



NOVEMBER 2022



The Economic Impact of the
**Agriculture and Forest
Industries in Virginia**

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Weldon Cooper Center
for Public Service



A photograph of several brown cows behind a wire fence, with one cow in the foreground looking directly at the camera.

ACKNOWLEDGEMENTS

The author would like to give special thanks to Secretary of Agriculture and Forestry Matthew Lohr and Deputy Secretary of Agriculture and Forestry Beth Walker Green for assistance in study planning and review. Amy Muldoon assisted with editing and document preparation. 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 forest industries in Virginia was nearly \$106 billion in total industry output in 2021, the year used for this study. This constitutes an estimated 11.2 percent of state output. The total employment impact was 490,295 employees, representing 9.4 percent of total state employment. The total value-added impact was \$55.1 billion, which made up 9.3 percent of the state gross domestic product.
- Every job created in the agriculture and forest industries results in another 1.6 jobs in the Virginia economy. Every dollar generated in value-added results in another \$1.39 value-added in the Virginia economy.
- The impacts of the agriculture and forest industries are felt throughout Virginia's economy. The largest output impact is felt in the manufacturing sector where agriculture and forest processing occurs. The largest employment and value-added impacts are in the services industry, where some agriculture and forest industry distribution activities are found. 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 industries affect every sector.
- The total economic impacts of agriculture and forest industries grew over the five-year period, 2016-2021. The total employment impact rose from 478,079 jobs in 2016 to 490,295 jobs in 2021 (3 percent). The total value-added impact grew from \$50.1 billion in 2016 to \$55.1 billion in 2021 (10 percent) in constant 2021 dollars.

AGRICULTURE

- The total economic impact of agriculture industries was \$82.3 billion in total industry output, 381,844 jobs, and \$43.8 billion in value-added.

FORESTRY

- Forest industries had a total impact of \$23.6 billion in total industry output, 108,451 jobs, and \$11.3 billion in value-added.

EXECUTIVE SUMMARY

The economic impact of the agriculture and forest industries in Virginia is widespread and extends far beyond the farms and forest plantations where most agricultural and forestry commodities are grown and harvested. These two industries employ a large number of Virginians and are comprised of a complex network of interrelated processes and industries. Beyond the production activities at farms and timber tracts, the agriculture and forest industries encompass a range of processing and manufacturing industries that include food and beverage processing, agricultural-fiber related textile and apparel manufacturing, wood products manufacturing, pulp and paper mills, and furniture manufacturing. In addition, distribution businesses, such as grain elevators and raw commodity warehouses, rely on Virginia farm and forest products for supplies. In turn, these production, manufacturing, and distribution sectors procure material, labor, and value-added services from Virginia-based businesses and households. This chain of purchasing events results in a “multiplier effect,” which captures the flow of dollars as it ripples through the Virginia economy. Due to this “ripple effect,” Virginia agriculture and forest industries affect every other industry in the commonwealth to some degree.

SECTOR TRENDS

Like many other sectors of Virginia’s economy, Virginia’s agriculture and forestry sectors have been profoundly affected by the COVID-19 pandemic and the deep but brief recession in 2020. The pandemic’s disruptive effects on consumer distribution channels, the supply chain, workplace safety, and labor force participation caused growth to stall in 2020. Employment in production and value-added sectors for both agriculture and forestry receded in 2020 but began to recover lost ground during 2021. Forestry production and forest product manufacturing experienced the same trend.

Real farm cash receipts grew by 40 percent from 2009 to 2014 due to rising commodity prices, but they slid 20 percent from 2014 to 2016. From 2016 to 2021, farm cash receipts experienced a modest one percent decrease, and state farm employment dropped from 50,846 in 2016 to 45,954 in 2021. In addition, farmland area shrunk from an estimated 8.1 million acres in 2014 to 7.7 million acres in 2021.

Virginia’s agricultural commodity mix has also changed in recent years. While farm cash receipts have increased for broilers, corn, soybean, and all other crops (mainly greenhouse and nursery products), they have decreased for dairy, cattle, turkey, and tobacco.

Virginia’s food, beverage, and fiber processors and manufacturers buy many of their agricultural commodity inputs from Virginia farmers. These industries have experienced overall growth over the last five years (2016-2021), which continues to be driven by beverage manufacturing at 22 percent (specifically by alcoholic beverage manufacturing, which includes breweries, wineries, and distilleries) and secondarily by food manufacturing at 3 percent. While tobacco products

manufacturing employment has stabilized near 2,000 jobs, textiles and apparel industries continue to decline with a 20 percent decrease in employment over the period.

Virginia's forest industry has experienced attrition in some areas over the last five years. Timber harvesting dropped to \$319 million in stumpage (the sales value of standing timber) from a peak harvest value in 2015 of \$388 million—a drop of 18 percent. Employment in Virginia's forest product manufacturing declined by 5 percent from 2016 to 2021. Employment in forest product manufacturing was declining before the COVID-19 pandemic, but the pandemic and recession led to some further weakening in 2020 with a small rebound in 2021.

Virginia's agriculture and forestry sectors continue to play an important role in the commonwealth economy. Using the same methodology adopted in three previous studies (*The Economic Impact of Agriculture and Forestry on the Commonwealth of Virginia* in 2008, *The Economic Impacts of Agriculture and Forest Industries in Virginia* in 2013 and *The Economic Impact of Virginia's Agriculture and Forest Industries* in 2017), this study gauges the magnitude of those sectors' economic contribution or "economic impact." Agriculture and forest industries are disaggregated into four components: 1) *production*, 2) *core processing*, 3) *extended processing*, and 4) *distribution*. Each component reflects a different position in the supply chain and the degree of dependency on Virginia's agriculture and forestry natural resources. *Production* activities are those industries associated with growing and harvesting farm, timber, and non-timber forest commodities. *Core processing* industries are manufacturing industries that are heavily dependent on state agricultural and forestry commodity inputs for production and would have a much smaller presence or none at all if the state did not produce the commodity. *Extended processing* industries are those agriculture and forest industries that rely heavily on other inputs or imported farm and forestry commodity inputs. In many instances, these industries select a location based on consumer market proximity, labor availability, or other factors rather than close proximity to agricultural commodity or timber inputs.

STUDY COMPONENTS: INPUT-OUTPUT ANALYSIS AND ECONOMIC IMPACT ESTIMATES

This study uses input-output analysis to perform the economic impact analysis. Input-output analysis produces industry-specific multipliers that indicate how economic activity in one sector of the economy affects the overall regional economy. For this study, we are interested in how changes in the size of the agricultural and forest industries affect the state economy. The total impact of agricultural and forest industries is made up of three parts: 1) a "direct impact," 2) "an indirect impact," and 3) an "induced impact."

The *direct impact* consists of the presence of economic activity in the region—in this case the output and associated employment of Virginia's agricultural and forest industries. This direct activity then causes a "ripple effect" on the state economy when money is spent by these industries. For example, Virginia businesses provide supplies and services to farms, such as fuel, fertilizer, veterinarian services, utilities, and insurance. These businesses spend a portion of their revenues on purchases of supplies and services from other companies in the state who

subsequently purchase some of their supplies and services from other resident companies. This cascading sequence of spending continues until the additional rounds of spending dissipate due to leakages in the form of spending outside the state. The cumulative effect of these continuing rounds of inter-industry purchases is referred to as the *indirect impact*. The final component of total impact (the *induced impact*) is attributable to the spending of households and other economic agents. For example, 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 impact is the sum of the impacts associated with these household purchases.

For this study, statewide economic impact estimates were developed for agriculture and forest industries. Economic impacts are evaluated using three different measures: 1) total industrial output, 2) employment, and 3) 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. Economic impact results are also disaggregated by traditional goods and service industries of impact (e.g., agriculture, mining, manufacturing). Finally, the economic impact results for agriculture and forestry in 2021 are compared to economic impact results five years earlier (2016).

SUMMARY OF THE ECONOMIC IMPACT IN VIRGINIA

In 2021, the direct impact of Virginia agriculture and forest industries was \$55 billion in total output, approximately 185,500 employees, and \$23.1 billion in value-added. Agriculture production is the largest component in terms of employment at 28 percent. However, the category of agriculture extended processing accounts for 41 percent of output and 53 percent of value-added.

The total economic impact (including direct, indirect, and induced impacts) of agriculture and forest industries was nearly \$106 billion in total industry output or sales, which is an estimated 11.2 percent of state output. The value-added impact was approximately \$55 billion dollars, which constitutes approximately 9.3 percent of Virginia gross domestic product (GDP). The total employment impact is approximately 490,295 employees or 9.4 percent of total state employment.

The impacts of agriculture and forestry are experienced in every sector of the economy. Large effects occur in the manufacturing and agriculture and forest industries where direct impacts are dominant. The largest employment and value-added impacts occur in the services industry, only partially because it hosts some distribution (landscaping and horticultural services) employment. Agriculture and forestry stimulate construction, trade, government, and other sectors as a result of 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

EXECUTIVE SUMMARY

payments components. The agriculture industry accounts for over 78 percent of total agriculture and forest industry output and employment impacts, and 79 percent of value-added impact, with forest industry making up the remainder. Relative to the state economy, agriculture industry impacts represent approximately 7.4 percent of Virginia's GDP. Forest industry represents 1.9 percent.

