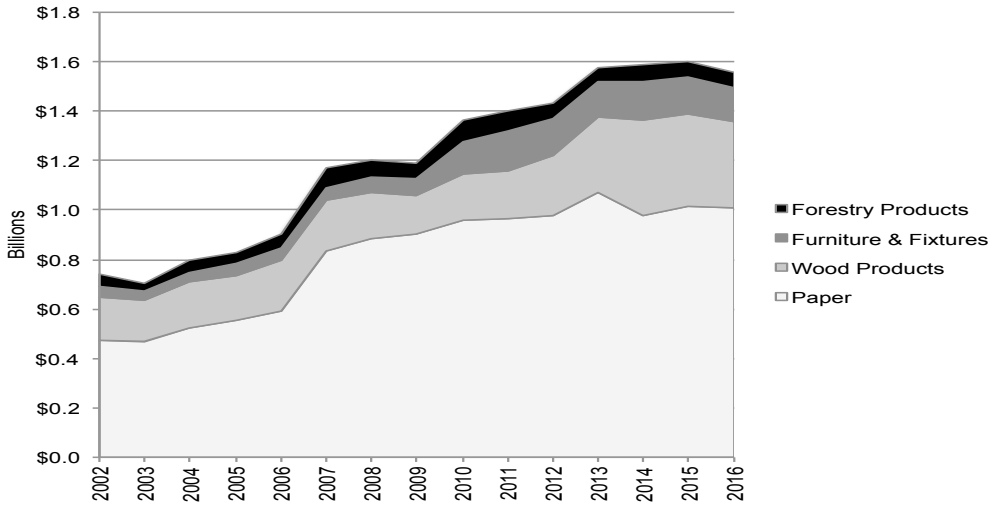
Virginia's forest resources are fairly evenly distributed throughout the state. However, urban commercial and residential development has reduced forestland, particularly in the Northern region. Timber removal value remains highest in the southern part of the state, reflecting the location of Virginia's softwoods, the presence of highly productive pine plantations, less costly logging conditions, and a greater concentration of wood products manufacturing industry in the region (see **Figure 1.13**). Timber harvests in this region have outpaced other areas of the state.

Virginia's forest product manufacturing employment reached its low point in 2011 with 29,877 jobs. It has since recovered modestly to 31,323 jobs (see **Figure 1.14**). However, employment still falls far short of the pre-recessionary level of 51,597 jobs in 2006 when national housing construction activity was at its peak. The vast majority of growth since 2011 has occurred in wood products manufacturing, reflecting the slow but steady improvement in the housing market since that time. Furniture manufacturing and pulp and paper manufacturing, in contrast, have changed little. This new equilibrium is a significant improvement over the steady decline in jobs that characterized the last decade, and reflects growth in consumer demand in the current recovery as well as industry restructuring that has restored competitiveness. Increasing international exports of wood and wood products have provided additional stimulus (See **Figure 1.15**)

Forest products industry production is much more variable over time than agricultural products because of macroeconomic, international, and technological factors. Because food and beverage products are non-durable goods, consumption is much smoother across the business cycle. Consumers eat regardless of business conditions; while they may trade up and down based on price and quality considerations, they cannot forego consumption entirely. Moreover, because most agricultural goods are highly perishable, production is much more likely to occur close to consumer markets. In contrast, forest products are often durable and produced at greater distances from consumers. Housing construction and renovation directly and indirectly drives most demand for solid wood products. Consumption is easily deferred, inventories may be warehoused for long periods of time, non-wood substitutes are often available, and lower costs of labor elsewhere combined with container shipping technologies makes it more profitable to offshore some production.

Although the housing crisis is now over, construction activity is only slowly returning to normalcy.

1.15 Virginia Forestry-Related Product Exports by Industry, 2002-2016



Source: U.S. Census Bureau (2017).

Thus, the revival in Virginia wood products industry employment has been slow as well (see Figure 1.15). The large surplus inventories of housing that piled up after the housing market collapse due to mortgage foreclosures and unsold inventories took years to draw down. More stringent mortgage lending terms resulting from financial regulation overhauls dampened demand for new buyers at the same time that mortgage interest rates had ratcheted down to historically low levels. Millennial financial circumstances and lifestyle changes resulted in more young adults living with their parents or in city multifamily dwellings and generated less demand for typical suburban tract single-family homes. Moreover, this shift to multifamily dwellings has ramifications for wood product demand since units are smaller than single-family homes and use less wood per unit (Prestemon, Wear, and Foster 2015). Lastly, increasing costs of site development because of government regulations and construction labor shortages has affected home building companies on the supply side, driving up costs—particularly for first-time homebuyer affordable housing. In Virginia, these trends were further aggravated by sequestration-related budgetary cutbacks that resulted in slower state than national growth over the period 2012-2015.

Since housing construction, home resale, and repair and remodeling are important determinants of furniture demand (Buehlmann and Schuler 2009), the Virginia furniture market has seen a slower revival as well. On the plus side, the furniture industry has emerged from a painful period of industry restructuring spurred by international competition on much more even footing. Walcott (2014) argues that a combination of company defaults, mergers and acquisitions, international outsourcing of some supply chain components, adoption of lean manufacturing, and targeting of high value-added market segments (e.g., upholstered, institutional, and office furniture) have made the remaining American furniture industry much more competitive. Furniture manufacturing employment has leveled off and, in some instances, a process of re-shoring has begun, driven by concerns about intellectual property theft, quality control problems, and slow delivery speed (Walcott 2014). Other products such as milled wood products and wood kitchen cabinetry and countertops continue to be largely shielded from international competition because of their unique marketing and distribution characteristics (Luppold and Bumgardner 2009; Buehlmann and Schuler 2009; Buehlmann and Schuler 2014).

Table 1.1 Virginia Biomass Power Generation Plants

Plant	Operator	Year	Power Unit
Pittsylvania Power Station	Dominion Power	1994	83MW
Virginia City Hybrid Energy Center	Dominion Power	2012	117MW (Only 20% biomass)
Altavista Power Station	Dominion Power	2013	51MW
Hopewell Power Station	Dominion Power	2013	51MW
Southampton Power Station	Dominion Power	2013	51MW
South Boston Power Station	NOVEC/NOVI Energy	2013	49MW
Covington Power Island	WestRock	2013	75MW

Source: Virginia Department of Forestry

Virginia pulp and paper industry employment has also leveled off after years of decline. This downturn was partly the result of decreased consumer demand, including competition from digital media. However, many of the same forces affecting the U.S. furniture industry were also at play. International competition led to the loss of U.S. market share in products such as newsprint and coated paper. But, mill closures and mergers and acquisitions have resulted in a pulp and paper industry that is leaner and more efficient. In addition, slowly improving manufacturing activity and burgeoning consumer Internet trade purchases increase demand for paper and paperboard packaging (Hetemäki, Hänninen, and Moiseyev 2014). Remaining mills are more likely to manufacture linerboard and paperboard packaging materials or tissue paper, which are less vulnerable to international competition because of their bulkiness and higher shipping costs (Li and Luo 2008; Hetemäki; Hänninen, and Moiseyev 2014).

Biomass energy production has emerged in recent years as a significant new market for surplus wood residues in Virginia. Federal clean and renewable energy programs and Virginia's voluntary Renewable Portfolio Standard offers incentives to the state's power companies to produce electricity from renewable resources (Woodall et al. 2012; Conrad and Bolding 2011). Woody biomass accounted for most of Virginia's renewable power generation in 2015 and approximately 5 percent of total power generation in the state.[5] Since 2012, Virginia has added over 300 MW in electrical power generation capacity (see **Table 1.1**). New power generation facilities added include the Virginia City Hybrid Center in St. Paul (2012), Altavista Power Station (2013), Hopewell Power Station (2013), Southampton Power Station (2013), South Boston Power Station (2013), and Covington Power Island (2013) at the WestRock mill. Wood pellet production for domestic heating and European export markets is another fast-growing sector in Virginia. Virginia hosts 10 wood pellet plants, most of which have been established in the last decade (see **Table 1.2**).

5 Energy Information Administration (2016). Net generation by state by type of producer by energy source (EIA-906, EIA-920, and EIA-923). http://www.eia.gov/electricity/data/state/

Table 1.2 Virginia Wood Pellet Plants

Plant	Location	Year	Thousand Tons
American Wood Fibers	Marion	2009	75
Enviva	Courtland	2013	800
Equustock	Chester	2007	80
Equustock	Troy	NA	40
Lignetics	Kenbridge	2009	50
O'Malley Wood Pellets	Tappahannock	2008	50
Potomac Supply	Kinsale	NA	60
Trae Fuels	Bumpass	NA	150
Turman Hardwood Pellets	Galax	2005	17
Wood Fuel Developers LLC	Waverly	2012	100

Source: Virginia Department of Forestry and Becker (2014)

Collectively, they processed over 1.4 million tons of wood, mill, and forest residues.

The housing market is forecasted to continue to gradually improve, providing additional tailwinds to the wood products industry. Although the Federal Reserve has begun to normalize the federal funds rate, historically low mortgage and consumer interest rates will persist a bit longer. Moreover, a modest uptick in economic growth and growing household incomes, increased young adult household formations, and an aging housing stock will help stimulate new housing demand. Single-family homes continue to grow larger too, though this reflects partly the difficulties of first-time homebuyers in securing loans for smaller, starter housing. The same forces that spur home sales and remodeling should improve the furniture industry's prospects as well.

Virginia's forestry and forest products industry faces some long-term resources challenges. Growing urban sprawl and fragmentation and non-industrial ownership hinder access and increase harvesting costs. Also, pests and disease, invasive species, air pollution, and changes in forest ecology from fire suppression are taking an increasing toll on Virginia forests.

Many of Virginia's challenges are national and international in scope. Demand for some forest products such as paper and paperboard products is decreasing because of electronic and plastic packaging material substitutes. Recovered paper, which constituted 37 percent of the fiber used in for papermaking in 2009, is expected to make further inroads, affecting the demand for pulpwood (Prestemon, Wear, and Foster 2015; Hetemäki, Hänninen, and Moiseyev 2014). Moreover, engineered wood (e.g., laminated veneer lumber, I-joists) and wood composite products are displacing solid-wood products due to their improved construction properties and lower costs, resulting in lower wood volume (Prestemon, Wear, and Foster 2015; Buehlman and Schuler 2014). At the same time, hardwood producers face increasing competition from lower cost and faster growing Asian and South American tropical nonconiferous hardwood materials (Prestemon, Wear, and Foster 2015; Hetemäki, Hänninen, and Moiseyev 2014). Developing countries are becoming more agile producers of a wider range of forest products and are tapping global markets (Hetemäki, Hänninen, and Moiseyev 2014). As the forestry and forest products sectors increase productivity through increased use of capital and technology, lower levels of employment are necessary (Prestemon, Wear, and Foster 2015).

Virginia continues to have significant advantages in forestry-products production over many other states. The state hosts relatively large forestry and wood products industry clusters.[6] Industry clusters are groups of interconnected businesses that become more productive by locating close to one another. It has a large and growing forest inventory, including large inventory of plantation grown trees. The availability of this fast-growing smaller tree resource is a significant advantage for attracting engineered wood and composite wood products industry production (Prestemon, Wear, and Foster 2015). Virginia's forestry products workforce is smaller and older than before the last recession but still remains significant in size. It can also access regional distribution and marketing assets, such as a major eastern seaport and the world's premiere furniture showroom located in nearby High Point, North Carolina. Higher education provides numerous educational and training programs and the state's land-grant university (Virginia Tech and Virginia State University) support industry-relevant research and development.

