The Economic Impacts of Agriculture and Forest Industries in Virginia

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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 is an update of a 2008 study, and applies the same basic methodology. The study relies on both published and unpublished data from multiple sources. It makes use of input-output analysis to identify agriculture and forestry backward and forward linkages to other industries and institutions. It also provides separate estimates of agriculture and forestry-related economic impacts, impacts by industry groupings arranged by level of dependency on raw materials originating within the state, impacts by locality, and the impacts of international exports. These estimates convey a much more complete picture of the importance of agricultural and forest natural resources to the economy of the commonwealth than gauging farm and forest growing and harvesting activities alone.

The author would like to thank many people for providing information, advice, and feedback used in completing this study. Deputy Secretary of Agriculture and Forestry Travis Hill helped to coordinate input from industry and agency staff members. Virginia Department of Agriculture and Consumer Services (VDACS) staff, Virginia Department of Forestry staff, and agricultural and forestry industry representatives provided helpful advice in revising the list of agricultural and forestry-related industries and shared their perspectives on industry trends, challenges, and opportunities. These participants included Katie Frazier of the Virginia Agribusiness Council, Martha Moore of the Virginia Farm Bureau, Dick Atkinson of the Virginia Soybean Association, Paul Howe of the Virginia Forestry Association, Randy Bush of the Virginia Forest Products Association, Buck Kline and Charles Becker of the Department of Forestry, and Kent Lewis and Perida Giles of VDACS.

Special thanks go to Mr. Charles Green, Director of Marketing and Development at VDACS, Charles Becker of the Virginia Department of Forestry, and David Tysinger of the Virginia Employment Commission for assistance in compiling data that were used in this study. Steve Kulp and Dave Borszich assisted with 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 forestry-related industries in Virginia was almost $70 billion in total industry output in 2011, the base year for this study. The total employment impact was approximately 414,700 employees. The total value-added impact was $34.6 billion, which made up 8.1 percent of state gross domestic product.

● Every job created in agriculture and forestry-related industries results in another 1.6 jobs in the Virginia economy. Every dollar generated in value-added results in another $1.63 value-added in the Virginia economy.

● The impacts of agriculture and forestry-related industries are felt in other sectors of the economy. The largest effects are in the directly affected agriculture, forestry, and hunting industries and manufacturing industries. However, agriculture and forestry stimulate large public and private services responses 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.

● Results indicate that every single Virginia locality is affected by agriculture and forestry-related industries to some degree. Sixty-eight localities have total employment impacts in excess of 1,000 jobs. The largest and more diffuse economic impacts were generally found for agriculture-related activities. Seven localities topped 5,000 jobs in economic impact including counties in the Shenandoah Valley, Northern Virginia, Southside, and Hampton Roads regions. The largest forestry-related activity impacts tend to be somewhat more geographically concentrated in areas with pulp and paper mills or furniture manufacturing plants, including the Southside region, Alleghany County and Covington City, and the Richmond area. Sixteen localities have total employment impacts of more than 1,000 jobs. These localities include seven with employment impacts in excess of 2,000 jobs.

● The total economic impact of agriculture and forestry-related industry exports is approximately 26,000 jobs, $1.8 billion in value-added, and nearly $4 billion in total output. This economic impact does not include the effect of related port activity. One in eight Virginia farm jobs can be attributed to these international exports.

● Results drawn from other Virginia studies suggest Virginia agri-tourism and forest recreation are important components of the state's tourism economic impact, accounting for millions of visitors and several billions of dollars in economic impact each year.

● Agriculture and forestry landscapes have significant societal and ecological benefits. Forests provide benefits in the form of improved air quality, wildlife habitat and biodiversity, flood mitigation, and improved water quality. Rural landscapes provide scenic amenities that improve the quality of life. The value of air and water environmental services provided by farmland and forestland likely amounts to several billions of dollars each year.

Agriculture

● The total impact of agriculture-related industries was over $52 billion in total industry output, approximately 310,900 jobs, and $25.9 billion in value-added.

Forestry

● The forestry sector had a total impact of over $17 billion in total industry output, approximately 103,800 jobs, and $8.8 billion in value-added.

EXECUTIVE SUMMARY

Virginia's agriculture and forest industries have historically been among the commonwealth's largest industries and continue to play a significant role in the Virginia economy. The impact of these sectors is felt far beyond the farms and forest plantations and tracts where the commodities are grown and harvested. Value-added industries such as food processing and the forest products industries also rely on Virginia agricultural commodities and timber as inputs to production. The growing/harvesting and processing sectors purchase production inputs, labor, and other value-added services from Virginia-based businesses, households, and institutions. These purchases cause a ripple effect in the Virginia economy. Thus, the health and vitality of agriculture and forestry affects every industry and area in Virginia to some degree.

The Virginia farm economy has experienced growth in recent years. Farm sales have jumped over the last decade, increasing 28 percent from 2006 to 2011 alone. This growth has occurred because of increases in agricultural commodity demand boosted in part by increasing international demand and expanding use of crops in ethanol production. Consequently, the loss of farmland and farm employment has either slowed or abated in recent years. Virginia farm employment actually increased for two consecutive years, from 2008 to 2010, for the first time in decades.

Virginia has a diverse agricultural sector. The composition of output continues to change in response to market conditions. Vegetable and hog production decreased from 2006 to 2011 while other commodities experienced growth. Poultry, soybeans, corn, and wheat production were among the largest gainers. Greenhouse and nursery product sales have continued to experience modest growth despite recent turmoil in housing markets and sluggish growth in the overall economy. Both peanuts and tobacco, which declined significantly over the previous decade as many farmers elected to sell their quota contracts and exit the industry, have since stabilized.

Farm production is spread throughout the commonwealth. But, it exhibits distinctive geographical production patterns by agricultural commodity. Generally speaking, crop farming is more prevalent in the eastern half of the state where growing conditions are better, while livestock and poultry farming is more common in the west where steeper slopes are less suitable for intensive cultivation. Cotton farming is concentrated in the southeastern portion of the state. Tobacco farming is found in Southside and the Southwest. Soybean and grain farming is more common in the eastern part of the state, particularly the southeast, Middle Peninsula, Northern Neck, and Eastern Shore. Poultry production is heavily concentrated in the Shenandoah Valley. Cattle and dairy farming occurs more often in the Shenandoah Valley and Southwest.

Virginia's forests are similarly diverse and productive. The state's forests are dominated by hardwood stands, though softwoods are more common removal species in the southeast and coastal regions. Timber growth continues to outpace removals, particularly for hardwood species. In recent years, decreased harvests attributable to declining domestic timber demand have contributed to this situation.

Virginia's agriculture and forest product value-added sectors have had more difficulty than the production sectors during the last five years. The forest products industry has been particularly hard hit, losing over 19 thousand jobs from 2006 to 2011. The severe recession during 2007-2009 and housing market turmoil caused rapid contraction in demand for wood products used in housing construction, furniture and related products. At the same time, international competition has continued to erode the capacity of hardwood furniture manufacturers, located mainly in Southside. The pulp and paper industry has also been affected by the general state of the economy but also faces reduced demand for its products because of the growth in electronic media. The result of the confluence of these forces is a smaller forest products industry that is much leaner and more efficient. It is expected to see renewed growth in the next decade as housing construction gradually recovers, some export markets expand, the cost advantages of relocating production abroad narrows, and domestic demand for woody biomass power generation, wood pellets, fluff pulp, and other products grow.

The agriculture industry is relatively insulated from many of the economic forces shaping forest product industries. Virginia's farms have experienced significant growth in sales in response to buoyant demand for field crops throughout the recession. Moreover, consumer nondurable purchases such as processed food products typically decrease less during recessions than nondurable purchases such as furniture. The main factors that have reduced employment in the industry are continued factory productivity improvements and rapid reductions in the size of isolated segments of the industry. Tobacco manufacturing employment continues to decline because of changing consumer attitudes toward the health risks of cigarette smoking, increasing tobacco product excise taxes, and spreading regulations that limit smoking. The textiles and apparel industries have continued to shrink in response to international competitive pressures. Offsetting these declines to a limited extent are growing specialty product industries that cater to consumer tastes for fresh and locally made products such as wineries and fresh-cut food manufacturing.

Although the agriculture and forestry sectors have seen significant changes in recent years, they continue to play an important role in the commonwealth economy. The purpose of this study is to gauge the magnitude of that economic contribution or "economic impact." In doing that, this study adopts the methodology used in a previous economic impact study, *The Economic Impact of Agriculture and Forestry on the Commonwealth of Virginia*, conducted in 2008. It defines the industry in basically the same way as before. Agriculture and forestry-related industries are aggregated into four different components as before: production, "core" processing, "extended" processing, and distribution, reflecting the different phase of the value chain and degree of dependency on Virginia's agriculture and forestry 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 that are unlikely to exist within the state if commodity production did not occur in the state. "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 affected by factors such as consumer market proximity or labor availability rather than distance to agricultural commodity or timber inputs.

The economic impact measurement tool used, input-output analysis, is also the same as the previous study. Input-output analysis provides a way to estimate the contribution of industry sales and employment on regional economic output, income, and employment. It is based on a transactions table that shows flows of goods and services among industries, households, and government. Economic multipliers are derived from these tables. These multipliers allow one to measure the total impact of changes in agricultural and forestry-related activity on the state economy. The total impact of this 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. For example, the sales of agricultural and forestry-related industries located in Virginia would count as the direct effect. 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. These businesses spend a portion of their sales revenues on their 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" or "induced impact") 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 and material 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. The sum of these various types of spending are referred to as multiplier effects because the total effect is a multiple of the initial "direct" effect due to the fact that it will include the sum of direct, indirect, and induced impacts.

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: production, core processing, extended processing, and distribution. Economic impact results attributable to agricultural support payments to Virginia's farmers from the federal government are presented. The study also estimates the statewide economic impact of Virginia's agricultural and forestry-related international exports. Lastly, the study furnishes economic impact estimates for each of Virginia's localities.

In 2011, the direct effect of Virginia agriculture and forest related industries accounted for $38 billion in total output, approximately 160,400 employees, and over $13 billion in value-added. Agriculture production is the largest component in terms of employment at 35 percent of total direct employment. However, agriculture processing extended accounts for over 40 percent of output and value-added.

The total economic impact (including direct, indirect, and induced effects) of agriculture and forestry-related industries was nearly $70 billion in total industry output or sales. The value-added impact was $34.6 billion dollars, which constitutes approximately 8.1 percent of Virginia gross domestic product (GDP). The total employment impact is approximately 414,700 employees.

The impacts of agriculture and forestry were felt in every sector of the economy. The largest effects were in the manufacturing and agriculture, forestry, fishing, and hunting industries where direct effects were dominant. However, agriculture and forestry stimulated trade, services, government and other sectors as well through the effects of industry purchases, household, and other institutional 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 approximately 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 6 percent of Virginia's GDP. Forestry-related industry represents 2 percent.

Looking at the value-added components, production industry impacts make up 21 percent of the total employment impact but a considerably smaller share, 10 percent, of value-added. This reflects the presence of many part-time farmers and seasonal employees in the sector. Core processing makes up 28 percent of employment and value-added. Extended processing is the largest impact category, constituting 39 percent of employment and 52 percent of value-added. Distribution and power generation activities account for 12 percent of employment and 9 percent of value-added. Government payments account for less than 1 percent of each.

Results for Virginia's localities show that every single Virginia locality is affected by agriculture and forestry-related industry to some degree. Sixty-eight localities have total employment impacts of more than 1,000 jobs. The largest impacts were found for agriculture-related activities with seven localities showing employment impacts in excess of 5,000 jobs. The largest clusters of employment impact were located in the Shenandoah Valley, Northern Virginia, the Richmond City area, Hampton Roads, and the Eastern Shore. The largest forestry-related impacts tend to be somewhat more geographically concentrated in areas with pulp and paper mills or furniture manufacturing plants. Sixteen counties have total employment impacts of more than 1,000 jobs. They are clustered in the Southside region, Alleghany County/Covington City, and the Richmond area.

International exports are a modest driver of agriculture and forestry-related industry economic impacts. The total impacts of agriculture and forestry-related industry exports are nearly $4 billion in total output, approximately 26,000 jobs, and $1.8 billion in value-added. Therefore, about 6 percent of the total output and employment impact and 5 percent of the value-added impact can be attributed to international exports. Agriculture-related industries account for two-thirds of the employment impact and 56 percent of the total value-added impact. The largest single industry component in terms of employment impact is agriculture production, which accounts for approximately 7,200 jobs. The

largest single value-added component is forestry core processing with an impact of $500 million. The total employment impact of agriculture and forest-related exports on the farming sector is 7,051 jobs. Therefore, one in eight Virginia farm jobs is dependent on these international exports.

Several facets of the agriculture and forestry industries were not captured in the economic impacts presented here. The study did not capture activities connected to corporate and regional offices, research and development laboratories, and logistical services operations of agribusiness. The Richmond area alone is home to several corporate offices in the agribusiness sector, including Fortune 500 companies Altria and Mead-Westvaco that employ thousands of workers in corporate administrative, research, and logistical areas.

Virginia farmers are deriving increasing amounts of income from farm related activities such as value-added products, energy production, and on-farm recreation. This farm related income would not generally be included in the impact estimates reported here. This study also did not compute estimates of agriculture and forestry's tourism and recreation's impact, including those economic impacts that stem from consumer spending outside of farm and park venues such as hotels, restaurants and retail shops. These activities include such things as freshwater fishing, hunting, hiking and backpacking, camping, wildlife watching, equine events and horseback riding, wineries and other agri-tourism, and agricultural festivals. Studies reviewed here that look at several of these activities suggest that visitors can be counted in the millions and economic impacts run in the billions of dollars. Therefore, the commonwealth's agricultural and forest resources are important assets for Virginia's tourism industry.

Virginia's agriculture and forested landscapes also provide important environmental services and other social economic benefits to the commonwealth. These benefits include improved water quality and flood control, air quality, conservation of wildlife habitat, containment of urban sprawl, preservation of scenic beauty, and maintenance of a sense of place. An attempt to quantify the value of water and air quality environmental services using the value transfer approach suggests that the Commonwealth receives approximately $157 million in value each year from agriculture and $6.385 billion in value from forestry in these ecological services alone.

INTRODUCTION

Virginia's agriculture and forestry industries have historically been among the commonwealth's largest industries and continue to play a significant role in the Virginia economy. The impact of these sectors is felt far beyond the farms and forest plantations and tracts with which they are traditionally identified and where the commodities are grown and harvested. Value-added industries such as food processing and the forest products industries also rely on Virginia agricultural commodities and timber as inputs to production. Both the production and processing sectors purchase inputs, labor, and value-added services from Virginia-based businesses, households, and other economic agents. These purchases cause a ripple effect in the Virginia economy. Thus, the health and vitality of Virginia agriculture and forestry affects every industry and locality in the state to some degree.

This study by the Center for Economic and Policy Studies, of the Weldon Cooper Center for Public Service at the University of Virginia was conducted for the Office of the Secretary of Agriculture and Forestry for the Commonwealth of Virginia. It is an update of a 2008 study conducted by the Center entitled *The Economic Impact of Agriculture and Forestry on the Commonwealth of Virginia* (Rephann 2008). It uses the same methodology as the previous study, including a nearly identical industry definition and the tool of input-output analysis to estimate the contribution of the agriculture and forestry to Virginia's economy. Agriculture and forestry-related industries are aggregated into four different components: production, "core" processing, "extended" processing, and distribution, reflecting the different phases of the value chain and degree of dependency on Virginia's agriculture and forestry resources.

This study has also been extended in several ways. In addition to statewide economic impact estimates, the study furnishes agriculture and forestry-related industry economic impact estimates for Virginia's localities. The study also estimates the statewide economic impact of Virginia's agricultural and forestry-related international exports. Finally, drawing from secondary data sources, the study attempts to quantify when possible other economic contributions of agriculture and forestry to Virginia, including agri-tourism and forest recreation impacts and beneficial environmental effects.

The study is divided into five sections. The first section examines characteristics of the agriculture and forestry production and processing sectors in Virginia. It also examines economic and industry trends likely to affect their size and resilience in the future. The second section describes the methods and data used in the study. The section includes an explanation of input-output analysis, a description of the computer model (IMPLAN) used in the study as well as an overview of the industry scope and data sources used. The fourth section presents the results. Impact estimates are provided in aggregate, by component, by locality, and for international exports. The fifth section describes other economic impacts and social benefits of agriculture and forestry in Virginia that are not represented in the economic impact analysis. The study ends with a summary and conclusion.

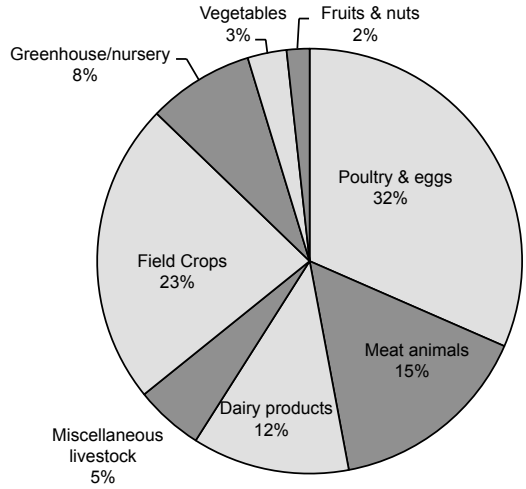
SECTION 1
VIRGINIA'S AGRICULTURE AND FORESTRY INDUSTRIES

Despite challenges to individual industries in the form of shifting international trade patterns, changing consumer tastes and declining demand caused by the recent deep recession and housing market turmoil, Virginia's agriculture and forestry industries continue to play an important part in the Virginia economy. This role is determined not only by the health and vitality of growing and harvesting activities but also primary processing and secondary manufacturing and other industries dependent on agricultural and forestry raw material inputs. This section examines in greater details the characteristics of Virginia's agricultural and forestry economic base, changes that have occurred over the last several years, and forces that are likely to shape the industries in the future.

Agriculture

Virginia has a diverse agriculture sector. Two-thirds of agricultural cash receipts are derived from livestock, poultry, and dairy products and the other third from crops. It is also a top producer for several agricultural commodities. It ranks fourth for tobacco, fifth for tomatoes, sixth for turkeys and apples, and seventh for grapes. Poultry and eggs accounted for 32 percent of total cash receipts in 2011. Field crops made up 23 percent (see **Figure 1.1**)

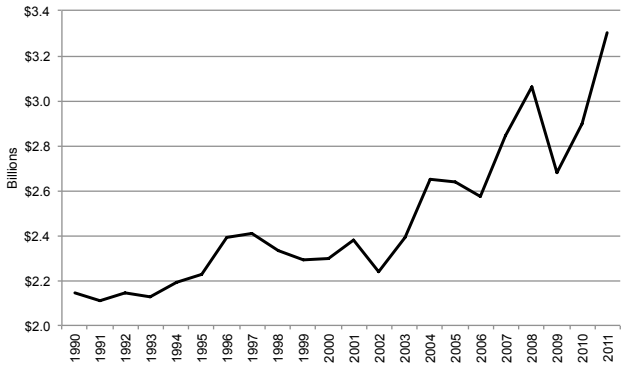
Figure 1.1 Cash Receipts by Commodity, Virginia, 2011



Source: U.S. Department of Agriculture, Economic Research Service (2012a)

Virginia's agricultural cash receipts have increased significantly over the last decade (see **Figure 1.2**). The pace quickened from 2006 to 2011, growing by 28 percent. This growth has occurred because of increases in agricultural commodity demand boosted in part by increasing international demand and increasing use of field crops in biofuel production. The steady rate of farmland and farm employment loss reported in the last agriculture and forestry impact study (Rephann 2008) has slowed or abated. Virginia farm employment actually increased from 2008 to 2010 for the first two-year period in decades (see **Figure 1.3**).

Figure 1.2 Virginia Agricultural Cash Receipts, 1990-2011

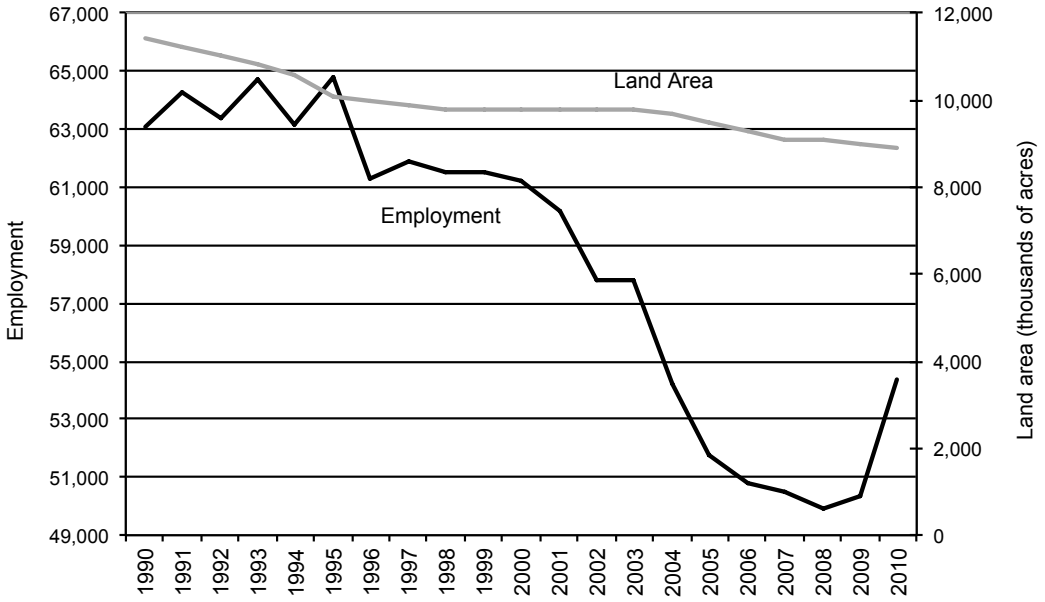


Source: U.S. Department of Agriculture, Economic Research Service (2012a)

The composition of Virginia agriculture production has also shifted slightly in the last five years. This is illustrated for major commodities in **Figure 1.4**, which shows the degree of Virginia commodity specialization measured by a location quotient[1] of Virginia

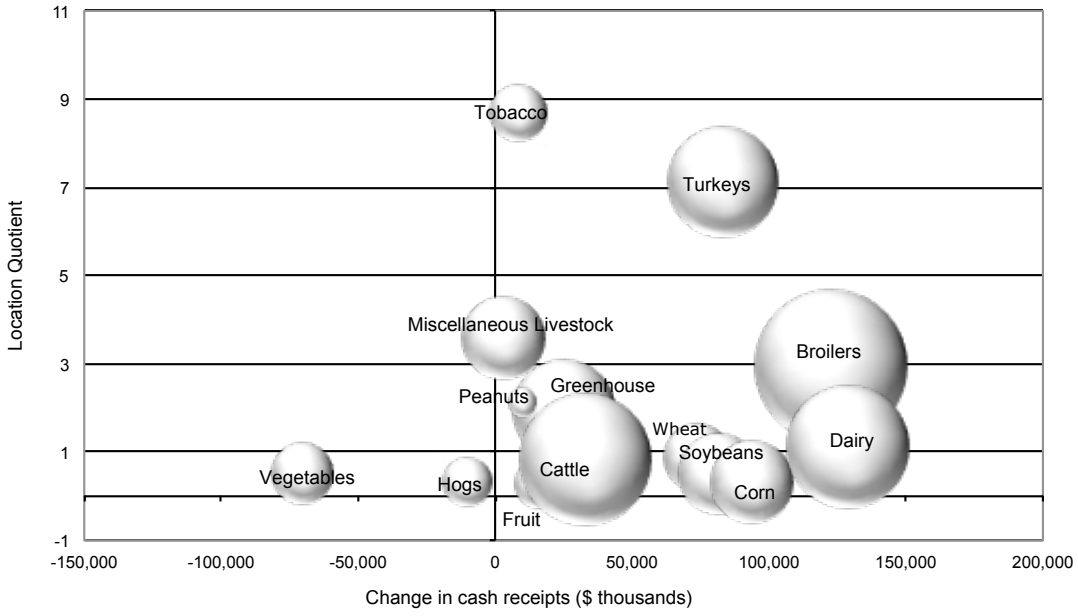
1 A location quotient provides a measure of regional (e.g., county, state) concentration in a given industry or commodity relative to a larger region of which it is part (e.g., nation). It is simply the share of a region's activity in an industry or commodity divided by the share of the larger region's same activity in the industry or commodity. A location quotient greater than one indicates a relative concentration of the activity.