Among the industry components, production industry impacts make up 17 percent of the total employment impact but a considerably smaller share, 8 percent, of value-added impact. This is due, in part, to a workforce comprised of part-time farmers and seasonal employees. Core processing makes up 25 percent of employment impact and 24 percent of value-added impact. Extended processing is the largest economic impact category, representing 40 percent of employment impact and 53 percent of value-added impact. Distribution and power generation activities account for 18 percent of employment impact and 14 percent of value-added impact. A small residual (<1 percent) is represented by government transfer payments to the farm sector.

The total economic impact of agriculture and forest industries has grown over the last five years. The total employment impact rose from 478,079 jobs in 2016 to 490,295 jobs in 2021 (3 percent). The total value-added impact grew from \$50.1 billion in 2016 to \$55.1 billion (10 percent) expressed in terms of 2021 real dollars.

INTRODUCTION

Virginia's agriculture and forest industries play an important role in Virginia's economy. These two industries employ a large number of Virginians, and their economic impacts can be felt far beyond the farms and forest plantations where most agricultural and forestry commodities are grown and harvested. Beyond production activities at farms and timber tracts, the agriculture and forest industries encompass a range of processing and manufacturing industries that include food and beverage processing, some agricultural-fiber related textile manufacturing, wood products manufacturing, pulp and paper mills, and furniture manufacturing. In addition, distribution businesses, such as grain elevators and raw commodity warehouses, rely on Virginia farm and forest products for supplies. In turn, these production, manufacturing, and distribution sectors procure material and service inputs, labor, and value-added services from Virginia-based businesses and households. This chain of purchasing events results in a "multiplier effect," which captures the flow of dollars as it ripples through the Virginia economy. Because of this "ripple effect," Virginia agriculture and forest industries affect every other industry in the commonwealth to some degree.

This study updates three earlier studies on the economic impact of Virginia's agriculture and forest industries (Rephann 2008, 2013, 2017) and retains features of those studies. It uses the same input-output methodology and economic impact model (IMPLAN) as the previous studies and defines and disaggregates the industry in the same manner. Agriculture and forest industries are disaggregated into four components: 1) production, 2) "core" processing, 3) "extended" processing, and 4) distribution. Each component reflects a different position in the supply chain and degree of dependency on Virginia's agriculture and forestry natural resources.

The study consists of four sections. The first section examines characteristics of the agriculture and forestry production and manufacturing sectors in Virginia. It also examines recent changes in industry economic activity. The second section describes the data and methodology used in the study. It describes input-output analysis and the economic impact model (IMPLAN) used, the method of delineating the industry, and the data sources used in economic impact analysis. The third section presents the results. The final section is a summary and conclusion.

SECTION 1: INDUSTRY OVERVIEW

VIRGINIA'S AGRICULTURE AND FOREST INDUSTRIES

Virginia's agriculture and forestry sectors are subject to different economic forces, but both were negatively affected by the recent COVID-19 pandemic. Virginia's agriculture industries are primarily influenced by population growth, consumer incomes and tastes, and government policy. Over the last five years, Virginia's agriculture industry has experienced shrinking farm employment, but relatively steady farm sales with a shift in the commodity composition of farm sales. Beverage manufacturing employment has seen continued rapid growth (primarily due to breweries, wineries, and distilleries) while growth in food processing employment has slowed. Textiles and apparel manufacturing employment continues to shrink while tobacco manufacturing employment has stabilized for the time being.

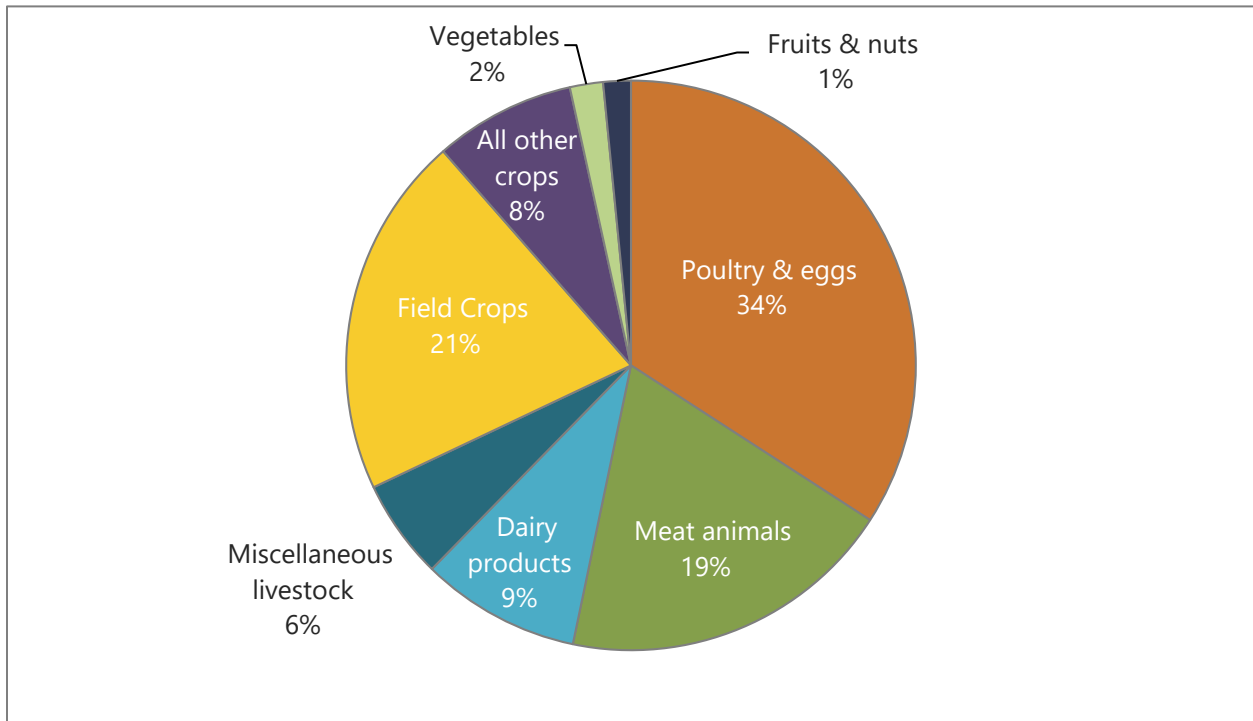
The vitality of the forest industry is strongly affected by the housing market and international trade patterns. The pickup in housing activity during the first half of the last decade slowed in the second half, and international competitors continued to make new inroads into domestic markets for furniture and other forestry products. These factors have contributed to some attrition in Virginia forest product manufacturing employment in the last five years.

The COVID-19 pandemic caused an abrupt downturn in both agriculture and forest industry employment in 2020 followed by a partial rebound in 2021. The pandemic effect on consumer demand was less severe than for other hard-hit sectors of the economy, such as hospitality and food services, that were deemed "non-essential industries" and subject to mandated closures during the first pandemic wave and consumer apprehension thereafter. However, food producers were profoundly affected by changes in consumer distribution channels resulting from consumers eating at home instead of at restaurants and entertainment venues due to stay-at-home orders and social distancing. Forest products, such as housing construction inputs and furniture, saw a surge in demand as households shifted away from spending on services to spending on durable goods, such as furniture and home improvements, and purchased suburban and exurban homes to ride out the pandemic and work remotely. Agriculture and forest product manufacturing industries were both negatively impacted by supply-side disruptions that made it difficult to secure supplies and workers for production.

AGRICULTURE

Virginia's farms produce a wide variety of products. Livestock account for approximately 63 percent 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, which account for the bulk of sales in a category called "all other crops," are also important agricultural commodities. Virginia is also a top 10 producer of several agricultural commodities. In 2021, the state ranked fourth for tobacco; seventh for apples; eighth for peanuts; and tenth for poultry, eggs, and trout aquaculture.