Virginia may also benefit from new products and services. New opportunities may exist for professional forestry-related services that cater to urban and suburban customers in such areas as harvesting and thinning, marketing, and other areas (Hull 2011). New products based on wood-plastic composites for construction (such as those produced by Winchester-based composite producer Trex); cross laminated timber (CLT) for heavy construction;

6 Industrial clusters were identified using the Harvard Business School's U.S. Cluster Mapping Project industry cluster framework. The forestry and wood products industry clusters had location quotients (a measure of economic concentration relative to the U.S.) greater than 1.3 in 2014 based on U.S. Census Bureau County Business Patterns employment data, indicating that Virginia was significantly more concentrated in these industry clusters than the United States as a whole.

biopolymers and nanocelluse for paper, textiles, and other products; wood chemicals for chemical products, pharmaceuticals, nutraceuticals, and cellulostics biofuels could present future possibilities (Cai et al. 2014; Hetemäki, Hänninen, and Moiseyev 2014). Changes in building codes such as those occurring in Europe that allow taller buildings to use wood frame construction would also provide a boost in construction demand (Prestemon et al. 2015).

The agenda of the new Trump administration may affect the agriculture and forestry industries in different ways, both positively and negatively. Proposed regulatory easing and tax reforms should reduce operating costs for farms and businesses, including the housing construction sector. Withdrawal in support for multilateral trade programs such as TPP and NAFTA, and greater trade restrictions can be expected to have a detrimental impact on production sectors, which rely heavily on international trade. But, the impacts on other value-added sectors that have been negatively affected by international trade competition such as furniture and pulp/paper are less certain. A crackdown on illegal immigration and more restrictive policies towards H2 visas would constrain labor availability for production and manufacturers. The Trump administration's FY 2017 proposed budget presented calls for significant cuts in discretionary spending programs with an unusually steep 21 percent cut in the U.S. Department of Agriculture, including the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), statistical services, and county-level Farm Service Agency staffing.[7] Lastly, lessened support for clean energy initiatives and environmental mitigation measures could affect the business models of alternative fuels producers and producers of specialized environmental services.[8] The net effect of these varied changes are difficult to predict.

Agriculture and Forestry Industries Development Program

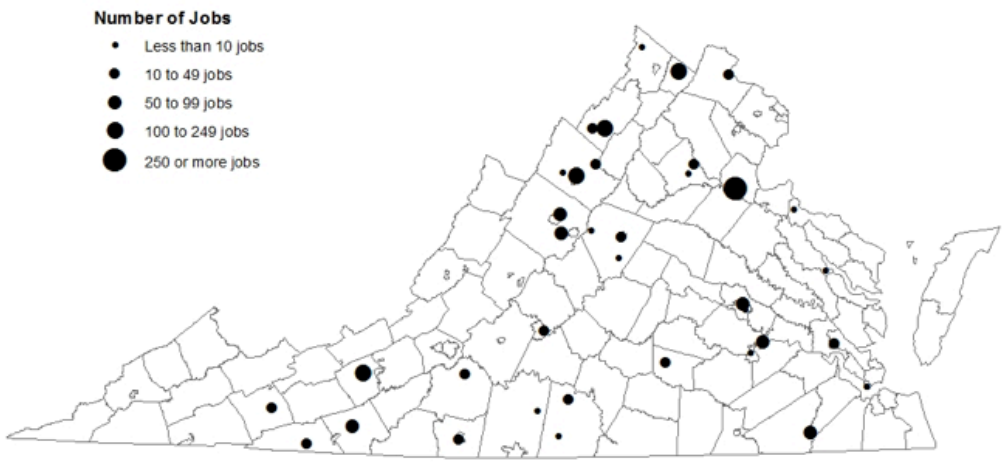
Virginia's agriculture and forestry production sectors have been aided in recent years by a new economic incentive program that aims to stimulate purchases of Virginia-grown commodities by value-added companies: the Governor's Agriculture and Forestry Industries Development Fund (AFID). The state offers several economic development incentive programs that sometimes support agribusinesses. For example, the Commonwealth's Opportunity Fund (COF) provides deal-closing grants to attract new and expanding businesses that sell most of their products outside Virginia. In recent years, agriculture and forestry-related manufacturing firms such as Monogram Food Solutions (Henry County), Stone Brewing Co. (Richmond City) and Appalachian Biofuels (Russell County) have benefitted from the program. The Tobacco Region Revitalization Commission has developed several economic assistance programs to support the Southside and Southwest regions' transition from tobacco farming to more diversified farming and value-added activities. The AFID facility grant program is different from these programs in that it requires value-added enterprise grant recipients to source a minimum percentage (30 percent) of agricultural and forestry inputs from Virginia. For example, Copper Fox Distillery (Williamsburg City) was awarded grant funding in part because it would use nearly $500,000 in Virginia agricultural products each year for its new distillery as well as create over 25 new jobs.

The AFID program was adopted by the General Assembly and signed into law in 2013. In addition to its provisions for purchasing a minimum percentage of Virginia products, the AFID statute emphasizes the importance of new jobs, capital investment, and geographic diversity. Its total appropriations from FY 2013 to FY2016 were $5 million. Since 2013, the program awarded 38 grants that are expected to create 1,666 jobs, $341.8 million in capital investment, and $543.3 million in Virginia agricultural and forestry product purchases (VEDP 2016). Forty-two

7 Sparshott, Jeffrey and Ted Mann. 2017. Budget plan slashes EPA, aids military. *Wall Street Journal*. March, 17, 2017. https://www.wsj.com/articles/trump-budget-seeks-big-cuts-to-environment-arts-foreign-aid-1489636861 (Accessed April 5, 2017).

8 For instance, the EPA had been expected to release regulations that would identify whether biomass feedstock was a carbon-neutral fuel and to what extent biomass could be substituted for fossil fuels in U.S. power generation (Hitaj and Suttles 2016, Howard and McKeever 2015). This regulatory framework is now in doubt.

Figure 1.16 AFID Grant Recipients and Number of Jobs Expected, FY2013-FY2016



Source: Virginia Department of Agriculture and Consumer Services

percent of the awardees were food manufacturing enterprises, 19 percent were beverage manufacturing, 16 percent were wood product manufacturing businesses, and the residual 13 percent were assorted agriculture and forestry production and distribution enterprises. Program participants can be found throughout the Commonwealth (see **Figure 1.16**).

The AFID program also funds a smaller planning grant program. The grants are awarded to local governments for agricultural strategic planning, feasibility studies, and other local capacity building initiatives. The program has been a catalyst for many localities to develop agricultural development strategic plans as well as business plans for new agricultural centers, cooperatives and business startups.

SECTION 2
METHODOLOGY

This section describes the methodology used to estimate agriculture and forestry economic impacts. The first part describes how economic activities directly linked to agriculture and forestry resources were defined for use in economic impact analysis. The second part describes the input-output analysis economic impact methodology and software (IMPLAN) used to measure state and local economic impacts. The third section describes the data used.

Agriculture and Forestry-Related Industry Identification

This study identifies the same sectors as the last study (Rephann 2013) as being directly related to agriculture and forestry.[9] These industries were identified using data from IMPLAN on forward linkages with agricultural and forestry commodities in combination with information from the U.S. Department of Agriculture's Economic Research Service (2005) and U.S. Department of Agriculture, Forest Service (2004) on industry scope.[10] A fuller discussion of the methodology is provided in the last study (Rephann 2013). The underlying theoretical and practical issues underpinning the selection of those industries are provided in the original study (Rephann 2008). These industries and their associated IMPLAN sectors and definitions are listed in **Appendix Table A.1**.

Forestry and agriculture-related industries were categorized into what are called "production," "core processing," "extended processing," and "distribution" activities based on their supply chain proximity to Virginia agricultural and forest commodities. *Production* activities consist of those industries involving the growing and harvesting of agricultural, timber, and non-timber forest product commodities. *Core* processing industries are manufacturing industries that rely on state commodity inputs for production and likely locate in close proximity to these raw materials to minimize production costs. These industries tend to be involved in primary processing industries that generally involve the first stage of converting a commodity input into a finished consumer product. Commodity inputs tend to be bulky or highly perishable. Examples of these industries include animal slaughtering and sawmills. *Extended* processing industries are secondary processing industries that are somewhat less dependent on Virginia farm and forest commodity inputs. They tend to involve cooking, blending, and packaging products from primary processing industries such as milled grains, dairy, and meat. Due to the high perishability or bulkiness of the finished products, these industries are more likely to require close access to consumer markets or transportation infrastructure such as ports and freeways. For example, beverage production often involves combining locally available water supplies with fruit, corn and sugar extracts and is produced close to final consumers. In much the same way, custom cabinetry firms locate close to customers in order to rapidly respond to consumer demand. *Distribution* industries are warehousing, wholesaling, and service industries with a close nexus to agricultural and forest products such as grain elevators and landscaping. Also included in this category is the biomass power generation industry, a growing power source in Virginia and elsewhere in the country, which was recently added to government economic accounting as a distinct industry (NAICS sector 221117).

9 Since there was a change in the number of IMPLAN sectors (moving from a 440-sector scheme to a 536-sector scheme), older agriculture and forestry-related sectors were aligned with the newer sectors.

10 The directly linked industries identified here are in some ways broader and in other ways narrower than those used in other state agriculture and forestry economic contribution studies. For instance, one forestry study includes "forest-based recreation, forestry-related service providers, mattress production, blinds and shades production, wood casket and wood musical instrument manufacturing, wood-based wholesale activity, and forest-related contributions from federal/state governments and universities" (Henderson et al. 2017). Some studies include farm, forest, food product, and lawn and garden machinery and equipment manufacturing, fertilizer and pesticide manufacturing, veterinary services, and food and drinking places (English, Popp, and Miller 2016; Lopez, Plesha and Campbell 2014). On the other hand, most agriculture economic contribution studies exclude textile and apparel industries reliant on natural fibers.

Economic Impact Modeling

This study uses input-output analysis to perform the economic impact analysis. Input-output analysis produces industry-specific multipliers that show how economic activity in one sector of the economy affects the overall state economy. For this study, we are interested in how agricultural and forestry-related activity affect the state economy.

The total impact of agricultural and forestry-related activity consists of three parts: a "direct effect," "an indirect effect," and an "induced effect." The *direct effect* consists of the injection of economic activity or expenditure into the region, namely the sales of agricultural and forestry-related industries located in Virginia. This direct expenditure then causes a "ripple effect" on the state economy when money is re-spent. For instance, state businesses provide supplies and services to farms such as seeds, fertilizer, veterinarian services, utilities, and insurance.[11] These businesses spend a portion of their sales revenues on purchases of supplies and services from other state firms who, in turn, purchase a portion of their supplies and services from other state firms. This cascading sequence of spending continues until the subsequent rounds of spending dissipate due to leakages in the form of spending outside the state. The cumulative effect of these cascading rounds of inter-industry purchases is referred to as the *indirect effect*. The final component of total impact (the *induced effect*) is attributable to the spending of households and other economic agents. For instance, businesses pay households for their labor services. These households then purchase goods and services from state firms who in turn receive a portion of their labor, material and public service inputs from within the state. Again leakages occur at each round due to purchases of goods and services outside the state. The induced effect is the sum of the impacts associated with these household purchases.[12]

The economic impact analysis uses IMPLAN (Impact analysis for PLANning) software. IMPLAN has been used in many economic impact studies, including the most recent economic impact studies of Virginia agriculture and forestry (Rephann 2008, 2013). It is perhaps the most common tool used in state agriculture and forestry industry impact analysis (Henderson et al. 2017; English, Popp, and Miller 2016). Models here are built using 2015 data released in December 2016 that utilize a 536-sector IMPLAN sector scheme. Since both statewide and local analyses are performed, tables were customized for Virginia and each of its localities.

