The Economic Impact of Agriculture and Forestry on the Commonwealth of Virginia

Terance J. Rephann, Ph.D

September 2008

Weldon Cooper
Center for Public Service
University of Virginia

THE ECONOMIC IMPACT OF AGRICULTURE AND FORESTRY ON THE COMMONWEALTH OF VIRGINIA

Terance J. Rephann, Ph.D.

Weldon Cooper Center for Public Service
University of Virginia

September 2008

Copyright © 2008 by the Rector and Visitors of the University of Virginia

WELDON COOPER
CENTER FOR PUBLIC SERVICE
University of Virginia

P.O. Box 400206
Charlottesville, VA 22904-4206
(434) 982-5522 • FAX: (434) 982-5536 • TDD: (434) 982-HEAR
Website: www.coopercenter.org/

Richmond
700 East Franklin Street, Suite 700
Richmond, VA 23219-2328
(804) 371-0202 • FAX: (804) 371-0234 • TDD: (804) 982-HEAR

Southwest
1 College Avenue
Wise, VA 24293-0016
(540) 328-0133 • FAX: (540) 328-0233 • TDD (540) 328-0191

Southside
1008 South Main Street
Danville, VA 24541-4088
(434) 791-5174 • (434) 791-5175 • FAX: (434) 791-5176

TABLE OF CONTENTS

List of Text Boxes iv
List of Tables v
List of Figures vi
Foreword vii
Study Highlights 1
Executive Summary 3
Introduction 7
Section 1. Virginia's Agriculture and Forestry Industries 9
    Agriculture 9
    Forestry 17
Section 2. Review of Methodological Issues 23
    Input-Output Analysis and Multipliers 23
    Sector Impact Measurement 24
    Defining the Scope of the Agriculture and Forestry Direct Effect 26
Section 3. Study Data and Research Design 29
    Industries for Agriculture and Forestry Direct Effects 30
    Data 31
    Model 34
Section 4. Results 35
    Direct Impacts 35
    Total Impacts 35
    Impact by Industry Components 37
    Impacts by Region 40
Section 5. Agriculture and Forestry Related Tourism Impacts 43
    Wildlife Recreation 43
    Equine Industry 43
    Wineries 43
    Other Agri-tourism, Agricultural Festivals, and Agricultural Fairs 44
Section 6. Summary and Conclusions 45
References 47
Appendix 53

LIST OF TEXT BOXES

Box 2.1. What is Input -Output Analysis? 23
Box 2.2. Weber Location Triangle 28
Box 3.1 What is IMPLAN? 29
Box 3.2 Backward versus Forward Linkages 30
Box 4.1 Value-added versus Total Industry Output 35

LIST OF TABLES

1.1 Virginia's Top 10 Commodities in U.S. Market, 2006 11
1.2 Regional Distribution of Virginia Farm Employment, Percentage of Total, 2004 16
1.3 Factors influencing Virginia Agriculture..... 16
1.4 Factors influencing Virginia Forestry 20
3.1 Virginia Agriculture and Forestry Sectors 32
4.1 Virginia Agriculture and Forestry Industries Direct Output, Employment, and Value-added, 2006 36
4.2 Virginia Total, Direct, Indirect, and Induced Impacts of Agriculture and Forestry, 2006 37
4.3 Total Impact of Virginia's Agriculture and Forestry by Major Industry, 2006 38
4.4 Total Impact of Virginia's Agriculture and Forestry by Component, Output in Millions of Dollars, 2006 38
4.5 Total Impact of Virginia's Agriculture and Forestry, Employment, 2006 39
4.6 Total Impact of Virginia's Agriculture and Forestry, Value-added in Millions of Dollars, 2006 39
4.7 Direct Impact of Virginia Agriculture and Forestry by District, 2006 41
4.8 Total Impact of Virginia Agriculture and Forestry by District, 2006 41
5.1 Wildlife Recreation Impacts in Virginia, 2001 43
A.1 Agriculture Statistic Districts 55
A.2 Virginia Agricultural Cash Receipts by IMPLAN Sector, 1990-2006 56

LIST OF FIGURES

1.1 Virginia Land Use Summary by Major Category, 2002 9
1.2 Farms and Market Sales Distribution by Farm Sales Category, Virginia, 2002 10
1.3 Average Farm Size, Virginia and the United States, 1970-2006 10
1.4 Cash Receipts by Commodity, Virginia, 2006 11
1.5 Virginia Real and Nominal Agricultural Cash Receipts, 1990-2006 12
1.6 Virginia Farm Employment and Land Area, 1990-2006 12
1.7 Change in Virginia Commodity Sales by Size and State Specialization, 1990-2006 13
1.8 Government Payments as a Percentage of Virginia Gross Cash Income, 1990-2006 14
1.9 Farm Employment as Percentage of Total Employment by Locality, 2006 15
1.10 Virginia Agriculture Statistic Districts 15
1.11 Virginia Land Area by Forest Type, 2005 18
1.12 Virginia Real and Nominal Stumpage Values, 1990-2006 18
1.13 Percentage of Total Acreage in Forest by Locality, 2001 19
1.14 Value of Virginia Stumpage by Locality, 2006 19
2.1 Multiplier Effects of $1 of New Sales 24
2.2 Virginia Farm and Farm-Related Employment, 1981-2002 26
4.1 Virginia Direct Effects by Agriculture and Forestry Component, 2006 36
4.2 Distribution of Virginia's Direct, Indirect, and Induced Employment Impacts by Industry, 2006 39
4.3 Virginia Total Impacts by Agriculture and Forestry Component, 2006 40
4.4 District Employment Impact as Percentage of Total Employment by District, 2006 41

FOREWORD

This study describes the contribution of the agriculture and forestry industries to Virginia's economy. The study relies on both published and unpublished data as well as literature that address trends in the agriculture and forestry industries. 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 impacts, impacts by industry groupings arranged by level of dependency on raw materials originating within the state, and impacts by region. These estimates can serve as a baseline for future work that gauges change in Virginia's agriculture and forestry industries economic impacts and provides insight into sources of that change.

The study was commissioned by the Virginia Secretary of Agriculture and Forestry and is a successor to studies sponsored by the Virginia Department of Agriculture and Consumer Services (VDACS) in the 1990s. These studies were conducted by the Department of Agricultural and Applied Economics at Virginia Tech. This study has many methodological similarities with those studies. Like those studies, some parts provide needed technical documentation, but the executive summary is suitable for a more general audience.

The author would like to thank various individuals for assistance in completing this study. Professor William Shobe of the Weldon Cooper Center for Public Service wrote the original proposal that made this study possible. Deputy Secretary of Agriculture and Forestry William Dickinson assisted greatly in coordinating input from industry and government and served as a resource for the study. VDACS staff, Virginia Department of Forestry staff, and agriculture and forestry industry representatives assisted in defining pertinent agricultural and forestry industries and provided the author with a perspective on economic trends within the industries. These participants included Donna Pugh Johnson of the Virginia Agribusiness Association, Wayne Pryor, Al Glass, and Tony Banks of the Virginia Farm Bureau, Paul Howe of the Virginia Forestry Association, Randy Bush of the Virginia Forest Products Association, James Mooney of the Virginia Loggers Association, State Forester Carl Garrison, Deputy State Forester John Carroll, Charles Becker, Ron Jenkins, and John Scrivani of the Department of Forestry, and Deputy Commissioner Donald Blankenship, James Green, Kent Lewis, Frank Graves, and Perida Giles of VDACS.