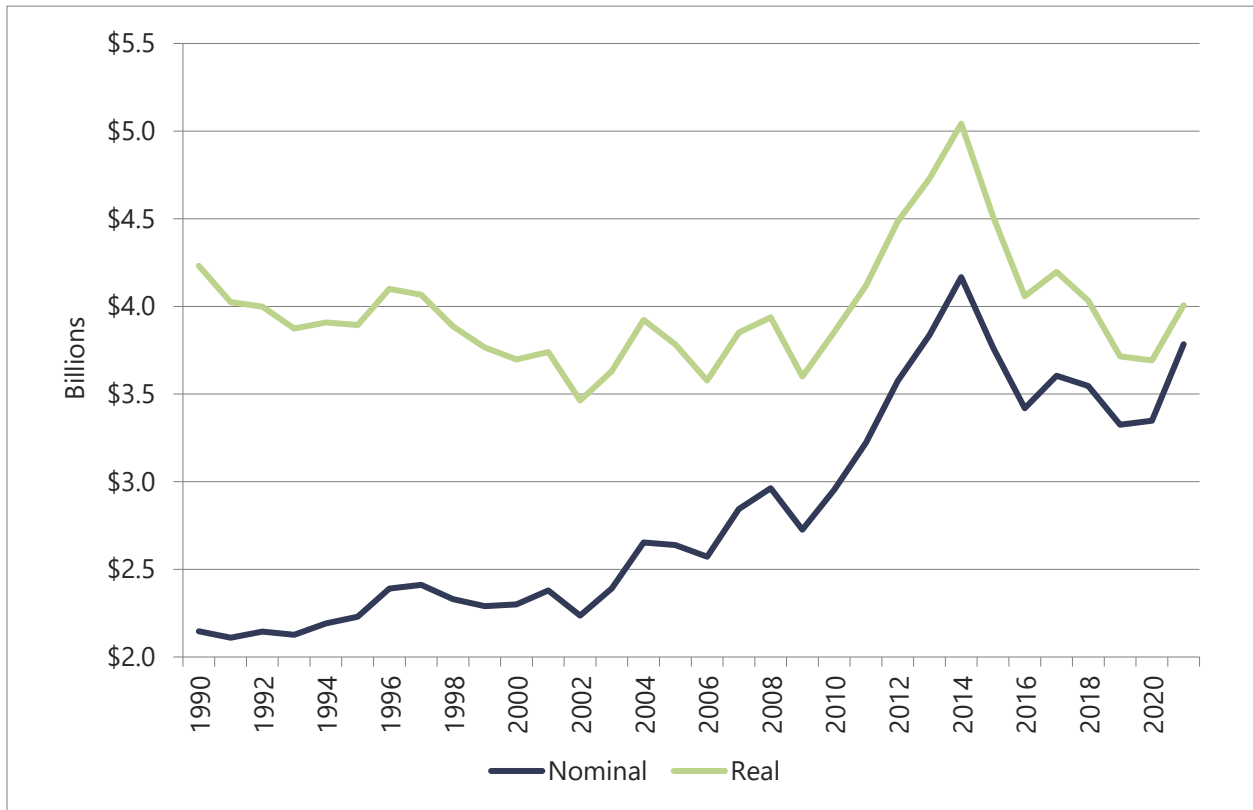
Figure 1.1 Cash Receipts by Commodity, Virginia, 2021



Source: U.S. Department of Agriculture, Economic Research Service (2022)

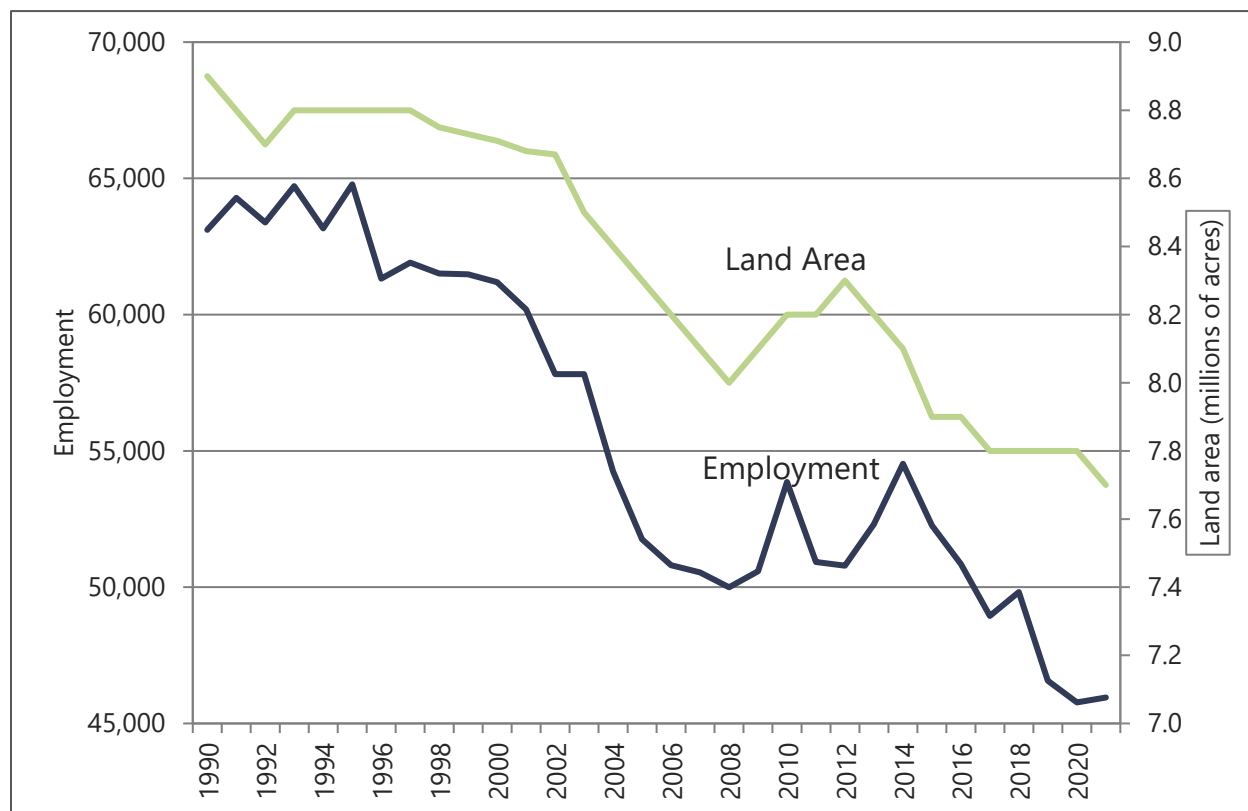
Real farm cash receipts grew by 40 percent from 2009 to 2014 due to rising commodity prices but slid 20 percent from 2014 to 2016. From 2016 to 2021, they levelled off with a slight one percent decrease (see **Figure 1.2**). During this same time period, state farm employment dropped from 50,846 in 2016 to 45,954 in 2021, and farmland area shrunk from an estimated 8.1 million acres in 2014 to 7.7 million acres in 2021 (see **Figure 1.3**).

Figure 1.2 Virginia Agricultural Nominal and Real (2022 Dollars) Cash Receipts, 1990-2021



Source: U.S. Department of Agriculture, Economic Research Service (2022)

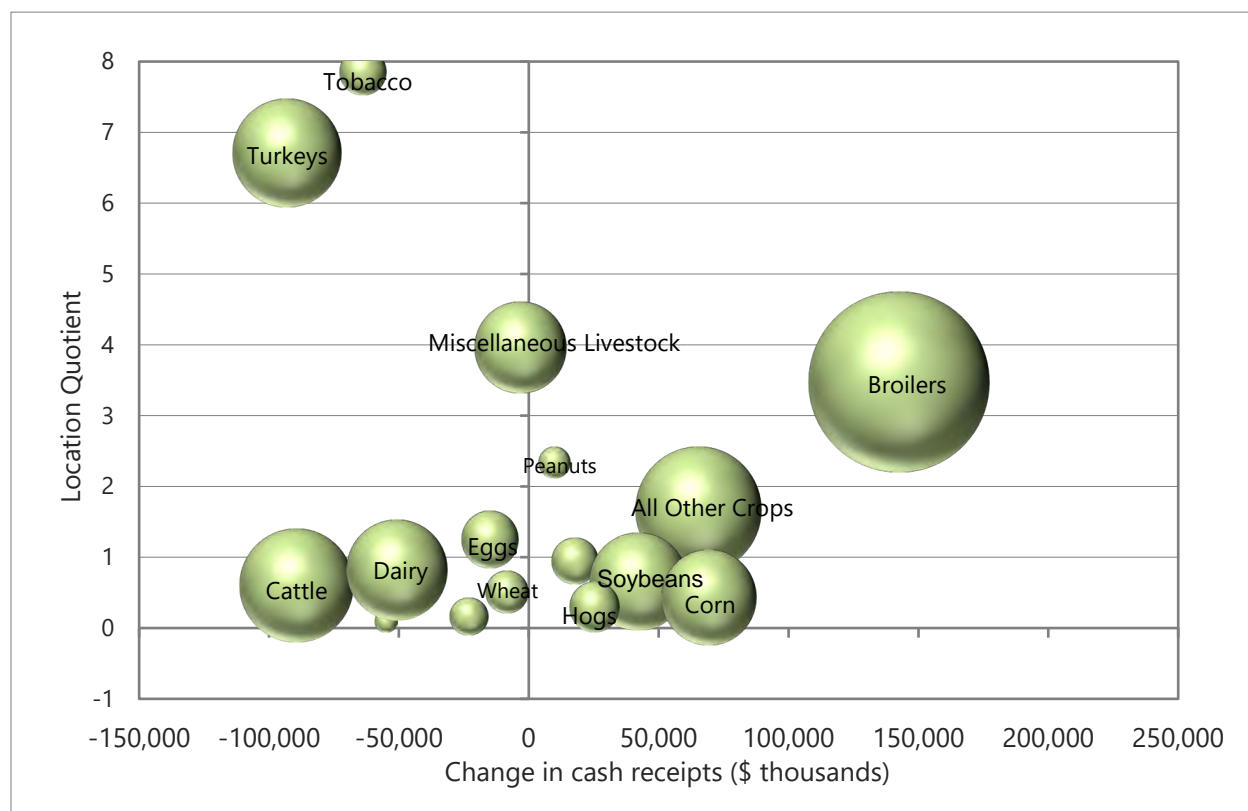
Figure 1.3 Virginia Farm Employment and Land Area, 1990-2021



Source: Lightcast™ (2022) and U. S. Department of Agriculture, National Agricultural Statistical Service (2022)