Impacts are evaluated within IMPLAN using three different measures: (a) total sales or total industrial output (TIO), (b) value-added, and (c) employment. Total sales or industry output is the total value of industry production during a period. It measures sales of intermediate inputs for use in production as well as sales of products to final consumers. Value-added is a subset of total industrial output. It reflects only sales to final consumers and therefore avoids the double counting that occurs when intermediate inputs are included. It is the most commonly used measure of economic activity. Value-added is the concept behind gross domestic product (GDP) and can be compared to the GDP numbers provided by the Bureau of Economic Analysis for states and metropolitan areas. It can also be represented as total factor income plus indirect business taxes. Employment is measured in terms of person-years of employment. A person-year of employment is a job of one year in duration. Employment includes

11 Two adjustments were made to avoid double counting of direct and indirect effects. First, agricultural byproducts of agricultural and forest commodity industries were modified so that each industry produces its primary commodity. Second, purchased inputs from each agriculture and forestry-related industry were disallowed by setting regional purchase coefficients (RPCs), which represent the portion of state demand purchased from state producers, to zero in each of the agriculture and forestry-related sectors included in the model. These procedures are recommended in recent peer studies of agriculture and forestry contribution analyses (Henderson et al. 2017; English, Popp, and Miller 2016).

12 A social accounting Matrix ("SAM") forms the underlying accounting system for the analysis. It show transfers between all economic agents that add value to products and services, including industries, labor/households, government, and capital. Social Accounting Matrix (SAM) type multipliers can include the effects from employee household spending as well as the induced effects of spending of firm profits, transfer payments, and other institutional transactions. For the statewide model, this study uses SAM multipliers that are closed in IMPLAN with respect to households, state and local government, federal non-defense government, capital, and enterprises.

full-time and part-time employment as well as the self-employed and is measured by place of work.

Data

This study uses data from the same four sources as previous studies. Farm and forestry-related employment data for core-processing, extended-processing, and distribution industries were obtained from the Virginia Employment Commission (VEC) Quarterly Census of Employment and Wages (QCEW) for the second quarter of 2015, which is representative of annual employment. Industry employment totals are aggregated into IMPLAN categories using North American Industrial Classification System (NAICS) codes. The employment numbers are then converted to sales/output equivalent figures by the model for use in generating economic impact estimates. Most production sectors were treated differently because proprietors and self-employed constitute most of the employment but are not generally included in the QCEW data. For farming sectors (IMPLAN sectors 1-14), U.S. Department of Agriculture commodity cash receipts data from 2015 were used (U.S. Department of Agriculture, Economic Research Service 2016a).[13] For forest nurseries, forest products, and timber tracts sector (IMPLAN sector 15), data from Virginia Department of Forestry timber product average tax receipts for fiscal years 2015 and 2016 (to estimate calendar year values) were substituted. For logging (IMPLAN sector 16) and hunting and trapping (IMPLAN sector 18), output and employment estimates from the Virginia IMPLAN database are used.[14]

In order to make estimates for localities, additional data imputations were needed because 2015 local agricultural cash receipt data were not available. Therefore, statewide 2015 values for cash receipts for each sector were scaled down to the local level using IMPLAN total industrial output estimates for 2015 by sector for localities.[15]

Estimates of agriculture and forestry-related industry exports are made using statewide employment and output totals by sector for industries included in Table A.1 and estimates by sector from IMPLAN. Foreign export shares of total output by sector for 2015 from IMPLAN are multiplied by 2015 state agricultural and forestry-related industry output described previously to obtain estimates of statewide agriculture and forestry-related industry. This procedure is the same as that used in the 2013 study.[16]

13 Appendix A.1 shows agricultural commodity sales trend data including the 2015 values used in the IMPLAN analysis for IMPLAN sectors 1-14.

14 IMPLAN employment data are generated from a variety of different sources including employment data from the U.S. Census Bureau (County Business Patterns), Bureau of Labor Statistics (Covered Employment and Wages), and Bureau of Economic Analysis (Regional Economic Information System). The imputed employment data reflect adjustments for proprietors by industry.

15 IMPLAN estimates the farm output numbers using U.S. Department of Agriculture data as described in Lindall (1998).

16 IMPLAN distributes national exports by industry to states based on the state's share of total national output in that industry. This method may tend to underestimate state exports from states having ports of exit such as Virginia because international shipping costs for many products will be lower for products produced in closer proximity to the port. On the other hand, export measures that rely on origin of movement data such as the U.S. Census Bureau's state export series produce the opposite problem. Export products are often consolidated at a transit point by shipping companies and wholesale and retail brokers. Thus, the origin of movement will reflect these transit point locations rather than where the product was produced. For agricultural products, the transit point is often the state containing the port of exit. Since Virginia contains a major seaport in Hampton Roads, exports based on origin of movement will tend to overestimate foreign exports.

SECTION 3
RESULTS

This section presents the economic impact results in four parts. The first part shows the statewide impacts of agriculture and forestry. The total economic impacts are divided into direct, indirect, and induced impacts. Furthermore, results are disaggregated into the components of production, core processing, extended processing, and distribution and power generation activities. Results are also disaggregated by industry of impact. The second part shows the economic impact of Virginia's six leading agricultural commodities (i.e., poultry, beef, dairy products, grains, soybeans, and greenhouse/nurseries), including associated value-added industries. The third part shows the economic impacts of international exports. The final part describes the direct and total economic impacts for forestry and agriculture by locality.

Table 3.1 Virginia Agriculture and Forestry-Related Industries Direct Output, Employment, and Value-Added, 2015

Component	Output (Million $)	Employment	Value-Added (Million $)
Agriculture			
Production	3,821	53,844	1,187
Core processing	11,347	20,755	2,605
Extended processing	22,977	21,113	12,640
Distribution	1,948	27,378	1,287
Total	40,092	123,090	17,720
Forestry			
Production	771	8,895	458
Core processing	6,557	16,997	1,613
Extended processing	3,221	12,899	899
Distribution	869	2,846	467
Total	11,417	41,637	3,437

Statewide Impacts

The direct effect of Virginia agriculture and forestry-related industries in 2015 by component is reported in **Table 3.1**. The industries accounted for $51.5 billion in total output, 164,727 employees, and $21.2 billion in value-added. The output, employment, and value-added direct effects are shown by their relative shares in agriculture and forestry components in **Figure 3.1**. Agriculture production is the largest component in terms of employment at nearly 33 percent. However, agriculture extended processing accounts for nearly 45 percent of output and 60 percent of value-added.

Figure 3.1 Virginia Direct Effects by Agriculture and Forestry Component, 2015

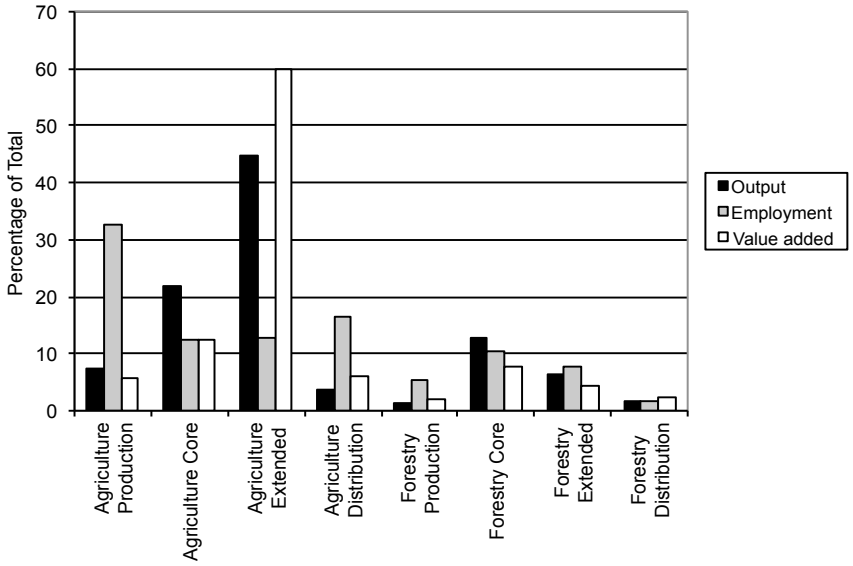


Table 3.2 presents the total economic impact of agriculture and forestry-related industries. It indicates that the total industry output or sales impact of agricultural and forestry industries in Virginia was over $91 billion in 2015, the employment impact was 442,260, and the value-added impact was approximately $45 billion. These total impacts include indirect impacts and induced impacts. Results indicate that agriculture-related activities account for 76 percent of total agriculture and forestry output and employment, and 80 percent of total value-added impact.

Table 3.2 Virginia Total, Direct, Indirect, and Induced Impacts of Agriculture and Forestry-Related Industries, 2015

Impact	Output (Million $)	Employment	Value-Added (Million $)
Agriculture and Forestry			
Direct	51,509	164,727	21,158
Indirect	9,369	45,574	4,791
Induced	30,474	231,958	19,522
Total	91,352	442,260	45,470
Multiplier	1.77	2.68	2.15
Agriculture			
Direct	40,092	123,090	17,720
Indirect	5,703	27,805	3,002
Induced	23,981	183,433	15,435
Total	69,776	334,328	36,158
Multiplier	1.74	2.72	2.04
Forestry			
Direct	11,417	41,637	3,438
Indirect	3,666	17,769	1,788
Induced	6,493	48,525	4,087
Total	21,576	107,931	9,312
Multiplier	1.89	2.59	2.71

The economic impacts of agriculture and forestry were felt in all other sectors of the economy to varying degrees (see **Table 3.3** and **Figure 3.2**). Manufacturing and agriculture were stimulated largely through the direct effects of farming, timber tract, logging, and related manufacturing activities. However, agriculture and forestry-related activity stimulated significant additional activity in the services, government, and trade sectors through the effects of industry purchases, household, and other institutional purchases and subsequent rounds of spending. Tens of thousands of jobs in the construction and transportation, information, and public utilities industries are also associated with agriculture and forestry activity.

Table 3.3 Total Impact of Virginia's Agriculture and Forestry-Related Industries by Major Industry, 2015

Industry	Output (Million $)	Employment	Value-Added (Million $)
Agriculture	4,612.0	63,310	1,662.5
Mining	118.1	707	49.5
Construction	3,132.9	18,830	1,420.8
Manufacturing	46,177.2	77,122	18,336.9
Transportation, Information, and Public Utilities	5,881.0	19,550	2,652.8
Trade	3,051.6	33,071	1,955.0
Service	22,927.8	173,766	14,362.9
Government	5,451.0	56,358	5,029.8
Total	91,351.7	442,260	45,470.2

The impacts were estimated by agriculture and forestry sectors and further broken down into their production, core processing, extended processing, distribution, and government payments components for output, employment, and value-added (**Table 3.4**). The table also shows the magnitude of the component economic impact relative to the size of the state economy for each metric. The total economic impact for each component is illustrated in **Figure 3.3**.