Special thanks go to Mr. Herman Ellison and David Mueller of the National Agricultural Statistics Service Richmond Office, Charles Becker of the Virginia Department of Forestry, and Timothy Kesner and David Tysinger of the Virginia Employment Commission for assistance in compiling data and information that were used in this report. Four external reviewers provided valuable recommendations for improving the study. Professor John Knapp of the Weldon Cooper Center provided helpful guidance and feedback. Steve Kulp assisted with document preparation. Rohan Pai and Caitlin Bailey helped with data collection and presentation. Dave Borszich and W. Grace Ng provided editing advice. Any errors or omissions are the responsibility of the author.

Terance J. Rephann
Regional Economist

Charlottesville, Virginia
September 2008

The Economic Impact of Agriculture and Forestry on the Commonwealth of Virginia

Terance J. Rephann, Ph.D.

STUDY HIGHLIGHTS

Agriculture and Forestry

• The total economic impact of agriculture and forestry-related industries in Virginia was almost $79 billion in total industry output in 2006, the base year for this study. The total employment impact was approximately 501,500 employees, which made up 10.3 percent of state employment.

• Every job created in agriculture and forestry related industry results in another 1.5 jobs in the Virginia economy. Every dollar generated in value-added results in another $1.75 value-added in the Virginia economy.

• The impacts of agriculture and forestry are felt in other sectors of the economy. The largest effects are in the directly affected manufacturing and agriculture, forestry, fishing, and hunting 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. The effects reverberate throughout the economy affecting every sector.

• There are notable regional differences in the sizes of agriculture and forestry related industries. The largest direct employment impact is in Northern Virginia (which in this case is defined to include the northern parts of the Shenandoah Valley as well as more metropolitan areas around Washington, D.C.), and the largest total impact is observed in Central Virginia. Impacts as a percentage of estimated total employment range from a low of approximately 5 percent of total employment in Northern Virginia to nearly one in four employees in the Southern district centered on Danville, which is heavily dependent on forest products industries.

• Although this study did not examine the full effects of agritourism and forest-related recreation, such as wildlife recreation, horse events, wine tourism, and agricultural festivals, results from other Virginia studies suggest that the impacts on output may amount to several billions of dollars.

• Agriculture and forestry activities have significant societal and ecological effects in addition to their economic benefits. Forests provide benefits in the form of carbon sequestration, wildlife habitat and biodiversity, flood mitigation and improved water quality. Rural scenic amenities may also improve quality of life.

• The impact results provided in this study are not comparable to previously published results based on earlier studies because of differences in agriculture and forestry-related sector definitions, input data, and model characteristics.

Agriculture

• The total impact of agriculture-related industries was over $55 billion in total industry output and approximately 357,100 jobs.

Forestry

• The forestry sector had a total impact of over $23 billion in total industry output and approximately 144,400 jobs.

EXECUTIVE SUMMARY

Agriculture and forestry are a highly visible part of Virginia's economic base. Nearly 21 million acres, or 82 percent, of the commonwealth's total land area is forest, cropland, or pasture and range. Additional land is forested parkland and public open space. In 2006, Virginia's farms generated an estimated $2.7 billion in cash receipts, and forest landowners received nearly $350 million for harvested timber. More importantly, agriculture and forestry have strong linkages with other industries in Virginia that add value throughout the value chain, including the processing and distribution industries. Many of these industries would not exist in the state in their current form without a strong base of regional agriculture and forest based raw materials. These industries purchase from other industries that in turn purchase from other industries in a cascading series of transactions that creates a stimulating effect on industries across the economic spectrum. In addition, agriculture and forestry related employment supports the expenditures of households that circulate throughout the economy creating additional earnings and employment.

Virginia has a rich and varied agricultural economy. It plays a prominent role in several national commodity markets, ranking third for fresh tomatoes, and fifth in tobacco. It provides one-twelfth of the U.S. output of turkeys. Apples, potatoes, snap beans, and broilers are other significant commodities. Moreover, production of some farm commodities is sizeable relative to state production. Nearly three-fifths of agricultural cash receipts are derived from livestock and poultry.

Although total employment and land area in agricultural use within Virginia have continued to decline, productivity improvements have meant that output has remained relatively steady. The composition of this output, however, has been in continuous flux. Over the last two decades, decreases in output of several farm products such as peanuts, tobacco, dairy, and hogs have been offset by gains in others such as poultry, equine, aquaculture, cotton, and greenhouse and nursery products.

Farm production shows strong geographical patterns. In terms of agricultural employment's share of total employment, the southwestern and southern parts of the state are more reliant on farm employment. However, the picture is more complex and differentiated than that simple snapshot. Virginia's agriculture sector shows substantial regional diversity because of strong regional specializations by farm commodity. For instance, cotton is primarily a southeastern crop. Over three-quarters of tobacco production can be found in the southern and southwestern regions. Half of poultry employment occurs in the northern region. Vegetable production is concentrated in the east, while fruit production shows a more northern pattern.

Virginia's forests are also quite diverse. Although the commonwealth's forests are dominated by hardwood stands, softwoods are more common removal species in the southeast and coastal regions. Oak-hickory is the dominant forest type followed by loblolly-shortleaf, and oak-pine. Virginia's forest resources are distributed throughout the state. Less forested areas are found in the Washington, DC environs and the eastern shore, while more forested areas exist in the west and south. The commonwealth's timber inventory is growing, and this growth is expected to continue into the near future. However, the long-term outlook is more uncertain because of urbanization pressures, environmental changes, disease, pests, and forest management problems

that arise from new property ownership patterns and the fragmentation of larger tracts into smaller parcels.

Forest stumpage (the sales value of timber) and production volume have remained fairly steady over the last ten years after a period of significant growth during the late 1980s and throughout the 1990s. Virginia produced an estimated 503 million cubic feet of roundwood timber products in 2005. Approximately 45 percent of this was saw logs, another 40 percent pulpwood, and the remainder composite panels, veneer logs, and other industrial products such as poles, posts, and mulch. Virginia mills produced 1.6 billion board-feet of lumber in 2006, including nearly 8 percent of the hardwood lumber in the nation making it the third largest producer after Pennsylvania and Tennessee.

Although the agriculture and forestry sectors have had fairly steady production in recent years, both sectors face opportunities and challenges in the process of maintaining either their absolute or relative positions within the economy. These positions will be shaped by numerous factors in the areas of production technology, consumer demand, energy, urban population growth, government policy, and the global economy.

This study is a successor to studies conducted by the Department of Agricultural and Applied Economics at Virginia Tech in the mid 1990s and a recent study by the Virginia Department of Forestry. Like those studies, it uses the standard tools of input-output analysis, including the personal computer based software program IMPLAN (IMpact analysis for PLANning) to estimate the contribution of agriculture and forestry to Virginia's economy and employment. Since the study is an economic impact study, no attempt is made to gauge the wider social benefits and costs of agriculture and forestry. However, clearly agriculture and forestry activity have tangible societal and ecological effects. Forests, in particular, provide benefits in the form of carbon sequestration, stabilization of soils, wildlife habitat and biodiversity, flood mitigation and improved water quality. Rural scenic amenities may also improve quality of life. Improper agricultural and logging practices, on the other hand, can impose costs arising from water quality degradation, noxious odors, and airborne pathogens.