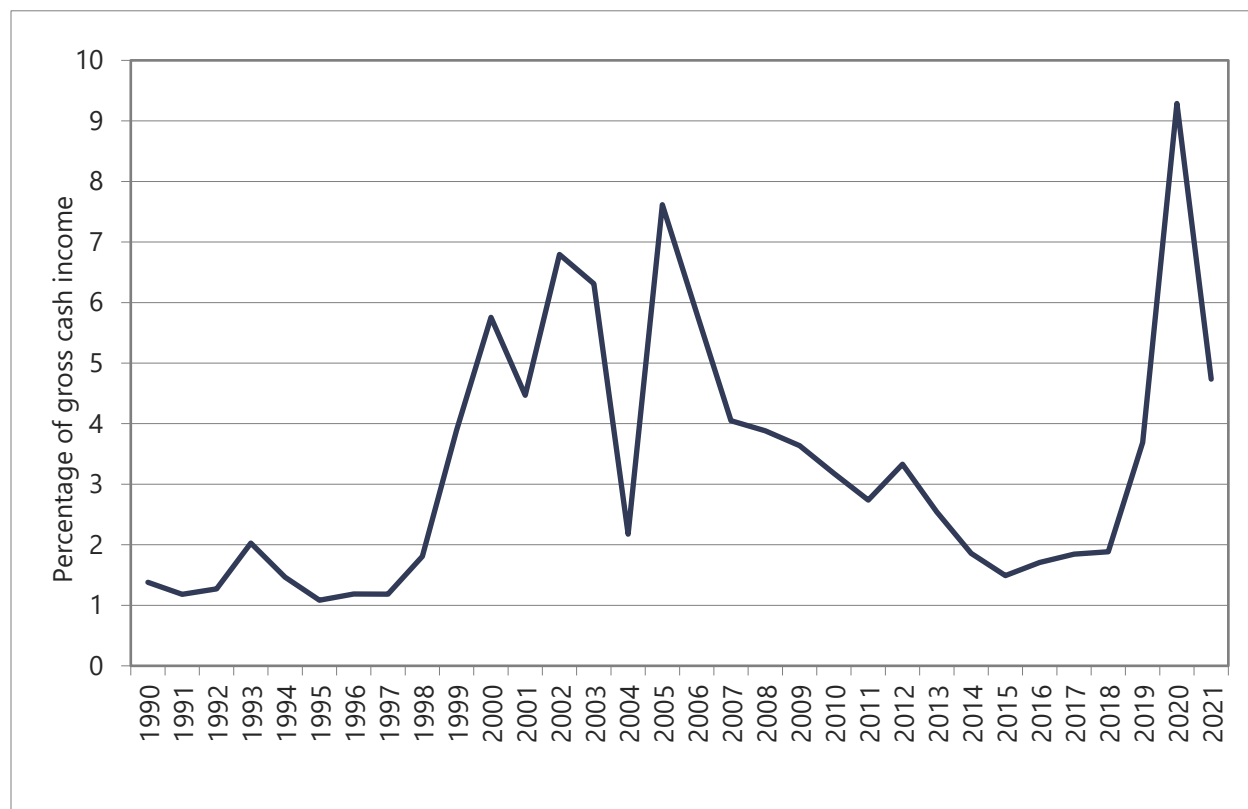
The value of Virginia's agricultural commodity mix has also changed in recent years. **Figure 1.4** illustrates these changes for major commodities from 2016-2021. The figure shows the degree of Virginia commodity concentration¹ versus the change in state nominal commodity sales on the horizontal axis. The relative size of state commodity sector sales is indicated by bubble size. Farm cash receipts have markedly increased for broilers, corn, soybean, and all other crops (mainly greenhouse and nursery products). They have substantially decreased for dairy, cattle, turkey, and tobacco.

Figure 1.4 Change in Virginia Farm Commodity Sales 2016-2021 by Size and State Specialization



Source: U. S. Department of Agriculture, Economic Research Service (2022)

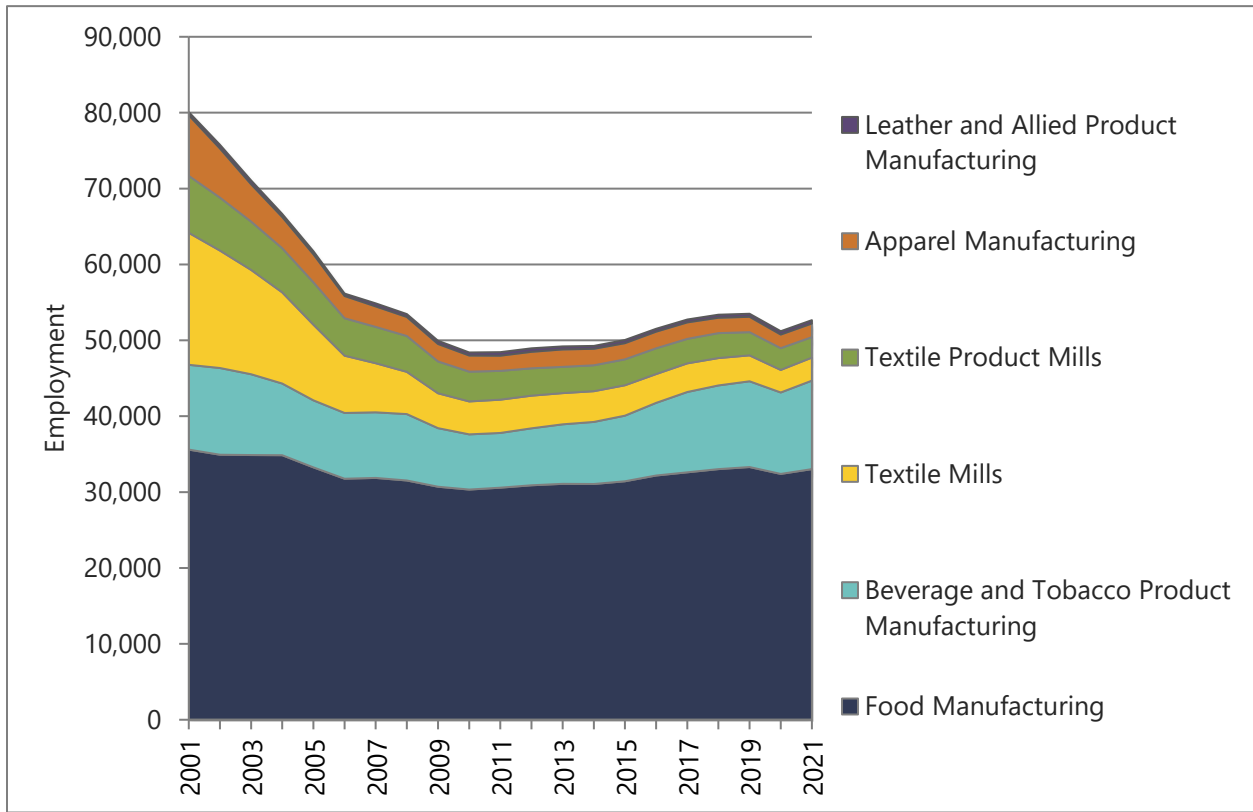
Federal farm transfer payments surged in 2020 due to coronavirus relief programs created to assist farmers affected by COVID-19 market disruptions. Funding for the U.S.D.A. Coronavirus Food Assistance Program (CFAP) was obtained from wide-ranging COVID-relief legislation adopted in the early days of the pandemic, including the Coronavirus Aid, Relief, and Economic Security Act (CARES) and the Families First Coronavirus Response Act (FFCRA). As a result of this assistance, federal farm payments rose from 3.6 percent of gross farm cash income in 2019 to 9.3 percent in 2020 (see **Figure 1.5**). In 2021, farm payments continued at a historically higher level, representing approximately 4.7 percent of gross farm cash income. The peak assistance in 2020 eclipsed the previous high in farm transfer payments that occurred during 1999-2007 as a result of federal peanut and tobacco quota buyout programs. During that period farm payments rose as high as 7.6 percent of gross farm income in 2005.

Figure 1.5 Government Payments as Percentage of Virginia Farm Gross Cash Income, 1990-2021

Source: U. S. Department of Agriculture, Economic Research Service (2022)

Virginia's food, beverage, and fiber processors and manufacturers buy many of their agricultural commodity inputs from Virginia farmers. These industries have grown by approximately 1,100 jobs (2 percent) over the last five years (2016-2021). Growth was interrupted in 2020 due to the COVID-19 pandemic and its disruptive effects on consumer distribution channels, the supply chain, workplace safety, and labor force participation (Weersink et al. 2020; Aday and Aday 2020). Employment recovered slightly in 2021 but still lagged behind the level before the pandemic (see **Figure 1.9**). Overall growth in the sector continues to be driven by beverage manufacturing at 22 percent (specifically by alcoholic beverage manufacturing, which includes breweries, wineries, and distilleries) and secondarily by food manufacturing at 3 percent. While tobacco products manufacturing employment has stabilized near 2,000 jobs, textiles and apparel industries continue to decline with employment decreasing 20 percent.