The agriculture and forest industry economic impacts are sizeable relative to the Virginia economy (see Table 3.4). Agriculture and forestry industry economic impacts represent 11.1 percent of total state output, 8.7 percent of total state employment, and 9.5 percent of state gross domestic product. Thus, approximately one of every eleven jobs in Virginia can be connected to its agriculture and forest industries.

Among the industry components, production industry impacts make up 19 percent of the total employment impact but a considerably smaller share, 7 percent, of value-added. This partly reflects the presence of many part-time farmers and seasonal

Figure 3.2 Distribution of Virginia's Direct, Indirect, and Induced Employment Impacts by Industry, 2015

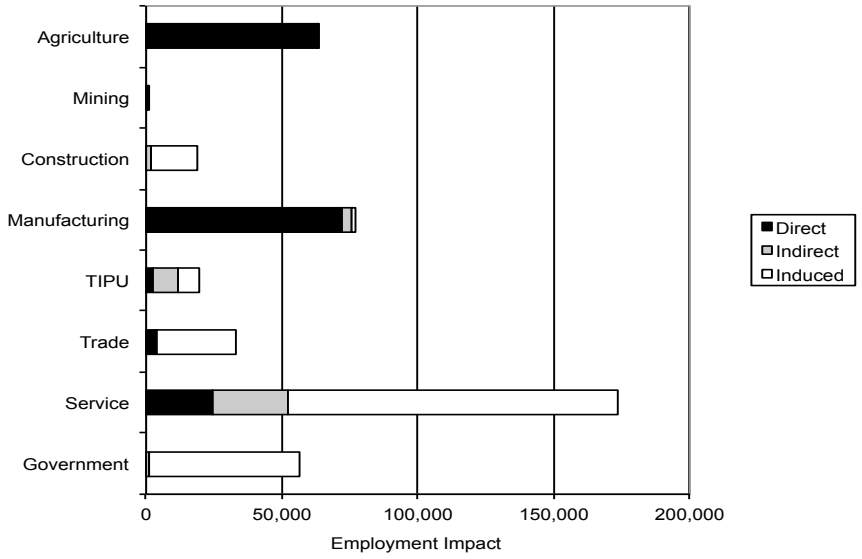


Figure 3.3 Virginia Total Impacts by Agriculture and Forestry Component, 2015

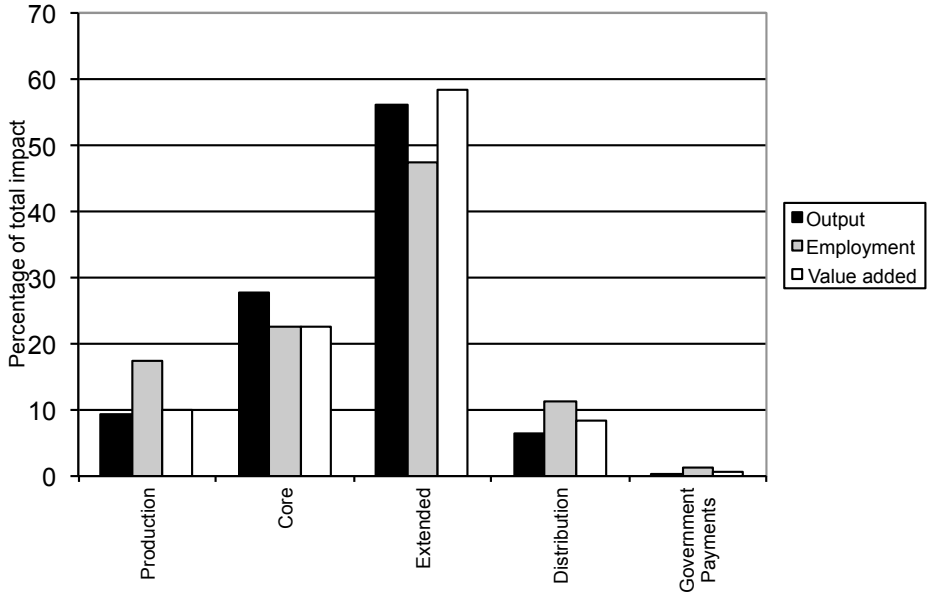


Table 3.4 Total Impact of Virginia's Agriculture and Forestry-Related Industries by Component: Output, Employment and Value-Added in Millions of Dollars, 2015

	Agriculture	Impact as Percentage of Total	Forestry	Impact as Percentage of Total
Output				
Production	5,899.0	0.72	1,422.2	0.17
Processing core	16,831.0	2.05	12,368.3	1.51
Processing extended	42,857.1	5.22	5,817.0	0.71
Distribution	4,189.0	0.51	1,968.1	0.24
Total	69,776.1	8.50	21,575.6	2.63
Employment				
Production	68,154	1.35	13,736	0.27
Processing core	58,094	1.15	53,696	1.06
Processing extended	164,715	3.26	29,719	0.59
Distribution	43,365	0.86	10,780	0.21
Total	334,328	6.61	107,931	2.13
Value-Added				
Production	2,451.6	0.51	865.0	0.18
Processing core	5,882.2	1.22	4,894.7	1.02
Processing extended	25,148.8	5.23	2,395.5	0.50
Distribution	2,675.2	0.56	1,157.2	0.24
Total	36,157.8	7.52	9,312.4	1.90

employees in the sector. Core processing makes up 25 percent of employment and 24 percent of value-added. Extended processing is the largest economic impact category, representing 44 percent of employment and 61 percent of value-added. Distribution and power generation activities account for 12 percent of employment and 8 percent of value-added.

Leading Agricultural Commodity Economic Impacts

Table 3.5 shows the economic impacts for Virginia's major agricultural commodities, including closely related value-added industries.[17] These economic impacts form part of the total agriculture-related economic impacts reported earlier. The largest economic impact in terms of total output ($6.8 billion) and value-added ($2.3 billion) is the poultry industry. The largest industry in terms of employment impact (37,450) is the beef cattle industry, which reflects partly the role of nearly 15,000 cattle farmers and farm employees. The dairy industry also has a sizeable economic impact, including over 16,000 jobs, approximately $4.3 billion in total output, and $2.2 billion in value-added. The economic impacts in these sectors are amplified because of the importance of local supply chains in production and the presence of sizeable value-added manufacturing activities connected to the sector. Smaller in size, but still economically significant, are the grain, greenhouse, and soybean industries.

International Export Economic Impacts

International exports are measured as described in section two. It should be noted that these economic impacts do not include the costs of shipping the final product to international markets, and thus do not reflect the impacts that accrue from freight forward-

17 The value-added sectors are as follows: (a) poultry (poultry processing; mayonnaise, dressing, and sauce manufacturing), (b) beef (animal, except poultry, slaughtering; meat processed from carcasses), (c) dairy (fluid milk manufacturing; cheese manufacturing; dry, condensed, and evaporated dairy product manufacturing; ice cream and frozen dessert manufacturing; creamery butter manufacturing), (d) grain (flour milling), (e) soybeans (soybean and other oilseed processing). No value-added sectors were used for calculating greenhouse/nursery economic impacts.

Table 3.5 Virginia Total, Direct, Indirect, and Induced Impacts of Leading Agricultural Commodities, 2015

Item	Output (Million $)	Employment	Value-Added (Million $)
Poultry			
Direct	3,991	14,329	775
Indirect	1,088	4,624	466
Induced	1,725	12,537	1,080
Total	6,804	31,490	2,320
Beef			
Direct	3,704	19,052	760
Indirect	821	6,745	409
Induced	1,585	11,652	1,002
Total	6,110	37,450	2,171
Dairy			
Direct	2,508	4,219	506
Indirect	645	3,613	342
Induced	1,130	8,242	710
Total	4,283	16,074	1,559
Grain			
Direct	456	2,333	88
Indirect	214	1,458	123
Induced	283	2,071	178
Total	954	5,862	390
Greenhouse			
Direct	303	6,347	169
Indirect	51	438	30
Induced	272	1,957	169
Total	626	8,742	367
Soybean			
Direct	193	830	47
Indirect	91	781	54
Induced	138	1,003	87
Total	422	2,614	187

ing and air and ocean cargo shipping. These margins were excluded to make the state export economic impact results comparable to those presented for the total statewide impact of Virginia's agriculture and forestry-related industries.

Table 3.6 shows the direct, indirect, induced, and total impacts of Virginia-based agriculture and forestry-related industry exports. The total impacts of agriculture and forestry-related exports are approximately $9 billion in total output, 46,600 jobs, and nearly $4.6 billion in value-added. Forestry is a relatively more important component of international export economic impact than it is of general economic impact. Forestry-related industries account for 32 percent of the export output impact, 34 percent of the export employment impact and 29 percent of the export value-added impact. These figures compare to about 21-26 percent of the statewide agriculture and forestry-related industry economic impacts on each of these measures as reported earlier. The total employment impact of on the farming sector (which is not shown in the table) is 5,693 jobs out of a total 52,406 farm jobs in 2015. Therefore, one in nine Virginia farm jobs is dependent on international exports.

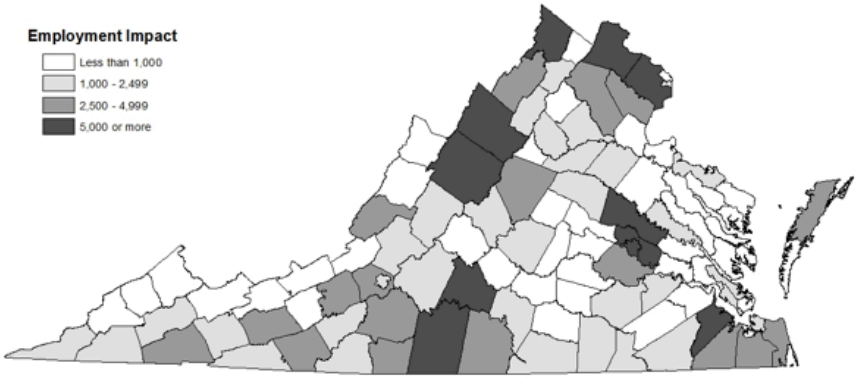
Table 3.6 Virginia Total, Direct, Indirect, and Induced Impacts of Virginia's Agriculture and Forestry-Related Industry Exports, 2015

	Output (Million $)	Employment	Value-Added (Million $)
Agriculture and Forestry Total			
Direct	4,004	12,307	1,619
Indirect	1,611	9,567	834
Induced	3,344	24,710	2,120
Total	8,959	46,584	4,574
Agriculture			
Direct	2,829	7,504	1,256
Indirect	972	5,443	490
Induced	2,332	17,320	1,486
Total	6,133	30,267	3,233
Forestry			
Direct	1,174	4,803	363
Indirect	639	4,124	344
Induced	1,012	7,390	634
Total	2,825	16,317	1,341

Locality Economic Impacts

Figures 3.4-3.6 show the employment impacts of agriculture-related industries, forestry-related industries, and combined agriculture and forestry-related industries for 105 localities within Virginia. These localities were formed by aggregating smaller independent cities into their surrounding county using a Bureau of Economic Analysis (BEA) classification scheme. Complete tables of results for employment, output, and value-added are provided in **Appendix tables C.1-C.3.**[19]

Figure 3.4 Agriculture and Forestry-Related Industry Employment Impact by Locality, 2015



Results show that agriculture and forestry-related industry affects every Virginia locality (see **Figure 3.4**). In sixty-two localities, the total employment impacts exceed 1,000 jobs.