This study differs in several important respects from those earlier studies. Because of some differences in methodology, including differences in the accounting and adjustment procedures used to generate the underlying input-output tables, differences in industrial classification schemes, and differences in the choices of agriculture and forestry related sectors to include in the analysis, the results are not directly comparable. Moreover, whereas the earlier studies examined the agriculture and forestry sectors in isolation, this study encompasses both agricultural and forestry and related industries and provides individual estimates for each industry. It also breaks manufacturing industries into separate categories in order to identify those sectors that exhibit the greatest degree of dependency on Virginia agricultural and forestry raw inputs. Industries for both forestry and agriculture were divided into production, core, extended, and distribution activities. "Production" activities are those industries associated with growing and harvesting farm commodities, timber, and non-timber forest commodities. "Core" processing activities are manufacturing industries that are heavily dependent on state commodity inputs for production as evidenced by strong forward linkages with production industries. It is unlikely that these industries would exist within the state in anything like their current form if commodity production did not occur in the state. An example of such an industry is milling lumber which is heavily dependent on nearby timber. "Extended" processing activities are manufacturing industries that are somewhat less dependent on Virginia farm and forest commodity inputs. An example of this industry is

soft drink manufacturing which relies primarily on syrups and concentrates produced elsewhere. "Distribution" industries consist of selected warehousing and wholesaling industries as well as landscaping services that are closely related to agriculture and forestry product distribution. Lastly, the study makes impact estimates for agricultural support payments to Virginia's farmers from the federal government.

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. The table can be manipulated to show the aggregate effects of change in one industry's output or employment on industries that provide inputs and the effects of induced spending by workers and government. It does this by generating multipliers that show the total effects, including direct effects, indirect effects, and induced effects, of a dollar change in direct sales.

These latter two effects occur when money retained in the state circulates through the economy. For instance, businesses provide inputs such as supplies and services to agricultural and forestry industries that in turn purchase inputs in order to produce the product or service and so forth. These effects are referred to as "indirect impacts." Also, the spending of new household income attributable to the direct and indirect effects of agriculture and forestry will induce subsequent rounds of spending. These effects are called "induced impacts." The incremental effect of each round of spending dissipates because a portion of the spending leaks out of the economy into another region. 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.

Economic impacts are evaluated using three different measures: total industry output, employment, and value-added. Total industrial output represents the total value of industry output during the period. Because total industry output "double counts" production inputs that are not available for final use, it is not emphasized in most economic analysis. Value-added, which refers to the additional value created or "added" to products at different stages of production, provides a better measure.

In 2006, the direct effect of Virginia agriculture and forest related industries accounted for $42 billion in total output, approximately 196,100 employees, and over $13 billion in value-added. Agriculture production is the largest component in terms of employment. However, agriculture extended processing 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 $79 billion in total industry output or sales. The value-added impact was $37 billion dollars, which constituted approximately 9.9 percent of Virginia gross domestic product (GDP). The total employment impact was approximately 501,500, which made up 10.3 percent of statewide employment.

The agriculture sector accounted for $55 billion in total industry output, approximately 357,100 jobs, and nearly $26 billion in value-added. The forestry sector had a total impact of approximately $23 billion in total industry output, approximately 144,400 jobs, and nearly $11 billion in value-added. The multipliers associated with agriculture were slightly larger than those for forestry.

The impacts of agriculture and forestry were felt in other sectors 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 large public and private services responses through the effects of industry purchases and subsequent rounds of indirect and induced spending. The effects reverberated throughout the economy affecting every sector.

The impacts were estimated for agriculture and forestry separately and further broken down into their production, core processing, extended processing, distribution, and government payments components. Results indicate that agriculture-related activities account for approximately 70 percent of total output, employment and value-added impacts with forestry-related activities making up the remainder. In terms of total impacts relative to total state employment and GDP impacts, agriculture-related industry represents approximately 7 percent of employment and 7 percent of GDP. Forestry-related industry impacts represent approximately 3 percent of statewide totals.

Looking at components along the agriculture and forestry value chain, production industry impacts make up 17 percent of the total employment impact but a considerably smaller share, 10 percent, of value-added and output impacts. Core processing makes up 23 percent of employment and value-added impacts but 27 percent of output impact. Extended processing is the largest impact category, constituting 47 percent of employment impact, 56 percent of output impact, and 58 percent of value-added impact. Distribution activities account for 11 percent of employment impact, 8 percent of value-added impact, and 6 percent of output impact. Government payments account for approximately 1 percent of each. Therefore, the bulk of the impact is attributable to industries with a somewhat weaker reliance on Virginia's farm commodities and timber.

Impacts were estimated for each of seven National Agricultural Statistical Service (NASS) agricultural statistic districts in Virginia. There are notable regional differences in the absolute and relative sizes of agriculture and forestry related industries. The largest direct employment impact is in the Northern district and the largest value-added impact is observed in the Central district. Impacts as a percentage of estimated total employment range from a low of approximately 5 percent of total employment in Northern Virginia to nearly one in four employees in the Southern district centered on Danville, which is heavily dependent on forest products industries.

Some forestry and agriculture impacts are not captured by the estimates in this study. For example, recreation and tourism are not fully reflected in the impacts because of the difficulty of measuring all consumer expenditures associated with agritourism and forest recreation activities. However, some estimates of the tourism contribution of agriculture and forestry available from other studies suggest that these impacts may amount to several billion dollars.

INTRODUCTION

Virginia's agriculture and forestry industries play an important role in the state's economy. The impact of the sectors exceeds the sales of the raw materials they sell. In 2006, Virginia's farms generated an estimated $2.7 billion in cash receipts, and forest landowners received nearly $350 million for harvested timber. More importantly, however, the sectors have strong linkages with other industries in Virginia that add value to these commodities. These industries make purchases from and sell to agriculture and forestry industries. Many manufacturers rely on Virginia agricultural and forestry commodities as inputs to production, and many firms sell products and services to producers of agricultural and forestry related products. In addition, food and fiber products are distributed to consumers within the state and exported to other states and to foreign markets. The infrastructure and services used in bringing these products to market and presenting them for consumer use are important elements of the value chain.

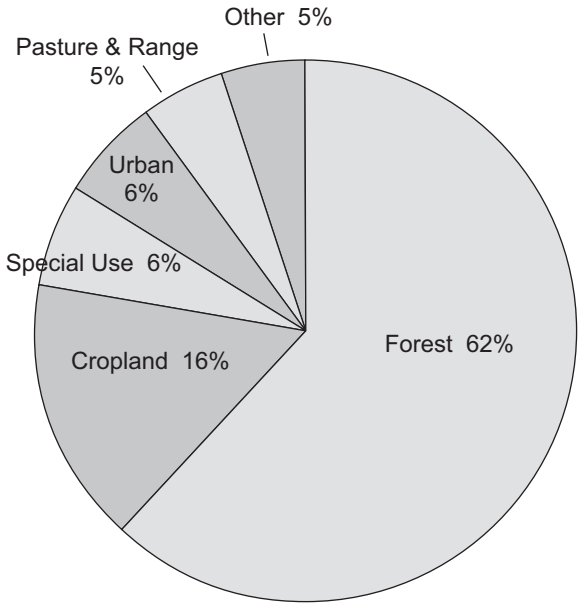
This study by the Business and Economics Research Section of the Weldon Cooper Center for Public Service at the University of Virginia was conducted for the Office of the Secretary of Agriculture and Forestry for the Commonwealth of Virginia. It is a successor to studies conducted by the Department of Agricultural and Applied Economics at Virginia Tech in the mid 1990s (Johnson and Wade 1994; Lamie 1997) and the Virginia Department of Forestry (Becker 2006). Like those studies, it uses the standard tools of input-output analysis to estimate the contribution of the agriculture and forestry to Virginia's economy and employment. However, whereas those studies examined each sector in isolation, this study encompasses both agriculture and forestry related industries. It also breaks manufacturing industries into separate categories in order to identify those sectors that exhibit the greatest degree of dependency on Virginia agricultural and forestry raw inputs. Lastly, the study makes separate impact estimates for agriculture, for forestry, and for regions within Virginia.