Figure 1.6 Virginia Agriculture Product Manufacturing Employment, 2001-2021

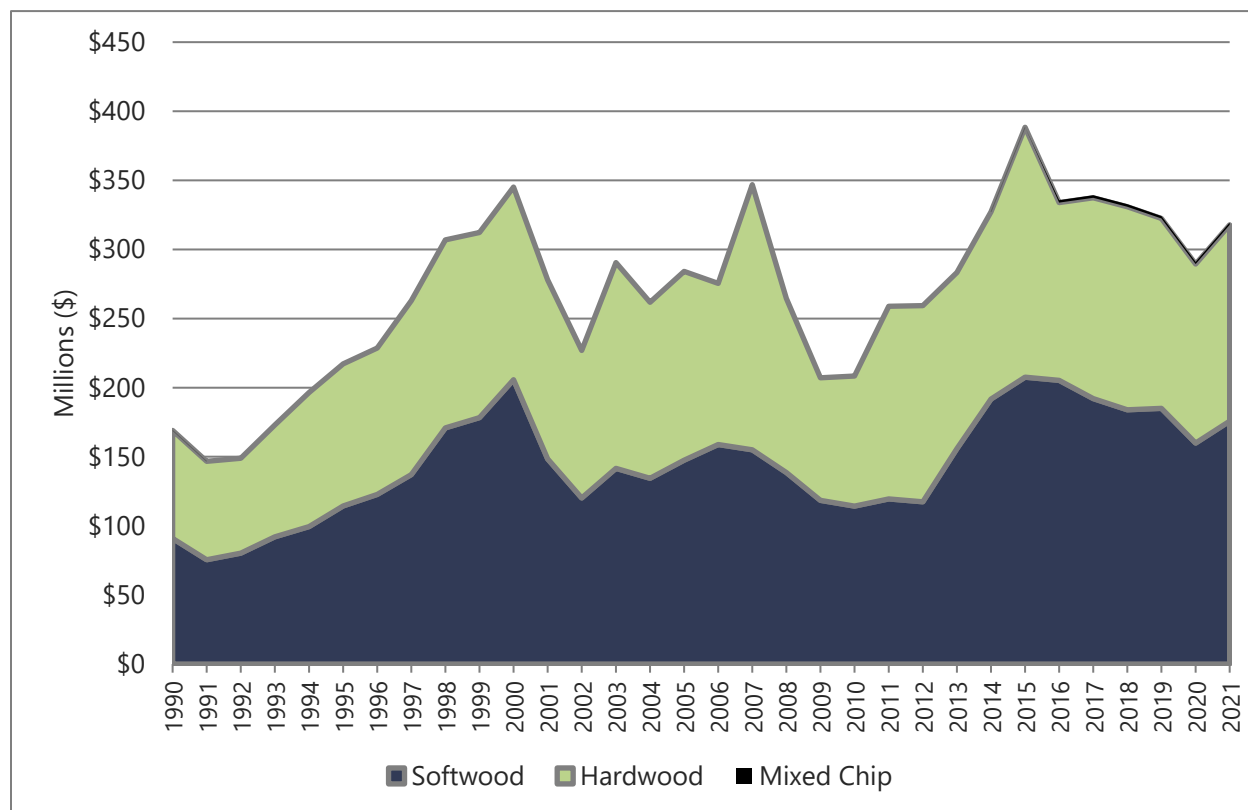


Source: Lightcast™ (2022)

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 decade, softwood timber values represent approximately 56 percent of the total timber extraction value. Virginia produced approximately \$319 million in stumpage (the sales value of standing timber) in 2021 (see **Figure 1.7**). This is down 18 percent since the peak harvest value in 2015 of \$388 million.

Figure 1.7 Virginia Stumpage Values, 1991-2021



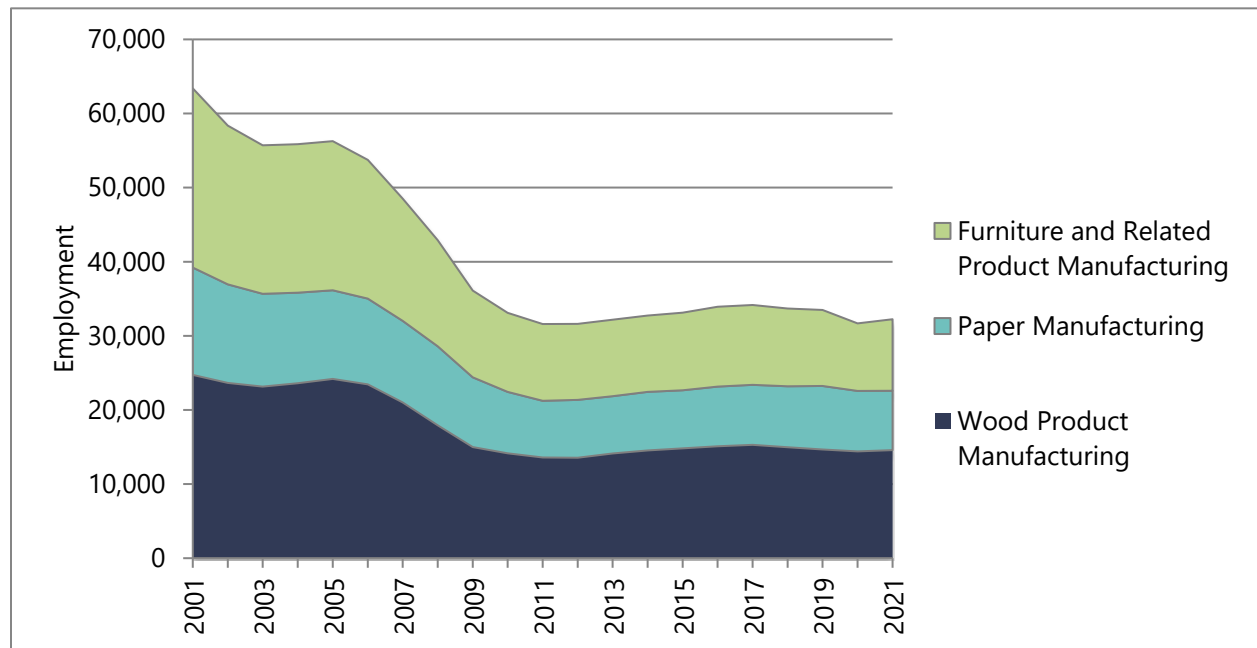
Source: Virginia Department of Forestry

Virginia's forest product manufacturing employment declined by 5 percent from 2016 to 2021 (see **Figure 1.14**). Forest product manufacturing activity had been relatively flat in the three years before the COVID-19 pandemic, but the pandemic and recession led to a significant weakening with a partial rebound in 2021. Wood products and furniture manufacturing is closely tied to home construction, but the recovery in single-family home construction that followed the "Great Recession" of 2007-2009 occurred primarily in the first half of the last decade. Moreover, international competitors supply an increasing share of hardwood and upholstered furniture for domestic consumption (Luppold and Bumgardner 2022). Paper manufacturing has been in long-term decline due to the growing popularity of electronic media and reduced consumption of paper for printing. However, the continued demand for tissue for personal hygiene and the

SECTION 1: INDUSTRY OVERVIEW

increased demand for paperboard and packing paper due to higher consumption of packaging for shipping has provided some industry resilience (Brandeis et al. 2021). Forest product manufacturing employment has been reduced over the last several decades due to reduced demand and the firm adoption of labor-saving technologies, but the COVID-19 pandemic led to an abrupt drop in employment due primarily to supply side issues, including a contraction in labor force participation and supply chain bottlenecks (Prestemon and Guo 2022).

Figure 1.8 Virginia Forest Product Manufacturing Employment, 2001-2021



Source: Lightcast™ (2022)

SECTION 2: METHODOLOGY

This section describes the methodology used to estimate agriculture and forestry economic impacts. The first part describes how Virginia's agriculture and forest industries were defined for use in economic impact analysis. The second part describes the input-output analysis, economic impact methodology, and software model (IMPLAN) used to measure state economic impacts. The third part identifies data inputs.

AGRICULTURE AND FOREST INDUSTRY IDENTIFICATION

This study includes sectors that are directly related to agriculture and forestry², which are the same sectors identified in the last study (Rephann 2017). These industries were identified by using data from IMPLAN on forward linkages with agricultural and forestry commodities and also by incorporating 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.³ These industries and their associated IMPLAN sectors and definitions are listed in in Appendix **Table A.1**.

Agriculture and forest 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 that grow and harvest agricultural, timber, and non-timber forest commodities.

Core processing industries are manufacturing industries that rely on state commodity inputs for production and are more likely to locate in close proximity to these raw material inputs to minimize production costs. In addition, commodity inputs tend to be bulky or highly perishable. These industries are generally primary processing industries that involve the first stage of converting a commodity input into a finished consumer product. Examples of these industries include animal slaughtering and sawmills.

Extended processing industries are manufacturing industries that are less dependent on Virginia farm and forest commodity inputs. They tend to be secondary processing industries that 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 value close proximity to consumer markets or transportation infrastructure, such as ports and freeways. For example, beverage production requires access to a large supply of locally available water, which is costly to transport, as well as smaller quantities of products such as fruit, and corn and sugar extracts, so production tends to be close to populated areas. In much the same way, custom cabinetry firms often locate close to populated areas in order to more rapidly serve consumers.

Distribution industries are warehousing, wholesaling, and service industries with a close nexus to agricultural and forest products. Examples of distribution industries include grain elevators, landscaping and horticultural services. Biomass power generation is also included in this category.