Since statewide agricultural-related industry economic impacts are larger than forestry-related industry impacts, their county-level economic impacts are generally much larger. They are also more diffuse. **Figure 3.5** shows several distinct area clusters where agriculture-related industry has its greatest employment impacts. They include the Shenandoah Valley, Northern Virginia, and the Richmond City area. In six localities, the employment impact exceeded 5,000 jobs. Rockingham County (which here includes Harrisonburg City) is the state's agribusiness powerhouse with an agriculture-related industry economic impact of 13,122 jobs. Richmond City ranks second with an economic impact of 7,909 jobs. Rounding out the top six are Loudoun County (6,763), Augusta County (including Staunton and Waynesboro cities) (6,495), Fairfax County (including Fairfax and Falls Church cities) (6,201), and Frederick County (including Winchester) (5,244). Richmond City has the largest value-added economic impact ($8.5 billion) because of the importance of manufacturing activities such as tobacco manufacturing to the area. Rockingham County and Harrisonburg City rank second at $1.3 billion value-added impact.

Forestry-related industry economic impacts are geographically more concentrated. They are most pronounced in the Southside region and communities with pulp and paper mills such as Alleghany County and Covington City. Total employment impacts exceed 1,000 jobs for fourteen localities. They include six localities where employment impacts were greater than 2,000 jobs: Alleghany County, including Covington City (3,421), Franklin County (2,810), Pittsylvania County and Danville City (2,697), Henrico County (2,571), Henry County and Martinsville City (2,288), and Richmond

18 The total direct output, employment, and value-added figures for the localities will be slightly lower than the statewide total reported in this section because a small number of firm employment numbers could not be assigned to individual localities based on Virginia Employment Commission records. The total impacts will not sum to the statewide totals provided here because of greater leakages from localities than the state and more restrictive SAM model closures as reported in section 2.

Figure 3.5 Agriculture-Related Industry Employment Impact by Locality, 2015

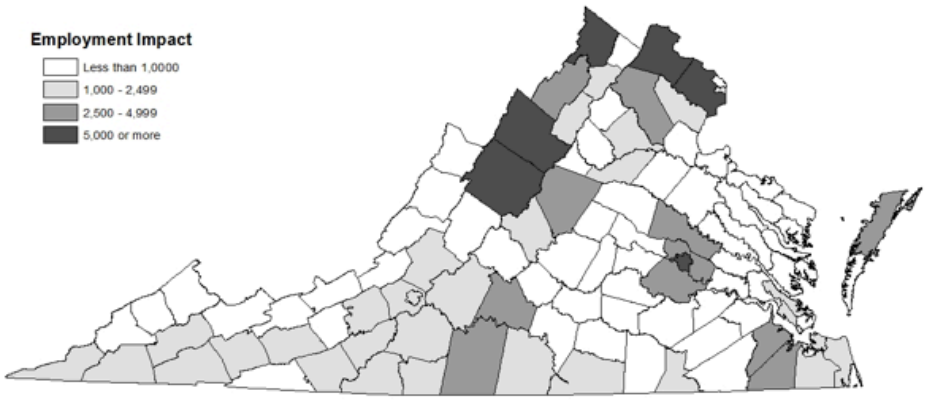
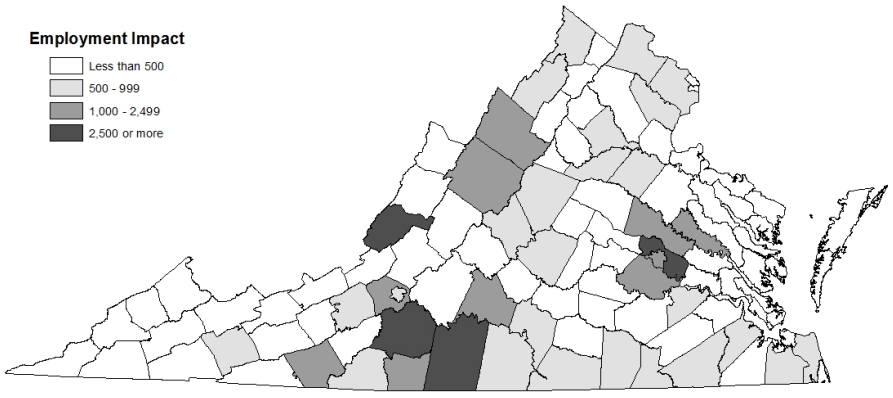


Figure 3.6 Forestry-Related Industry Employment Impact by Locality, 2015



City (2,044). The largest value-added impacts were found in Alleghany County and Covington City ($388 million), Henrico County ($230 million), and Richmond City ($208 million).

SECTION 4
OTHER AGRICULTURE AND FORESTRY ECONOMIC IMPACTS AND BENEFITS

The main focus of this study is to gauge the economic impact of agriculture and forestry in the Commonwealth. However, it is much more difficult to measure every economic impact, including the economic impacts of other farm-related revenue-generating activities such as agritourism, energy production, and farm-based value-added activities. Only direct farm sales of agricultural commodities to agritourists were captured in the previous results. Moreover, agriculture and forestry landscapes produce other social benefits that are not captured by an economic impact study such as improved water and air quality, flood mitigation, wildlife habitat, scenic amenities, etc. This section reviews some of these other economic contributions, organized into the categories of other farm-related income, agriculture and forest-related tourism and recreation, miscellaneous other economic impacts, and environment and quality of life. Quantitative and qualitative evidence are presented to support the important role that agriculture and forestry provide in these areas.

Other Farm-Related Income

Farm-related activities such as value-added products, energy production, recreational services, custom work and agricultural services, and land leasing are increasingly important sources of income for many Virginia farmers. Some of these activities would be reflected in the economic impact results presented in the previous section. For example, agricultural products sold to agritourists would already be counted as part of sales that form part of the direct impact. Several farm income sources were not included. According to the 2012 Agricultural Census, 2,267 Virginia farms produced and sold value-added commodities such as jams, cheese, processed meat, and floral arrangements. This number represents a 10 percent increase from the 2,058 farms reported in the 2007 Agricultural Census. Virginia farmers are also increasingly generating renewable energy and harvesting biomass for use in renewable energy. Three hundred and ninety two Virginia farms generated energy or electricity on their farms in 2007 from sources such as wind turbines, methane digesters, and solar panels. Three hundred and eighty-seven farms reported growing biomass in 2012. The number of farms obtaining income from recreational services (e.g., pumpkin patches, corn mazes, petting zoos, farm festivals, hayrides, hunting, trail riding) has continued to increase, from 476 farms and $12.9 million in income for 2007 to 814 farms and $15.2 million of income for 2012.

Agriculture and Forest-Related Tourism and Recreation

Virginia generated approximately $23 billion in travel expenditures from visitors in 2015, up from $20 billion in 2011 (Virginia Tourism Corporation 2016). Survey results suggest that a significant number of leisure visitors are attracted by the state's rural amenities and participate in rural outdoors recreation and leisure activities (see **Table 4.1**). Fourteen percent of leisure visitors cited rural sightseeing among their reasons for visiting. Other popular agritourism and forest recreation venues include national parks (8 percent), state parks (7 percent), wildlife viewing (5 percent), gardens (4 percent) and wine tasting/winery tour (3 percent). Visitors may conduct multi-purpose and multi-venue visits. So, the participation rates are not additive.

Agritourists deliver a significant boost to the state's tourism industry. A new study (Magnini 2017) estimates that Virginia agritourists accounted for over $1.3 billion on off-farm tourism-related expenditures such as hotels, restaurants, entertainment, fuel, and other incidentals. Virginia's 261 wineries alone generated $188 million in associated tourism expenditures (Frank, Rimerman + Co. LLP 2017). They also attracted an estimated 2.25 million wine-related tourists in 2015, a 43 percent increase from 2010. Virginia hosted almost 1,200 horse shows and competitions in 2010 that drew approximately 940 thousand people who spent more than $220 million on travel and associated expenses (Rephann 2011).

Wildlife recreation is also supported by the availability of rural and forested landscapes. The U.S.

Table 4.1 Top Rural, Agriculture and Forest Activities and Attractions for Virginia Leisure Visitors, 2015

Activity/Attraction	Percentage
Rural sightseeing	14
National park/Monuments/Recreation areas	8
State park/Monuments/Recreation areas	7
Wildlife viewing	5
Gardens	4
Wine tasting/winery tour	3
Craft breweries	2
Nature travel/ecotouring	2
Bird watching	2
Farms/ranches/agri-tours	1
Horseback riding	1
Distilleries	< 0.5
Hunting	< 0.5
Rodeo/State fair	< 0.5
Other nature	3

Source: Virginia Tourism Corporation, Leisure Trip Profile, 2015

Department of Interior estimated that there were 551,000 freshwater anglers, 432,000 hunters and 2.5 million wildlife watchers participating in Virginia for 2011 (see **Table 4.2**), totaling to 3.5 million such participants (U.S. Department of Interior and U.S. Department of Commerce 2008). Freshwater anglers generated an economic impact of nearly $1.3 billion, while hunters and wildlife watchers accounted for an additional $860 million and $1.7 billion respectively (Southwick Associates 2012a, 2012b; U.S. Department of the Interior, Fish and Wildlife Service 2014).

Table 4.2 Wildlife Recreation Economic Impacts in Virginia, 2011

Activity	Participants (Thousands)	Total Output ($ million)	Employment
Freshwater fishing	551	1295.6	11,496
Hunting	432	863.2	12,472
Wildlife watching	2,509	1730.7	23,616
Total	3,492	3889.5	47,584

Source: Southwick Associates (2012a, 2012b) and U.S. Fish and Wildlife Service (2014)

National and state parks and forests generate a significant amount of wilderness recreation visitor traffic. Virginia's National Parks attracted 27.1 million recreation visitors in 2016.[19] Virginia's state parks hit a new all-time high in attendance in the same year with 10 million visitors.[20] In addition, the George Washington and Jefferson National Forests had an estimate 2.3 million visits in 2011, the most recent year available.[21] Similar visitor estimates for Virginia's State Forests are unavailable at this time.

Other Economic Impacts

This study limited its attention to production, value-added, and distribution activities directly linked to agriculture and forestry. Thus, it did not capture economic activity connected to corporate and regional offices, research and development laboratories, and other operations by agribusiness-related firms. These operations are classified as "management of companies and enterprises" (NAICS 55), "professional, scientific, and technical services" (NAICS 54), and other NAICS sectors. Virginia hosts several significant agribusiness-related headquarters, including Fortune 500 companies Altria and WestRock. Other notable companies headquartered in Virginia include Smithfield Foods, Universal Corporation, Mars, Inc., American Woodmark, and Southern States Cooperative. These facilities employ thousands of workers who perform administrative, research, and logistical work in support of their national and international agribusiness operations.

Also excluded were some economic impacts that are sometimes associated with agriculture and forestry. For example, the "green industry" includes a variety

19 U.S. Department of the Interior, National Park Service. NPS Stats. https://irma.nps.gov/Stats/Reports/National (accessed March 31, 2017)

20 Virginia Department of Conservation and Recreation. Record breaking attendance for Virginia state parks. http://www.dcr.virginia.gov/state-parks/blog/record-breaking-attendance-for-virginia-state-parks

21 U.S. Department of Agriculture, Forest Service. National Visitor Use Monitoring, Natural Resource Manager. http://apps.fs.fed.us/nfs/nrm/nvum/results/ (Accessed March 31, 2017).

of activities such as golf course and sport facility turf grass maintenance services, and retail/wholesale trade and distribution of horticultural products such as garden centers and florists. These activities were not counted as part of the agriculture and forestry direct impact.