Figure 1.3 Virginia Farm Employment and Land Area, 1990-2010



Source: U.S. Department of Commerce, Bureau of Economic Analysis (2012a) and U. S. Department of Agriculture, Economic Research Service (2012a)

Figure 1.4 Change in Virginia Farm Commodity Sales 2006-2011 by Size and State Specialization



Source: U. S. Department of Agriculture, Economic Research Service (2012a)

versus national sales on the vertical axis, change in state nominal commodity sales on the horizontal axis, and size of state commodity sector sales scaled according to bubble size. Several commodities have experienced substantial growth. Poultry production, including boilers and turkeys, was among the largest gainers during the most recent period (2006-2011), building on previous strong growth and state specialization. Soybeans, corn, and cotton sales have grown in tandem with the national commodity boom. Dairy production has rebounded after declining during the previous decade. Greenhouse and nursery product sales have continued to experience modest growth despite recent turmoil in housing construction and slow growth in the overall economy. Both peanuts and tobacco, which shrank over the previous decade as farmers sold their quotas and exited the industry, have since stabilized. Hogs and vegetables were the only two major commodities to experience a drop in cash receipts over the period.

Virginia farmers are much less dependent on federal farm program subsidies than those in other states. Yet the size of government payments increased during the late 1990s until 2006 (see **Figure 1.5**). Since then these payments have ebbed with the expiration of peanut quota buyouts and a gradual phasing out of tobacco quota buyouts to be complete by 2014. Direct payments and countercyclical payments were also higher during this earlier period. Counter-cyclical payments have declined with the rebound in field crop prices.

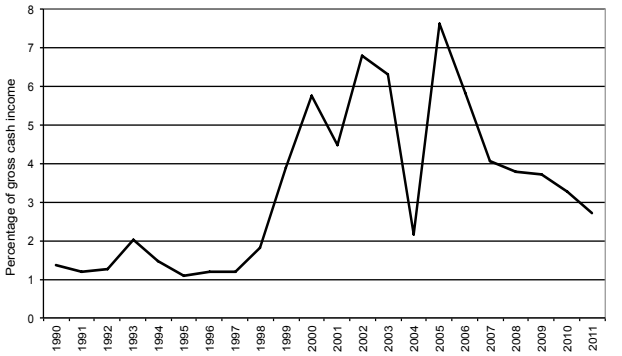
Farm production can be found throughout the commonwealth but significantly higher concentrations of employment are found in certain regions. In 2010, the top five farm employment localities were Rockingham County and Harrisonburg City (2,359), Augusta County and Waynesboro and Staunton cities (1,979), Washington County and Bristol City (1,778), Loudoun County (1,764), and Pittsylvania County and Danville City (1,620). Eleven other localities had more than one thousand employees in the farm sector. Farm employment as a share of total employment (see **Figure 1.6**) was generally greater in the southwestern and southern parts of the state. As one might expect, there are also strong rural-urban differences. Sixty-eight percent of farm employment is located in nonmetropolitan areas and makes up 1.6 percent of total employment there versus 0.7 percent of total employment in metropolitan areas.

Virginia also shows strong regional specialization by agricultural commodity. Generally speaking, crop farming is more prevalent in the eastern half of the state where growing conditions are better and the terrain is flatter while livestock and poultry farming is more common in the west where steeper slopes are less suitable for intensive cultivation (see **Figures A.1-A12** in **Appendix A**). Cotton farming occurs in the southeastern portion of the state. Tobacco farming is found in the Southside and the Southwest. Soybean and grain farming is more common in the eastern part of the state, particularly the southeast, Middle Peninsula, Northern Neck, and Eastern Shore. Poultry production is heavily concentrated in the Shenandoah Valley. The Shenandoah Valley and Southwest have relatively more cattle and dairy farming.

Many different factors contribute to Virginia agricultural competitiveness, including a suitable climate for growing a variety of crops, a sufficient supply of available farmland with significant portions now protected by permanent agricultural easements, a central location among growing northeastern urban markets, close proximity to a major seaport, good transportation infrastructure, international demand for its agricultural products, state and federal regulatory and farm program policies, workforce availability and costs, and quality agricultural extension and agronomic research and development activities provided by its higher education institutions.

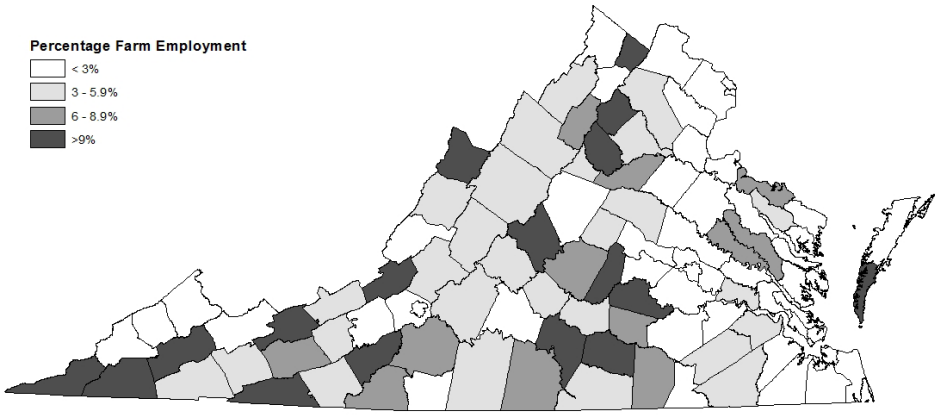
Virginia's farmers have benefited in recent years from increased international demand. An expanding middle

Figure 1.5 Government Payments as Percentage of Virginia Farm Gross Cash Income, 1990-2011



Source: U. S. Department of Agriculture, Economic Research Service (2012a)

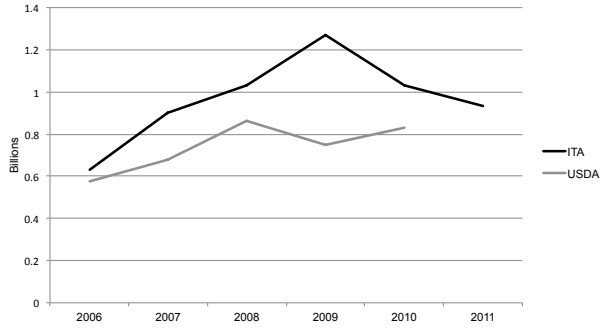
Figure 1.6 Farm Employment as Percentage of Total Employment by Locality, 2010



Source: U.S. Department of Commerce, Bureau of Economic Analysis (2012b)*
*NOTE: Total employment includes self-employed, wage and salary workers, civilian and military.

class in rapidly growing developing countries has contributed to growing demand for U.S. food and fiber exports. In addition, the state has boosted its export marketing efforts. Two alternative measures of state exports indicate that the state's agricultural exports have grown significantly (see **Figure 1.7**). The first measure (labeled ITA) is based on agricultural commodity export data from the International Trade Administration, which uses "origin of movement" reporting to identify which state was the starting point for export. The second measure (labeled USDA) uses state agricultural commodity and primary value-added product exports estimated by the U.S. Department of Agriculture's Economic Research Service on the basis of national industry export patterns.[2] The former measure indicates a 44 percent increase in agricultural commodity exports from 2006 to 2010 while the latter measure indicates a 63 percent increase in agriculture-related product exports over the same period.

Figure 1.7 Virginia Agricultural Exports, 2006-2011

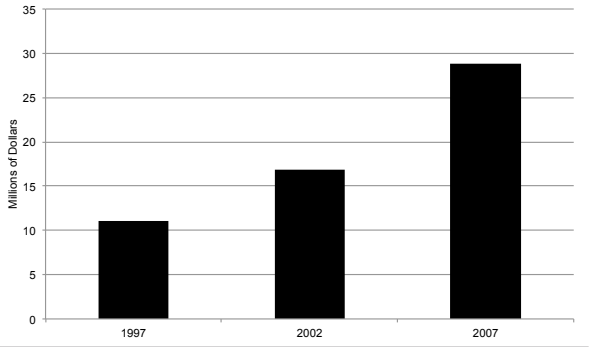


Source: U. S. Department of Agriculture, Economic Research Service (2012b); Virginia Department of Agriculture and Consumer Services based on Global Trade Information Services (GTIS) system data.

Domestic demand has also expanded for some commodities. Many consumers, increasingly concerned about the quality, healthiness and environmental impacts of their product choices, are demanding more fresh products that are locally and organically grown. This trend is reflected in increasing direct to consumer sales of Virginia farms. Although total direct sales are still a relatively modest share of total farm cash receipts at

2 Each of these export measures has certain limitations (U.S. Department of Agriculture, Economic Research Service 2012c). Exports defined by origin of movement sometimes reflect the locations of final consolidation points rather than point of production. Since Virginia contains a major port, it will tend to have many such consolidation hubs and exports from other states may be incorrectly identified as Virginia exports. The alternative method used by the Economic Research Service is to allocate exports by industry to states based the state's share of total national output in that industry. This measure may underestimate Virginia exports because closer proximity to a port should provide it competitive advantages for export because of lower transportation costs to international markets.

Figure 1.8. Direct Sales of Agricultural Products, Virginia, 1997-2007



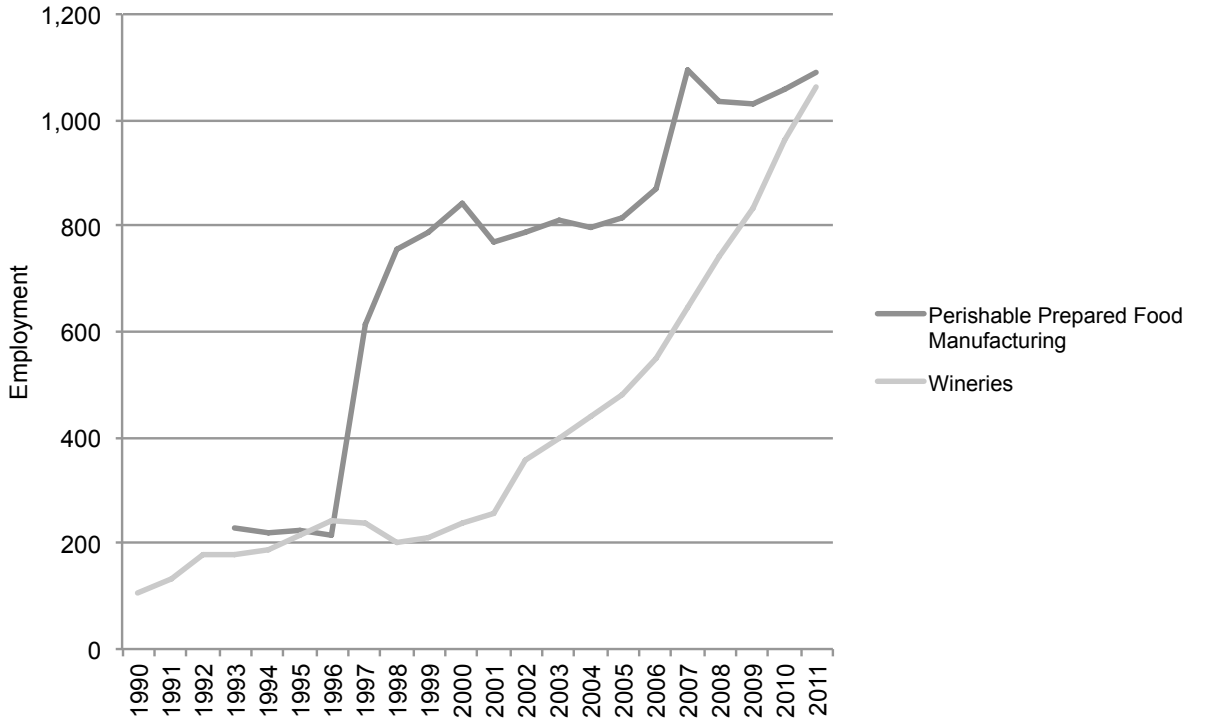
Source: U.S. Department of Agriculture, National Agricultural Statistics Service (2004, 2009)

roughly one percent according to the 2007 Census of Agriculture, they have grown at a rapid rate (see **Figure 1.8**). Moreover, the importance of local food markets is only partly reflected in direct sales data. Intermediated marketing channels (which includes grocery stores, restaurants, and other regional distributions and retailers) generate more sales of local products, but they are not surveyed by the Census of Agriculture (Low and Vogel 2011). Indications are that local foods continue to gain in popularity. The number of farmers markets rose from 118 in 2009 to 168 in 2011. Survey data from the Hampton Roads region shows a doubling of direct sales there between 2006 and 2010 (Rephann 2012).[3]

Changing consumer tastes have worked to the benefit of some of Virginia's agricultural manufacturing firms. For example, employment in fresh-packed food manufacturing and wineries has grown substantially in Virginia throughout an economically turbulent period (see **Figure 1.9**). Employment in the perishable prepared food manufacturing (e.g., pre-packaged salads, pre-cut/wrapped items, baby carrots, and fresh-cut fruit) has quintupled since 1997. The Virginia wine industry has experienced explosive growth with 193 wineries operating in 2010 compared to 129 wineries in 2005. The

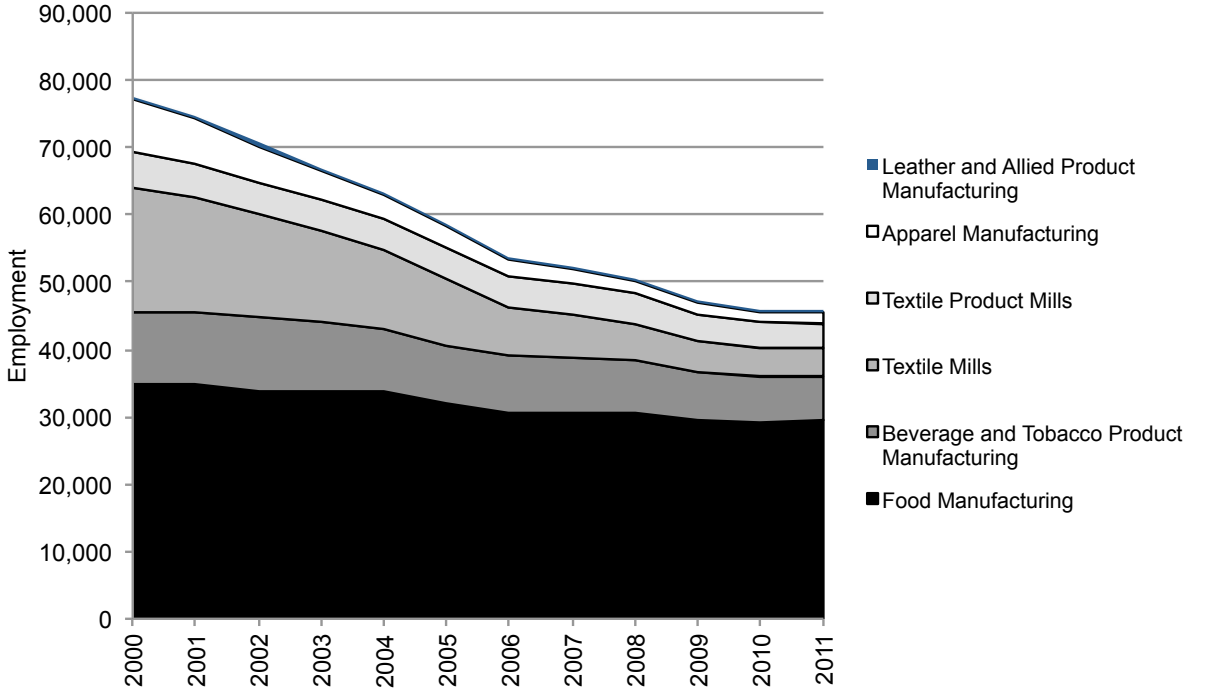
3 Virginia's local food market attractiveness is boosted by its proximity to major urban markets, favorable demographics and local food marketing initiatives such as the *Buy Fresh Buy Local* campaign (http://www.buylocalvirginia.org/) and *Virginia Grown* (http://www.vdacs.virginia.gov/vagrown/).

Figure 1.9 Employment Creation Agriculture-related Manufacturing Industries in Virginia



Source: Virginia Employment Commission, Quarterly Census of Employment and Wages

Figure 1.10 Virginia Agriculture-related Manufacturing Employment, 2000-2011



Source: Virginia Employment Commission, Quarterly Census of Employment and Wages

Virginia wine industry now employs over 1,000 workers directly and supports thousands of jobs indirectly through linkages with vineyards, tourism, and other industries (A Frank, Rimerman and Co. LLP, 2012).

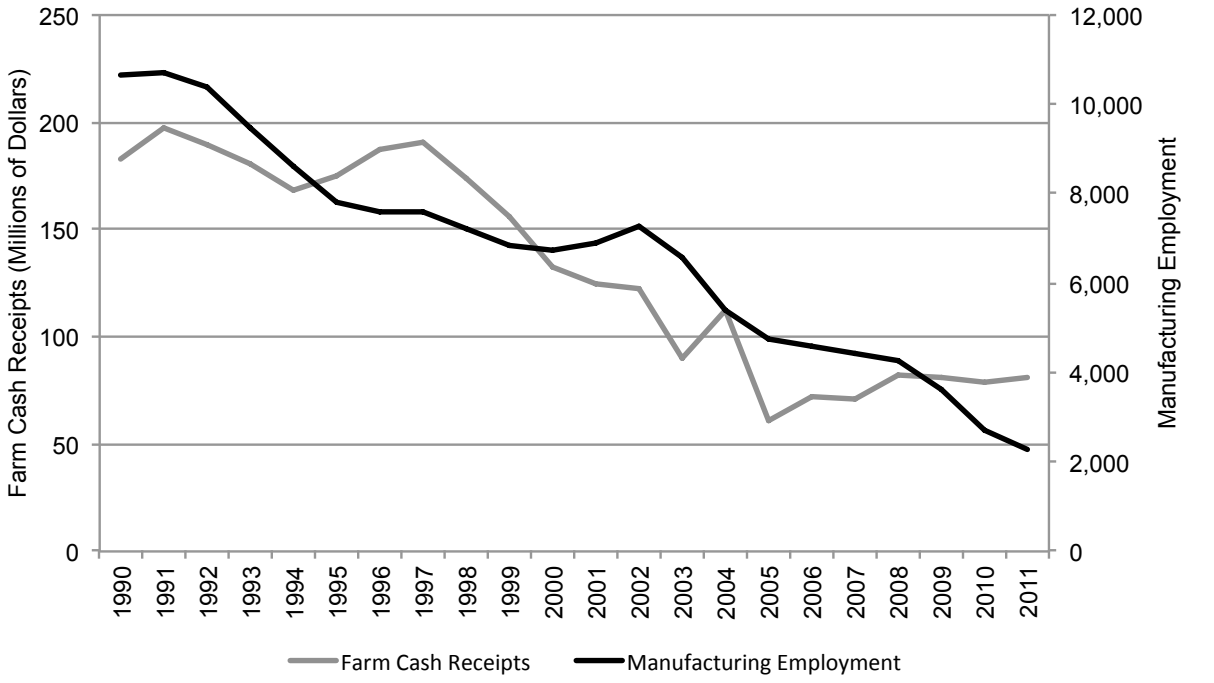
The experience of these two industries is somewhat atypical. Most other agriculture-related manufacturing industries have suffered employment losses (see **Figure 1.10**). Continual investment in manufacturing automation is one factor constraining employment growth. The recent deep recession and subsequent slow growth have also had a dampening effect on domestic consumer demand with some consumers limiting their purchases and trading down to less expensive food products.

Two historically important Virginia agriculture-related manufacturing industries, in particular, have borne the brunt of recent employment decreases: the tobacco product and textile and apparel industries. The reasons for their decline are different from many other agriculture-related manufacturing industries. The tobacco products manufacturing industry is declining nationwide because of rapidly decreasing consumer demand caused by changing consumer attitudes toward the health risks of cigarette smoking, increasing excise taxes, and spreading regulatory policies that restrict smoking. Product exports have also declined because of lower cost production locations abroad. As a result, Virginia has seen its tobacco product manufacturing employment shrink from nearly 11,000 in 1990 to fewer than an estimated 2,400 today, a downshift that roughly parallels slippage in tobacco farming (see **Figure 1.11**).[4] The loss of these high-paying jobs with close linkages to the state tobacco farming and distribution sectors has an outsized negative impact on the state economy.

The textiles and apparel industries have also experienced rapid employment losses. These industries principally located in the state to take advantage of low cost

4 These figures do not include employment in corporate headquarters, research and development activities, administrative services, and logistical operations of tobacco manufacturing firms located in the state such as Altria in Richmond. Employment in each of these activities is classified as a separate industry such as "management of companies and enterprises" and "research and development" by the North American Industrial Classification System.

Figure 1.11 Virginia Tobacco Farm Cash Receipts and Tobacco Manufacturing Employment, 1990-2011



Source: U.S. Department of Agriculture, Economic Research Service (2012a); Virginia Employment Commission; IMPLAN; and 2011 Extrapolation

labor in the early 20th century rather than to be close to cotton farming (Wheeler 1998). Employment in these sectors had been shrinking since the mid 1970s because of productivity improvements in the case of textiles and international competition for both textiles and apparel (Kestner and Lang n.d.). The gradual lifting of Multifiber Arrangement (MFA) quotas that ended in 2005, resulted in a further exodus of firms and employment from the industry (Meyer, MacDonald, and Foreman 2007; Duke University, Center on Globalization, Governance, and Competitiveness 2007).