ECONOMIC IMPACT MODELING

This study uses an economic input-output model in the economic impact analysis. Input-output analysis produces industry-specific multipliers that indicate how economic activity in one sector of the economy affects the overall state economy.⁴ For this study, we are interested in how changes in agriculture and forest industries affect the state economy.

The total impact of agricultural and forest industry activity is comprised of three parts, 1) a *direct impact*, 2) an *indirect impact*, and 3) an *induced impact*. The *direct impact* consists of the economic activity or expenditure in the region, namely the output of Virginia's agriculture and forest industries. In order to produce this output, companies must spend on goods, services, and labor inputs. This spending 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 then spend a portion of their sales revenues on purchases of supplies and services from other Virginia companies who, in turn, purchase a portion of their supplies and services from other companies in the commonwealth. 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 continuing rounds of inter-industry purchases is referred to as the *indirect impact*.⁵ The final component of total impact (the *induced impact*) is attributable to the spending of households and other economic agents. For instance, businesses employ individuals from households across the state. These households then purchase goods and services from companies in the commonwealth 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 impact* is the sum of the impacts associated with these household purchases.

The economic impact analysis uses IMPLAN (Impact analysis for PLANning) software. IMPLAN has been used in many economic impact studies, including the three most recent economic impact studies of Virginia agriculture and forestry (Rephann 2008, 2013, 2017). It is perhaps the most common tool used in state agriculture and forest industry economic impact analysis (Henderson et al. 2017; English, Popp, and Miller 2016). Models here are built using 2020 IMPLAN Pro data released in November 2021 that utilizes a 546-sector IMPLAN sector scheme (IMPLAN® model. n.d.). Tables were customized for Virginia using the software.

Impacts are evaluated within IMPLAN using three different measures: 1) *total sales* or *total industrial output* (TIO), 2) *value-added*, and 3) *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

SECTION 2: METHODOLOGY

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

DATA

This study uses model input data from three different sources: 1) Lightcast™ (formerly Emsi/Burning Glass), 2) U.S. Department of Agriculture, Economic Research Service and 3) Virginia Department of Forestry.

Lightcast™ 2021 employment data was used to measure economic activity for most sectors.⁶ NAICS sector employment was aggregated into IMPLAN categories using an NAICS/IMPLAN sector crosswalk. The model then converts employment numbers to sales/output equivalent figures for use in generating economic impact estimates. Most production sectors were treated differently. For farming sectors (IMPLAN sectors 1-14), U.S. Department of Agriculture commodity cash receipts data from 2021 were used (U.S. Department of Agriculture, Economic Research Service 2022).⁷ This data was used because Lightcast™ does not provide detailed employment data for the 14 farm-related IMPLAN sectors. For forest nurseries, forest products, and timber tracts sector (IMPLAN sector 15), data from Virginia Department of Taxation stumpage values used to compute forest product tax receipts for 2021 was substituted to provide a more comprehensive measure of direct activity. This data was obtained from the Virginia Department of Forestry.

SECTION 3: RESULTS

This section presents the economic impact results. It shows the statewide impacts of agriculture and forest industries. 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 further disaggregated by traditional industry of impact. In addition, the economic impact results for agriculture and forest industries in 2021 are compared to the economic impact results from five years earlier (2016).

The direct impact of Virginia agriculture and forest industries in 2021 by IMPLAN sector is reported in **Table 3.1**. The industries accounted for \$55 billion in total output, 185,500 jobs, and \$23.1 billion in value-added. The output, employment, and value-added direct impacts 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 impact at nearly 28 percent. However, agriculture extended processing accounts for nearly 41 percent of output impact and 53 percent of value-added impact.

Table 3.1 Virginia Direct Impacts by Agriculture and Forest Industry Component, 2021

Component	Output (Million \$)	Employment	Value-Added (Million \$)
Agriculture and Forestry			
Production	4,614	60,255	1,942
Core processing	18,471	40,004	4,815
Extended processing	26,641	39,927	13,344
Distribution	5,285	45,314	2,964
Total	55,011	185,500	23,065
Agriculture			
Production	3,948	52,712	1,447
Core processing	11,821	23,055	2,734
Extended processing	22,612	26,047	12,175
Distribution	4,368	41,332	2,458
Total	42,749	143,146	18,815

SECTION 3: RESULTS

Forestry			
Production	666	7,544	494
Core processing	6,650	16,949	2,081
Extended processing	4,029	13,880	1,168
Distribution	917	3,982	507
Total	12,262	42,355	4,251

Figure 3.1 Virginia Direct Impacts by Agriculture and Forest Industry Component as Percentage of Total, 2021

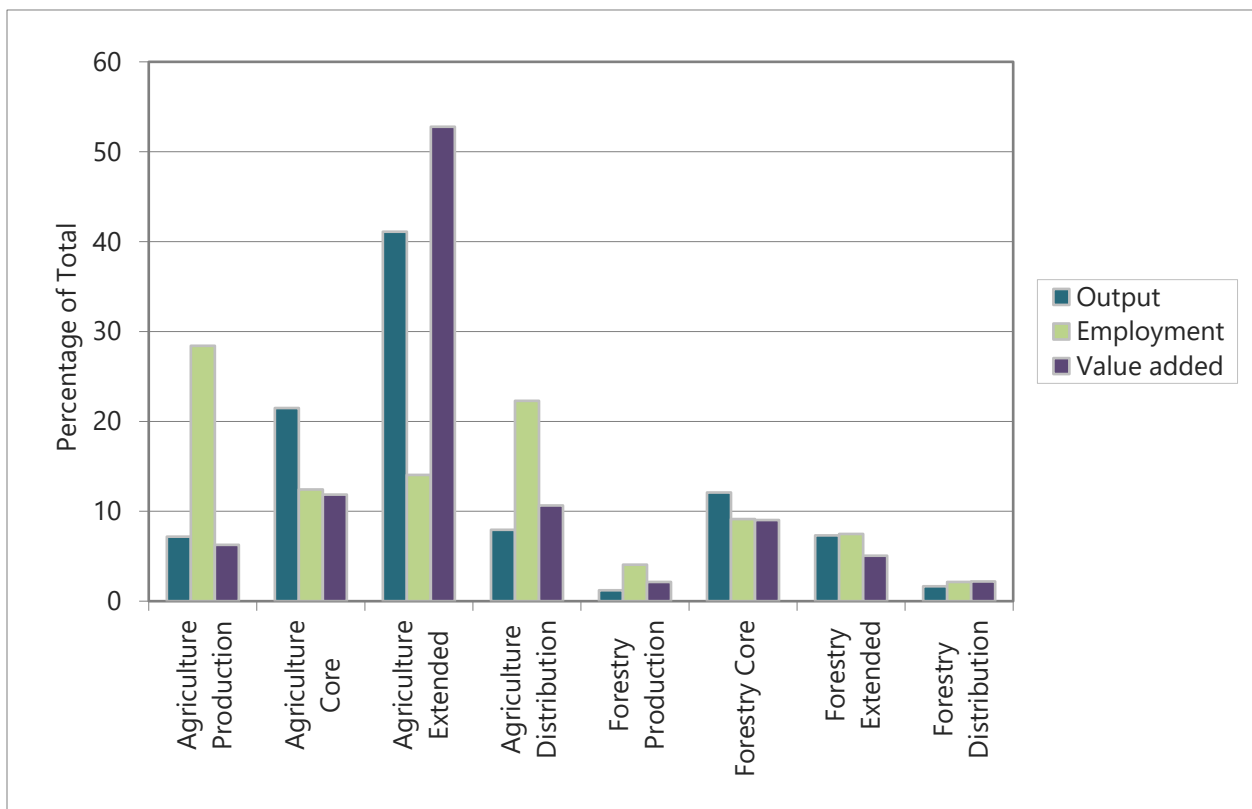


Table 3.2 presents the total economic impact of agriculture and forest industries. It indicates that the total industry output or sales impact of the agriculture and forest industries in Virginia was nearly \$106 billion in 2021; the employment impact was 490,295; and the value-added impact was approximately \$55 billion. These total impacts include indirect impacts and induced impacts. Results indicate that the agriculture industry accounts for 78 percent of total agriculture and forest industry output and employment impacts, and 79 percent of total value-added impact.

Table 3.2 Virginia Total, Direct, Indirect, and Induced Impacts of Agriculture and Forest Industries, 2021

Impact	Output (Million \$)	Employment	Value-Added (Million \$)
Agriculture and Forest Industries			
Direct	55,011	185,500	23,065
Indirect	10,803	50,438	5,886
Induced	40,089	254,357	26,203
Total	105,902	490,295	55,154
<i>Multiplier</i>	<i>1.93</i>	<i>2.64</i>	<i>2.39</i>
Agriculture			
Direct	42,749	143,146	18,815
Indirect	7,937	37,260	4,272
Induced	31,642	201,439	20,728
Total	82,329	381,844	43,815
<i>Multiplier</i>	<i>1.93</i>	<i>2.67</i>	<i>2.33</i>
Forestry			
Direct	12,262	42,355	4,251
Indirect	2,866	13,179	1,614
Induced	8,446	52,918	5,474
Total	23,574	108,451	11,339
<i>Multiplier</i>	<i>1.92</i>	<i>2.56</i>	<i>2.67</i>

The economic impacts of agriculture and forest industries 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 impacts of farming, timber tract, logging, and related agriculture and forest product manufacturing activities. However, the agriculture and forest industry stimulated significant additional activity via the construction, trade, and government sectors primarily as a result of purchases by the industry, households, and other institutions and subsequent rounds of spending. The largest total employment (198,879 jobs) and total value-added (\$19 billion) impacts occurred in the services industry, which also partially reflects the

SECTION 3: RESULTS

presence of agriculture industry direct employment, namely landscaping and horticultural services employment. Tens of thousands of jobs in the construction, transportation, information, and public utilities industries are also associated with agriculture and forestry activity.