The study is divided into several sections. The first section examines important characteristics of the agriculture and forestry production sectors in Virginia and forces that have shaped the industries and that are likely to affect them in the future. The second section describes methodological issues that will affect how the impacts of agriculture and forestry activities are gauged. These issues include various features of the impact analysis method, input-output analysis, and the definition of agriculture and forestry related industries. The third section describes the industry definitions, input data, and microcomputer based model (IMPLAN) used in this study. Agriculture and forestry related industries are aggregated into four different components, 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. The fourth section presents the results. Impact estimates are provided in aggregate, by component, and by region. The fifth section reviews recent economic impact studies of forestry-related recreation and agritourism. The study ends with a summary and conclusion.

SECTION 1
VIRGINIA'S AGRICULTURE AND FORESTRY INDUSTRIES

Agriculture and forestry are highly visible parts of Virginia's economic base. Nearly 21 million acres, or 82 percent, (see **Figure 1.1**) of Virginia's total land area is forest, cropland, or pasture and range. Additional land is forested parkland and public open space. This section provides a brief background for each of the principal economic sectors and sketches some of the forces that are shaping the industries today and are likely to have an influence in the future.

Figure 1.1 Virginia Land Use Summary by Major Category, 2002

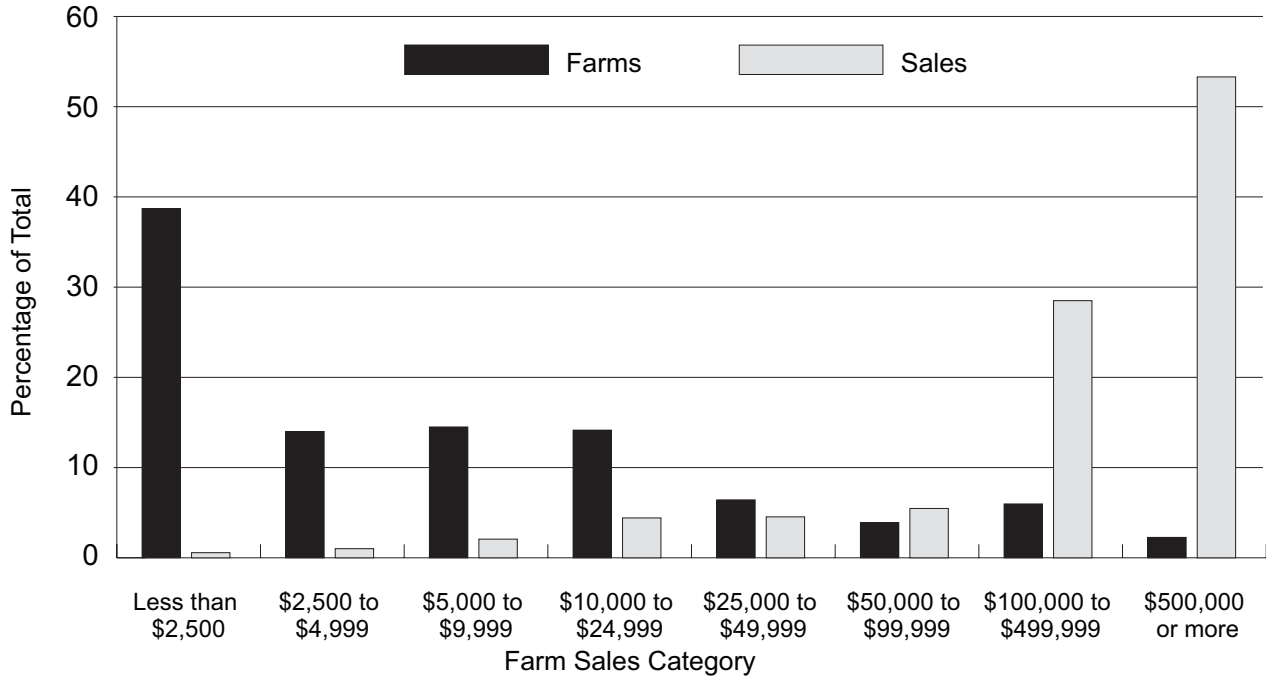


Source: Lubowski et al. (2006)

Agriculture

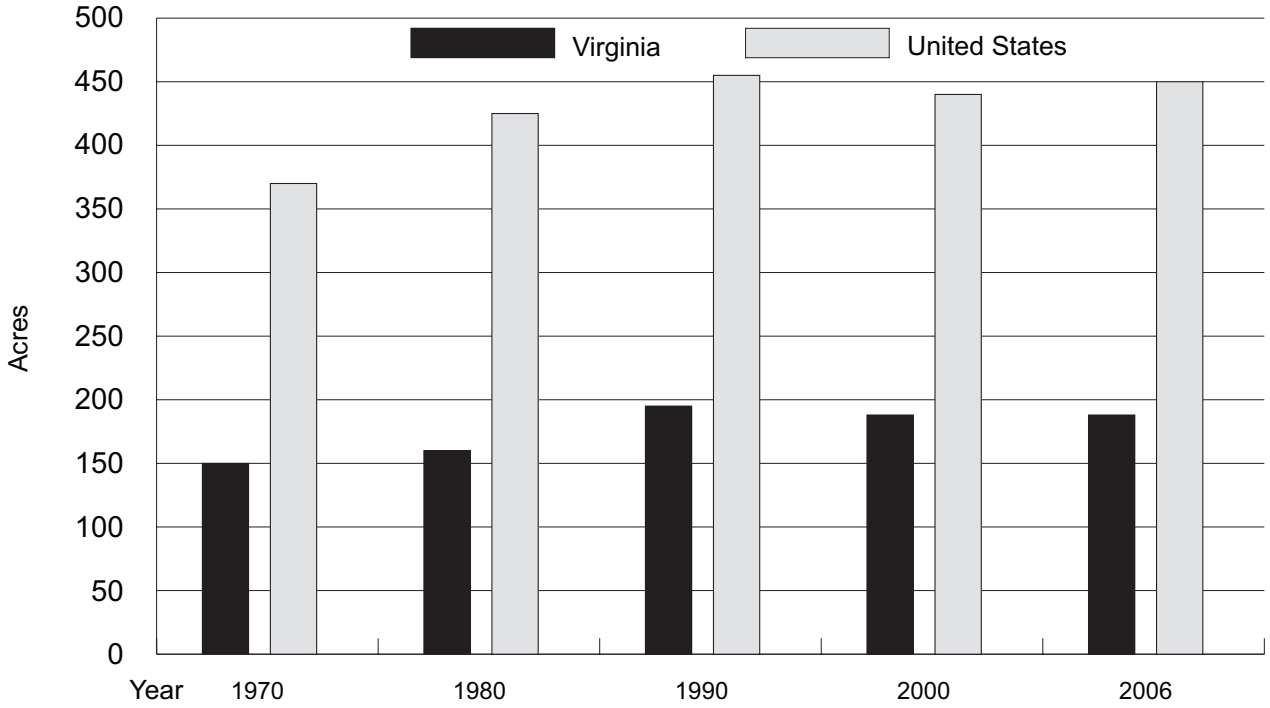
In 2006, Virginia's estimated number of farms was 46,000. The Census of Agriculture defines a farm as an enterprise that sold at least $1,000 worth of agricultural commodities or would so in a normal year. Most Virginia farms are relatively small with sales amounting to less than $5,000. The majority of sales, in contrast, are made by large farms (see **Figure 1.2**). Like farms elsewhere in the U.S., some farm attrition and consolidation continues to occur. Moreover, the number of small and large farms has increased while the number of medium-sized farms has decreased. The average farm size in Virginia is estimated to be 182 acres, which is an increase from 150 acres in 1970. However, it is considerably smaller than the U.S. average farm size of 446 acres which reflects the influence of large scale operations in the western U.S. (see **Figure 1.3**)