The forces behind recent farm and agriculture-related manufacturing employment changes, including technology, productivity, consumer preferences, international trade, energy prices, and government policy, continue to shape the industry and will be felt for years to come. They are also affecting agricultural land use patterns, with more land being allocated to feed crops because of the surge in demand and away from competing crops and land conservation (Hoffman et al. 2007). At the same time, feed price increases are reducing margins for livestock and poultry farms and processors.

Livestock and poultry production provides an example of a sector undergoing profound value chain and locational restructuring with ramifications for producers and producing states. Hog, poultry, and cattle production are consolidating into increasingly larger farms with greater farm specialization in one stage of production to achieve economies of scale (McBride and Mathews 2011; MacDonald 2008; Key and McBride 2007; Miller and Blayney 2006). Substantial regional differences in the cost of production such as land prices, feed costs, and the costs of complying with environmental regulations have resulted in the shifting of some livestock production to certain sections of the country, for instance to the west for the dairy industry and to the midwest for hog production (Key and McBride 2007; Miller and Blayney 2006). Virginia has benefited from such locational

advantages in the past, giving rise to important industry clusters centered around hog production in the vicinity of Smithfield and poultry production in the Shenandoah Valley and Delmarva Peninsula.

Energy costs are affecting agribusiness in different ways. Biofuel production growth has increased feed crop prices with disparate effects on crop and livestock markets. Energy price increases have contributed to increased costs for farm inputs, including fuel, feed, and fertilizers (Westcott 2007). But, higher energy costs can sometimes benefit domestic producers. Higher energy costs for products exposed to international competition may improve domestic market share since it increases logistical and shipping costs for overseas competitors more than domestic suppliers. Virginia's close proximity to the Hampton Roads ports provides it a key transportation cost advantage over other U.S. production areas. In addition, rising energy prices may boost demand for natural fiber such as cotton by increasing the relative costs of synthetics.

On the consumer side, population characteristics and preferences will also influence the size and composition of Virginia agriculture. The national consumer market is increasingly fragmented. Many consumers are more health conscious and discriminating in their food choices, which translates into increased demand for fresh products and for vegetarian, nutritiously dense, low carbohydrate, low fat, gourmet, and high value-added specialty products. Some consumers are basing their purchases on social and environmental criteria such as corporate responsibility, adequate worker compensation, environmentally sustainable production practices, and humane treatment of livestock and poultry. Immigration, cultural diversity, and the popularity of recreational cooking have increased demand for new ethnic foods and spices, with many of these items being imported. The sluggish economy has also affected food purchases, with many thrifty consumers willing to trade down from name brand goods, choice cuts of meat, and fresh produce to less expensive options and bulk purchases to manage stagnant or shrinking household budgets. Virginia's close proximity to swelling Northeastern markets is a key advantage moving forward. Future population increases also present opportunities such as increased demand for locally grown food, horticulture/nursery products, and agri-tourism.

More so, perhaps, than other industries, the agriculture sector is sensitive to changes and uncertainty in government policy. Federal government policies are changing in response to the need to curtail large budget deficits, adhere to new international trade agreements, address public health concerns, alleviate environmental problems, and control unauthorized immigration.

Federal farm programs are an important element of government policy. Although less reliant on farm payments programs than other states, new congressional farm bills could have an impact on Virginia by eliminating direct payments to farmers and making changes to risk management programs. Older farm legislation is still affecting tobacco and peanut production. Federal quota systems for these crops were eliminated in the last decade with quota certificates purchased by the federal government. Peanut payments expired in 2006 and tobacco quota payments will end by 2014. These buyouts have aided the transition to a free market but resulted in the exit of some Virginia farmers from the industry. Without quota constraints, peanut and tobacco production has been free to expand in other southern states where growing conditions are often better (Dohlman, Foreman, and Da Pra 2009).

Tobacco production is likely to be further affected by a continued tightening of federal, state, and local regulations on tobacco consumption. The Family Smoking Prevention and Tobacco Control Act adopted in 2009 allows the U.S. Food and Drug Administration (FDA) to regulate the ingredients used to manufacture tobacco. The FDA is examining a possible ban on Menthol cigarettes. Dissolvable tobacco products are also drawing increased scrutiny. Meanwhile, tobacco excise taxes continue to climb. The federal government increased tobacco taxes by 61 cents per pack to fund expansion of the State Children's Health Insurance Program (SCHIP) in 2009. States continue to view cigarette taxes as an attractive means to close budget gaps, with 25 states increasing cigarette excise taxes from 2007 to 2011 (Orzechowski and Walker 2011).

Agriculture faces workforce challenges on several different fronts. The average age of Virginia farmers has been increasing. Farm succession planning becomes more important as baby boomers begin to retire in the

next decade. New farmers and workers also require greater levels of education and training as crop and animal biotechnologies, new animal breeding and feeding methods, digital technologies, and precision agriculture become more widespread. Farm laborers may also be increasingly hard to find. Federal and state immigration policies and economic-demographic changes in traditional sender countries such as Mexico are beginning to affect the availability of migrant labor in some states. Worker availability is a particularly pressing problem for labor-intensive farming such as fruits and vegetables, nursery products, and tobacco. According to recent national survey data, illegal immigrants make up over half of the hired workforce for crop agriculture (Calvin and Martin 2010). While the H-2A visa program is utilized by many farmers, some farmers are reluctant to use it because of administrative and compliance costs, while dairy and nursery farmers find the H-2A program unsatisfactory because it provides only for seasonal labor instead of year-round labor (Zahniser, et al. 2012).

Environmental issues related to urban sprawl, water quality, and air quality are likely to affect Virginia agriculture in the future. Continued population growth in Virginia's urban corridor (Northern Virginia, the Richmond Metropolitan Area, and Hampton Roads) is placing pressure on rural land and resulting in the conversion of farmland to urban and non-agricultural uses. Virginia's agricultural land shrunk by 882,000 acres from 1982 to 2007 but the rate of decrease has been lower than neighbors such as Maryland, North Carolina, and Tennessee that are facing similar urbanization pressures (Rephann 2010). Land conservation tools such as use value taxation, agricultural and forestal districts, purchase of development (PDR), and the Land Preservation Tax Credit program have played a role in slowing this rate of conversion. Approximately 3.73 million acres (or 14.8 percent of the commonwealth's entire land area) of open space, farms, and forests have been preserved by various government agencies and private organizations so far, and the state has the goal of preserving more than 300,000 additional acres by 2014.

Many Virginia farmers in the Chesapeake Bay Watershed region are faced too with costs and regulatory uncertainty associated with adopting Best Management Practices (BMP) to help alleviate nutrient and sediment pollution into the Chesapeake Bay. In 2011, the U.S. Environmental Protection Agency unveiled a new Total Maximum Daily Load (TMDL) for the entire Chesapeake Bay and a timeline in which the state will be required to achieve full implementation of pollution reduction practices by 2025. The state recently submitted its Watershed Implementation Plan (Phase I and II) outlining its approach, which includes staffing, funding, monitoring, tracking voluntary adoptions, and contingency plans.

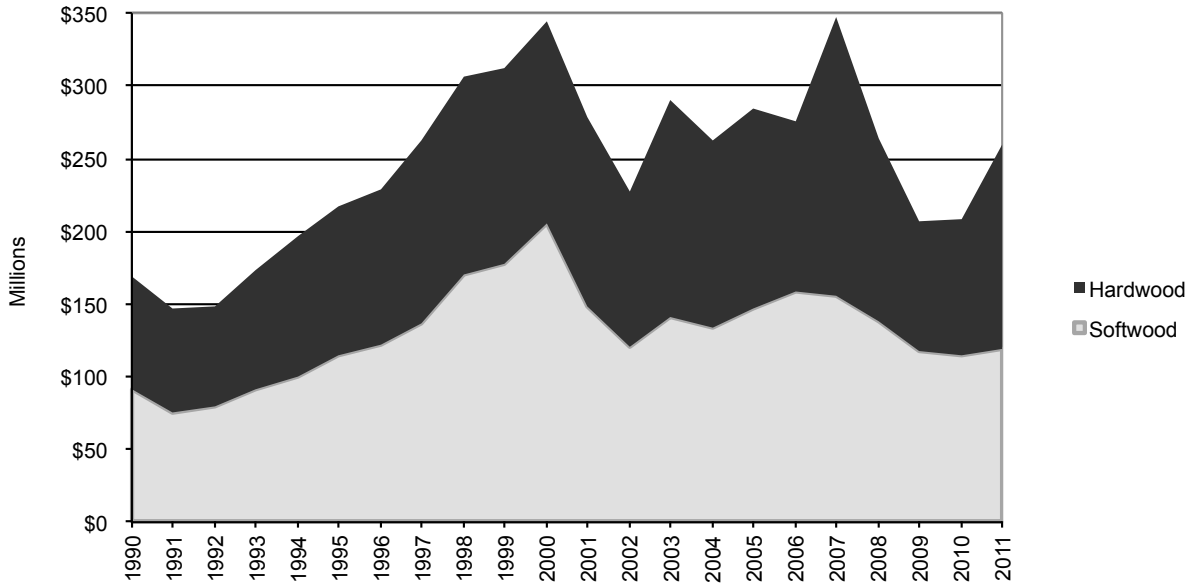
In coming decades, climate change may also have an impact on Virginia agriculture. Climate models forecast that average temperatures will increase in the future with effects on both rainfall and temperature. These changes could shift crop acreage and planting patterns and change farm production practices (Malcolm et al. 2012). It is unclear whether a national climate policy will be adopted in response to these possible impacts to limit carbon emissions. If so, a number of different tax, subsidy, emission credit trading, and regulatory policies under consideration could affect land use patterns and agriculture profitability.

Forestry

Virginia is a major producer of both softwood and hardwood timber. The state's forests are dominated by hardwood stands, though softwoods are more common removal species in the southeast and coastal regions. Over the past decade, harvested timber values have been roughly evenly divided between hardwoods and softwoods. Virginia produced approximately $257 million in stumpage (the sales value of standing timber) in 2010-11. This value dropped to a 15 year low in 2009 at the depth of the recent recession before recovering some of the lost ground in FY 2010 and FY 2011 (see **Figure 1.12**). Forest Inventory Analysis (FIA) data indicates that timber growth continues to outpace removals, particularly for hardwood species. Consequently, the 2010 forest inventory indicates that Virginia now has approximately 15.4 million acres of timberland, up from 15.3 million in 2006 (Brandeis et al. 2012).

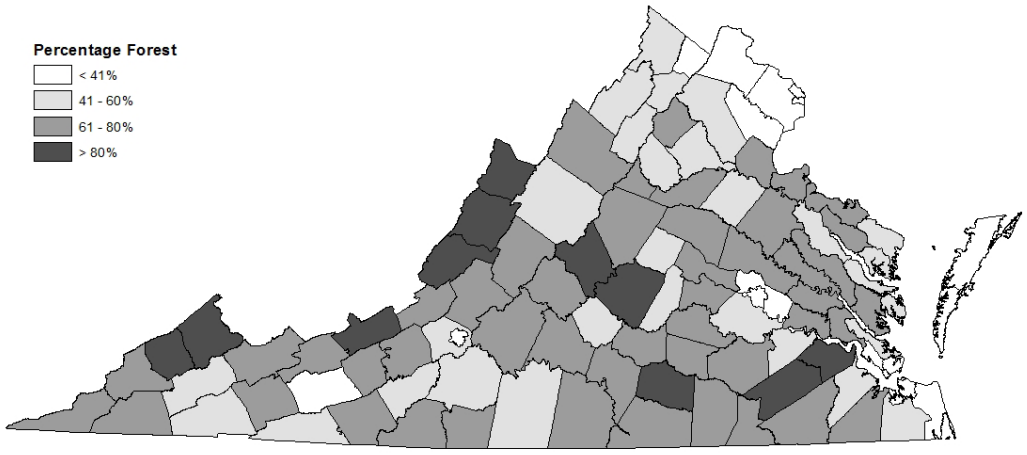
Virginia's forest resources are fairly evenly distributed throughout the state. However, urban commercial and residential development has reduced forestland, particularly in the Northern region (see **Figure 1.13**). Stumpage is highest in the southern part of the state, reflecting the location of Virginia's softwoods, the presence of

Figure 1.12 Virginia Stumpage Values, FY 1991-2011



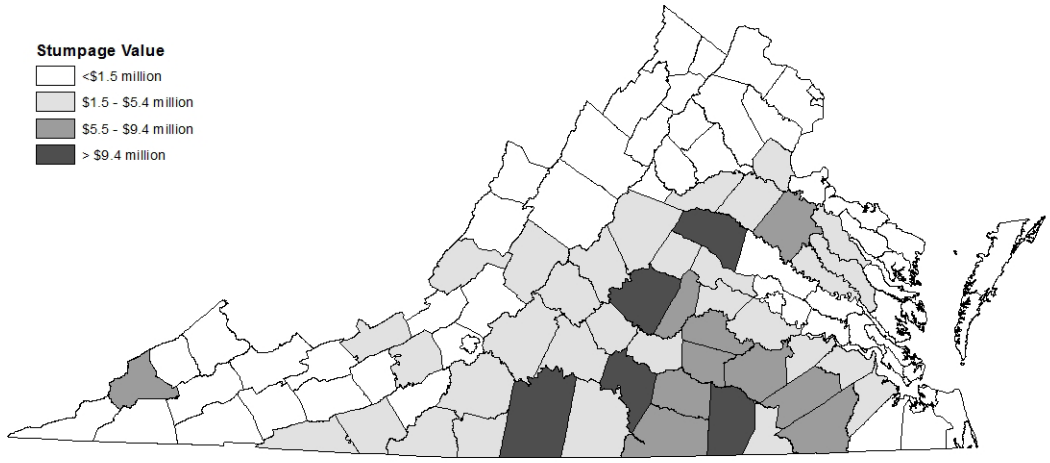
Source: Virginia Department of Forestry

1.13 Forest Land as Percentage of Total Land Area, 2008-2011



Source: U.S. Forest Service, Southern Research Station, Forestry Inventory Analysis System

1.14 Value of Virginia Stumpage by Locality, FY 2011



Source: Virginia Department of Forestry

highly productive pine plantations, less costly logging conditions, and a greater concentration of wood products manufacturing industry in the region (see **Figure 1.14**).

Virginia's forest product industries, like elsewhere in the U.S., have been affected by a severe contraction in demand caused by the national housing slump, the recent recession and slow growth economy, and long-term structural changes induced by new technology and international competition. The logging industry has also been hampered by supply issues such as increased fuel costs, the steep costs of capital equipment, an aging workforce, difficulties recruiting employees, and the need to adapt logging practices to deal with an increasingly smaller forest tract sizes (Bolding et al. 2010).

Figure 1.15 shows that employment declined substantially in the furniture and paper manufacturing industries before the recent recession. This decline accelerated with the housing downturn that began in 2006 and began to spread to other forest product manufacturing industries. Although primary wood product establishments had been closing and consolidating earlier (shrinking from 259 sawmills in 1999 to 168 in 2005—see **Table 1.1**), the changes resulted in larger, more efficient firms (Brandeis et al. 2012). Because of a buoyant housing market, overall employment did not decrease.

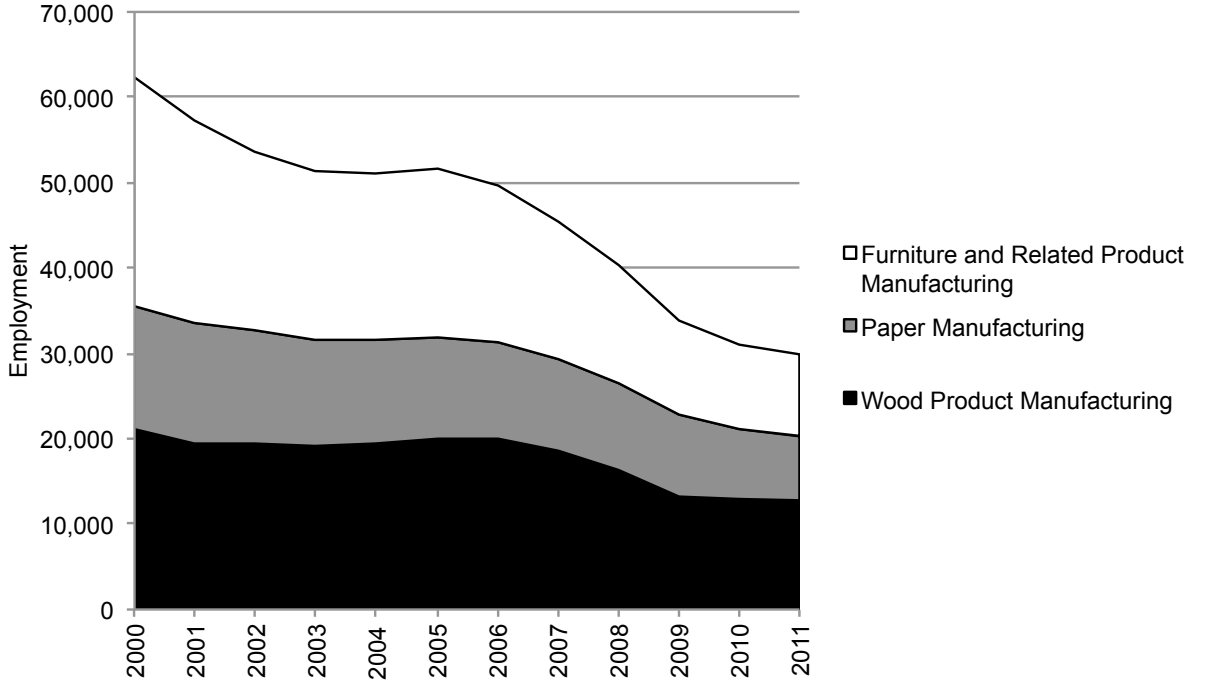
International competition had already begun to reduce employment in the U.S. furniture industry before the recession. The solid wood furniture industry had been rapidly losing market share to overseas producers (see **Figure 1.16**) for over a decade earlier as a result of shrinking shipping costs due to the adoption of shipping technologies such as containerization, cost advantages stemming from low wage labor and new large-scale plants equipped with the latest technology in Asia, the

Table 1.1 Number of Wood-using Mills by Type, Virginia, 1992-2009

	Sawmills	Veneer or plywood mills	Pulp mills	Composite panel mills	Other mills
1992	276	9	9	3	14
1995	254	8	9	3	15
1999	254	7	9	4	16
2001	217	5	9	3	14
2003	204	5	9	3	13
2005	168	4	8	3	13
2007	155	4	8	3	9
2009	129	3	8	3	8

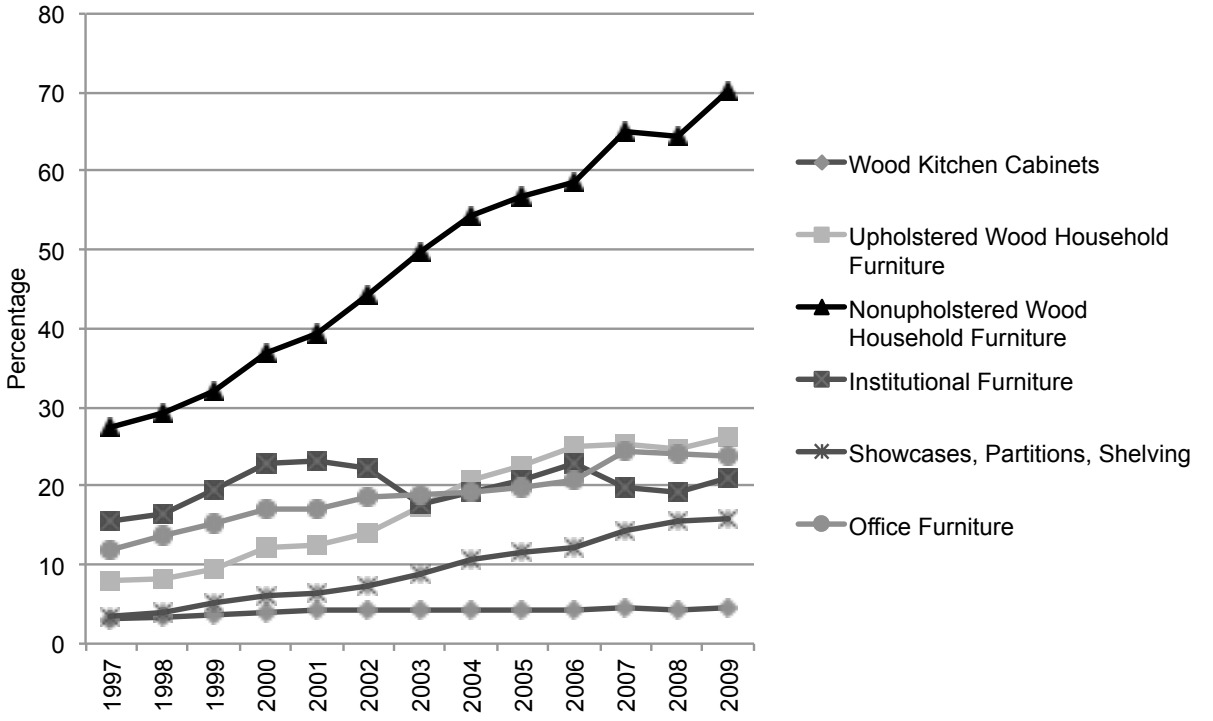
Source: Brandeis et al. (2012)

Figure 1.15 Virginia Forest Product Manufacturing Employment, 2000-2011



Source: Virginia Employment Commission, Quarterly Census of Employment and Wages

Figure 1.16 Import Share of U.S. Consumption for Furniture and Related Products, 1997-2009



Source: International Trade Administration (n.d.)

penetration of products with innovative design and modularization features such as the ready-to-assemble furniture manufactured by Swedish firm IKEA, unfavorable currency exchange rates, competition from non-wood furniture products, and more stringent U.S. environmental regulations (Buehlmann and Schuler 2009; Drayse 2008; Duke University 2007; Schuler, Taylor and Araman 2001). In contrast, U.S. furniture exports were small and remained relatively flat during this time period (Pirc and Vlosky 2010).

Other forest products such as upholstered furniture, kitchen cabinets, office furniture, institutional furniture and flooring have been somewhat insulated from international competition (Buehlmann and Schuler 2009). Upholstered wood furniture and wood kitchen cabinetry and countertops are more likely to be manufactured to the specifications of individual customers than solid wood products, which tend to be mass-produced. The wood kitchen cabinetry industry has also benefitted from close marketing and distribution relationships with home improvement centers, investment in new equipment and manufacturing processes, and growing household preferences for larger and modern kitchens (Luppold and Bumgardner 2009; Buehlmann and Schuler 2009). Although some segments of the wood products industry have largely dodged international competition to this point, flooring and more homogeneous milled wood products may become more vulnerable in the near future (Buehlmann et al. 2007; Grushecky et al. 2006).