Table 3.3 Total Impact of Virginia’s Agriculture and Forest Industries by Major Industry, 2021

	Output (Million \$)	Employment	Value-Added (Million \$)
Agriculture	4,656	60,851	1,979
Mining	128	322	47
Construction	3,849	23,311	2,044
Manufacturing	46,611	82,983	18,569
Transportation, Information, and Public Utilities	6,500	25,561	3,187
Trade	6,481	42,109	3,959
Services	30,790	198,879	18,980
Government	6,888	56,279	6,389
Total	105,902	490,295	55,154

The economic impacts were estimated by agriculture and forestry sectors and further broken down into their production, core processing, extended processing, distribution, and government payments components (**Table 3.4**). The table also shows the magnitude of the component economic impact relative to the size of the state economy for output, employment, and value-added. The total economic impact for each component relative to the total economic impact for the agriculture and forest industries is illustrated in **Figure 3.2**.

The agriculture and forest industry economic impacts are sizeable relative to the Virginia economy (see **Table 3.4**). Agriculture and forest industry economic impacts represent an estimated 11.2 percent of total state output, 9.4 percent of total state employment, and 9.3 percent of the state gross domestic product. Thus, approximately one of every eleven jobs in Virginia can be tied to its agriculture and forest industries.

SECTION 3: RESULTS

Table 3.4 Total Impact of Virginia's Agriculture and Forest Industries by Component; Output, Employment and Value-Added in Millions of Dollars, 2021

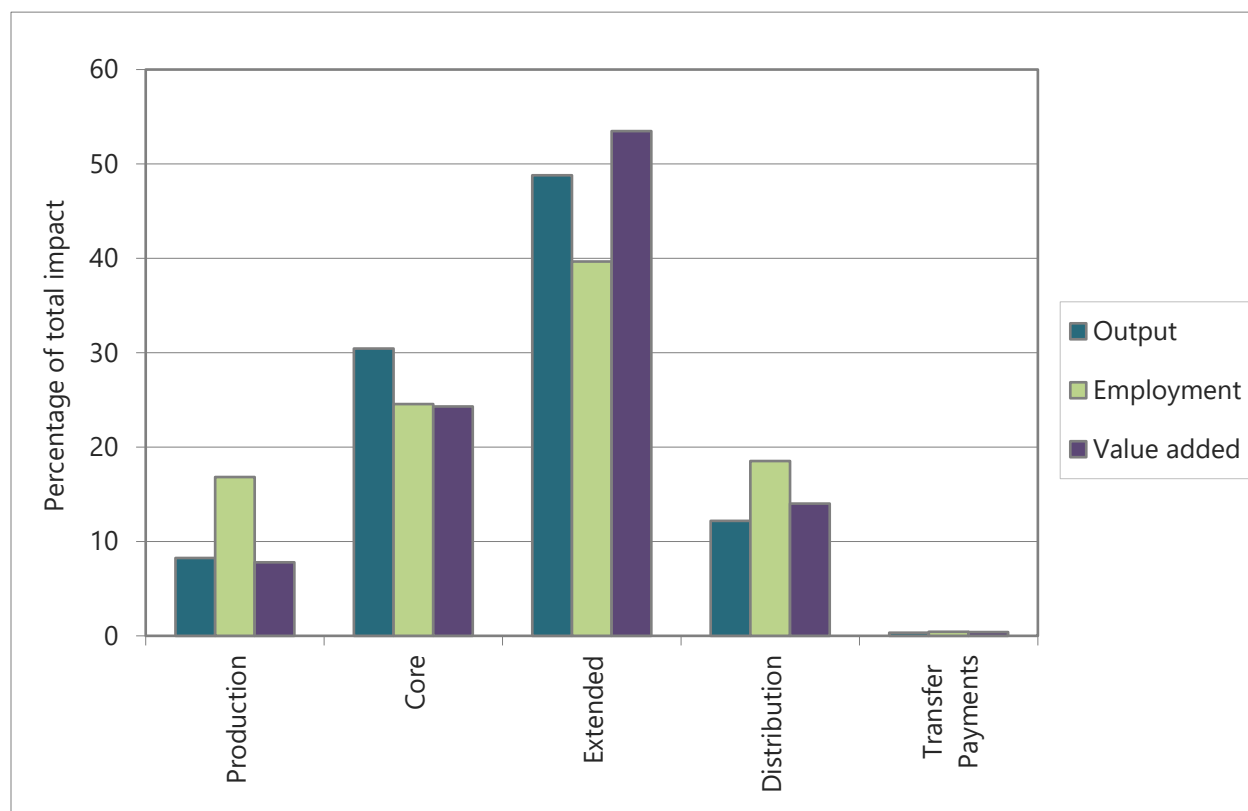
Output				
	Agriculture	Impact as Percentage of Total Employment	Forestry	Impact as Percentage of Total Employment
Production	7,279	0.77	1,460	0.15
Processing core	19,898	2.11	12,330	1.31
Processing extended	44,310	4.70	7,372	0.78
Distribution	10,495	1.11	2,412	0.26
Transfer payments	346	0.04	--	--
Total	82,329	8.74	23,574	2.50

Employment				
	Agriculture	Impact as Percentage of Total Employment	Forestry	Impact as Percentage of Total Employment
Production	70,082	1.35	12,455	0.24
Processing core	70,752	1.36	49,659	0.95
Processing extended	161,050	3.09	33,387	0.64
Distribution	77,822	1.49	12,951	0.25
Transfer payments	2,137	0.04	--	--
Total	381,844	7.33	108,451	2.08

Value-Added				
	Agriculture	Impact as Percentage of Total State GDP	Forestry	Impact as Percentage of Total State GDP
Production	3,295	0.56	1,003	0.17
Processing core	7,771	1.31	5,634	0.95
Processing extended	26,249	4.43	3,250	0.55
Distribution	6,282	1.06	1,451	0.25
Transfer payments	219	0.04	--	--
Total	43,815	7.40	11,339	1.92

Note: Total state employment is based on Lightcast™. Total state GDP is based on Bureau of Economic Analysis (BEA) State Gross Domestic Product. Total state output is 2021 estimation based on IMPLAN output, deflator and Lightcast™ employment.

Figure 3.2 Virginia Total Impacts by Agriculture and Forest Industry Component, 2021



Among the industry components, production industry impacts make up 17 percent of the total employment impact but a considerably smaller share, 8 percent, of value-added impact. This is due, in part, to a workforce comprised of part-time farmers and seasonal employees in the sector. Core processing makes up 25 percent of employment impact and 24 percent of value-added impact. Extended processing is the largest economic impact category, representing 40 percent of employment impact and 53 percent of value-added impact. Distribution and power generation activities account for 18 percent of employment impact and 14 percent of value-added impact. A small residual (<1 percent) can be attributed to government transfer payments to the farm sector.

The total economic impacts of agriculture and forest industries has grown over the last five years (see **Table 3.5**). The total employment impact rose from 478,079 jobs in 2016 to 490,295 jobs in 2021 (3 percent). The total value-added impact grew from \$50.1 billion in 2016 to \$55.1 billion (10 percent) in terms of 2021 real dollars.

SECTION 3: RESULTS

Table 3.5 Virginia Total, Direct, Indirect, and Induced Impacts of Agriculture and Forest Industries, 2016 (expressed in terms of 2021 dollars)

Impact	Output (Million \$)	Employment	Value-Added (Million \$)
Agriculture and Forestry			
Direct	55,535	188,373	23,128
Indirect	9,301	45,926	5,124
Induced	33,395	243,780	21,769
Total	98,231	478,079	50,021
Multiplier	1.77	2.54	2.16
Agriculture			
Direct	43,152	144,214	19,100
Indirect	6,299	30,823	3,471
Induced	26,377	193,281	17,257
Total	75,828	368,318	39,828
Multiplier	1.76	2.55	2.09
Forestry			
Direct	12,384	44,159	4,029
Indirect	3,001	15,103	1,653
Induced	7,018	50,499	4,512
Total	22,403	109,761	10,194
Multiplier	1.81	2.49	2.53

SECTION 4: SUMMARY AND CONCLUSION

The agriculture and forest industries constitute an important part of Virginia's industrial base. In 2021, these industries generated a combined estimated \$106 billion in total output, \$55 billion in value-added and 490,295 jobs for the Virginia economy. The value-added impact amounts to 9.3 of state gross domestic product while the employment impact makes up 9.4 percent of total state employment. The agriculture industry accounted for approximately 78 percent of total output, employment, and value-added impacts with the forest industry making up the remainder. The 2021 statewide economic impacts are larger than those obtained using 2016 data (expressed in 2021 dollars), which estimated \$98.2 billion in total industry output or sales, \$50.1 billion of value-added, and 478,079 jobs.