Environment and Quality of Life

Virginia's farm and forest landscapes provide important environmental benefits to the commonwealth. These benefits include improved water and air quality, flood risk mitigation, and wildlife habitat conservation. Open space preservation can also limit urban sprawl and lower the public costs of development such as the provision of public infrastructure, pollution and traffic congestion. Lastly, farm and forest open space preserves scenic beauty and helps maintain a sense of place.

Economists attempt to quantify the social economic benefits that flow from natural resources uses using a variety of empirical methods. The value transfer approach, which utilizes estimates drawn from other studies similar to the area of interest, is a common approach for valuing the environmental benefits of rural land uses. These study estimates are based on detailed empirical analyses.

This section briefly examines two environmental benefits of agriculture and forestland uses for illustrative purposes. Forests and rangeland/pasture contribute to better air quality by reducing criteria air pollutants (e.g., sulfur dioxide, sulfur dioxide, particulates) and greenhouse gases emissions that cause respiratory problems, acid rain, and climate change. They also regulate water flow, prevent soil erosion, and assist in filtering water of toxins, nutrients, and sediment. Synthesizing the results of environmental valuation studies from around the globe, Costanza et al. (1997) estimate the average value of the air pollution mitigation services for forests to be $141 per hectare and $7 per hectare for rangeland/pasture in terms of 1994 dollars. Average water environmental values are $559 per hectare for forests and $120 for grasslands and pasture. These values are adjusted for inflation and rescaled in terms of acres in **Table 4.3**. Based on the most recently available inventory of Virginia's rangeland/pasture and forestland from the U.S. Department of Agriculture, Virginia receives approximately $184 million in estimated air and water environmental benefits each year from agricultural rangeland/pastureland and $6.686 billion from forestland.

Table 4.3 Ecological Values of Virginia Farm and Forest Land

	Agriculture	Forest
Number of Acres	2,435,064	16,042,800
Value per Acre of Water Environmental Services	$71.44	$332.80
Value per Acre of Air Environmental Services	$4.17	$83.94
Total Value of Water Environmental Services	$173,964,973	$5,339,027,581
Total Value of Air Environmental Services	$10,147,957	$1,346,695,687
Total Environmental Value	$184,112,929	$6,685,723,268

Source: Land acreage (U.S. Forest Service, Forest Inventory and Analysis inventory data for 2014; U.S. Department of Agriculture, National Agricultural Statistics Service 2014), Costanza et al (1997)

SECTION 5
SUMMARY AND CONCLUSION

The agriculture and forestry industries constitute an important part of Virginia's industrial base. These industries generated a combined estimated $91 billion in total output, $45 billion in value-added and 442,600 jobs in 2015 for the Virginia economy. The value-added impact amounts to 9.5 percent of state gross domestic product while the employment impact makes up 8.7 percent of total state employment. Agriculture-related activities accounted for approximately 75 percent of total output, employment and value-added impacts with forestry-related activities making up the remainder. International export markets form an important portion of the total statewide impact, including $9 billion in total output, approximately 46,600 jobs, and $4.6 billion in value-added. Moreover, one in nine Virginia farm jobs depends on international exports.

The statewide economic impacts are larger than those obtained in the last economic impact analysis based on 2011 data, which estimated $70 billion in total industry output or sales, $35 billion of value-added (which was 8.1 percent of Virginia's GDP), and 414,700 jobs. Since that study, the industries have seen an increase in direct employment because of an improvement in business activity, increased housing construction activity, and growth in international exports.

The agriculture and forestry industries have widespread effects across the economy. They affect every industry and locality. Although a significant amount of the economic impact occurs in the agriculture and forestry directly linked manufacturing industries, the cumulative cascading effects of industry purchases and payrolls affects every industry. Moreover, every Virginia locality is affected by agriculture and forestry-related industry to some degree. Sixty-two localities have total employment impacts in excess of 1,000 jobs. The largest and most widespread impacts were generally found for agriculture-related activities. Forestry impacts tend to be somewhat more geographically concentrated in areas with pulp and paper mills or a concentration of furniture manufacturing plants, including the Southside region, Alleghany County including Covington City, and the Richmond City area.

This study did not account for several areas that would have further boosted the economic impact estimates. We did not capture economic activities connected to corporate and regional offices, research and development laboratories, and other operations of agribusiness manufacturing firms. Virginia hosts several significant agribusiness-related headquarters that employ thousands of workers. We also did not account for the full economic impact of agritourism and forest recreation, including those impacts that stem from consumer spending outside of farm and forest venues such as hotels, restaurants and retail shops. Economic impact estimates gleaned from other recent studies suggest that these economic impacts may run in the billions of dollars.

Virginia's agriculture and forested landscapes also provide important environmental and other social economic benefits for the commonwealth. These benefits include improved water and air quality, flood risk mitigation, and wildlife habitat conservation. Based on the most recently available inventory of Virginia's rangeland/pasture and forestland from the U.S. Department of Agriculture and environmental valuation parameters from other studies, Virginia receives approximately $184 million in estimated air and water environmental benefits each year from agricultural rangeland/pastureland and $6.686 billion from forestland.

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Appendix

Table A.1 Virginia Agriculture and Forestry-Related Industries by Component

Sector	IMPLAN Description	Sector	IMPLAN Description
Agriculture Production		Forestry Production	
1	Oilseed farming	15	Forestry, forest products, and timber tract production
2	Grain farming	16	Commercial logging
3	Vegetable and melon farming	18	Commercial hunting and trapping
4	Fruit farming	19	Support activities for agriculture and forestry
6	Greenhouse, nursery, and floriculture production		NAICS 1153 Support activities for forestry
7	Tobacco farming		
8	Cotton farming		
10	All other crop farming		
11	Beef cattle ranching and farming, including feed-lots and dual-purpose ranching and farming		
12	Dairy cattle and milk production		
13	Poultry and egg production		
14	Animal production, except cattle and poultry and eggs		
19	Support activities for agriculture and forestry		
	NAICS 1151 Support activities for crop production		
	NAICS 1152 Support activities for animal production		
Agriculture Core Processing		Forestry Core Processing	
67	Flour milling	134	Sawmills
72	Fats and oils refining and blending	135	Wood preservation
84	Fluid milk manufacturing	136	Veneer and plywood manufacturing
85	Creamery butter manufacturing	137	Engineered wood member and truss manufacturing
86	Cheese manufacturing	138	Reconstituted wood product manufacturing
87	Dry, condensed, and evaporated dairy product manufacturing	139	Wood windows and door manufacturing
88	Ice cream and frozen dessert manufacturing	140	Cut stock, resawing lumber, and planing
89	Animal, except poultry, slaughtering	141	Other millwork, including flooring
90	Meat processed from carcasses	142	Wood container and pallet manufacturing
91	Rendering and meat byproduct processing	145	All other miscellaneous wood product manufacturing
92	Poultry processing	147	Paper mills
99	Roasted nuts and peanut butter manufacturing	148	Paperboard mills
100	Other snack food manufacturing		
105	All other food manufacturing		
109	Wineries		
Agriculture Extended Processing		Forestry Extended Processing	
65	Dog and cat food manufacturing	143	Manufactured home (mobile home) manufacturing
66	Other animal food manufacturing	144	Prefabricated wood building manufacturing
76	Nonchocolate confectionery manufacturing	149	Paperboard container manufacturing
77	Chocolate and confectionery manufacturing from cacao beans	150	Paper bag and coated and treated paper manufacturing
78	Confectionery manufacturing from purchased chocolate	151	Stationery product manufacturing

80 Frozen specialties manufacturing
81 Canned fruits and vegetables manufacturing
83 Dehydrated food products manufacturing
93 Seafood product preparation and packaging
94 Bread and bakery product, except frozen, manufacturing
95 Frozen cakes and other pastries manufacturing
96 Cookie and cracker manufacturing
97 Dry pasta, mixes, and dough manufacturing
98 Tortilla manufacturing
101 Coffee and tea manufacturing
103 Mayonnaise, dressing, and sauce manufacturing
104 Spice and extract manufacturing
106 Bottled and canned soft drinks & water
107 Manufactured ice
108 Breweries
110 Distilleries
111 Tobacco product manufacturing
112 Fiber, yarn, and thread mills
113 Broadwoven fabric mills
114 Narrow fabric mills and schiffli machine embroidery
117 Textile and fabric finishing mills
125 Other apparel knitting mills
126 Cut and sew apparel contractors
127 Men's and boys' cut and sew apparel manufacturing
128 Women's and girls' cut and sew apparel manufacturing
129 Other cut and sew apparel manufacturing
130 Apparel accessories and other apparel manufacturing
132 Footwear manufacturing
133 Other leather and allied product manufacturing
152 Sanitary paper product manufacturing
153 All other converted paper product manufacturing
368 Wood kitchen cabinents and countertops
369 Upholstered household furniture manufacturing
370 Nonupholstered wood household furniture manufacturing
372 Institutional furniture manufacturing
374 Custom architectural woodwork and millwork
376 Showcase, partition, shelving, and locker manufacturing

Agriculture Distribution	
395 Wholesale trade	47 Electric power generation - Biomass
NAICS 4225 Farm product raw material wwholesalers	395 Wholesale trade
416 Warehousing and storage	NAICS 42331 Lumber, plywood, millwork, & wood panel wholesalers
NAICS 49312 Refrigerated wareousing & storage	416 Warehousing and storage
NAICS 49313 Farm product warehousing & storage	NAICS 49319 Other warehousing & storage
469 Landscape and horticultural services	

Table B.1 Virginia Agricultural Cash Receipts by IMPLAN Sector, 2008-2015 ($ Thousands)

Year	1	2	3	4	6	7	8	10	11	12	13	14	Total
2008	137,641	224,195	89,986	53,435	291,824	77,666	27,689	97,538	394,772	371,088	924,390	272,603	2,962,826
2009	195,941	220,743	97,877	52,109	296,196	81,622	38,443	106,443	287,836	264,384	833,503	251,355	2,726,452
2010	182,267	177,159	79,418	46,362	294,227	79,602	54,248	83,418	374,000	331,934	980,460	270,822	2,953,916
2011	178,459	239,041	73,285	55,298	299,425	80,010	55,388	125,167	454,146	395,241	997,511	270,220	3,223,190
2012	308,540	357,029	71,121	88,127	300,838	97,227	92,740	159,841	413,558	357,552	1,065,614	262,409	3,574,597
2013	323,370	334,006	72,472	51,621	300,340	111,330	71,831	150,958	566,687	396,857	1,189,556	268,674	3,837,702
2014	259,311	338,029	62,240	56,443	299,294	116,936	81,237	129,610	703,341	478,170	1,360,823	276,142	4,161,575
2015	192,803	246,736	71,156	59,239	302,820	111,869	63,337	134,168	676,037	342,022	1,290,435	260,501	3,751,121

Notes to Tables C.1-C.3. Locality Economic Impacts

Tables C.1-C.3 show the output, employment, and value-added impacts of agriculture-related industries, forestry-related industries, and combined agriculture and forestry-related industries for 105 localities within Virginia. These localities were formed by aggregating smaller independent cities into their surrounding county using a Bureau of Economic Analysis (BEA) classification scheme.