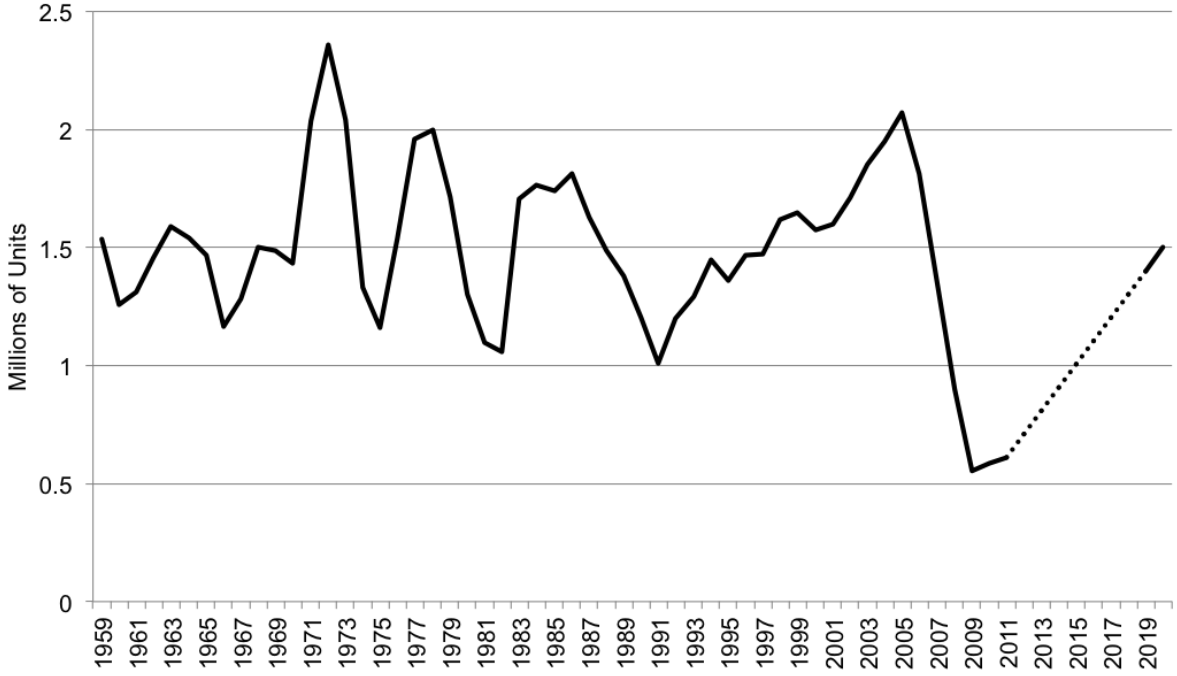
The U.S. pulp and paper industry has also experienced substantial job losses in the last decade. Once again, international competition has played a key role in the losses with lower cost international producers capturing U.S. market share, particularly in newsprint and coated paper. U.S. pulp and paper producers are also disadvantaged by higher U.S. environmental regulatory costs, occasional export dumping, and the unsustainable pulp sourcing practices of some international competitors (Haight and Thieme 2012; Seneca Creek Associates 2007). On the demand side, consumer expenditures have been shrinking due to the growth of electronic communication media. Also, the economic downturn weakened demand for paper packaging and paperboard packaging (Woodall et al. 2012). The confluence of these forces along with inadequate capital investment and aging mills has resulted in widespread mill closures in recent decades (Conrad et al. 2011a; Hodges et al. 2011). The pulp and paper industry that remains, however, is leaner and more efficient (Conrad et al. 2011b). Moreover, Virginia mills are now primarily manufacturing linerboard and paperboard packaging materials which are less vulnerable to international competition because of their bulkiness and higher shipping costs (Li and Luo 2008). Demand for these products is expected to grow with the gradual improvement in the U.S. economy (Hodges et al. 2011).

Up until 2006, solid wood product industries had been buoyed by easy credit, explosive housing construction growth, and a trend towards larger homes. The piercing of the housing bubble, onset of the worst housing market since the Great Depression (see **Figure 1.17**), and recessionary aftermath have had profound effects on the wood product industries. Tightening credit, home mortgage foreclosures, underwater mortgages, and huge surplus inventories of housing have led to historical lows in new housing starts and a concomitant drop in demand for housing construction materials such as structural lumber, engineered wood and roof trusses.

The plunge in housing construction, general deterioration in consumer sentiment, and lackluster employment situation that has accompanied the economic downturn and subsequent slow growth economy also had knock-on effects on the furniture industry. New housing construction, home resale, and repair and remodeling are important determinants of furniture demand (Pirc and Vlosky 2010; Buehlmann and Schuler 2009). Housing market difficulties have thus constrained furniture demand. Moreover, as consumer housing wealth and incomes decline, furniture has suffered a fate similar to other consumer durables. Consumer durables purchases are relatively large portion of the household budget and akin to investment decisions. They can generally be deferred until absolutely necessary or until the household's long-term economic lookout improves.

More so than agriculture and agriculture-related industries, forestry and forest products face some long-term resource management challenges. Although not an immediate concern because of surplus forest inventory, continued urban sprawl and fragmentation of forest and expanding non-industrial ownership patterns point to the likelihood that the quality and availability of

Figure 1.17. U.S. Housing Starts, Actual (1959-2011) and Forecasted (2020)



Source: U.S. Census Bureau and Bryn and Frey (2012)

timber stocks will decrease at some point and costs of harvesting will increase. When land is conserved through agricultural and open space conservation easements, restrictions are often placed on forestland management. The industry also faces more formidable challenges in combating pests and disease, invasive species, air pollution, and changes in forest ecology from fire suppression, which are taking an increasing toll on Virginia forests.

The industry also must contend with increasing international competition and mounting regulatory and consumer scrutiny. International competitors are making continued inroads into hardwood furniture and now even previously insulated forest products such as office furniture, upholstered furniture, and flooring. Mounting federal regulations governing water and air quality are increasing production costs. Local ordinances can sometimes encumber logging activities. Third-party certification of wood products to ensure compliance with ecologically sustainable forest management practices may increase the complexity and costs of forest management, presenting significant barriers to participation for some landowners.

Despite these challenges, the outlook for the industry is now largely on the upside. Substantial industry restructuring has already occurred. Virginia has formidable forestry and forest product manufacturing locational advantages that will persist. Moreover, the industry is primed to grow again as the general economy recovers, the housing market improves, firms continue to adapt new production processes, and firms exploit new product and service markets and recover some ground lost to international competition.

The furniture industry in the Southside region of Virginia and Piedmont region of North Carolina grew to be a significant employer for a number of reasons, including the quality and availability of timber, good transportation infrastructure, and the cost and quality of labor (Walcott 2011; Duke University 2007). Despite recent attrition, the region continues to confer significant cost advantages for firms locating in the region over competing locations in the U.S. The industry constitutes a distinct industry cluster with a well developed supply chain, including wood resources, skilled labor with industry experience, distributional and marketing networks, educational and

training programs, research and development activities, and the world's premiere furniture showroom located in nearby High Point, North Carolina. IKEA, which located its first North American plant in Danville in 2008 and brought with it supply firms such as Com.40. ltd. cited such factors in choosing the Southside region to establish its North American plant (Walcott 2011).

The general improvement in the U.S. housing market and aging housing stock also point to the likelihood of revived demand for primary wood products for new construction and renovation. Federal Reserve policies like quantitative easing and "Operation Twist" have led to historically low mortgage and consumer interest rates. Low rates, a slowly improving economy, aging housing stock, and a growing population are factors leading many analysts to predict a housing market that gradually improves through the next several years, although it is not likely to reach lofty levels seen before the recession (see Figure 1.17). The same forces that spur home sales and remodeling should improve the furniture industry's prospects as well.

International exports, the improved economy, changing consumer tastes, and new and recaptured markets may present other opportunities for growth. U.S. exports of paper and paperboard are up in the last few years (Woodall et al. 2012). International exports of Virginia rough wood have increased by approximately 25 percent over the period 2006-2010 according to origin of movement export data.[5] New export opportunities may arise from international markets, including ones opened by new international trade agreements. In addition, rising labor costs in developing nations, quality and risk concerns, and currency depreciation might lead more forest product manufacturers to repatriate (or "onshore") production from their foreign plants to the United States (Aeppel 2012; Walcott 2011; Buehlmann and Shuler 2009).

Domestic markets also present opportunities. Demand for some forest products has increased in recent years such as railroad ties (Buehlmann et al. 2010), fluff pulp for personal hygiene products (McWhirter 2012), animal bedding, and wood fuel pellets (Bloxom 2009). The Bureau of Labor Statistics projects that the veneer, plywood, and engineered wood product manufacturing industry will be among the top 5 fastest growing industries by employment over the next decade (Bryn and Frey 2012). The market for non-timber forestry products such as medicinal and dietary supplements and edible forest commodities, though of small and uncertain size, may grow in response to increased demand by a health conscious American public (Chamberlain, Bush, and Hammett 1998).

New and emerging markets are also important. Growth in the green design and construction sector has increased demand for sustainably produced wood and local wood products. The creation of ecosystem services markets such as nutrient or carbon credit trading to reduce pollution could also benefit forestland owners. New opportunities may exist also 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). Furniture and other forest products firms might develop new markets by placing more emphasis on design, customization, fostering efficient supply chains and supplier relationships, and building long-term customer service relationships through service agreements (Buehlmann and Schuler 2009).

Biomass energy production has emerged in recent years as a promising new market for surplus wood residues. Federal clean and renewable energy programs and Virginia's voluntary Renewable Portfolio Standard offers incentives to state's power companies to produce electricity from renewable resources (Woodall et al. 2012; Conrad and Bolding 2011b). Over half of Virginia's renewable energy came from biomass generation in 2010.[6] According to Conrad and Bolding (2011b), Virginia had seventy-one facilities producing electricity from woody biomass in 2011. The largest electricity producer was the 79MW Pittsylvania Power Station, which has since been joined by a Wise County co-firing plant that produces 55MW from wood. Several additional plants have been planned (see **Table 1.2**) that would collectively add 275MW in capacity.

Some wood product firms, especially pulp and paper mills, have expressed concerns about the potential

5 Author's calculation based export data retrieved from Global Trade Information Services (GTIS) system by the Virginia Department of Agriculture and Consumer Services.

6 Energy Information Administration (2012). EIA http://www.eia.gov/state/state-energy-profiles.cfm?sid=VA

competition from biomass electricity generation for wood resources. Conrad et al. (2011a) find that such competition is not yet evident but could occur "in the next decade" or over the longer term. Environmental regulations may also constrain the pace of biomass generation growth in the future as evidenced by citations for pollution violations issued to 85 of 107 U.S. biomass plants during the past five years (Scheck and Dugan 2012).

Table 1.2 Virginia Biomass Power Plants, Existing and Proposed

Plant	Power Unit	Status
Pittsylvania Power Station	79MW	Open
Virginia City Hybrid Energy Center	59MW	Open
Plywood Trail	50MW	Proposed
Altavista Power Station Retrofit	50MW	Proposed
Hopewell Power Station	50MW	Proposed
Southampton Power Station	50MW	Proposed
MeadWestvaco Covington Mill	75MW	Proposed

Source: Southern Environmental Law Center (2012)

SECTION 2
METHODOLOGY

This methodological discussion contains three parts. The first part consists of a discussion of how to define economic activities directly linked to agriculture and forestry resources for use in economic impact analysis. Delineating the agriculture and forestry industry is made especially difficult because virtually every good and service in the economy depends to some degree on agriculture and forestry product inputs. For instance, the automobile industry uses natural fiber composites in interior trim and the chemical industry produces chemicals from organic compounds. Both industries use tons of paper products for administrative functions such as management, finance, and marketing. In defining the industries, only those with the closest supply linkages with agriculture and forestry resources will be considered. The second part of this section describes the economic impact methodology used to measure the economic impacts on the state and local economies. The method relies on input-output analysis or rather its close relative, Social Accounting Matrix (SAM) multiplier analysis, which estimates the "ripple effects" of agriculture and forestry industries on supplying industries as well as households and other economic actors. The third section describes the data used.

Agriculture and Forestry-related Industry Identification

This study uses a similar methodology to identify industries linked with agriculture and forestry production as that used in the previous economic impact study of Virginia Agriculture and Forestry (Rephann 2008). A fuller discussion of the underlying theoretical and practical issues underpinning the selection of these industries is provided in that study.

Agriculture related industries are identified using Economic Research Service's list of farm and farm-related processing and marketing industries classified as being "closely related" to agriculture (U.S. Department of Agriculture, Economic Research Service 2005). These industries include manufacturing industries within three-digit North American Industrial Classification (NAICS) codes of 311 (food manufacturing), 312 (beverage and tobacco products), 313 (textile mills), 315 (apparel manufacturing), and 316 (leather and allied product manufacturing). They also include farm-related raw materials wholesale trade, and farm product warehousing. One service industry, landscaping services, was added to this list because of evidence of strong forward linkages with agriculture and forestry production from a supply-side input-output analysis.

Forestry-related industries are identified using a similar list compiled by the U.S. Forestry Service (U.S. Department of Agriculture, Forest Service 2004) based on recommendations from a roundtable workshop. They include three digit NAICS codes 113 (logging), 114 (hunting and trapping), 321 (wood product manufacturing), 322 (paper manufacturing), and selected industries within 337 (furniture and related product manufacturing). To provide some symmetry with the treatment of the agricultural sector, closely related forest product wholesale and warehousing industries are also included. In addition, based on the recommendations of an agriculture and forestry industry advisory group for the study, the biomass power generation sector was added (NAICS sector 221117). This industry did not exist as a distinct 6-digit industry until relatively recently but it is growing in importance as a power source in Virginia and elsewhere in the U.S.

Industries for both forestry and agriculture were further divided into production, core processing, extended processing, and distribution and power generation activities.[1] "Production" activities are those industries associated with growing and harvesting agricultural, timber, and non-timber forest product commodities. "Core processing" industries are manufacturing industries that are heavily reliant on state commodity inputs. They tend to be primary processing industries such as animal slaughtering and sawmills, which generally

1 Supply multipliers (see Miller and Blair 2009 for a fuller explanation) derived from the Virginia IMPLAN input-output model were used to distinguish between "core" and "extended" processing sectors. Industries with supply multipliers in excess of .027 were identified as "core" industries while the others were "extended" industries.

involve the first stage of converting a commodity input into a finished consumer product. They depend on commodity inputs that are often bulky or highly perishable. "Extended processing" industries are manufacturing industries that are somewhat less dependent on Virginia farm and forest commodity inputs. They tend to be secondary processing industries such as beverage and food manufacturing that involve cooking, blending, and packaging products from primary processing industries such as milled grains, milk, and meat. Due to the high perishability or bulkiness of the finished products, these industries are likely heavily influenced by the proximity of consumer markets. For example, beverage production often involves combining locally available water supplies with fruit, corn and sugar extracts. Lastly, "distribution and power generation" industries are the remaining warehousing, wholesaling, and landscaping industries described above. Using this classification scheme, industries are listed in **Appendix Table B.1**.

Economic Impact Modeling

Regional economic impact analysis is often conducted using input-output analysis. Input-output models are based on input-output tables, which show flows of purchases and sales among sectors of the economy. Social accounting Matrices (or "SAM") are expanded accounting systems similar to input-output tables that represent not only transactions among industries but transactions and transfers between all economic agents that add value to products and services. Among these other agents are households, government, and capital.

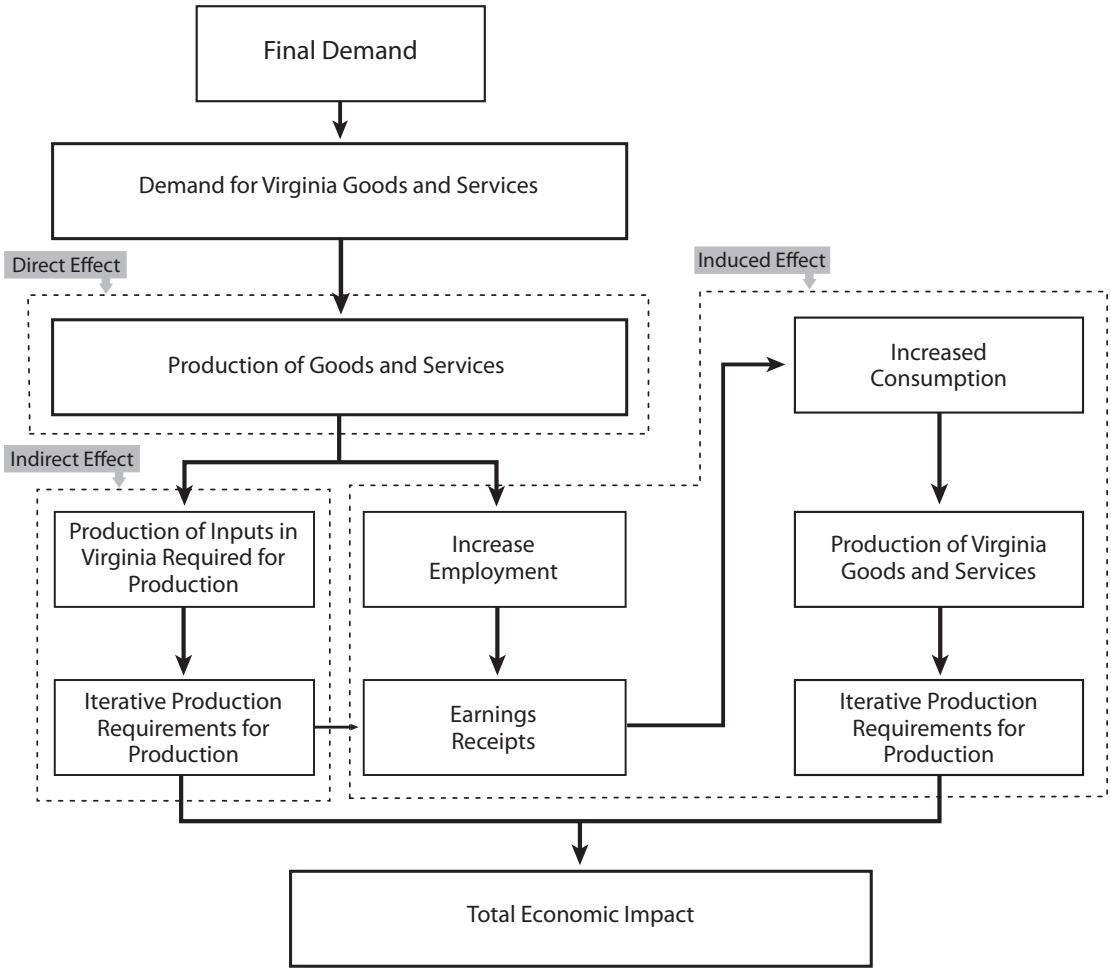
Economic multipliers are derived from these tables (Miller and Blair 2009). These multipliers allow one to measure the total impact of changes in agricultural and forestry-related activity on the state economy. The total impact of this activity consists of three parts, a "direct effect," "an indirect effect," and an "induced effect" (see **Figure 2.1**). The "direct effect" consists of the injection of economic activity or expenditure into the region. For example, the sales of agricultural and forestry-related industries located in Virginia would count as the direct effect. 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.[2] These businesses spend a portion of their sales revenues on their 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" or "induced impact") 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.[3]

The impact analysis for this study used IMPLAN (Impact analysis for PLANning). This model has been used in many economic impact studies, including the last economic impact study of Virginia agriculture and forestry (Rephann 2008) and many other state agriculture and forestry industry impact studies--see, for example, recent studies for Minnesota (Deckard and Skurla 2011) and Utah (Ward, Jakus, and Feuz 2010). The model uses the most currently available national and regional economic data from several federal government agencies to update and regionally customize an older national table. The result is a 440 sector matrix that is custom-

2 In order to avoid double counting agricultural and forestry-industry inputs, firm inputs from these industries were disallowed. Double counting occurs when you include the impact of a sector as a direct effect and then count it again as the indirect effect of another sector because it serves as an input to that sector. This suppression was accomplished 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. This approach is recommended by Miller and Blair (2009), pp. 621-625.

3 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.

Figure 2.1 Economic Impact Diagram



ized for the particular region of study.[4, 5] Since this study involved both a statewide and local analyses, the tables were customized for Virginia and each of its localities.

4 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. For the locality models, SAM multipliers that are closed to households only are used. This more restrictive closure reflects a much greater likelihood of government and investment spending leakages derived from taxes and profit payments to factors and institutions for localities.

5 IMPLAN changed from a 509-sector scheme to 440 sectors since the last Virginia economic impact study was published.

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

Data

This study draws data from four sources. Employment data was obtained from the Virginia Employment Commission (VEC) Quarterly Census of Employment and Wages (QCEW) for the second quarter of 2011, which is representative of annual employment. Industry employment figures are aggregated into IMPLAN categories using North American Industrial Classification System (NAICS) codes. The employment numbers are converted to sales/output equivalent figures by the model for use in generating impact estimates. The major problem with these data is that proprietors and self-employed individuals are not included. The absence of these business owners is particularly problematic for the farming, timber tracts, logging, and hunting industries. Therefore, data for these sectors were supplemented or corrected in three ways. For farming sectors (IMPLAN sectors 1-14), U.S. Department of Agriculture commodity cash receipts data from 2011 were used (U.S. Department of Agriculture, Economic Research Service 2012a).[6] For forest nurseries, forest products, and timber tracts sector (Implan sector 15), data from Virginia Department of Forestry product tax receipts for fiscal year 2011 were substituted. For logging (IMPLAN sector 16) and hunting and trapping (IMPLAN sector 18), estimates of employment were inflated using data from the IMPLAN database to correct for the absence of proprietors in these figures.[7]

The study also captures the economic impact of federal government farm programs with government payments data from the U.S. Department of Agriculture (U.S. Department of Agriculture, Economic Research Service 2012a). These payments amounted to $100.4 million in 2011, with about half of the total going toward tobacco transition payments. These payments were assigned to IMPLAN as additional income to Virginia farm households.

In order to make estimates for localities, additional data imputations were needed because 2011 local agricultural cash receipt and government payments data were not available. Therefore, statewide 2011 values for cash receipts for each sector were scaled down to the local level using IMPLAN total industrial output estimates for 2010 by farm sector for localities. Local cash receipts by sector were estimated by assuming that localities would produce the same share of total state farm output by sector in 2011 as they did in 2010. Bureau of Economic Analysis data on farm income and expenses from the Regional Economic Information System are used to identify government payments by locality for 2010. Locality shares of total statewide government payments for 2010 were assumed to persist into 2011. They were multiplied by the statewide government payments figure of $100.4 in 2011 to get locality estimates for that year.

Measurement of U.S. exports by state is challenging because custom agents at ports of exit collect information based on origin of movement rather than origin of production. In many instances, export products are consolidated at a transit point by shipping companies and wholesale and retail brokers (Cruz 2005; U.S. Department of Agriculture, Economic Research Service 2012c). Therefore, 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.

An alternative method is to distribute exports by industry to states based the state's share of total national output in that industry.[8] This method may tend to underestimate state exports from states having ports of exit

6 The raw data for 1990-2011 mapped onto IMPLAN sectors are shown in Appendix C.1.

7 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.