The agriculture and forest industries have widespread effects across the economy and in every industry. While industries that directly employ agriculture and forestry workers experience the most substantial economic impacts, all industries benefit due to the cumulative cascading effects of industry purchases and payroll.

This study does not include several economic activities that would have increased the economic impact estimates. It does not capture economic activity connected to corporate and regional offices, research and development laboratories, and other operations of agribusiness manufacturing firms. The employment related to these activities would have been included in other industries such as "Management of Companies and Enterprises" (NAICS 55) or Professional, Scientific, and Technical Services (NAICS 54). For example, the thousands of workers employed by agriculture and forest industries headquarters in Virginia, such as Altria, Andros, American Woodmark, Mars, Shenandoah Growers, Smithfield Foods, Southern States, and Universal were not included. It also does not account for the full economic impact of agritourism and forest recreation, such as farm winery visits and equestrian sports, including those impacts that stem from consumer spending outside of farm and forest venues, such as hotels, restaurants and retail shops.

Finally, the study did not address the environmental and other social economic benefits of agriculture and forested landscapes for the commonwealth. These benefits include improved water and air quality, flood risk mitigation, wildlife habitat conservation, and scenic amenities.

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APPENDICES

Table A.1 Virginia Agriculture and Forest 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 feedlots 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		

APPENDICES

Sector	IMPLAN Description	Sector	IMPLAN Description
Agriculture Core Processing		Forestry Core Processing	
65	Flour milling	132	Sawmills
67	Malt manufacturing	133	Wood preservation
70	Fats and oils refining and blending	134	Veneer and plywood manufacturing
82	Cheese manufacturing	135	Engineered wood member and truss manufacturing
83	Dry, condensed, and evaporated dairy product manufacturing	136	Reconstituted wood product manufacturing
84	Fluid milk manufacturing	137	Wood windows and door manufacturing
85	Creamery butter manufacturing	138	Cut stock, resawing lumber, and planing
86	Ice cream and frozen dessert manufacturing	139	Other millwork, including flooring
88	Poultry processing	140	Wood container and pallet manufacturing
89	Animal, except poultry, slaughtering	143	All other miscellaneous wood product manufacturing
90	Meat processed from carcasses	145	Paper mills
91	Rendering and meat byproduct processing	146	Paperboard mills
97	Roasted nuts and peanut butter manufacturing		
98	Other snack food manufacturing		
103	All other food manufacturing		
107	Wineries		

APPENDICES

Sector	IMPLAN Description	Sector	IMPLAN Description
Agriculture Extended Processing		Forestry Extended Processing	
63	Dog and cat food manufacturing	141	Manufactured home (mobile home) manufacturing
64	Other animal food manufacturing	142	Prefabricated wood building manufacturing
73	Sugar cane mills and refining	147	Paperboard container manufacturing
74	Nonchocolate confectionery manufacturing	148	Paper bag and coated and treated paper manufacturing
75	Chocolate and confectionery manufacturing from cacao beans	149	Stationery product manufacturing
76	Confectionery manufacturing from purchased chocolate	150	Sanitary paper product manufacturing
77	Frozen fruits, juices and vegetables manufacturing	151	All other converted paper product manufacturing
78	Frozen specialties manufacturing	365	Wood kitchen cabinets and countertops
79	Canned fruits and vegetables manufacturing	366	Upholstered household furniture manufacturing
80	Canned specialties	367	Nonupholstered wood household furniture manufacturing
81	Dehydrated food products manufacturing	369	Institutional furniture manufacturing
92	Seafood product preparation and packaging	370	Wood office furniture manufacturing
93	Bread and bakery product, except frozen, manufacturing	371	Custom architectural woodwork and millwork
87	Frozen cakes and other pastries manufacturing	373	Showcase, partition, shelving, and locker manufacturing
94	Cookie and cracker manufacturing		
95	Dry pasta, mixes, and dough manufacturing		
96	Tortilla manufacturing		
99	Coffee and tea manufacturing		
100	Flavoring syrup and concentrate manufacturing		
101	Mayonnaise, dressing, and sauce manufacturing		
102	Spice and extract manufacturing		
104	Bottled and canned soft drinks & water		
105	Manufactured ice		
106	Breweries		

APPENDICES

Sector	IMPLAN Description	Sector	IMPLAN Description
108	Distilleries		
109	Tobacco product manufacturing		
110	Fiber, yarn, and thread mills		
111	Broadwoven fabric mills		
112	Narrow fabric mills and schiffli machine embroidery		
115	Textile and fabric finishing mills		
123	Other apparel knitting mills		
124	Cut and sew apparel contractors		
125	Men's and boys' cut and sew apparel manufacturing		
126	Women's and girls' cut and sew apparel manufacturing		
127	Other cut and sew apparel manufacturing		
128	Apparel accessories and other apparel manufacturing		
129	Leather and hide tanning and finishing		
130	Footwear manufacturing		
131	Other leather and allied product manufacturing		

Sector	IMPLAN Description	Sector	IMPLAN Description
Agriculture Distribution		Forestry Distribution	
400	Wholesale - Other nondurable goods merchant wholesalers	47	Electric power generation - Biomass
	NAICS 4245 Farm product raw material wholesalers	396	Wholesale - Other durable goods merchant wholesalers
422	Warehousing and storage		NAICS 42331 Lumber, plywood, millwork, & wood panel wholesalers
	NAICS 49312 Refrigerated warehousing & storage	422	Warehousing and storage
	NAICS 49313 Farm product warehousing & storage		NAICS 49319 Other warehousing & storage
477	Landscape and horticultural services		

Table B.1 Virginia Agricultural Cash Receipts by IMPLAN Sector, 2013-2021 (\$ Thousands)

Year	(1) Oilseeds	(2) Grains	(3) Vegetables & melons	(4) Fruits	(6) Greenhouse, nursery, & floriculture	(7) Tobacco	(8) Cotton	(10) All other crops	(11) Beef cattle	(12) Dairy cattle & milk	(13) Poultry & eggs	(14) Other animals	Total
2013	323,370	334,006	74,463	53,421	300,400	111,330	71,831	150,958	557,190	396,857	1,189,526	273,674	3,837,026
2014	259,311	338,029	62,415	56,443	299,409	116,936	81,237	129,610	703,341	478,170	1,360,806	281,057	4,166,764
2015	192,670	246,837	70,426	59,239	327,997	115,684	63,190	134,168	652,976	342,022	1,290,474	269,077	3,764,760
2016	212,080	234,927	59,450	57,039	360,946	110,433	41,581	136,020	415,628	308,340	1,218,830	264,086	3,419,360
2017	208,519	215,089	71,102	73,395	402,821	109,030	51,176	139,625	468,988	334,844	1,264,101	265,733	3,604,423
2018	205,710	227,124	61,249	37,256	452,825	97,456	68,240	141,193	415,733	284,375	1,268,792	286,073	3,546,026
2019	182,671	222,921	16,427	34,566	461,355	71,234	72,473	130,625	342,570	290,080	1,193,502	306,275	3,324,699
2020	254,843	261,576	14,990	35,631	519,406	53,362	71,703	139,102	375,228	297,667	1,024,376	299,620	3,347,504
2021	277,937	319,894	14,816	42,169	466,400	63,335	63,295	143,808	381,428	297,840	1,396,707	316,881	3,784,510

Source: U. S. Department of Agriculture, Economic Research Service (2022)

ENDNOTES

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.

² There have been multiple changes in the IMPLAN sectoral scheme since that study. The model moved from a 440-sector scheme introduced in 2009 to a 536-sector scheme in 2014 and to a 446-sector scheme in 2018. Older agriculture and forestry-related sectors were re-aligned with the new sectoral scheme.

³ A fuller discussion of the methodology is provided in Rephann (2013). The underlying theoretical and practical issues underpinning the selection of those industries are provided in the original study (Rephann 2008).

⁴ A social accounting Matrix ("SAM") forms the underlying accounting system for the analysis. It shows 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.

⁵ Two adjustments were made to avoid double counting of direct and indirect impacts. 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 forest 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 forest industry sectors included in the model. These procedures are recommended in recent peer recommendations studies of agriculture and forestry contribution analyses (Henderson et al. 2017; English, Popp, and Miller 2016).

⁶ This employment data source is different from that used in previous agriculture and forestry economic impact studies. Those studies relied on Virginia Employment Commission (VEC) Quarterly Census of Employment and Wages (QCEW) employment tallies by IMPLAN sector for the second quarter of the respective study years. Lightcast™ (formerly Emsi/Burning Glass) data was used in lieu of VEC QCEW data because it is annual data not affected by 2nd quarter seasonal blips. Moreover, Lightcast™ adjusts QCEW data to capture proprietors and self-employed individuals who are not included in the VEC employment data which is a census of jobs covered by unemployment insurance. Proprietors and the self-employed are an important component of employment in several agriculture and forest industries, including farming, logging, agricultural services, and landscape and horticultural services. Thus, previous studies that relied on QCEW employment data undercounted actual direct employment in agriculture and forest industries. A fuller discussion of employment data series coverage for agriculture and forest industries can be found in Rephann (2022).

⁷ Appendix B.1 shows agricultural commodity sales trend data including the 2021 values used in the IMPLAN analysis for IMPLAN sectors 1-14.

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