Figure 1.2 Farms and Market Sales Distribution by Total Sales Category, Virginia, 2002



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

Figure 1.3 Average Farm Size, Virginia and the United States, 1970-2006



Source: U.S. Department of Agriculture, Economic Research Service (2007)

Table 1.1. Virginia's Top 10 Commodities in U.S. Market, 2006

Commodity	National Rank	Percentage of U.S. Production
Tomatoes, Fresh Market	3	6.06
Tobacco	5	6.42
Apples	6	2.18
Potatoes, Summer	6	8.24
Beans, Snap, Fresh Market	7	4.16
Turkeys	8	8.21
Peanuts	8	1.43
Grapes	8	0.09
Sweet Potatoes	9	0.30
Broilers	10	2.88

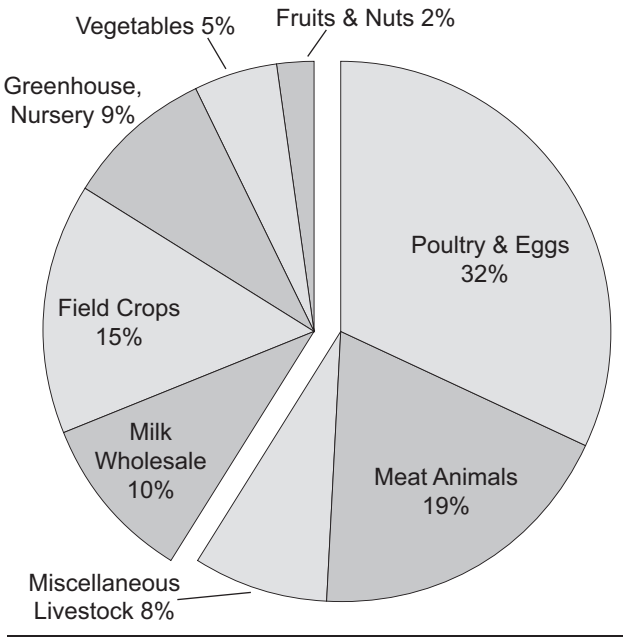
Source: U.S. Department of Agriculture, Economic Research Service (2007)

Virginia plays a prominent role in several U.S. commodity markets (see **Table 1.1**). It ranks third for fresh tomatoes and fifth for tobacco. It also provides one-twelfth of the U.S. output of turkeys. Apples, potatoes, snap beans, and broilers are other significant commodities. Nearly three-fifths of agricultural cash receipts are derived from livestock and poultry. Poultry and eggs accounts for nearly a third of the total. Field crops account for 15 percent of total cash receipts (see **Figure 1.4**).

Virginia's agricultural sector has undergone significant modernization in recent decades. Productivity improvements due to increased mechanization and the adoption of new technologies have meant that production levels have been maintained with fewer land and labor inputs. **Figure 1.5** shows that, while nominal cash receipts have increased rapidly in the last five years, sales adjusted by producer prices have decreased slightly. However, employment and estimated land acreage have decreased at a similar rate (see **Figure 1.6**). This pattern is similar to national trends (Fuglie, MacDonald, and Ball 2007).

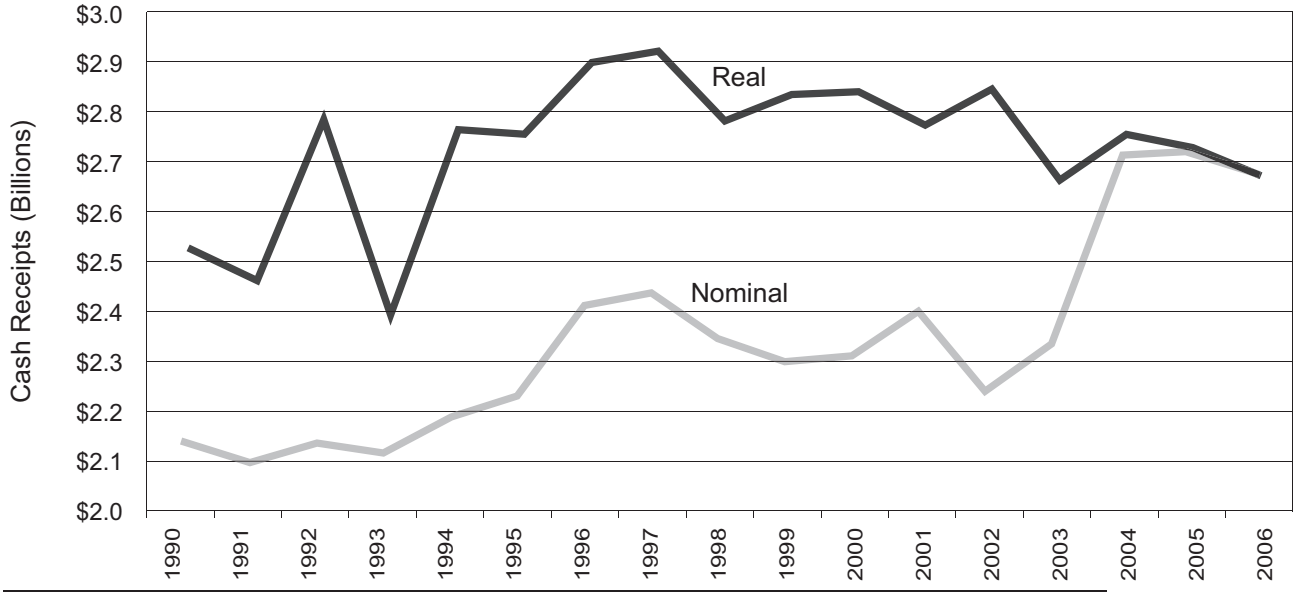
The types of commodities produced have also shifted. This is illustrated for major commodities in **Figure 1.7** which shows the degree of Virginia commodity specialization measured by a location

Figure 1.4 Cash Receipts by Commodity, Virginia, 2006



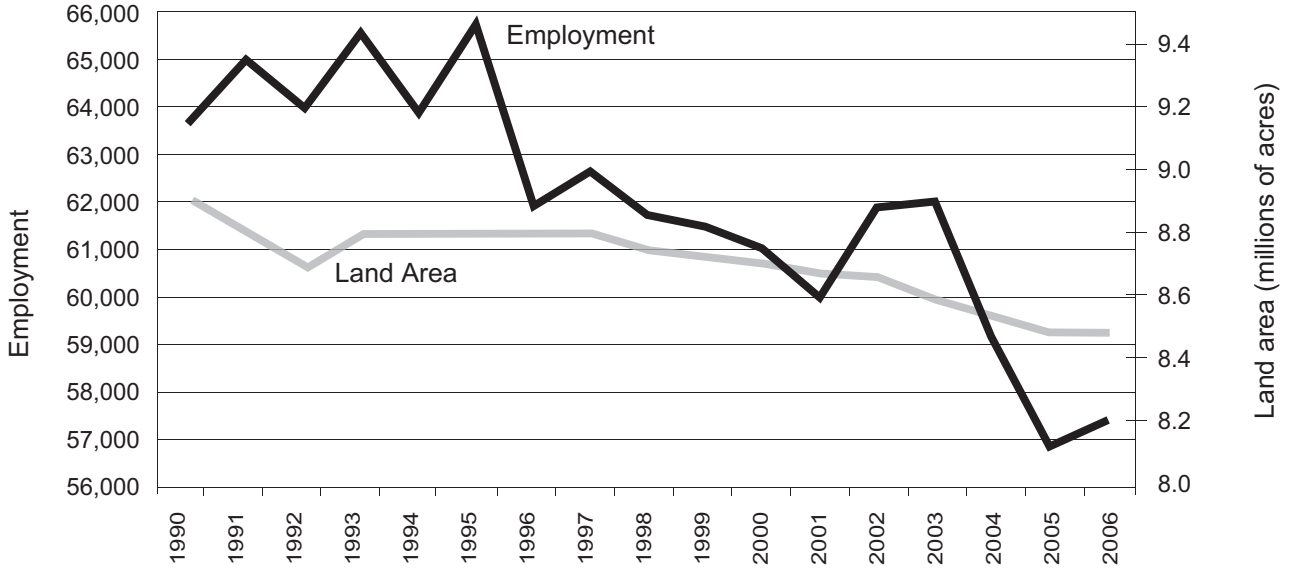
Source: U.S. Department of Agriculture, Economic Research Service (2007)