8 A third method used by Bairak and Hughes (1996) in Louisiana was to survey exporters about the proportion of their products passing through Louisiana ports that originated from within the state.

because international shipping costs for many products will be lower for products produced in closer proximity to the port (Bairak and Hughes 1996). Thus, Virginia products should constitute a higher share of national exports for any particular product than shown by this data. This method is used by the U.S. Department of Agriculture, Economic Research Service to estimate state agricultural exports and by IMPLAN to estimate state and county-level foreign exports (Economic Research Service 2012c; MIG, Inc. 2004).

This study uses IMPLAN estimates of state agricultural exports. The IMPLAN estimates are adopted here in order to provide a more conservative estimate of state foreign exports than would be obtained from relying on origin of movement data. Once again, 2010 export patterns based on IMPLAN data are assumed to persist into 2011. Export levels by industry are estimated for 2011 by multiplying 2011 state agricultural and forestry-related industry output by foreign export shares of total output by corresponding industry in 2010 from IMPLAN.

SECTION 3
RESULTS

This section presents the economic impact results in three parts. The first part shows the statewide impacts of agriculture and forestry. The total economic impacts are divided into direct, indirect, and induced impacts. Moreover, results are disaggregated by the categories of production, core processing, extended processing, and distribution and power generation activities. The second part describes the direct and total economic impacts for forestry and agriculture by locality. The last part shows the economic impacts of international exports.

Statewide Impacts

The direct effect of Virginia agriculture and forestry-related industries in 2011 by industry component is reported in **Table 3.1**. The industries accounted for $37.7 billion in total output, 160,432 employees, and $13.1 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 35 percent. However, agriculture extended processing accounts for over 40 percent of output and value-added.

Table 3.1 Virginia Agriculture and Forestry-related Industries Direct Output, Employment, and Value-added, 2011

Component	Output (Million $)	Employment	Value-added (Million $)
Agriculture			
Production	3,335.6	55,417	1,005.0
Core processing	8,612.2	20,713	1,556.5
Extended processing	15,286.6	21,197	6,572.5
Distribution	1,563.1	24,870	856.3
Government Payments	63.9	532	41.8
Total	28,861.5	122,728	10,032.1
Forestry			
Production	807.6	5,931	405.0
Core processing	4,691.9	15,034	1,481.3
Extended processing	2,845.0	13,606	865.7
Distribution	510.8	3,133	402.0
Total	8,855.2	37,704	3,154.0

Figure 3.1 Virginia Direct Effects by Agriculture and Forestry Component, 2011

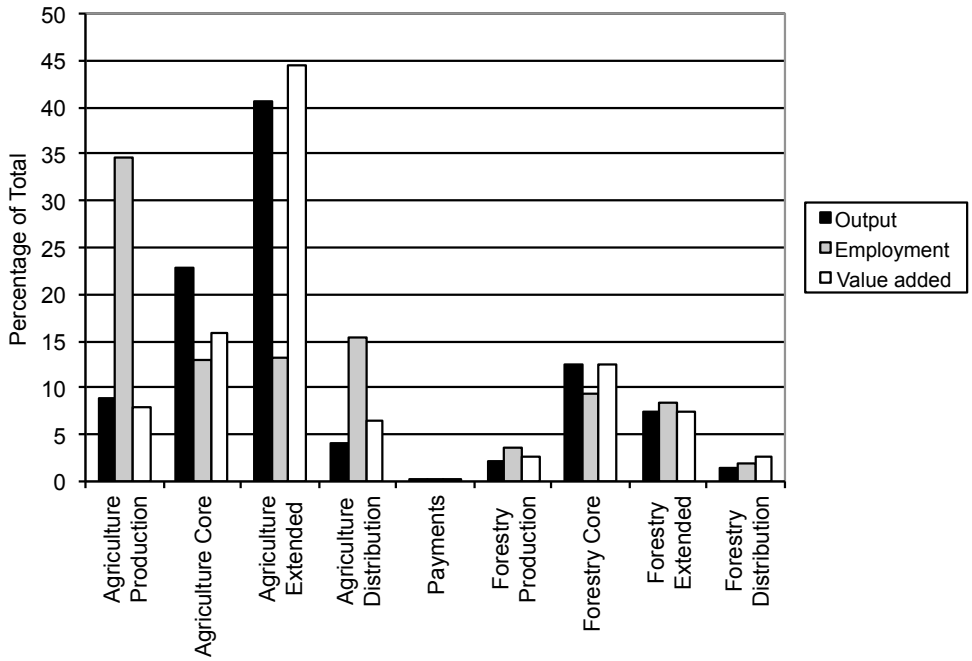


Table 3.2 presents the total economic impact of agriculture and forestry-related industries. It indicates that the total industry output or sales impact of agricultural and forestry industries in Virginia was nearly $70 billion in 2011, employment was approximately 415,000, and value-added nearly $35 billion. This impact includes indirect impacts and induced impacts. Employment and value-added impacts were responsible for an estimated 8.1 percent of Virginia's Gross Domestic Product.

The impacts of agriculture and forestry were felt in other sectors of the economy (see **Table 3.3** and **Figure 3.2**). The largest effects were in manufacturing and agriculture, forestry, fishing, and hunting where direct effects were dominant. However, agriculture and forestry stimulated large effects for trade, services, government and other sectors through the effects of industry purchases, household, and other institutional purchases and subsequent rounds of spending. The effects trickled down throughout the state economy affecting every sector.

Table 3.2 Virginia Total, Direct, Indirect, and Induced Impacts of Agriculture and Forestry-related Industries, 2011

Impact	Output (Million $)	Employment	Value-added (Million $)
Agriculture and Forestry			
Direct	37,716.8	160,432	13,186.1
Indirect	8,011.8	48,553	5,032.7
Induced	23,870.0	205,724	16,434.6
Total	69,598.6	414,709	34,653.3
Multiplier	1.85	2.58	2.63
Agriculture			
Direct	28,861.5	122,728	10,032.1
Indirect	5,781.0	34,542	3,625.6
Induced	17,739.4	153,591	12,247.5
Total	52,382.0	310,861	25,905.3
Multiplier	1.81	2.53	2.58
Forestry			
Direct	8,855.2	37,704	3,154.0
Indirect	2,230.8	14,010	1,407.0
Induced	6,130.6	52,133	4,187.0
Total	17,216.7	103,848	8,748.0
Multiplier	1.94	2.75	2.77

Table 3.3 Total Impact of Virginia's Agriculture and Forestry-related Industries by Major Industry, 2011

	Output (Million $)	Employment	Value-added (Million $)
Ag, Forestry, Fish & Hunting	4,156.0	61,670	1,414.3
Mining	92.9	484	60.0
Utilities	916.6	1,203	720.4
Construction	2,083.3	15,122	932.5
Manufacturing	32,525.1	73,050	10,795.6
Wholesale Trade	2,191.4	12,752	1,769.0
Retail trade	1,694.4	27,415	1,132.1
Transportation & Warehousing	1,551.3	13,785	888.5
Information	1,564.3	4,077	889.4
Finance & insurance	2,806.5	12,549	1,484.7
Real estate & rental	4,271.4	12,477	3,617.2
Professional, scientific & tech services	2,707.5	19,523	1,915.0
Management of companies	1,087.9	5,087	717.9
Administrative & waste services	2,274.2	37,688	1,284.2
Educational services	312.2	4,503	172.2
Health & social services	2,317.7	25,181	1,405.8
Arts, entertainment & recreation	236.7	5,243	127.6
Accommodation & food services	953.1	17,197	513.3
Other services	1,154.6	14,274	660.1
Government & other	4,701.5	51,428	4,153.8
Total	69,598.6	414,709	34,653.3

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. Impacts are shown for output (**Table 3.4**), employment (**Table 3.5**), and value-added (**Table 3.6**). The distribution of each by component is illustrated in **Figure 3.3**.

Results indicate that agriculture-related activities account for approximately 75 percent of total agriculture and forestry 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 6 percent of Virginia's GDP. Forestry-related industry represents the 2 percent of GDP.

Figure 3.2 Distribution of Virginia's Direct, Indirect, and Induced Employment Impacts by Industry, 2006

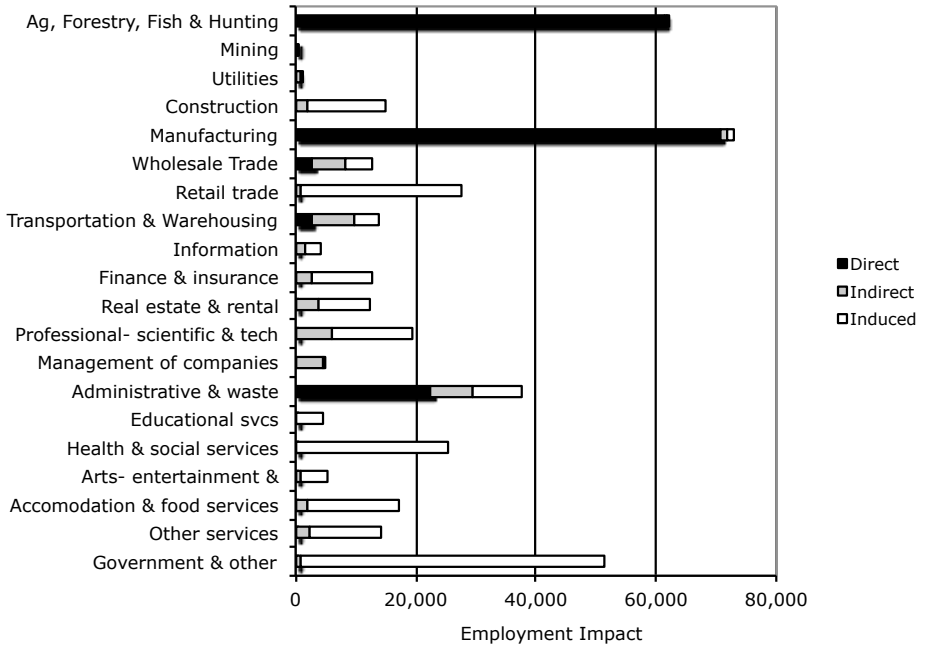


Table 3.4 Total Impact of Virginia's Agriculture and Forestry-related Industries by Component, Output in Millions of Dollars, 2011

	Agriculture	Forestry
Production	5,886.7	1,506.4
Processing core	14,513.3	9,035.7
Processing extended	28,225.8	5,409.3
Distribution	3,601.0	1,265.3
Government payments	155.2	---
Total	52,382.0	17,216.7

Table 3.5 Total Impact of Virginia's Agriculture and Forestry-related Industries by Component, Employment, 2011

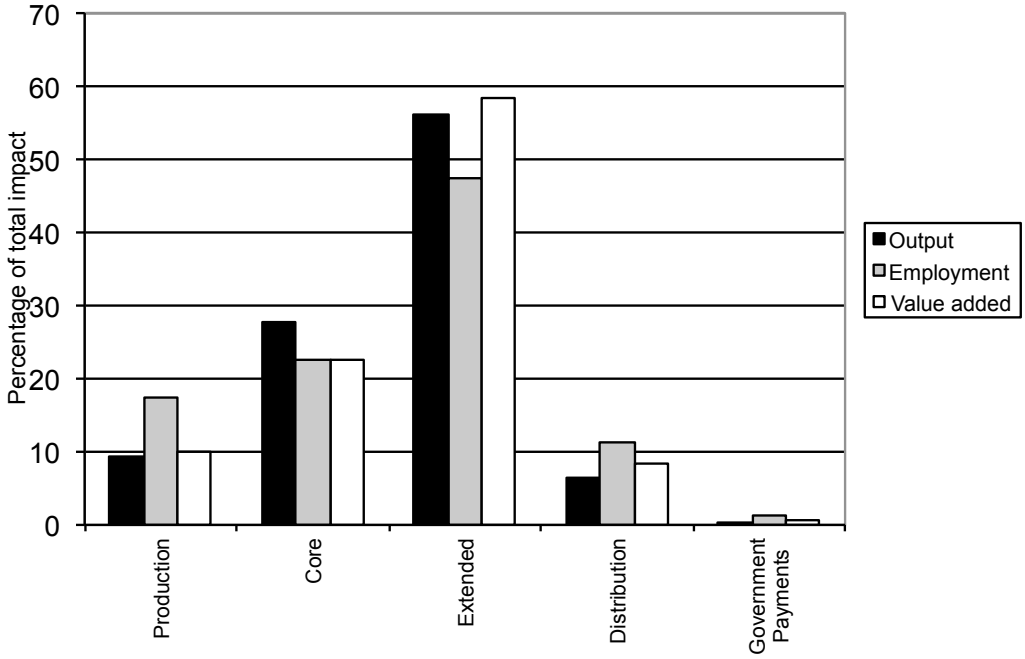
	Agriculture	Forestry
Production	74,834	11,788
Processing core	65,705	48,755
Processing extended	127,619	33,725
Distribution	41,422	9,579
Government payments	1,280	---
Total	310,861	103,848

Table 3.6 Total Impact of Virginia's Agriculture and Forestry-related Industries by Component, Value-Added in Millions of Dollars, 2011

	Agriculture	Impact as Percentage of Total GSP	Forestry	Impact as Percentage of Total GSP
Production	2,714.5	0.63	878.7	0.20
Processing core	5,484.8	1.28	4,371.7	1.02
Processing extended	15,384.9	3.59	2,576.0	0.60
Distribution	2,217.6	0.52	921.6	0.21
Government payments	103.5	0.02	---	---
Total	25,905.3	6.04	8,748.0	2.04

Looking at the value-added components, production industry impacts make up 21 percent of the total employment impact but a considerably smaller share, 10 percent, of value-added. This reflects the presence of many part-time farmers and seasonal employees in the sector. Core processing makes up 28 percent of employment and value-added. Extended processing is the largest impact category, constituting 39 percent of employment

Figure 3.3 Virginia Total Impacts by Agriculture and Forestry Component, 2011



and 52 percent of value-added. Distribution and power generation activities account for 12 percent of employment and 9 percent of value-added. Government payments account for less than 1 percent of each.

Locality Impacts

Local economic impacts will be determined by two factors: (a) the size of agriculture and forestry-related industry in the locality and (b) the degree to which business and consumer purchases are made in the locality. Nonmetropolitan localities often have comparatively large agriculture and forestry production sectors. However, metropolitan areas have larger populations and often a greater amount of employment in agriculture and forestry-related industries such as manufacturing and distribution. Moreover, generally speaking, more urbanized areas will have a denser network of business providers and shopping options than rural areas. Therefore, there will be fewer spending leakages from urban localities than rural localities, resulting in greater economic multipliers and higher economic impacts.

Economic impacts were estimated for each of the 105 localities using a Bureau of Economic Analysis classification scheme that combines smaller independent cities with their surrounding county. **Figures 3.4-3.6** show the employment impacts of agriculture-related industries, forestry-related industries, and combined agriculture and forestry-related industries. Complete tables of results for employment, output, and value-added are provided in **Appendix tables D.1-D.3**.[1]

Results indicate that every single Virginia locality is affected by agriculture and forestry-related industry to some degree. Sixty-eight localities have total employment impacts in excess of 1,000 jobs.

The largest and most diffuse impacts were found for agriculture-related activities. Seven localities topped 5,000 jobs including localities in the Shenandoah Valley, Northern Virginia, Southside, and Hampton Roads

1 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 3.4 Agriculture-related Industry Employment Impact by Locality, 2011

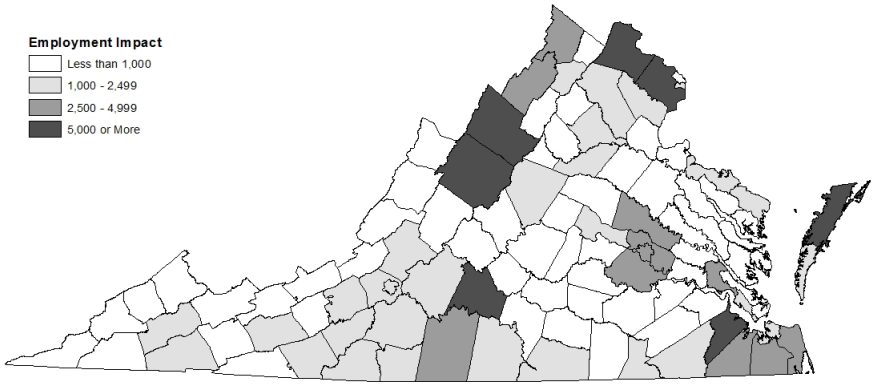


Figure 3.5 Forestry-related Industry Employment Impact by Locality, 2011

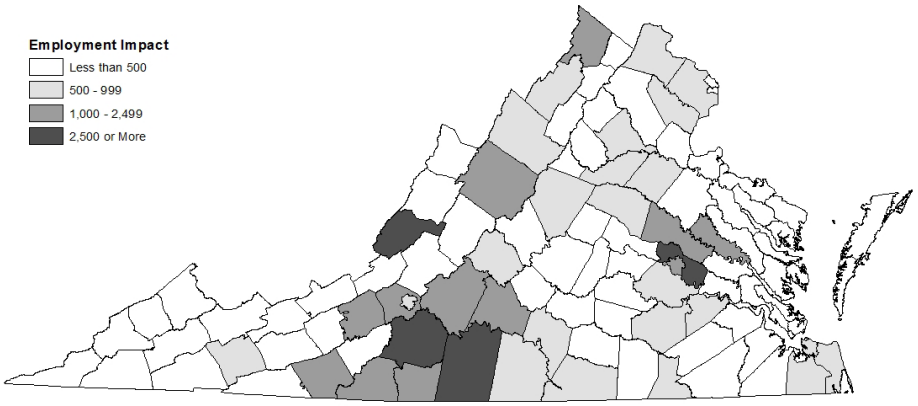
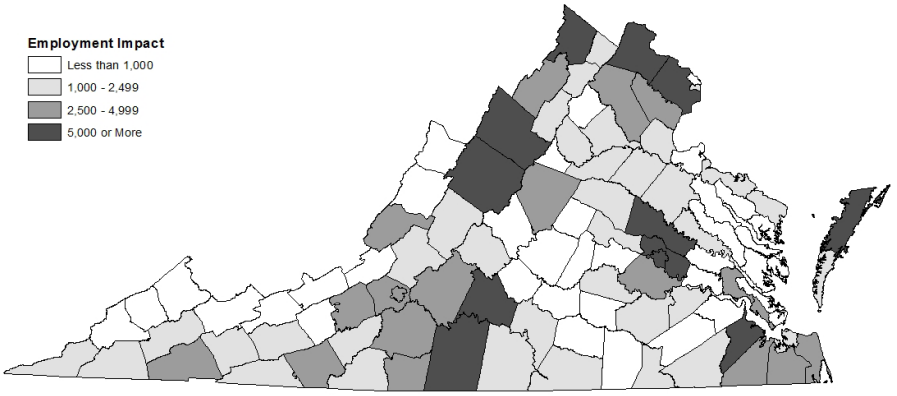


Figure 3.6 Agriculture and Forestry-related Industry Employment Impact by Locality, 2011



regions: Rockingham County including Harrisonburg City (11,857), Fairfax County including Fairfax City and Falls Church City (7,068), Augusta County including Staunton City and Waynesboro City (6,732), Loudoun County (5,950), Campbell County and Lynchburg City (5,468), Accomack County (5,372), and Isle of Wight County (5,125). Figure 3.5 shows five distinct area clusters where agriculture-related industry has its greatest impacts. They include the Shenandoah Valley, Northern Virginia, the Richmond City area, Hampton Roads, and the Eastern Shore. The ordering of total value-added impacts is slightly different with Richmond City and Chesterfield County ranking at the top because of the presence of especially high value-added processing activities such as tobacco manufacturing.

The largest forestry impacts tend to be somewhat more geographically concentrated in areas with pulp and paper mills or furniture manufacturing plants. They include the Southside region, Alleghany County and Covington City, and the Richmond area. Sixteen localities have total employment impacts of more than 1,000 jobs. These localities include seven with employment impacts greater than 2,000 jobs: Alleghany County including Covington City (3,371), Henrico County (3,141), Pittsylvania County including Danville City (2,983), Franklin County (2,554), Richmond City (2,387), and Henry County including Martinsville City (2,381).

International Export 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 forwarding 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 3.7 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 $4 billion in total output, 26,000 jobs, and nearly $1.6 billion in total output. Forestry accounts for a relatively higher share of the international export impact than it does the general statewide economic impact. Forestry-related industries account for 40 percent of the export output impact, 34 percent of the export employment impact and 44 percent of the export value-added impact. These figures compare to about 25 percent of the statewide agriculture and forestry-related industry economic impacts on each of these measures as reported earlier.

Table 3.8 shows a breakdown of impacts by industry component. The largest single industry component in terms of employment impact is agriculture production, which accounts for approximately 7,200 jobs. The largest single value-added component is forestry core with an impact of $500 million. The total employment impact of agriculture and forest-related exports on the farming sector (which is not shown in the table) is 7,051 jobs. Therefore, one in eight Virginia farm jobs is dependent on international exports.

Table 3.7 Virginia Total, Direct, Indirect, and Induced Impacts of Agriculture and Forestry-Related Industry Exports, 2011

	Output (Million $)	Employment	Value-added (Million $)
Agriculture and Forestry Total			
Direct Effect	2,072.0	11,273	612.2
Indirect Effect	857.4	6,145	455.0
Induced Effect	1,019.1	8,620	716.2
Total Effect	3,948.6	26,038	1,783.4
Agriculture			
Direct Effect	1,282.7	8,550	337.2
Indirect Effect	538.2	4,030	279.9
Induced Effect	545.3	4,634	384.5
Total Effect	2,366.2	17,214	1, 001.5
Forestry			
Direct Effect	789.3	2,723	275.0
Indirect Effect	319.3	2,114	175.1
Induced Effect	473.8	3,987	331.7
Total Effect	1,582.4	8,824	781.9

Table 3.8 Virginia Total, Direct, Indirect, and Induced Impacts of Agriculture and Forestry-Related Industry Exports by Component, 2011

	Output (Millions $)	Employment	Value-added (Millions $)		Output (Millions $)	Employment	ValueAdded (Millions $)
Agriculture Production				Forestry Production			
Direct Effect	218.2	5,607	63.4	Direct Effect	52.0	494	22.3
Indirect Effect	102.2	910	65.2	Indirect Effect	15.1	159	8.2
Induced Effect	81.5	699	57.8	Induced Effect	44.3	375	31.0
Total Effect	401.9	7,216	186.4	Total Effect	111.5	1,027	61.5
Agriculture Core				Forestry Core			
Direct Effect	503.6	1,212	80.3	Direct Effect	540.7	1,250	162.2
Indirect Effect	269.2	2,209	122.0	Indirect Effect	244.5	1,598	132.1
Induced Effect	192.6	1,603	134.3	Induced Effect	294.6	2,474	206.1
Total Effect	965.5	5,024	336.6	Total Effect	1,079.8	5,322	500.4
Agriculture Extended				Forestry Extended			
Direct Effect	538.7	1,584	176.2	Direct Effect	137.6	628	43.2
Indirect Effect	161.9	875	89.4	Indirect Effect	47.2	266	26.6
Induced Effect	248.0	2,133	175.9	Induced Effect	72.0	595	50.0
Total Effect	948.6	4,592	441.5	Total Effect	256.9	1,489	119.8
Agriculture Distribution				Forestry Distribution			
Direct Effect	22.1	147	17.3	Direct Effect	58.9	351	47.3
Indirect Effect	4.9	37	3.3	Indirect Effect	12.4	92	8.2
Induced Effect	23.2	199	16.4	Induced Effect	62.9	543	44.7
Total Effect	50.2	383	37.0	Total Effect	134.2	985	100.2
Agriculture Total				Forestry Total			
Direct Effect	1,282.7	8,550	337.2	Direct Effect	789.3	2,723	275.0
Indirect Effect	538.2	4,030	279.9	Indirect Effect	319.3	2,114	175.1
Induced Effect	545.3	4,634	384.5	Induced Effect	473.8	3,987	331.7
Total Effect	2,366.2	17,214	1,001.5	Total Effect	1,582.4	8,824	781.9

SECTION 4
OTHER AGRICULTURE AND FORESTRY ECONOMIC IMPACTS AND BENEFITS

As with any study, it is not possible to measure every possible economic impact or benefit of agriculture and forestry. For instance, the impacts of farm-related revenue-generating activities such as agri-tourism, energy generation, and farm-based value-added activities were not addressed in this study. Moreover, this study is an economic impact study rather than a social cost-benefit analysis. No attempt is made to gauge the wider social benefits associated with agriculture and forestry landscapes such as water quality and air quality preservation, flood mitigation, wildlife habitat, and scenic amenities, etc. In this section, these other economic contributions are briefly discussed for the areas of farm-related income, agriculture and forest-related tourism and recreation, miscellaneous other economic impacts, and environment and quality of life.