The locality analyses uses data from the same four sources as the statewide analysis to compute direct impacts. Farm and forestry-related employment for manufacturing and distribution industries for each locality was obtained from the Virginia Employment Commission (VEC) Quarterly Census of Employment and Wages (QCEW) for the second quarter of 2015. The employment numbers are then converted to sales/output equivalent figures by the model for use in generating economic impacts. For a few sectors where self-employment is important, alternative data sources were used. For forest nurseries, forest products, and timber tracts sector (IMPLAN sector 15), data from Virginia Department of Forestry timber product average tax receipts for fiscal years 2015 and 2016 by locality were used. For logging (IMPLAN sector 16) and hunting and trapping (IMPLAN sector 18), output and employment estimates were obtained from the Virginia IMPLAN database for each locality. For farming sectors (IMPLAN sectors 1-14), U.S. Department of Agriculture commodity cash receipts data from 2015 were used. In order to make estimates for localities, additional data imputations were needed because 2015 local agricultural cash receipt and government payments data were not available. Therefore, statewide 2015 values for cash receipts for each sector were scaled down to the local level using IMPLAN total industrial output estimates for 2015 by sector for localities.

Economic impacts for each locality were generated using IMPLAN models created for each county. The total economic impact reported sums the direct, indirect, and induced impacts.

Table C.1 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-Related Industries by Locality, Output 2015 ($ Millions)

	Agriculture		Forestry		Agriculture & Forestry	
	Direct	Total	Direct	Total	Direct	Total
Accomack County	1,172.0	1,289.9	7.5	8.9	1,179.5	1,298.8
Albemarle County and Charlottesville City	426.9	546.0	74.2	102.2	501.1	648.1
Alexandria County	269.5	324.9	14.7	20.1	284.2	345.0
Alleghany County and Covington City	26.9	29.4	1,286.4	1,523.6	1,313.3	1,553.0
Amelia County	103.3	115.0	58.7	68.5	161.9	183.5
Amherst County	26.2	28.6	29.7	36.7	55.9	65.3
Appomattox County	20.7	21.7	16.1	18.8	36.9	40.5
Arlington County	52.5	66.1	5.7	7.0	58.2	73.1
Augusta County, Staunton City, and Waynesboro City	1,563.2	1,824.1	227.3	295.8	1,790.4	2,119.9
Bath County	5.7	6.4	5.9	7.3	11.6	13.8
Bedford County	38.6	42.7	13.4	18.1	51.9	60.8
Bland County	18.1	19.1	0.2	0.2	18.3	19.3
Botetourt County	129.2	148.3	74.9	89.6	204.1	237.9
Brunswick County	27.3	32.6	100.7	116.5	128.0	149.1
Buchanan County	2.6	3.0	3.1	3.8	5.7	6.8
Buckingham County	49.4	55.1	53.6	64.0	103.0	119.1
Campbell County and Lynchburg City	1,561.7	1,788.3	319.0	416.2	1,880.7	2,204.5
Caroline County	17.0	18.2	73.0	85.9	89.9	104.1
Carroll County and Galax City	234.6	262.0	219.0	259.4	453.6	521.4
Charles City County	21.7	24.3	68.1	76.0	89.8	100.3
Charlotte County	31.8	35.1	132.7	155.0	164.5	190.2
Chesapeake City	127.7	177.2	108.1	148.7	235.8	325.9
Chesterfield County	1,643.2	1,847.0	165.3	228.1	1,808.4	2,075.0
Clarke County	43.2	48.4	30.7	38.2	73.9	86.6
Craig County	6.4	6.7	0.6	0.7	7.0	7.4
Culpeper County	99.2	121.3	114.2	148.4	213.4	269.7
Cumberland County	64.0	68.9	17.8	20.2	81.7	89.1
Dickenson County	1.7	1.5	8.7	10.4	10.5	11.9
Dinwiddie County, Colonial Heights City, and Petersburg City	56.9	69.3	74.5	90.6	131.4	159.9
Essex County	21.8	25.3	66.9	82.5	88.7	107.8
Fairfax County, Fairfax City and Falls Church City	563.9	780.7	114.5	164.6	678.4	945.3
Fauquier County	255.8	296.6	30.1	39.9	285.9	336.5
Floyd County	87.2	95.8	3.7	4.4	90.9	100.2
Fluvanna County	27.6	29.9	11.7	13.7	39.3	43.6
Franklin County	147.9	166.9	537.3	616.6	685.2	783.5
Frederick County and Winchester City	1,247.1	1,528.3	127.3	169.9	1,374.4	1,698.2
Giles County	16.4	17.9	11.9	14.0	28.3	31.9
Gloucester County	39.3	45.8	1.7	2.1	41.0	47.9
Goochland County	55.3	62.6	3.0	3.5	58.4	66.2
Grayson County	31.1	34.0	48.6	52.8	79.7	86.8
Greene County	19.5	22.6	5.1	6.1	24.6	28.7

Table C.1 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-Related Industries by Locality, Output 2015 ($ Millions) (continued)

	Agriculture		Forestry		Agriculture & Forestry	
	Direct	Total	Direct	Total	Direct	Total
Greensville County and Emporia City	502.9	548.9	128.1	160.8	631.0	709.7
Halifax County	388.1	428.1	165.0	202.6	553.1	630.7
Hampton City	59.9	71.5	30.9	38.1	90.8	109.6
Hanover County	440.6	546.9	339.5	429.5	780.1	976.4
Henrico County	1,573.5	1,833.4	408.4	563.8	1,981.9	2,397.2
Henry County and Martinsville City	322.8	361.7	344.3	429.8	667.1	791.5
Highland County	20.8	25.1	4.0	4.6	24.8	29.7
Isle of Wight County	2,216.7	2,390.9	273.2	329.6	2,489.9	2,720.5
James City County and Williamsburg City	103.3	125.5	36.7	48.5	140.0	174.1
King and Queen County	20.5	22.9	32.2	36.6	52.7	59.5
King George County	11.5	12.7	4.2	4.9	15.7	17.6
King William County	19.7	21.2	516.5	572.0	536.1	593.2
Lancaster County	35.9	44.0	3.0	3.8	38.9	47.9
Lee County	24.1	27.7	8.8	10.8	32.9	38.5
Loudoun County	585.0	750.7	83.4	109.4	668.4	860.1
Louisa County	27.8	32.5	69.9	86.0	97.6	118.5
Lunenburg County	23.2	26.7	26.7	31.9	49.9	58.6
Madison County	67.9	74.9	78.6	87.3	146.5	162.2
Mathews County	24.5	27.4	2.3	2.8	26.9	30.2
Mecklenburg County	198.7	251.2	61.1	80.5	259.8	331.7
Middlesex County	30.7	35.9	14.6	17.0	45.3	52.9
Montgomery County and Radford City	464.7	525.3	152.9	185.0	617.6	710.4
Nelson County	347.4	372.7	268.7	321.1	616.1	693.8
New Kent County	15.0	16.6	25.4	28.9	40.4	45.6
Newport News City	555.8	654.3	85.2	107.0	641.0	761.3
Norfolk City	194.7	240.5	42.4	56.8	237.1	297.3
Northampton County	147.3	164.0	3.0	3.5	150.2	167.5
Northumberland County	178.7	204.8	1.7	2.1	180.4	206.9
Nottoway County	60.6	66.7	76.0	92.4	136.6	159.1
Orange County	77.4	91.1	118.7	141.2	196.0	232.2
Page County	214.1	235.8	65.6	76.9	279.7	312.7
Patrick County	106.3	118.2	156.5	176.7	262.8	294.9
Pittsylvania County and Danville City	342.4	412.9	394.7	496.9	737.1	909.9
Portsmouth City	115.5	126.0	16.9	21.8	132.3	147.9
Powhatan County	19.6	22.5	18.6	22.3	38.2	44.8
Prince Edward County	31.8	40.0	18.8	22.8	50.6	62.8
Prince George County and Hopewell City	71.2	84.3	289.5	324.7	360.7	409.0
Prince William County, Manassas City, and Manassas Park City	172.1	223.2	93.6	132.0	265.7	355.2
Pulaski County	25.5	29.6	5.5	7.0	31.0	36.6
Rappahannock County	27.2	31.1	6.3	7.8	33.6	38.9
Richmond City	11,088.6	12,162.8	476.6	628.8	11,565.2	12,791.6

Table C.1 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-Related Industries by Locality, Output 2015 ($ Millions) (continued)

	Agriculture		Forestry		Agriculture & Forestry	
	Direct	Total	Direct	Total	Direct	Total
Richmond County	13.6	15.8	52.6	59.7	66.2	75.5
Roanoke City	413.2	514.5	99.4	130.3	512.6	644.8
Roanoke County and Salem City	238.1	311.0	258.4	343.5	496.5	654.5
Rockbridge County, Buena Vista City, and Lexington City	47.7	52.1	88.0	105.8	135.6	157.9
Rockingham County and Harrisonburg City	3,402.2	3,972.7	198.0	251.5	3,600.2	4,224.2
Russell County	36.8	42.1	2.5	3.2	39.3	45.3
Scott County	19.7	20.2	20.4	24.1	40.1	44.4
Shenandoah County	754.3	883.1	144.3	172.8	898.6	1,055.9
Smyth County	72.0	82.4	112.1	131.1	184.1	213.5
Southampton County and Franklin City	141.5	163.4	64.5	76.9	206.0	240.4
Spotsylvania County and Fredericksburg City	56.9	70.2	80.6	110.9	137.5	181.1
Stafford County	104.5	121.5	19.5	23.4	124.0	145.0
Suffolk City	1,023.9	1,197.7	35.9	45.0	1,059.8	1,242.7
Surry County	45.8	49.8	19.3	21.7	65.1	71.5
Sussex County	40.6	49.1	15.0	17.2	55.6	66.3
Tazewell County	29.5	35.8	27.5	35.8	56.9	71.6
Virginia Beach City	184.0	249.2	83.2	120.0	267.2	369.2
Warren County	136.6	162.9	35.2	43.0	171.8	205.9
Washington County and Bristol City	358.3	402.8	24.8	31.5	383.1	434.3
Westmoreland County	111.1	126.9	21.8	24.9	132.9	151.7
Wise County and Norton City	88.3	105.4	49.9	59.6	138.2	165.1
Wythe County	619.5	691.8	16.4	20.8	636.0	712.6
York County and Poquoson City	767.8	855.0	8.9	11.6	776.7	866.6

Table C2 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-Related Industries by Locality, Employment 2015