Figure 1.5 Virginia Real (2006 dollars) and Nominal Agricultural Cash receipts, 1990-2006



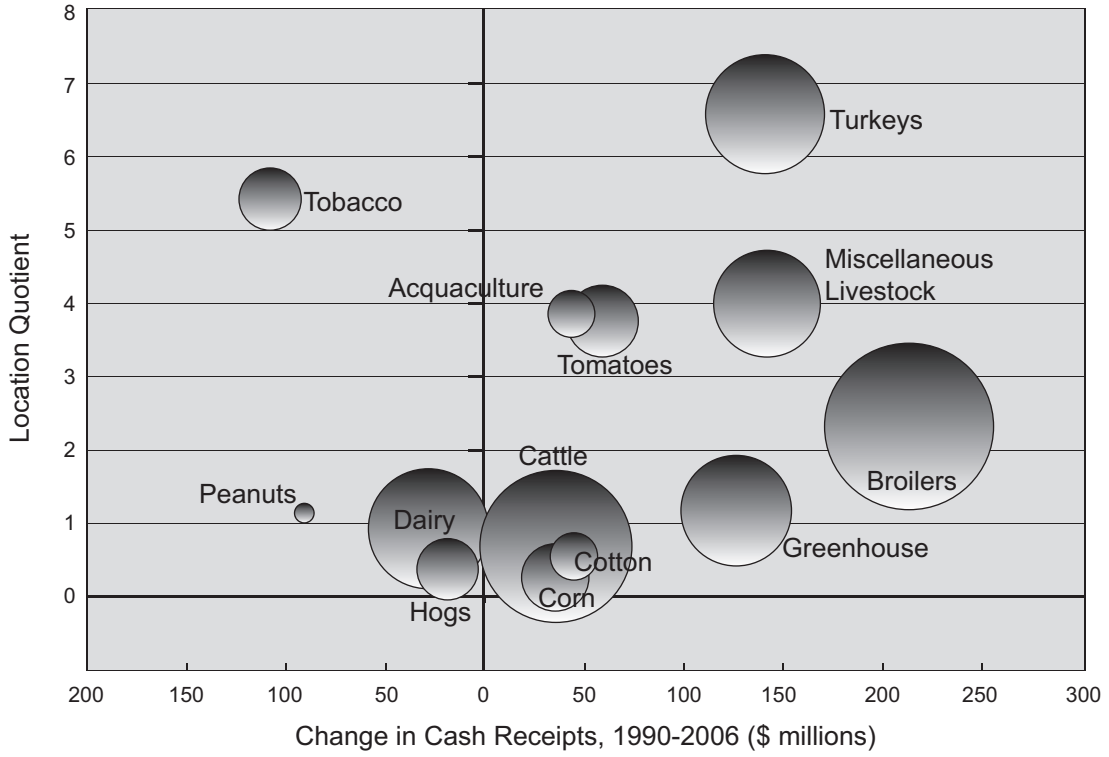
Sources: USDA, ERS, Farm Income: Data Files (2007) and Implan (2004).

Figure 1.6 Virginia Farm Employment and Land Area, 1990-2006



Source: U.S. Department of Commerce, Bureau of Economic Analysis (2008) and U.S. Department of Agriculture, Economic Research Service (2007)

Figure 1.7 Change in Virginia Commodity Sales by Size and State Specialization, 1990-2006



Source: U.S. Department of Agriculture, Economic Research Service (2007)

quotient[1] of Virginia versus national sales on the vertical axis, change in nominal commodity sales on the horizontal axis, and size of commodity sector sales scaled according to bubble size. Patterns of growth and decline vary by commodity with various factors such as national and international competitive pressures, consumer tastes, disease, environmental regulations, industry technology, weather, transportation costs, federal farm policy and payments, and urban development encroachment playing varied roles (Pease et. al 2005).

A few Virginia commodities have experienced marked decreases in production over the last sixteen years. Peanuts and tobacco, two crops which are more commonly farmed in Virginia, have declined significantly in production with changes in U.S. farm policy toward these commodities and unfavorable consumer attitudes towards smoking. Many Virginia tobacco and peanut farmers have participated in quota program buyouts in recent years and it appears that many growers used this as an opportunity to exit the market. In addition, the state has lost some dairy and hog production. These sectors increasingly favor larger scale operations (Key and McBride, 2007; MacDonald et al. 2007). Also, hog farms are becoming much more specialized in a particular growth phase of hog production such as breeding, farrowing, or growing (Key and McBride 2007). Industry trends for both commodities favor production areas in the Midwest that are less densely populated and are located closer to feed crops.

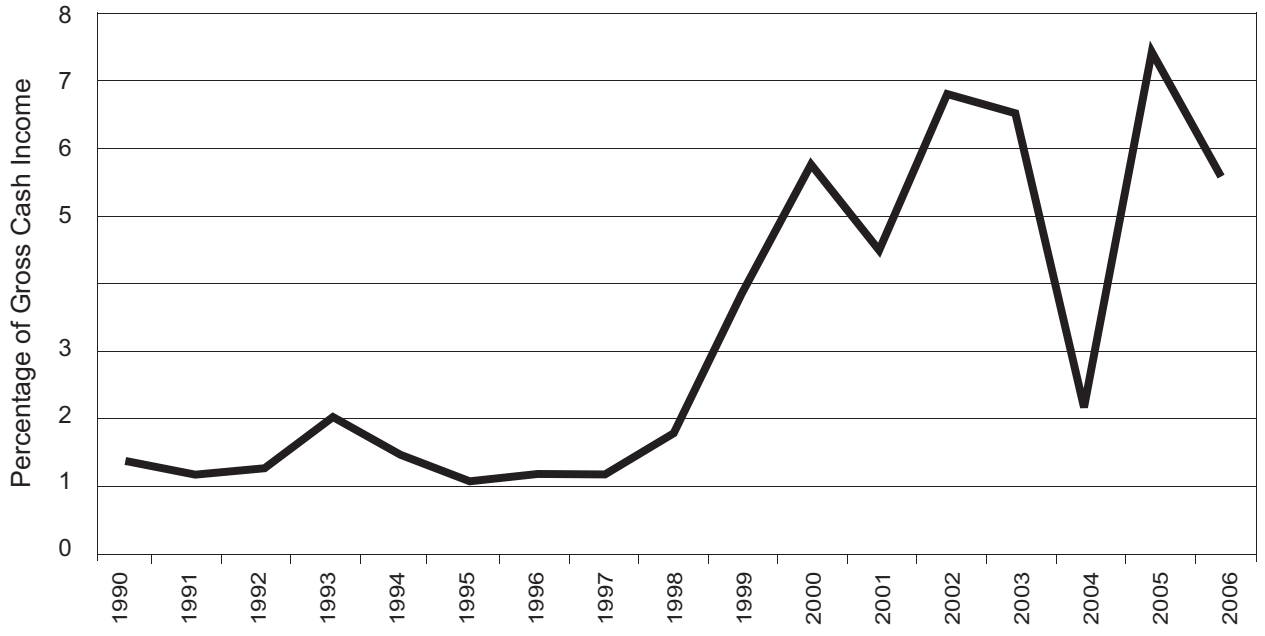
1 A location quotient (LQ) provides a measure of regional (e.g., county, state) concentration in a given industry or commodity relative to a larger region of which it is part (e.g., nation). It is simply the share of a region's activity in an industry or commodity divided by the share of the larger region's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