Farm-related Income

Virginia farmers are deriving increasing amounts of income from farm-related activities such as value-added products, energy production, agri-tourism, custom work and agricultural services, land leases, and federal and state government payments. Some of these activities would be captured in the economic impact results presented in the previous section. For example, agricultural services provided by one farm would be represented as an input purchase by another farm and be measured within the indirect impact. Federal government farm payments were also included.

Some farm-related income was not included. According to the 2007 Agricultural Census, 2,058 Virginia farms produced and sold value-added commodities such as jams, cheese, beef jerky, and floral arrangements. Three hundred and ninety two farms generated energy or electricity on their farms (presumably not all for farm use). Farm income from recreational services such as pumpkin patches, corn mazes, petting zoos, farm festivals, hayrides, hunting, and trail riding quadrupled from $2.7 million in 2002 to $12.9 million in 2007. Indeed, some communities are beginning to organize agri-tourism marketing initiatives such as the Fields of Gold program in the Shenandoah Valley to expand the economic impact of this non-traditional farm activity.

Agriculture and Forest Related Tourism and Recreation

According to a recent study by the Virginia Tourism Corporation (U.S. Travel Association 2012), Virginia generated approximately $20 billion in travel expenditures from visitors in 2011. Unknown is how much of this impact can be attributed to Virginia's farms, forests, and rural areas. A Leisure Trip Profile conducted for the Virginia Tourism Corporation suggests that a significant number of Virginia visitors are attracted by the state's rural amenities and engage in rural outdoors recreation and leisure activities (see **Table 4.1**). Visitors may conduct multi-purpose and multi-venue visits. So, the participation rates are not additive.

Table 4.1 Top Rural, Agriculture and Forest Activities and Attractions for Virginia Leisure Visitors, 2011

Activity/Attraction	Percentage
Rural sightseeing	15
State/National Park	10
Wildlife viewing	4
Camping	3
Gardens	3
Nature travel/ecotouring	3
Hiking/backpacking	3
Fishing (Fresh/saltwater)	2
Bird watching	2
Horseback riding	1
Caverns	1
Whitewater rafting/kayaking	1
Hunting	< 0.5%
Rock/mountain climbing	< 0.5%

Source: Virginia Tourism Corporation, Leisure Trip Profile, 2011

Estimates based on survey data are available for specific types of agri-tourism. According to one recent study, approximately 940 thousand people attended almost 1,200 Virginia horse shows and competitions in

2010 and generated more than $220 million in travel-related expenditures, much of it outside the horse event venue (Rephann 2011). A study of the Virginia wine and grapes industry (Frank, Rimerman + Co. LLP, 2012) estimated that Virginia's 193 wineries in 2010 attracted 1,618,000 wine-related tourists and generated $131 million in associated tourism expenditures. Virginia also hosts dozens of agricultural festivals each year. They include festivals celebrating farm commodities such as apples, peaches, peanuts, garlic ramps, strawberries, blackberries and dairy products. Although independent estimates of the impact of these festivals are not available, one festival alone (the Pungo Stawberry Festival in Virginia Beach) draws an average of 170,000 visitors each year (Rephann 2012).

Wildlife recreation too depends on rural landscapes. The U.S. Department of Interior estimated that there were 622,000 freshwater anglers, 413,000 hunters and 2.312 million wildlife watchers participating in Virginia for 2006 (U.S. Department of Interior and U.S. Department of Commerce 2008a). The former group was responsible for $481 million in related spending, while the latter two generated $501 million and $960.2 million respectively (Southwick Associates 2007, 2008; and U.S. Department of the Interior, U.S. Fish and Wildlife Service 2008b). Estimates were not available for other outdoor wilderness activities such as camping and hiking. **Table 4.2** summarizes the results of recent economic impact studies for these activities based on the U.S. Department of Interior Survey data.

The national and state park and forest systems are responsible for a significant portion of wilderness recreation visitor traffic. Virginia's National Parks attracted 23.5 million visits in 2011 while the Virginia State Park System counted 7.8 million visits.[1] In addition, the George Washington and Jefferson National Forests had 1.5 million annual average visits each year for the 2005-2009 period.[2] Information on visitations to Virginia's State Forests was not available.

Table 4.2 Wildlife Recreation Economic Impacts in Virginia, 2006

Activity	Participants (thousands)	Total Output ($ million)	Employment
Freshwater fishing	622	809.2	9,213
Hunting	413	880.2	9,376
Wildlife watching	2,312	1,582.4	17,489
Total	3,347	3,271.8	36,078

Source: Southwick Associates (2007, 2008) and U.S. Fish and Wildlife Service (2008b)

Other Economic Impacts

The study did not capture the effects of employment in agriculture and forestry-related firms outside of the production, manufacturing, and distribution industrial sectors described in the second section. Thus, employment connected to corporate and regional offices, research and development laboratories, and logistical operations by agribusiness manufacturing firms is excluded. Instead, under the North American Industrial Classification System, employment in these areas is classified under separate industries such as "management of companies and enterprises" (NAICS 55), "professional, scientific, and technical services" (NAICS 54), and "transportation" (NAICS 48). The Richmond area alone is home to several corporate offices in the agribusiness sector, including Fortune 500 companies Altria and Mead-Westvaco that employ thousands of workers doing administrative, research, and logistical work in support of their national and international operations.

The study excluded some economic impacts that are often connected to agriculture and forestry. For example, the rapidly growing "green industry" has areas of intersection with commercial agriculture such as landscape services and horticultural production (Hughes and Hinson 2000). These activities were included in the estimates of direct impact. Green industry services outside these sectors 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 are other important components of the green industry that were not included in the direct impacts.

1 U.S. Department of the Interior, National Park Service. NPS Stats. http://www2.nature.nps.gov/stats/viewReport.cfm?selectedReport=SystemYTDByState.cfm (accessed September 19, 2012); Virginia Department of Conservation and Recreation. Virginia state parks sets overnight visitation record in 2011. http://www.dcr.virginia.gov/pr_relz_detail.shtml?id=2012-01-17-13-01-02-44142

2 U.S. Department of Agriculture, Forest Service. National Visitor Use Monitoring, Natural Resource Manager. http://apps.fs.fed.us/nrm/nvum/results/A08008.aspx/Round2 (accessed September 19, 2012).

Economic impacts of direct sales to consumers by farms were captured in the economic impact results. Often these sales occur in venues such as farmers markets located in shopping areas that create pecuniary externalities that benefit other merchandisers. Farmers markets draw increased customer flow to conventional shopping areas because of the wide variety of vendors, unique types of products available, and recreational and entertainment offerings. Some studies estimate that farmers markets generate sales for nearby businesses that are equal or more than the farmers market sales (Hughes et al. 2008).

Table 4.3 Ecological Values of Virginia Farm and Forest Land

	Agriculture	Forest
Number of Acres	2,150,933	15,907,038
Value per Acre of Water Environmental Services	$68.81	$320.56
Value per Acre of Air Environmental services	$4.01	$80.86
Total Value of Water Environmental Services	$148,005,700	$5,099,160,101
Total Value of Air Environmental Services	$8,625,241	$1,286,243,093
Total Environmental Value	$156,630,941	$6,385,403,194

Source: Land acreage (U.S. Forest Service, Forest Inventory and Analysis inventory data for 2008-2011; U.S. Department of Agriculture, National Agricultural Statistics Service 2009), Costanza et al (1997)

Environment and Quality of Life

Virginia's agriculture and forested landscape provides important environmental services to the commonwealth. These environmental benefits include improved water quality and flood control, air quality, conservation of wildlife habitat, and containment of urban sprawl. The more orderly development pattern resulting from open space preservation can help lower costs of development such as the provision of public utilities and reduce the costs associated with urbanization such as pollution and traffic congestion. Lastly, farm and forestland protection helps to preserve the scenic beauty of the region, sustain agrarian and historic landscapes, and maintain a sense of place.

Economists attempt to quantify the social economic benefits of ecological services provided by farmland and forestland in specific regions. One way to quantify the value of these services for Virginia is the value transfer approach, which uses estimates of the contribution of conserved land drawn from other studies similar to the area of interest. These estimates may be obtained from different economic valuation methods.[3]

Two ecological services are examined here for purposes of illustration and to quantify their order of importance. Forests and rangeland/pasture can reduce the quantity of sulfur dioxide, particulates and greenhouse gases emitted by industry and transportation 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. Based on a synthesis of economic valuation studies conducted around the world, 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 1994 dollars. The average values of water ecological services are $559 per hectare for forests and $120 for grasslands and pasture. The values adjusted for inflation and rescaled in terms of acres are reported in **Table 4.3**. Based on the most recently available inventory of Virginia's rangeland/pasture and forestland, the Commonwealth receives approximately $157 million in estimated air and water environmental services value each year from agriculture and $6.385 billion in estimated value from forestry.

3 Methods used to estimate economic values include hedonic price valuation, travel cost valuation, contingent valuation, replacement cost estimation, cost avoidance estimation, and drawing values from actual pollution trading markets set up to mitigate emissions such as nutrients and air pollution. A review of such methods can be found in Madureira, Rambonilaza, and Karpinski (2007).

SECTION 5
SUMMARY AND CONCLUSION

Virginia's agriculture and forestry industries continue to form an important part of the commonwealth's industrial base. These industries generated a combined estimated $70 billion in total output, $34.6 in value-added and 414,700 jobs in 2011 for the Virginia economy. Value-added amounts to 8.1 percent of state gross domestic product. 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 accounted for a relatively modest portion of the total statewide impact, including $4 billion in total output, approximately 26,000 jobs, and $1.8 billion in value-added. However, an estimated one in eight Virginia farm jobs depends on international exports.

Admittedly the statewide economic impacts are smaller than obtained in the last economic impact analysis based on 2006 data which estimated $78 billion in total industry output or sales, $35.5 billion of value-added (which was 9.9 percent of Virginia's GDP), and 501,000 jobs. Since that study, however, the industries have shrunk in size relative to the state economy due to the combined effects of national recession, collapse of the housing market, continued international competition and various other factors.

The wood products industry has experienced the most attrition. The severe recession during 2007-2009 devastated the housing market and caused consumers to defer purchases of durable goods. This downturn has caused a rapid reduction in demand for wood products used in housing construction and millwork and furniture to equip new, remodeled, and existing homes. At the same time, global competition has continued to erode the capacity of hardwood furniture manufacturers, located mainly in Southside. The pulp and paper industry has been shaped by many of the same forces but has also been affected by reduced demand due to growth in electronic media and recycling (Wear et al. 2007). The result of the confluence of these forces is a smaller forest products industry that is much leaner and more efficient. It is expected to see renewed growth in the next decade as housing construction gradually increases, some export markets expand, the cost advantages of locating international operations narrows, and new forest product markets such as woody biomass power generation and other wood-based products grow.

Agriculture and agriculture-related industry has been relatively insulated from many of the forces affecting forestry-related industries. Indeed, Virginia's farms experienced significant growth in sales during this period due in part to high feed crop commodity prices driven by biofuel expansion and international demand. In addition, production of consumer nondurable purchases such as food typically slow less than nondurable purchases like furniture. The main factors that have reduced employment in the industry are continued factory productivity improvements and significant downsizing of certain segments of the industry. Tobacco manufacturing, a traditional economic powerhouse in Virginia, continues to shrink its economic footprint in the state due to declining demand and government tax and health policies. Textiles and apparel continue to recede in importance with increased international competition. Offsetting these declines to a small extent are growing specialty product industries that cater to growing consumer markets for local and fresh foods such as wineries and fresh-cut food manufacturing.

There are no sectors of the economy or localities within the state that are unaffected by the economic vitality of the agriculture and forestry industries. Although most activity takes place in the manufacturing and agriculture, forestry, fishing, and hunting industries, the cumulative cascading effects of industry purchases and payrolls affects every industry including public and private services. Moreover, every Virginia locality is affected by agriculture and forestry-related industries to some degree. Sixty-eight localities have total employment impacts in excess of 1,000 jobs. The largest and more diffuse impacts were generally found for agriculture-related activities. Seven localities topped 5,000 jobs in economic impact including counties in the Shenandoah Valley, Northern Virginia, Southside, and Hampton

Roads regions. Forestry-related industry 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 Area.

Several activities that would affect agriculture and forestry industries impacts were not measured here. The study did not capture activities connected to corporate and regional offices, research and development laboratories, and logistical operations of agribusiness firms. The Richmond area alone is home to several corporate offices in the agribusiness sector, including Fortune 500 companies Altria and Mead-Westvaco that employ thousands of workers in corporate administrative, research, and logistical areas.

Virginia farmers are deriving increasing amounts of income from farm-related activities such as value-added products, energy production, and on-farm recreation. This farm-related income would not generally be included in the impact estimates reported in the last section. This study also did not compute estimates of agriculture and forestry's tourism and recreation's impact, including those impacts that stem from consumer spending outside of farm and forest venues such as hotels, restaurants and retail shops. These activities include such things as freshwater fishing, hunting, hiking and backpacking, camping, wildlife watching, equine events and horseback riding, wineries and other agri-tourism, and agricultural festivals. Studies reviewed here that examine just a few of these activities are suggestive that visitors can be counted in the millions and impacts run in the billions of dollars. Therefore, agriculture and forestry are important components of Virginia tourism.

Virginia's agriculture and forested landscapes also provide important environmental services and other social economic benefits to the commonwealth. These benefits include improved water quality and flood control, air quality, conservation of wildlife habitat, containment of urban sprawl, preservation of scenic beauty, and maintenance of a sense of place. An attempt to quantify the value of a these water and air quality environmental services using the value transfer approach suggests that the commonwealth receives approximately $157 million in value each year from farmland and $6.385 billion in value from forestry land in these ecological service areas alone.

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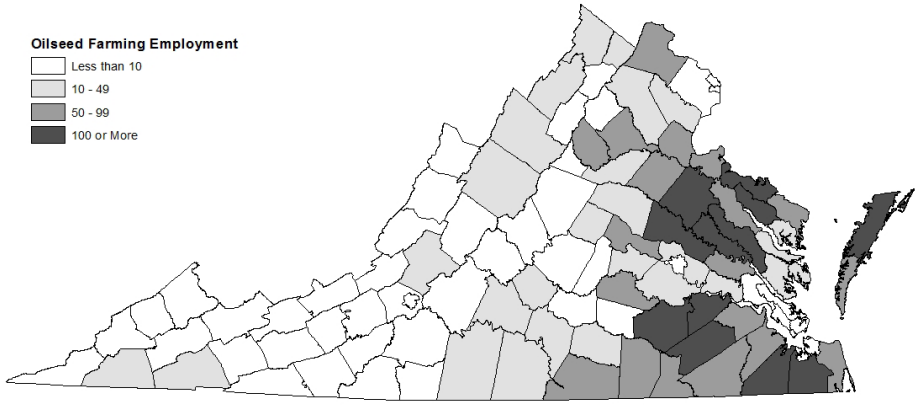
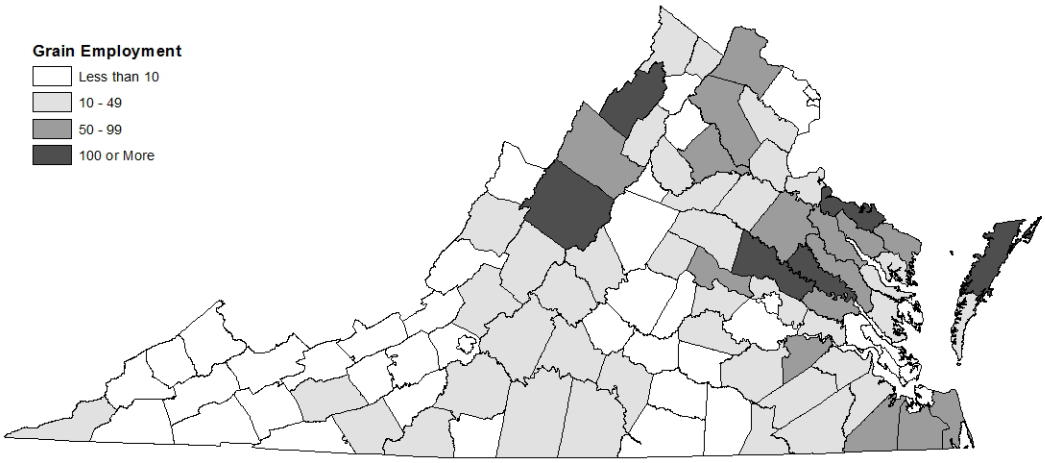
APPENDIX A.
FARM COMMODITY EMPLOYMENT BY LOCALITY FOR 2010