	Agriculture		Forestry		Agriculture & Forestry	
	Direct	Total	Direct	Total	Direct	Total
Accomack County	3,573	4,581	61	73	3,634	4,654
Albemarle County and Charlottesville City	2,576	3,347	312	504	2,888	3,851
Alexandria County	1,031	1,346	89	120	1,120	1,466
Alleghany County and Covington City	225	239	1,717	3,421	1,942	3,660
Amelia County	539	638	252	344	791	982
Amherst County	446	469	154	224	600	693
Appomattox County	518	527	122	146	640	673
Arlington County	363	436	59	65	422	501
Augusta County, Staunton City, and Waynesboro City	4,462	6,495	818	1,370	5,280	7,865
Bath County	160	167	27	35	187	202
Bedford County	1,320	1,379	123	169	1,443	1,547
Bland County	404	413	2	2	406	415
Botetourt County	830	999	266	389	1,096	1,388
Brunswick County	415	464	644	785	1,059	1,249
Buchanan County	104	107	26	32	130	139
Buckingham County	420	471	459	547	879	1,018
Campbell County and Lynchburg City	3,279	4,901	1,113	1,815	4,392	6,716
Caroline County	294	307	294	407	588	714
Carroll County and Galax City	1,743	2,014	1,243	1,627	2,986	3,641
Charles City County	192	211	275	340	467	550
Charlotte County	579	614	741	942	1,320	1,556
Chesapeake City	1,498	1,894	521	838	2,019	2,732
Chesterfield County	1,718	3,133	723	1,201	2,441	4,334
Clarke County	677	721	126	185	803	906
Craig County	208	212	4	5	212	217
Culpeper County	1,035	1,210	534	807	1,569	2,017
Cumberland County	295	331	87	108	382	439
Dickenson County	141	139	38	53	179	191
Dinwiddie County, Colonial Heights City, and Petersburg City	553	658	299	431	852	1,089
Essex County	179	209	251	403	430	612
Fairfax County, Fairfax City and Falls Church City	4,914	6,201	534	829	5,448	7,031
Fauquier County	2,206	2,537	180	262	2,386	2,799
Floyd County	1,102	1,196	33	40	1,135	1,236
Fluvanna County	381	399	142	156	523	556
Franklin County	1,502	1,710	2,077	2,810	3,579	4,520
Frederick County and Winchester City	3,060	5,244	462	806	3,522	6,051
Giles County	399	413	59	75	458	489
Gloucester County	354	418	19	23	373	441
Goochland County	660	720	25	29	685	750
Grayson County	799	827	189	227	988	1,054
Greene County	320	350	35	43	355	393
Greensville County and Emporia City	1,104	1,480	463	693	1,567	2,173
Halifax County	1,339	1,682	685	978	2,024	2,660

Table C2 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-Related Industries by Locality, Employment 2015 (continued)

	Agriculture		Forestry		Agriculture & Forestry	
	Direct	Total	Direct	Total	Direct	Total
Hampton City	386	474	106	164	492	638
Hanover County	3,204	4,238	1,111	1,833	4,315	6,071
Henrico County	2,261	3,964	1,515	2,571	3,776	6,536
Henry County and Martinsville City	1,028	1,356	1,540	2,288	2,568	3,644
Highland County	287	330	28	34	315	365
Isle of Wight County	3,101	4,417	415	752	3,516	5,169
James City County and Williamsburg City	522	675	176	269	698	944
King and Queen County	155	171	159	191	314	363
King George County	205	215	60	66	265	281
King William County	214	228	773	1,271	987	1,499
Lancaster County	215	274	24	30	239	304
Lee County	1,057	1,087	73	89	1,130	1,177
Loudoun County	5,692	6,763	506	679	6,198	7,443
Louisa County	609	657	361	499	970	1,156
Lunenburg County	400	435	172	217	572	653
Madison County	723	786	234	316	957	1,101
Mathews County	140	172	20	26	160	197
Mecklenburg County	1,398	1,821	402	560	1,800	2,381
Middlesex County	167	211	66	89	233	300
Montgomery County and Radford City	1,457	1,896	719	977	2,176	2,873
Nelson County	1,010	1,169	468	733	1,478	1,901
New Kent County	182	193	182	209	364	401
Newport News City	1,266	2,025	274	409	1,540	2,434
Norfolk City	957	1,225	362	450	1,319	1,675
Northampton County	652	770	27	32	679	802
Northumberland County	474	706	9	12	483	718
Nottoway County	463	512	283	403	746	915
Orange County	1,152	1,259	680	864	1,832	2,123
Page County	939	1,128	315	423	1,254	1,551
Patrick County	1,003	1,112	784	969	1,787	2,081
Pittsylvania County and Danville City	2,293	2,976	1,835	2,697	4,128	5,673
Portsmouth City	236	301	105	144	341	445
Powhatan County	411	436	131	162	542	598
Prince Edward County	442	511	153	188	595	700
Prince George County and Hopewell City	773	870	350	622	1,123	1,493
Prince William County, Manassas City, and Manassas Park City	2,102	2,486	492	784	2,594	3,270
Pulaski County	510	560	43	56	553	617
Rappahannock County	501	536	31	43	532	580
Richmond City	2,691	7,909	1,220	2,044	3,911	9,953
Richmond County	173	190	148	207	321	397
Roanoke City	965	1,585	456	659	1,421	2,244
Roanoke County and Salem City	1,272	1,814	893	1,544	2,165	3,358
Rockbridge County, Buena Vista City, and Lexington City	898	946	283	438	1,181	1,384

Table C2 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-Related Industries by Locality, Employment 2015 (continued)

	Agriculture		Forestry		Agriculture & Forestry	
	Direct	Total	Direct	Total	Direct	Total
Rockingham County and Harrisonburg City	8,630	13,122	704	1,143	9,334	14,265
Russell County	1,121	1,174	23	29	1,144	1,203
Scott County	1,225	1,229	97	128	1,322	1,357
Shenandoah County	2,896	3,835	382	586	3,278	4,421
Smyth County	889	1,010	528	726	1,417	1,736
Southampton County and Franklin City	779	966	494	610	1,273	1,576
Spotsylvania County and Fredericksburg City	589	696	344	584	933	1,280
Stafford County	679	794	95	123	774	916
Suffolk City	2,189	3,482	137	205	2,326	3,687
Surry County	213	231	82	93	295	325
Sussex County	413	485	179	198	592	682
Tazewell County	609	671	131	192	740	863
Virginia Beach City	1,720	2,191	350	624	2,070	2,815
Warren County	822	1,022	181	240	1,003	1,262
Washington County and Bristol City	2,163	2,495	89	145	2,252	2,640
Westmoreland County	639	782	253	282	892	1,064
Wise County and Norton City	291	416	201	274	492	690
Wythe County	1,773	2,403	97	137	1,870	2,540
York County and Poquoson City	1,188	1,820	48	70	1,236	1,890

Table C.3 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-Related Industries by Locality, Value Added 2015 ($ Millions)

	Agriculture		Forestry		Agriculture & Forestry	
	Direct	Total	Direct	Total	Direct	Total
Accomack County	226	285	2	2	228	287
Albemarle County and Charlottesville City	164	232	25	41	189	273
Alexandria County	92	126	6	9	97	136
Alleghany County and Covington City	4	5	268	388	272	393
Amelia County	23	29	23	28	47	57
Amherst County	8	9	14	18	22	27
Appomattox County	6	7	5	6	11	13
Arlington County	32	40	2	3	34	43
Augusta County, Staunton City, and Waynesboro City	576	713	62	97	638	810
Bath County	2	2	1	2	3	4
Bedford County	13	15	9	12	22	26
Bland County	5	5	0	0	5	5
Botetourt County	34	43	15	21	49	64
Brunswick County	13	15	50	58	62	73
Buchanan County	1	1	2	2	3	3
Buckingham County	12	15	21	26	33	41
Campbell County and Lynchburg City	381	497	99	150	479	647
Caroline County	5	5	23	29	28	34
Carroll County and Galax City	48	61	63	82	111	143
Charles City County	8	9	21	25	29	34
Charlotte County	12	13	51	61	62	74
Chesapeake City	73	100	45	67	117	168
Chesterfield County	1,050	1,157	58	91	1,108	1,248
Clarke County	18	21	15	19	34	40
Craig County	2	2	0	1	3	3
Culpeper County	26	36	44	61	69	97
Cumberland County	13	16	5	6	19	22
Dickenson County	1	0	3	4	4	4
Dinwiddie County, Colonial Heights City, and Petersburg City	18	25	23	32	41	57
Essex County	7	9	19	26	26	35
Fairfax County, Fairfax City and Falls Church City	324	463	56	88	380	551
Fauquier County	112	131	13	18	125	150
Floyd County	25	29	2	2	27	31
Fluvanna County	8	9	5	6	13	15
Franklin County	44	54	160	200	204	254
Frederick County and Winchester City	306	454	39	62	345	516
Giles County	6	7	3	4	9	11
Gloucester County	11	14	1	1	12	15
Goochland County	30	35	2	2	32	36
Grayson County	9	10	10	13	19	23
Greene County	10	11	2	2	11	13
Greensville County and Emporia City	87	110	32	47	119	157

Table C.3 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-Related Industries by Locality, Value Added 2015 ($ Millions) (continued)

	Agriculture		Forestry		Agriculture & Forestry	
	Direct	Total	Direct	Total	Direct	Total
Halifax County	118	138	64	83	182	221
Hampton City	21	27	12	16	33	43
Hanover County	148	206	94	146	242	351
Henrico County	827	983	136	230	964	1,213
Henry County and Martinsville City	57	76	117	160	174	235
Highland County	5	6	2	2	6	8
Isle of Wight County	502	592	58	90	560	682
James City County and Williamsburg City	37	49	15	22	52	71
King and Queen County	9	11	14	16	23	26
King George County	4	4	2	2	6	7
King William County	7	8	149	177	156	185
Lancaster County	9	13	1	1	10	15
Lee County	9	10	4	5	13	16
Loudoun County	301	399	37	52	338	452
Louisa County	12	14	24	32	35	46
Lunenburg County	11	12	9	12	20	24
Madison County	21	24	19	23	40	47
Mathews County	7	8	1	2	8	10
Mecklenburg County	67	94	26	36	93	130
Middlesex County	7	10	2	3	10	14
Montgomery County and Radford City	68	99	40	57	108	156
Nelson County	166	178	65	87	231	265
New Kent County	4	5	9	10	13	15
Newport News City	152	209	22	35	174	244
Norfolk City	76	102	18	27	94	129
Northampton County	61	69	1	1	62	70
Northumberland County	60	75	1	1	61	76
Nottoway County	15	18	20	28	35	46
Orange County	32	39	35	47	67	86
Page County	51	62	20	25	71	87
Patrick County	25	30	58	67	83	97
Pittsylvania County and Danville City	107	143	118	169	225	312
Portsmouth City	18	23	10	13	28	36
Powhatan County	8	10	4	6	13	16
Prince Edward County	11	15	5	7	16	22
Prince George County and Hopewell City	33	41	74	92	107	132
Prince William County, Manassas City, and Manassas Park City	89	118	48	69	137	187
Pulaski County	9	11	2	3	11	14
Rappahannock County	10	11	1	2	11	13
Richmond City	7,830	8,516	117	208	7,946	8,724
Richmond County	4	6	12	16	17	22
Roanoke City	103	163	31	49	135	212

Table C.3 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-Related Industries by Locality, Value Added 2015 ($ Millions) (continued)

	Agriculture		Forestry		Agriculture & Forestry	
	Direct	Total	Direct	Total	Direct	Total
Roanoke County and Salem City	67	105	76	120	143	225
Rockbridge County, Buena Vista City, and Lexington City	14	16	24	33	38	49
Rockingham County and Harrisonburg City	1,024	1,331	51	80	1,075	1,410
Russell County	12	14	1	2	13	16
Scott County	6	7	5	7	12	14
Shenandoah County	158	225	46	60	204	285
Smyth County	29	34	40	48	69	83
Southampton County and Franklin City	51	62	28	35	79	97
Spotsylvania County and Fredericksburg City	27	34	30	46	57	80
Stafford County	31	40	5	7	36	47
Suffolk City	399	493	9	14	408	507
Surry County	13	15	7	9	21	24
Sussex County	18	23	6	7	24	30
Tazewell County	10	13	6	10	16	23
Virginia Beach City	76	112	32	53	108	165
Warren County	60	73	11	15	71	88
Washington County and Bristol City	117	140	9	12	126	152
Westmoreland County	36	44	6	8	42	51
Wise County and Norton City	17	26	13	18	31	45
Wythe County	170	207	8	10	178	218
York County and Poquoson City	439	485	5	6	444	491

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