Several commodities have experienced substantial growth. Poultry production, including boilers and turkeys, was among the largest gainers during the period 1990-2006 although production has stagnated in recent years. The large change in "miscellaneous livestock" primarily reflects increases in the size of the equine industry which numbers an estimated 170,000 horses, ponies, and mules, making Virginia the fifth largest equine state in the nation (Virginia Department of Agriculture and Consumer Services 2005). The aquaculture industry, which produces primarily saltwater species such as clams, and the fresh tomatoes industry have been the state's most rapidly growing agricultural commodities in recent years in percentage terms. Cotton sales skyrocketed in the early to mid-1990s but have tailed off since. Greenhouse and nursery product sales have grown in tandem with the region's population and are well situated to serve the Mid-Atlantic's burgeoning urban markets (Purcell 2001).

In recent years, government payments have played a bigger role in farm income (see **Figure 1.8**). Much of the increase was temporary since it was connected with one-time tobacco and peanut quota buyouts. However, direct payments and disaster assistance associated with droughts have also increased.

Farm production shows strong geographical patterns. The top five counties in farm employment are Rockingham, Washington, Augusta, Pittsylvania, and Scott, which collectively accounted for approximately one-fifth of state agricultural employment in 2006. In terms of agricultural employment's share of total employment, the picture is more complex and differentiated (see **Figure 1.9**), but the southwestern and southern parts of the state are more reliant on farm employment. However, this is an incomplete picture of the regional diversity of Virginia agriculture because of the strong regional specialization by farm commodity (see **Table 1.2**).

Figure 1.8 Government Payments as a Percentage of Virginia Gross Cash Income, 1990-2006



Source: U.S. Department of Agriculture, Economic Research Service (2007)

Figure 1.9 Farm Employment as Percentage of Total Employment by Locality, 2006

Source: U.S. Department of Commerce, Bureau of Economic Analysis (2008)*
*NOTE: Total employment includes self-employed, wage and salary workers, civilian and military.

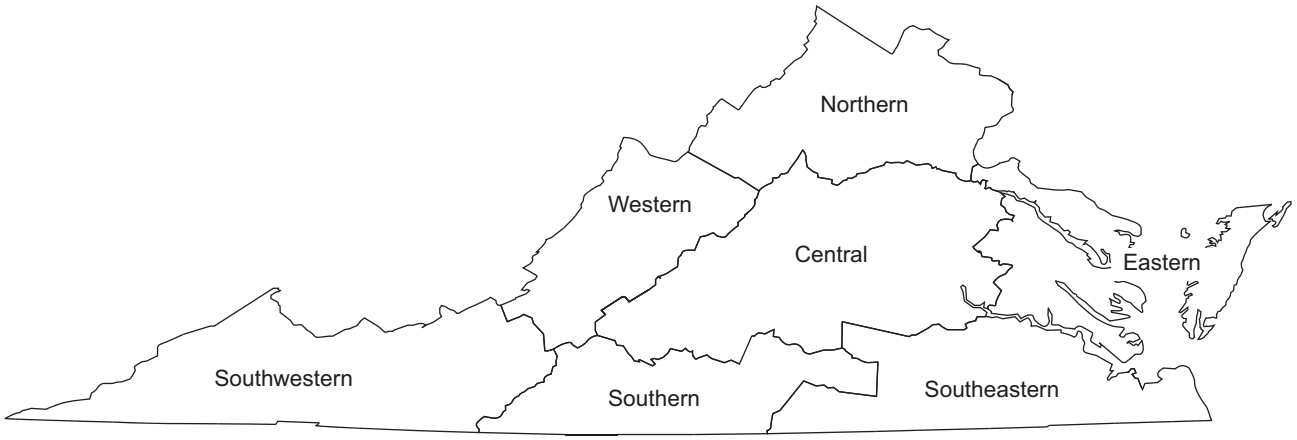
Several distinct regional patterns are evident using agricultural statistic districts (see **Figure 1.10**)[2]. Cotton is primarily a southeastern crop. Over three quarters of tobacco production can be found in the southern and southwestern districts. Half of poultry production occurs in the northern district. Vegetable production is concentrated in the east, while fruit production shows a more northern pattern.

The Virginia farm sector faces both opportunities and challenges in the process of maintaining or increasing its position within the state economy. The factors likely to affect agriculture are grouped into six major categories including production technology, consumer demand, energy prices, urban population growth, government policy, and the global economy (see **Table 1.3**).

Staying competitive in the national and international marketplaces rests on continued productivity improvements including greater specialization, outsourcing of traditional agricultural production activities, greater use of contracting and vertical integration arrangements, greater mechanization, and continuing adoption of biological, information, and process control technologies. These forces should continue to have a dampening influence on employment.

2 Refer to Appendix Table A.1 for localities within districts.

Figure 1.10 Virginia Agriculture Statistic Districts



Source: National Agricultural Statistics Service

Table 1.2 Regional Distribution of Virginia Farm Employment, Percentage of Total, 2004

Commodity	Northern	Eastern	Western	Southern	Southwestern	Central	Southeastern
Oilseed	11	34	1	2	1	15	37
Grain	18	33	5	4	5	17	18
Vegetable & melon	4	48	4	5	19	14	5
Fruit & nut trees	44	4	5	8	14	24	2
Greenhouse & nursery	18	8	10	5	20	23	17
Tobacco	0	0	0	44	34	6	16
Cotton	0	5	0	0	3	1	91
All other crops	15	1	11	9	35	20	8
Cattle & dairy	20	1	12	12	36	17	2
Poultry & eggs	50	7	14	4	4	18	3
Other animal production	31	7	7	6	17	25	8

Source: IMPLAN

Increased energy costs are likely to play a more prominent role in future agricultural commodity markets. Growth in bio-fuels, particularly ethanol production, has contributed to recent surges in corn, substitute feed crop, and grain prices, which has benefited many U.S. farmers. On the downside, energy price increases have contributed to increased costs for farm inputs, not only of energy, but feed stocks and fertilizers (Westcott 2007). Also, most of the bio-fuel distilleries are located in the Midwest. Since an important byproduct of the process is distilled grains that can be fed to livestock, midwestern livestock farmers will be the principal beneficiaries.