Figure A.1 Oilseed Farming Employment



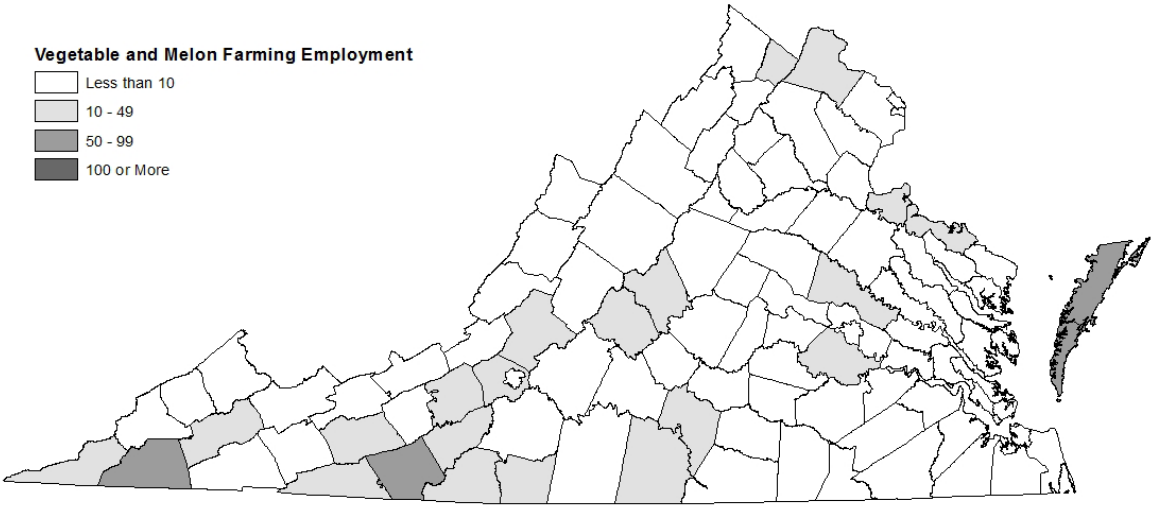
Source: IMPLAN

Figure A.2 Grain Farming Employment



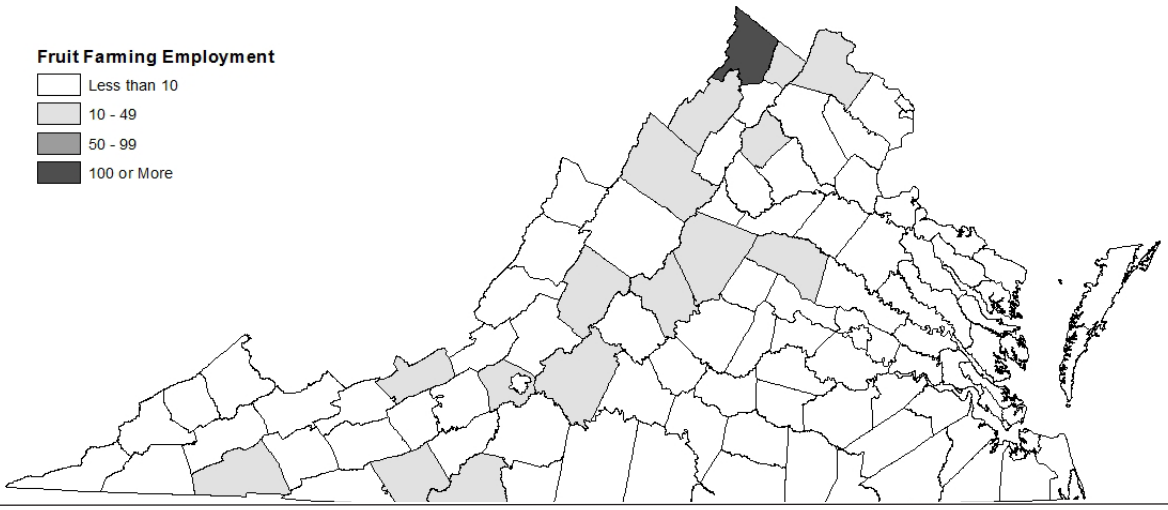
Source: IMPLAN

Figure A.3 Vegetable and Melon Farming Employment



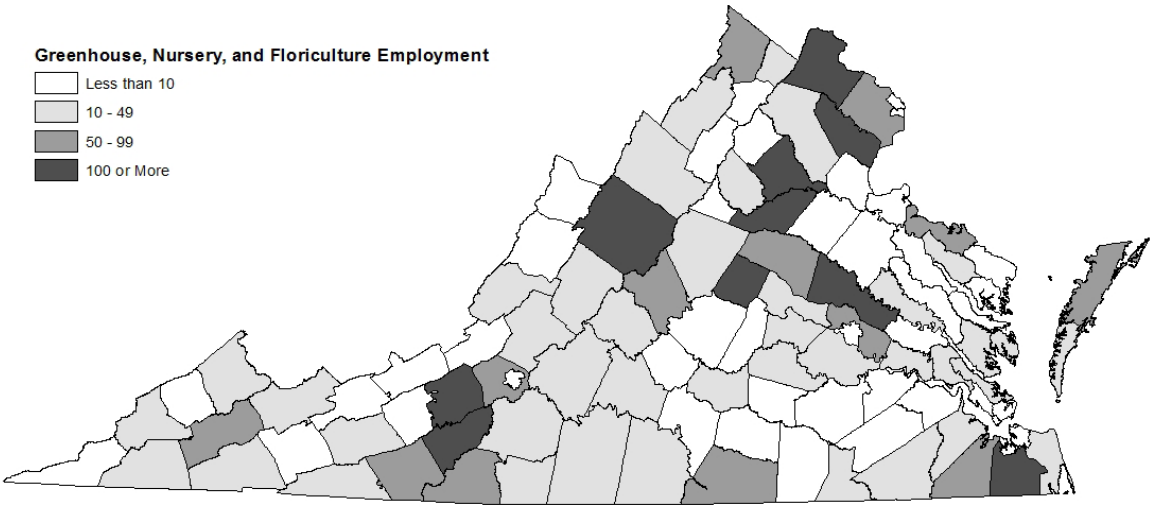
Source: IMPLAN

Figure A.4 Fruit Farming Employment



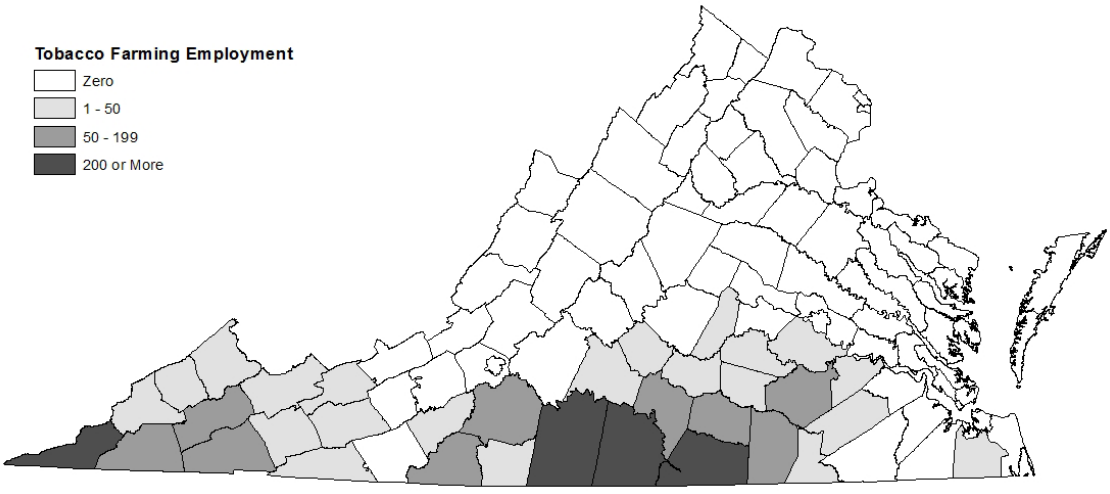
Source: IMPLAN

Figure A.5 Greenhouse, Nursery, and Floriculture Employment



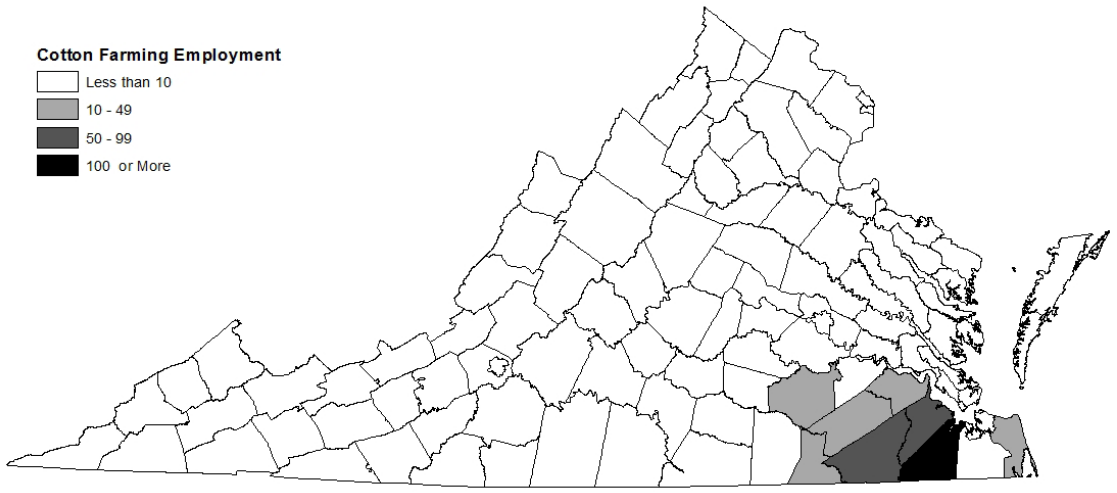
Source: IMPLAN

Figure A.6 Tobacco Farming Employment



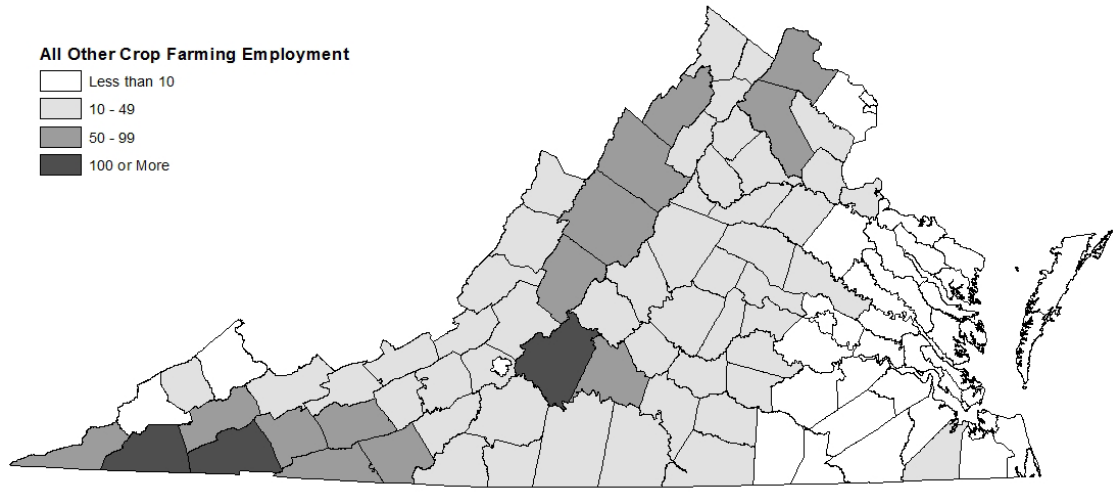
Source: IMPLAN

Figure A.7 Cotton Farming Employment



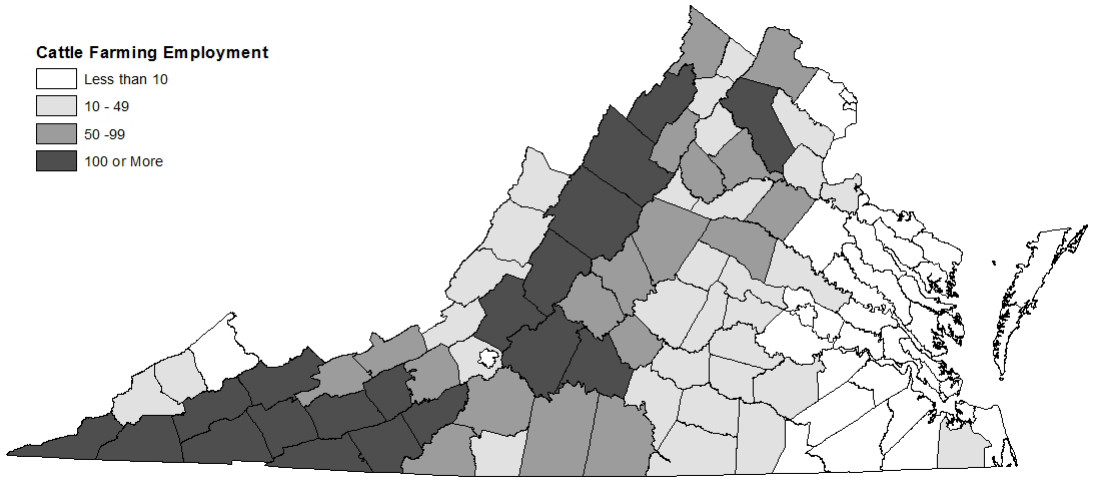
Source: IMPLAN

Figure A.8 Other Crop Farming Employment



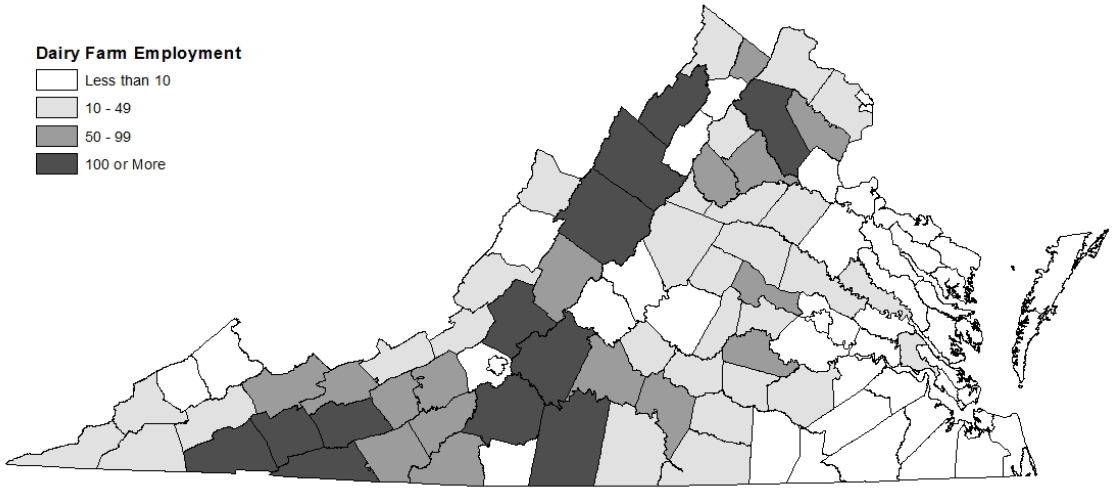
Source: IMPLAN

Figure A.9 Cattle Ranching and Farming Employment



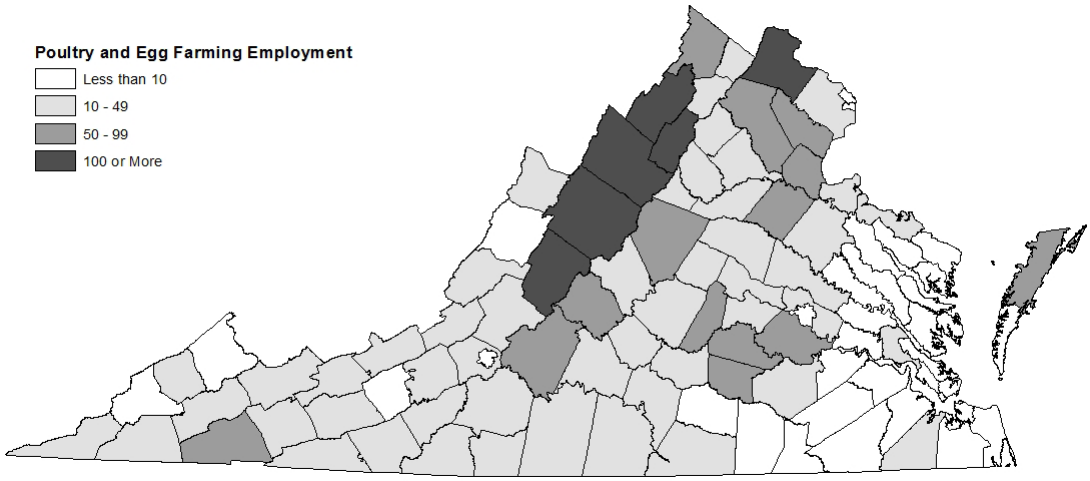
Source: IMPLAN

Figure A.10 Dairy Cattle and Milk Production Employment



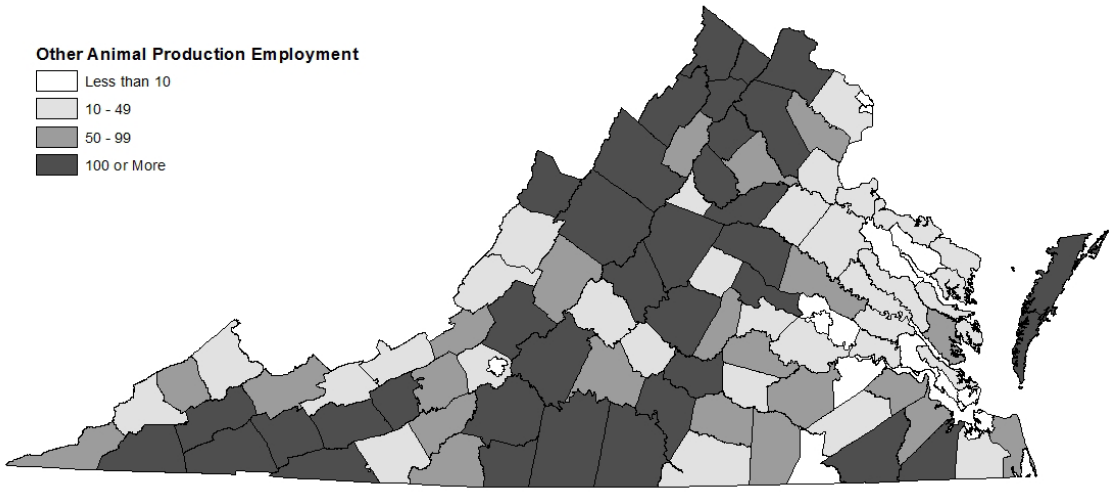
Source: IMPLAN

Figure A.11 Poultry and Egg Production Employment



Source: IMPLAN

Figure A.12 Other Animal Production Employment



Source: IMPLAN

Table B.1 Virginia Agriculture and Forestry-related Industries by Component

IMPLAN Sector	IMPLAN Description
Agriculture Production	
1	Oilseed farming
2	Grain farming
3	Vegetable and melon farming
4	Fruit farming
6	Greenhouse, nursery and floriculture production
7	Tobacco farming
8	Cotton farming
10	All other crop farming
11	Cattle ranching and farming
12	Dairy cattle and milk production
13	Poultry and egg production
14	Animal production, except cattle and poultry
19	Support activities for agriculture and forestry
	NAICS 1151 Support activities for crop production
	NAICS 1152 Support activities for animal production
Forestry Production	
15	Forestry, forest products, and timber tracts
16	Logging
18	Hunting and trapping
19	Support activities for agriculture and forestry
	NAICS 1153 Support activities for forestry
Agriculture Core Processing	
43	Flour milling and malt manufacturing
46	Fats and oils refining and blending
55	Fluid milk and butter manufacturing
56	Cheese manufacturing
57	Dry, condensed, and evaporated dairy products
58	Ice cream and frozen dessert manufacturing
59	Animal, except poultry, slaughtering, rendering, and processing
60	Poultry processing
65	Snack food manufacturing
69	All other food manufacturing
72	Wineries
Forestry Core Processing	
95	Sawmills and wood preservation
96	Veneer and plywood manufacturing
97	Engineered wood member and truss manufacturing
98	Reconstituted wood product manufacturing
99	Wood windows and doors and millwork manufacturing
100	Wood container and pallet manufacturing
103	All other miscellaneous wood product manufacturing
105	Paper and paperboard mills
106	Paperboard mills

Table B.1 Virginia Agriculture and Forestry-related Industries by Component (continued)

IMPLAN Description Sector	IMPLAN Description Sector
Agriculture Extended Processing	Forestry Extended Processing
41 Dog and cat food manufacturing	101 Manufactured home (mobile home) manufacturing
42 Other animal food manufacturing	102 Prefabricated wood building manufacturing
48 Sugar cane mills and refining	107 Paperboard container manufacturing
50 Chocolate and confectionary manufacturing from cacao beans	108 Coated and laminated paper, packaging paper and plastics film manufacturing
51 Confectionery manufacturing from purchased chocolate	109 All other paper bag and coated and treated paper manufacturing
52 Non-chocolate confectionery manufacturing	110 Stationary product manufacturing
53 Frozen food manufacturing	111 Sanitary paper product manufacturing
54 Fruit and vegetable canning, pickling, and drying	112 All other converted paper product manufacturing
61 Seafood product preparation and packaging	295 Wood kitchen cabinet and countertop manufacturing
62 Bread and bakery product manufacturing	296 Upholstered household furniture manufacturing
63 Cookie, cracker, and pasta manufacturing	297 Non-upholstered wood household furniture manufacturing
64 Tortilla manufacturing	299 Institutional furniture manufacturing
66 Coffee and tea manufacturing	300 Wood television, radio, and sewing machine cabinet manufacturing
68 Seasoning and dressing manufacturing	301 Office furniture and custom architectural woodwork and millwork manufacturing
70 Soft drink and ice manufacturing	302 Showcases, partition, shelving, and locker manufacturing
71 Breweries	
73 Distilleries	
74 Tobacco product manufacturing	
75 Fiber, yarn, and thread mills	
76 Broadwoven fabric mills	
77 Narrow fabric mills and schiffli machine embroidery	
78 Nonwoven fabric mills	
80 Textile and fabric finishing mills	
86 Apparel knitting mills	
87 Cut and sew apparel contractors	
88 Men's and boys' cut and sew apparel manufacturing	
89 Women's and girls' cut and sew apparel manufacturing	
90 Other cut and sew apparel manufacturing	
91 Apparel accessories and other apparel manufacturing	
93 Footwear manufacturing	
94 Other leather and allied product manufacturing	
Agriculture Distribution	Forestry Distribution
319 Wholesale Trade	31 Electric power generation, transmission, and distribution
NAICS 4245 Farm product raw material wholesalers	NAICS 221117 Biomass electric power generation
340 Warehousing and storage	319 Wholesale Trade
NAICS 49312 Refrigerated warehousing and storage	NAICS 42331 Lumber, plywood, millwork, and wood panel wholesalers
NAICS 49313 Farm product warehousing and storage	
388 Services to buildings and dwellings	340 Warehousing and storage
NAICS 561730 Landscaping services	NAICS 49319 Other warehousing and storage

Table C.1 Virginia Agricultural Cash Receipts by IMPLAN Sector, 1990-2011 ($ Thousands)

Year	1	2	3	4	6	7	8	10	11	12	13	14	Total
1990	101,490	97,929	113,674	32,402	113,348	182,793	1,828	134,085	394,630	297,300	503,212	174,046	2,146,737
1991	85,953	84,621	100,188	53,980	117,551	197,171	5,614	114,834	387,203	269,325	516,917	176,602	2,109,959
1992	80,111	123,328	104,231	47,533	127,163	189,667	7,720	110,393	336,371	291,888	555,473	170,829	2,144,707
1993	77,608	93,293	83,343	44,430	134,023	180,807	9,364	83,097	333,775	276,500	618,058	192,619	2,126,917
1994	80,549	104,415	109,517	43,905	137,951	168,590	25,698	107,047	297,797	272,272	663,504	180,352	2,191,597
1995	79,782	146,114	105,119	49,899	139,287	174,906	42,072	92,765	245,575	266,340	703,456	184,034	2,229,349
1996	94,464	187,638	68,047	45,058	147,139	187,793	53,690	104,361	220,512	289,980	787,263	204,455	2,390,400
1997	99,405	137,347	94,638	42,903	160,235	190,781	48,764	92,514	351,260	258,020	734,824	200,902	2,411,593
1998	64,027	85,678	90,549	47,499	162,660	173,551	50,075	90,988	294,222	296,136	790,877	184,164	2,330,426
1999	50,326	71,822	76,610	63,275	170,662	155,883	39,038	83,377	324,546	291,706	786,825	175,485	2,289,555
2000	66,135	102,054	74,332	44,907	188,117	132,064	33,968	88,636	309,449	279,276	773,789	206,990	2,299,717
2001	76,073	107,475	85,960	45,760	104,357	124,374	37,407	95,987	349,753	318,240	816,492	217,284	2,379,162
2002	66,429	94,039	110,363	46,614	228,676	121,995	23,478	63,494	322,331	267,386	651,898	239,798	2,236,501
2003	80,313	100,380	112,699	41,023	227,505	89,521	39,194	64,219	339,260	244,666	720,786	332,142	2,391,708
2004	126,456	145,259	144,104	47,663	234,880	112,920	31,975	65,896	317,677	308,417	874,494	243,328	2,653,069
2005	102,996	123,749	142,317	54,975	235,778	60,527	43,593	58,120	408,700	293,040	891,004	223,492	2,638,291
2006	87,212	127,224	168,438	41,563	241,379	72,213	38,800	53,348	419,750	266,213	814,455	241,835	2,572,430
2007	140,066	177,740	114,710	39,892	255,153	71,059	39,088	56,261	416,697	371,685	926,015	235,739	2,844,105
2008	160,711	295,483	114,385	56,329	256,494	82,746	32,042	98,504	394,773	371,088	960,370	237,494	3,060,419
2009	186,604	198,182	121,193	61,132	261,400	80,962	40,311	95,632	292,101	264,384	866,501	214,295	2,682,697
2010	162,994	142,678	96,555	54,243	261,700	78,409	59,930	85,476	373,186	331,934	1,015,460	235,828	2,898,393
2011	168,703	311,581	98,070	57,422	266,900	80,850	71,452	127,504	452,337	395,241	1,042,448	231,535	3,304,043

Table D.1 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-related Industries by Locality, Output 2011 ($ Millions)

	Agriculture		Forestry		Agriculture & Forestry	
Locality	Direct	Total	Direct	Total	Direct	Total
Accomack	861.9	998.4	3.3	4.1	865.2	1,002.5
Albemarle and Charlottesville City	269.9	355.5	69.3	98.3	339.2	453.8
Alexandria	203.8	288.9	11.7	17.3	215.6	306.2
Alleghany and Covington City	6.1	6.8	1,029.3	1,226.2	1,035.4	1,233.0
Amelia	50.7	57.9	57.5	72.0	108.2	129.9
Amherst	20.6	23.7	227.7	281.5	248.3	305.2
Appomattox	14.7	17.2	33.1	40.7	47.8	57.9
Arlington	57.5	80	3.1	4.0	60.7	84.1
Augusta and Staunton and Waynesboro cities	1,334.80	1,595.80	160.9	209.7	1,495.7	1,805.5
Bath	7.1	8.9	5.9	7.4	13.0	16.2
Bedford and Bedford City	146.5	182.9	299.4	394.4	445.9	577.3
Bland	19.1	20.9	1.2	1.4	20.2	22.2
Botetourt	124	150.4	72.5	96.1	196.5	246.4
Brunswick	26.7	31.3	65.6	80.8	92.4	112.2
Buchanan	5.3	6.4	3.2	4.1	8.5	10.5
Buckingham	31.6	34.8	45.6	56.5	77.1	91.3
Campbell and Lynchburg City	1,278.80	1,584.50	245.9	329.7	1,524.6	1,914.2
Caroline	23.4	30.5	52.1	66.3	75.4	96.7
Carroll and Galax City	210.8	244.4	143.3	181.7	354.1	426.0
Charles City	20.6	25	42.9	52.0	63.5	77.0
Charlotte	26.9	31.3	95.2	117.8	122.1	149.0
Chesapeake	155.1	232	84.2	131.0	239.4	363.0
Chesterfield	956.4	1,185.40	93.2	126.9	1,049.6	1,312.3
Clarke	74.9	90.5	14.2	18.6	89.1	109.2
Craig	11.2	12.5	0.3	0.3	11.5	12.8
Culpeper	95.9	125.6	72.6	109.5	168.4	235.1
Cumberland	27	29.1	21.7	25.3	48.6	54.4
Dickenson	2.1	2.3	9.7	11.8	11.7	14.1
Dinwiddie and Colonial Heights and Petersburg cities	119.9	143.8	80.4	107.0	200.3	250.9
Essex	23.4	30.9	44.8	58.3	68.2	89.3
Fairfax and Fairfax and Falls Church cities	591.2	896.4	108.6	165.7	699.8	1,062.2
Fauquier	141.4	180.6	23.2	33.6	164.6	214.2
Floyd	158.7	187.4	5.9	7.6	164.6	195.0
Fluvanna	27.4	31	8.7	10.8	36.1	41.7
Franklin	140	167.4	326.2	425.6	466.2	593.0
Frederick and Winchester city	977.6	1,245.90	120.9	164.6	1,098.5	1,410.5
Giles	11.6	13.2	6.7	8.6	18.3	21.9

Table D.1 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-related Industries by Locality, Output 2011 ($ Millions)

	Agriculture		Forestry		Agriculture & Forestry	
Locality	Direct	Total	Direct	Total	Direct	Total
Gloucester	33.4	41.4	3.0	4.1	36.4	45.5
Goochland	34	43.9	8.6	11.1	42.6	55.0
Grayson	39.6	45	35.8	42.5	75.3	87.5
Greene	18.3	22.1	8.6	11.0	26.9	33.2
Greensville and Emporia City	356.3	409	145.3	179.5	501.6	588.5
Halifax	362.8	408	76.3	96.9	439.1	505.0
Hampton	45.6	61.9	16.4	22.1	62.0	84.0
Hanover	386.5	506.9	278.8	374.1	665.3	881.0
Henrico	866.7	1,184.70	306.6	473.6	1,173.3	1,658.3
Henry and Martinsville	273.5	317.6	303.9	386.5	577.5	704.1
Highland	14.9	16.6	7.4	8.9	22.3	25.6
Isle of Wight	1,282.10	1,486.10	61.7	75.2	1,343.8	1,561.3
James City and Williamsburg City	712.3	1,023.70	18.0	25.5	730.3	1,049.2
King and Queen	19.4	24.4	23.9	28.2	43.3	52.6
King George	16.9	20.3	4.9	5.9	21.8	26.2
King William	20.3	26	481.3	572.3	501.7	598.4
Lancaster	31	44.5	2.8	3.9	33.8	48.4
Lee	26.5	35.5	7.3	11.4	33.8	46.9
Loudoun	359.1	516.3	58.1	84.9	417.2	601.2
Louisa	24.5	35	63.4	98.5	87.9	133.5
Lunenburg	82.8	91.6	26.7	32.3	109.4	123.9
Madison	56.5	65.7	32.6	39.9	89.1	105.6
Mathews	11.7	13.8	0.9	1.2	12.6	15.1
Mecklenburg	184.6	237.1	84.4	113.0	269.0	350.1
Middlesex	30.6	40.6	13.3	17.1	43.9	57.6
Montgomery and Radford City	355.2	459	136.8	179.3	492.0	638.3
Nelson	100.8	114.4	22.4	27.6	123.2	142.1
New Kent	10.2	12.7	21.3	27.0	31.6	39.6
Newport News	421.6	543.4	88.9	118.5	510.5	661.9
Norfolk	206.8	275.8	96.6	116.5	303.5	392.3
Northampton	145.9	174.9	3.4	4.5	149.3	179.4
Northumberland	148.4	182.9	1.5	1.9	149.8	184.8
Nottoway	31.1	36.2	47.1	59.2	78.2	95.4
Orange	135.5	165.9	59.3	81.1	194.9	247.0
Page	124.4	140	49.7	63.9	174.1	204.0
Patrick	106.1	124.8	156.0	194.6	262.1	319.4
Pittsylvania and Danville City	319.8	400.9	406.6	523.8	726.4	924.7
Portsmouth	266.7	319.6	6.5	9.8	273.2	329.3

Table D.1 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-related Industries by Locality, Output 2011 ($ Millions)

	Agriculture		Forestry		Agriculture & Forestry	
Locality	Direct	Total	Direct	Total	Direct	Total
Powhatan	15.1	18.5	26.6	34.1	41.7	52.7
Prince Edward	27.9	31.5	35.6	49.4	63.5	81.0
Prince George and Hopewell City	58.8	73.8	212.3	253.9	271.1	327.7
Prince William and Manassas and Manassas Park cities	149.7	216.1	70.6	101.6	220.3	317.7
Pulaski	39.9	47.1	7.2	9.5	47.1	56.6
Rappahannock	26.7	31.3	4.6	5.6	31.3	36.9
Richmond	24.4	28.3	26.8	32.7	51.2	61.0
Richmond City	5,609.00	6,384.40	423.3	580.7	6,032.2	6,965.1
Roanoke City	322.5	435.7	92.1	141.4	414.5	577.1
Roanoke and Salem City	203.4	289.5	159.9	237.4	363.4	526.9
Rockbridge and Buena Vista and Lexington cities	51	58	68.3	84.4	119.3	142.4
Rockingham and Harrisonburg City	2,600.10	3,078.50	136.4	180.6	2,736.5	3,259.1
Russell	42	54.1	5.6	7.6	47.7	61.7
Scott	19.8	21.7	15.4	18.6	35.1	40.3
Shenandoah	510.8	620.2	126.4	157.1	637.2	777.3
Smyth	39.8	48.7	57.8	81.4	97.6	130.1
Southampton and Franklin City	209	239.9	26.7	32.4	235.7	272.3
Spotsylvania and Fredericksburg City	44.8	64.3	89.6	135.8	134.4	200.0
Stafford	84.6	107.3	17.7	22.9	102.3	130.2
Suffolk	876.1	1,123.80	22.5	30.5	898.6	1,154.4
Surry	37.8	43.1	14.9	17.7	52.7	60.8
Sussex	31.1	36.1	9.1	10.4	40.1	46.5
Tazewell	113.4	140.6	19.3	26.8	132.7	167.4
Virginia Beach	165.6	250.6	70.2	108.0	235.8	358.7
Warren	138	176.4	22.7	29.8	160.7	206.2
Washington and Bristol City	254.5	323.2	28.5	39.5	283.0	362.7
Westmoreland	90.5	113.4	35.9	45.5	126.4	158.8
Wise and Norton City	81.6	95.6	31.5	41.2	113.1	136.8
Wythe	506.1	584.5	11.3	14.4	517.4	598.9
York and Poquoson City	34.7	53	7.3	10.1	42.0	63.1

Note: columns for ‘Forestry’ and ‘Agriculture and Forestry’ were corrected on 9/18/2013 to reflect proper counts. Previous counts for both columns were incorrect.

Table D.2 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-related Industries by Locality, Employment 2011

	Agriculture		Forestry		Agriculture & Forestry	
Locality	Direct	Total	Direct	Total	Direct	Total
Accomack	4,142	5,372	23	29	4,165	5,401
Albemarle and Charlottesville City	1,776	2,405	363	584	2,139	2,989
Alexandria	984	1,506	94	126	1,078	1,632
Alleghany and Covington City	164	170	1,688	3,371	1,852	3,541
Amelia	590	655	345	463	935	1,118
Amherst	361	389	452	918	813	1,307
Appomattox	293	314	241	312	534	626
Arlington	487	615	21	26	508	641
Augusta and Staunton and Waynesboro cities	4,692	6,732	803	1,179	5,495	7,911
Bath	171	183	33	43	204	226
Bedford and Bedford City	1,486	1,826	868	1,736	2,354	3,562
Bland	291	305	4	5	295	310
Botetourt	874	1,072	251	434	1,125	1,506
Brunswick	452	494	358	491	810	985
Buchanan	137	147	21	29	158	176
Buckingham	455	486	251	351	706	837
Campbell and Lynchburg City	3,087	5,468	999	1,640	4,086	7,108
Caroline	712	766	298	409	1,010	1,175
Carroll and Galax City	1,662	1,970	1,064	1,397	2,726	3,367
Charles City	250	277	240	308	490	585
Charlotte	546	581	554	737	1,100	1,318
Chesapeake	1,869	2,500	532	914	2,401	3,414
Chesterfield	1,629	2,944	318	575	1,947	3,519
Clarke	763	885	109	146	872	1,031
Craig	181	191	3	4	184	195
Culpeper	958	1,205	465	775	1,423	1,980
Cumberland	234	253	115	142	349	395
Dickenson	152	154	53	70	205	224
Dinwiddie and Colonial Heights and Petersburg cities	752	905	332	547	1,084	1,452
Essex	406	470	251	371	657	841
Fairfax and Fairfax and Falls Church cities	5,260	7,068	581	950	5,841	8,018
Fauquier	2,079	2,400	151	237	2,230	2,637
Floyd	1,073	1,319	43	58	1,116	1,377
Fluvanna	351	384	69	86	420	470
Franklin	1,419	1,684	1,666	2,554	3,085	4,238
Frederick and Winchester city	2,784	4,847	672	1,007	3,456	5,854
Giles	248	262	43	58	291	320

Table D.2 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-related Industries by Locality, Employment 2011

	Agriculture		Forestry		Agriculture & Forestry	
Locality	Direct	Total	Direct	Total	Direct	Total
Gloucester	385	454	31	41	416	495
Goochland	950	1,031	70	90	1,020	1,121
Grayson	728	774	196	253	924	1,027
Greene	259	292	60	80	319	372
Greensville and Emporia City	1,095	1,572	684	925	1,779	2,497
Halifax	1,288	1,703	403	564	1,691	2,267
Hampton	335	467	107	156	442	623
Hanover	3,476	4,524	792	1,581	4,268	6,105
Henrico	1,967	4,226	1,951	3,141	3,918	7,367
Henry and Martinsville	1,096	1,507	1,676	2,381	2,772	3,888
Highland	217	231	40	53	257	284
Isle of Wight	3,317	5,125	121	234	3,438	5,359
James City and Williamsburg City	1,020	2,712	119	184	1,139	2,896
King and Queen	417	451	114	147	531	598
King George	356	382	42	50	398	432
King William	719	763	692	1,436	1,411	2,199
Lancaster	306	427	32	41	338	468
Lee	832	984	60	97	892	1,081
Loudoun	4,859	5,950	339	530	5,198	6,480
Louisa	651	798	302	625	953	1,423
Lunenburg	387	417	160	204	547	621
Madison	753	830	204	267	957	1,097
Mathews	167	187	8	12	175	199
Mecklenburg	1,289	1,736	470	706	1,759	2,442
Middlesex	356	450	76	109	432	559
Montgomery and Radford City	1,110	1,755	860	1,217	1,970	2,972
Nelson	671	767	164	206	835	973
New Kent	417	437	164	209	581	646
Newport News	1,205	2,146	272	496	1,477	2,642
Norfolk	1,141	1,607	493	628	1,634	2,235
Northampton	917	1,176	17	26	934	1,202
Northumberland	758	1,038	13	16	771	1,054
Nottoway	341	383	231	324	572	707
Orange	1,078	1,302	367	525	1,445	1,827
Page	781	944	343	466	1,124	1,410
Patrick	1,011	1,199	721	1,083	1,732	2,282
Pittsylvania and Danville City	2,013	2,679	2,048	2,983	4,061	5,662
Portsmouth	707	1,146	62	87	769	1,233

Table D.2 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-related Industries by Locality, Employment 2011

	Agriculture		Forestry		Agriculture & Forestry	
Locality	Direct	Total	Direct	Total	Direct	Total
Powhatan	372	399	140	198	512	597
Prince Edward	448	481	336	457	784	938
Prince George and Hopewell City	846	958	355	647	1,201	1,605
Prince William and Manassas and Manassas Park cities	1,951	2,465	452	710	2,403	3,175
Pulaski	515	581	47	67	562	648
Rappahannock	439	475	29	36	468	511
Richmond	427	460	134	184	561	644
Richmond City	2,683	4,879	1,383	2,387	4,066	7,266
Roanoke City	828	1,661	600	976	1,428	2,637
Roanoke and Salem City	1,181	1,905	754	1,362	1,935	3,267
Rockbridge and Buena Vista and Lexington cities	663	722	316	444	979	1,166
Rockingham and Harrisonburg City	7,883	11,857	600	945	8,483	12,802
Russell	1,065	1,161	40	56	1,105	1,217
Scott	939	955	116	142	1,055	1,097
Shenandoah	2,690	3,587	449	681	3,139	4,268
Smyth	718	801	464	680	1,182	1,481
Southampton and Franklin City	1,066	1,340	155	205	1,221	1,545
Spotsylvania and Fredericksburg City	685	848	574	948	1,259	1,796
Stafford	697	873	89	129	786	1,002
Suffolk	2,440	4,331	99	162	2,539	4,493
Surry	379	414	88	105	467	519
Sussex	451	489	60	71	511	560
Tazewell	603	816	112	172	715	988
Virginia Beach	1,872	2,555	399	707	2,271	3,262
Warren	809	1,136	161	220	970	1,356
Washington and Bristol City	1,822	2,356	147	238	1,969	2,594
Westmoreland	1,145	1,355	279	361	1,424	1,716
Wise and Norton City	286	381	191	264	477	645
Wythe	1,704	2,345	86	117	1,790	2,462
York and Poquoson City	603	715	62	86	665	801

Table D.3 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-related Industries by Locality, Value-added 2011 ($ Millions)

	Agriculture		Forestry		Agriculture & Forestry	
Locality	Direct	Total	Direct	Total	Direct	Total
Accomack	168.6	257.8	1.4	1.8	169.9	259.6
Albemarle and Charlottesville City	64.8	119.4	24.5	42.6	89.2	161.9
Alexandria	50.5	111.3	4.9	8.6	55.4	119.9
Alleghany and Covington City	1.9	2.4	284.3	399.3	286.2	401.6
Amelia	13.2	18.8	24.9	33.8	38.1	52.6
Amherst	4.3	6.5	67.6	99.2	72.0	105.7
Appomattox	3.7	5.5	11.7	16.2	15.4	21.7
Arlington	17.6	33.8	1.4	2.0	19.0	35.8
Augusta and Staunton and Waynesboro cities	399.3	572.3	43.2	72.4	442.5	644.8
Bath	2.1	3.4	1.8	2.7	3.9	6.2
Bedford and Bedford City	33.0	56.7	87.2	142.8	120.1	199.5
Bland	3.9	5.2	0.7	0.9	4.6	6.1
Botetourt	21.8	38.5	25.4	40.3	47.2	78.8
Brunswick	9.4	12.6	36.6	45.8	46	58.3
Buchanan	1.6	2.3	1.5	2.0	3.1	4.4
Buckingham	9.3	11.8	19.6	26.0	28.9	37.8
Campbell and Lynchburg City	277.5	470.6	85.4	136.1	362.9	606.7
Caroline	6.7	11.9	18.2	26.4	24.9	38.3
Carroll and Galax City	55.0	76.1	54.5	76	109.5	152.1
Charles City	6.0	8.8	15.7	21.1	21.7	30.0
Charlotte	7.9	11.2	34.1	47.4	42	58.5
Chesapeake	79.0	129.2	42.6	72.7	121.6	201.9
Chesterfield	535.8	655.9	56.1	77.4	592	733.4
Clarke	21.0	31.6	8.2	11.1	29.2	42.7
Craig	2.9	3.9	0.1	0.1	3.0	4.0
Culpeper	25.3	47.1	31.1	54.1	56.3	101.3
Cumberland	6.1	7.7	8.6	10.6	14.8	18.2
Dickenson	0.5	0.7	3.1	4.3	3.6	4.9
Dinwiddie and Colonial Heights and Petersburg cities	60.7	74.0	31.7	48.1	92.4	122.2
Essex	8.1	13.6	12.1	19.8	20.2	33.4
Fairfax and Fairfax and Falls Church cities	202.8	402.5	58.7	98.6	261.5	501.1
Fauquier	46.8	73.4	12.4	18.9	59.2	92.3
Floyd	46.8	66.4	2.0	3.0	48.8	69.4
Fluvanna	7.8	10.6	3.8	5.0	11.6	15.7
Franklin	39.6	58.4	117.2	174.2	156.8	232.5
Frederick and Winchester city	218.3	395.4	42.8	69.9	261.1	465.3
Giles	4.1	5.3	2.8	3.9	6.9	9.2

Table D.3 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-related Industries by Locality, Value-added 2011 ($ Millions)

	Agriculture		Forestry		Agriculture & Forestry	
Locality	Direct	Total	Direct	Total	Direct	Total
Gloucester	9.9	15.4	0.9	1.6	10.9	17
Goochland	12.7	19.6	3.8	5.4	16.4	24.9
Grayson	11.1	14.8	8.0	11.4	19.0	26.2
Greene	5.7	8.3	2.8	4.3	8.5	12.6
Greensville and Emporia City	39.7	73.2	56.9	76.2	96.7	149.4
Halifax	121.1	153.9	30.4	42.5	151.5	196.4
Hampton	13.3	22.7	7.7	11.2	21.0	33.9
Hanover	117.4	197.9	120.0	180.6	237.4	378.4
Henrico	251.8	468.1	92.2	201.1	344.0	669.2
Henry and Martinsville	51.4	78.5	99.1	145.9	150.5	224.4
Highland	3.3	4.4	3.0	3.9	6.3	8.3
Isle of Wight	185.6	322	25.9	34.3	211.5	356.3
James City and Williamsburg City	306.3	474.2	9.5	14.4	315.8	488.6
King and Queen	5.9	9.4	13.4	16.0	19.3	25.5
King George	5.5	7.9	2.6	3.2	8.1	11.2
King William	6.6	10.7	206.2	261.9	212.8	272.5
Lancaster	6.0	14.0	0.6	1.2	6.5	15.2
Lee	8.0	12.2	2.7	4.7	10.7	16.9
Loudoun	142.9	248.9	27.8	45.8	170.7	294.7
Louisa	8.1	14.2	26.7	46.2	34.8	60.4
Lunenburg	49.6	53.1	9.5	12.8	59.1	65.9
Madison	14.2	20.8	10.8	15.0	25.0	35.9
Mathews	4.1	5.6	0.2	0.3	4.2	5.9
Mecklenburg	69.6	103.6	40.2	57.4	109.9	160.9
Middlesex	5.6	11.6	2.9	4.9	8.5	16.6
Montgomery and Radford City	54.3	105.5	44.7	69.4	99.0	174.9
Nelson	29.9	38.5	9.5	12.7	39.4	51.2
New Kent	3.3	5.1	9.6	12.9	12.8	18.1
Newport News	72.9	144.8	32.4	50.3	105.3	195.1
Norfolk	57.6	101.4	67.7	81	125.3	182.4
Northampton	60.3	81.6	1.5	2.2	61.9	83.8
Northumberland	30.1	50.7	0.6	0.8	30.7	51.5
Nottoway	7.9	11.4	14.8	21.6	22.7	33.0
Orange	58.0	80.8	18.7	32.1	76.7	112.9
Page	27.7	38.1	14.2	21.8	41.9	59.9
Patrick	27.3	39.3	83.8	106.6	111.0	145.9
Pittsylvania and Danville City	88.4	141.3	150.2	219.8	238.5	361.2

Table D.3 Direct and Total Economic Impacts of Virginia Agriculture and Forestry-related Industries by Locality, Value-added 2011 ($ Millions)

	Agriculture		Forestry		Agriculture & Forestry	
Locality	Direct	Total	Direct	Total	Direct	Total
Portsmouth	34.0	69.8	3.9	5.9	38.0	75.7
Powhatan	4.8	7.1	11.3	15.8	16.2	23.0
Prince Edward	7.9	10.4	15.6	23.3	23.5	33.8
Prince George and Hopewell City	26.0	35.3	66.8	92.9	92.8	128.2
Prince William and Manassas and Manassas Park cities	63.9	106.6	43.4	64.6	107.4	171.2
Pulaski	9.8	14.6	2.3	3.6	12.1	18.2
Rappahannock	6.0	9.1	1.0	1.5	7.0	10.6
Richmond	5.7	8.5	7.9	11.0	13.6	19.4
Richmond City	3,761.9	4,062.6	103.8	206.0	3,865.7	4,268.6
Roanoke City	58.0	128.9	39.7	70.2	97.7	199.1
Roanoke and Salem City	55.2	114.1	49.1	96.0	104.2	210.1
Rockbridge and Buena Vista and Lexington cities	12.0	16.8	17.0	25.7	29.0	42.5
Rockingham and Harrisonburg City	657.4	974.8	37.1	63.8	694.5	1,038.6
Russell	14.4	21.7	2.2	3.3	16.6	25.0
Scott	4.9	6.3	4.8	6.6	9.7	12.8
Shenandoah	94.4	165.0	42.6	60.6	137.0	225.6
Smyth	11.0	16.8	17.0	29.8	28.0	46.5
Southampton and Franklin City	50.9	72.5	10.8	14.1	61.6	86.5
Spotsylvania and Fredericksburg City	13.9	27.0	34.3	63.4	48.2	90.4
Stafford	21.2	36.0	6.9	10.1	28.2	46.1
Suffolk	231.3	386.5	7.2	12.1	238.6	398.6
Surry	7.3	11.5	4.9	6.5	12.2	18.0
Sussex	9.2	12.3	4.1	4.9	13.3	17.2
Tazewell	17.1	32.9	4.9	9.1	22.0	42
Virginia Beach	58.9	114	34.5	59.1	93.3	173.1
Warren	42.8	66.5	8.4	12.7	51.2	79.2
Washington and Bristol City	64.3	108.1	10.0	16.8	74.3	124.9
Westmoreland	19.4	33.4	15.3	20.6	34.7	54.0
Wise and Norton City	11.3	19.5	11.5	17.2	22.8	36.8
Wythe	70.7	115.5	7.2	9.3	77.8	124.8
York and Poquoson City	18.0	26.5	3.2	4.9	21.2	31.5

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