Changing consumer tastes will also influence the competitiveness and composition of Virginia agricultural output. Consumer demand is becoming much more differentiated (Martinez 2007). Consumers are increasingly more health conscious and discriminating in their food choices, which means increased demand for fresh produce and for vegetarian, low carbohydrate, low fat, gourmet, and high value-added specialty products. Increased concern for the community and environment has raised demand for

Table 1.3 Factors influencing Virginia Agriculture

Factor	Opportunity	Challenge
Production technology	Increased mechanization, adoption of new computer/ electronic and biological technologies	Economies of scale for some commodities which favor other locations, availability of labor
Consumer demand	Growth in demand for fresh vegetables, locally grown, and organic products	Growth in demand for non-competitive international goods and specialty products
Energy prices	Increased demand for bio-fuel commodities	Increased costs for farm inputs such as energy, fertilizer, and feed stock
Urban population growth	Growth in local market commodities and agri-tourism	Urban encroachment on farm land, decreased rural political clout
Government policy	Increased measures to protect rural areas to improve environmental sustainability, federal policy toward bio-fuels	Increased environmental regulations, changes in farm support programs, immigration policy
Global economy	Decrease in value of dollar, increased demand for food from developing countries	Increased production and competition from developing nations, increased commodity price volatility

organically and locally grown products. More immigration and cultural diversity have increased demand for new ethnic foods and spices. As consumers are pressed for time, they will continue to desire more food preparation convenience that should contribute to continued growth in food and drinking establishments and less food production at home.

Since Virginia is situated adjacent to the Northeastern Megalopolis, continued rapid population growth is expected and urban encroachment on farmland will continue to be a concern. Moreover, suburban and exurban residents may be expected to place additional zoning and other regulatory burdens on farms. However, population increases also present opportunities such as increased demand for locally grown food and horticulture/nursery products and for agritourism of the type that has spurred rapid recent growth in Virginia's winery and horse industries.

Government policy will continue to shape Virginia agriculture. Federal and state policies are in continuous flux. Federal farm policy in recent years has become more market oriented, partly influenced by international trade agreements which require farm support payments to be decoupled from production decisions (Westcott, Young, and Price 2002). In turn, commodity price volatility has increased. Relatively liberal enforcement of immigration law has resulted in increases in the availability of migrant farm labor, but whether government immigration enforcement practices will impact labor availability in the future is uncertain (Kandel 2008). Conservation easements have helped mitigate urban development pressures on farmland. However, more stringent environmental regulations such as requirements that farmers adopt Best Management Plans (BMP) to mitigate waste runoff are expected to increase the complexity and cost of Virginia farming.

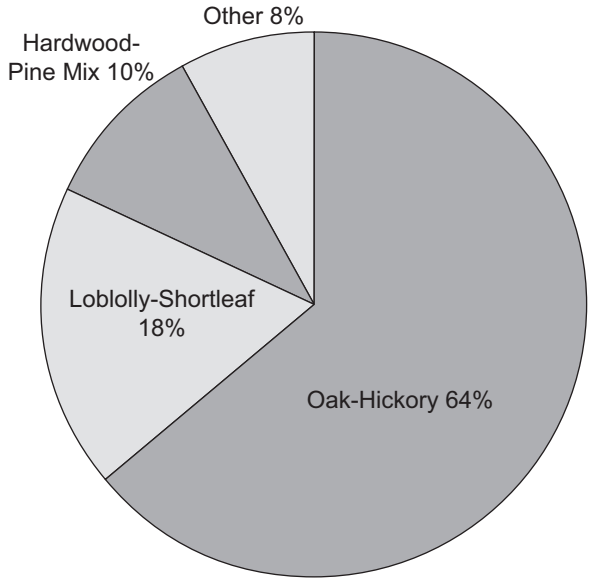
The international economy is also important. Significant decreases in the value of the U.S. dollar have raised the competitiveness of U.S. products in international commerce. Moreover, growth in developing countries is increasing international demand for protein and higher value-added products (Gelhlar et al. 2007; Shane and Liefert 2007). However, the composition of U.S. exports and imports is changing in unforeseen ways. U.S. agricultural exports to slow growing developed country markets such as Japan and the European Union have been supplanted by exports to faster-growing developing country markets like Mexico and China. At the same time, many of these developing countries have expanded domestic production of crops. So, the main export growth opportunities are seen to exist in animal and value-added products.

Forestry

A recent forest inventory indicates that Virginia had 15,765,707 acres of forestland in 2005, a small decrease from 15,844,000 acres in 2001 (Rose 2007; Virginia Department of Forestry 2007). The vast majority of forestland (12,220,631 acres or 77 percent of the total) is non-industrial private forest (NIPF) and corporate ownership outside the forest industry, with the rest in public (2,781,857 acres or 18 percent) and forest industry ownership (763,219 acres or 5 percent) (Virginia Department of Forestry 2007). Forestland owned by private individuals is splintered among an estimated 373,000 people (Rose 2007). Recent data indicate a distinct trend toward less forest industry ownership, more ownership by timber industry management organizations (TIMOs), and more ownership by private landowners with smaller parcels. This trend, if continued, may present challenges to optimal forest management for forest production.

The state's forests are dominated by hardwood stands, though softwoods are more common removal species in the southeast and coastal regions. Oak-hickory is the most prevalent forest type statewide (see **Figure 1.11**) followed by loblolly-shortleaf,

Figure 1.11 Virginia Land Area by Forest Type, 2005



Source: Virginia Department of Forestry (2007)

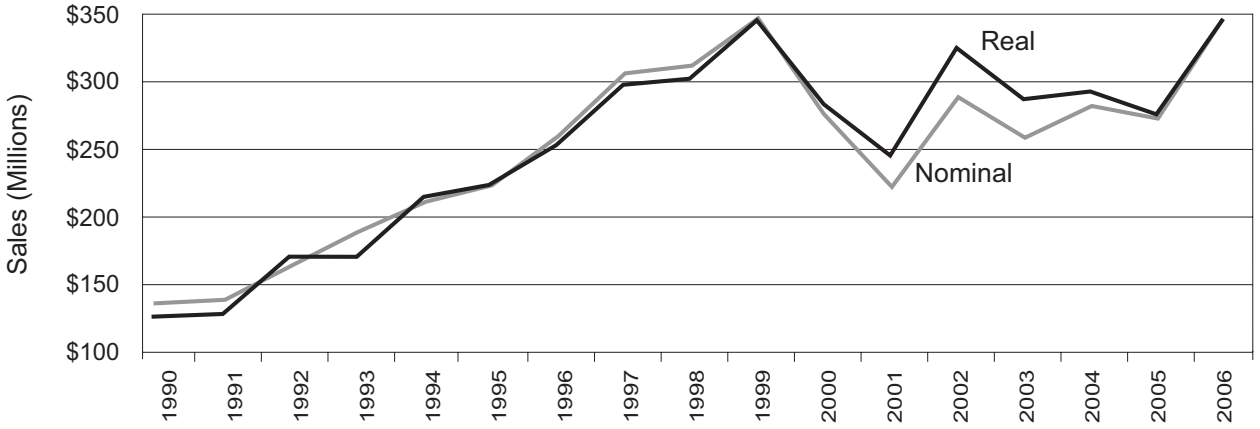
and oak-pine. Virginia's forest inventory is growing; 155.9 million cubic feet were added in 2005 (Virginia Department of Forestry 2007). However, this is only about half of the rate of growth, 292.1 million cubic feet, estimated in 2001 (Rose 2007). Virginia's forests contain a mix of maturities. Forty-five percent of Virginia's forests are sawtimber size stands; poletimber and seedling/sapling tree stands make up 36 and 19 percent respectively of forest acreage (Rose 2007).

Virginia produced approximately $350 million in stumpage, which is the sales value of timber, in 2006. Fifty-five percent of this value was hardwood. Stumpage value changed little over the period 1999-2006 (see **Figure 1.12**) after a substantial growth during the late 1980s and throughout the 1990s.[3] Virginia produced an estimated 503 million cubic feet of roundwood timber products in 2005. Approximately 45 percent of this was saw logs, another 40 percent pulpwood, and the remainder composite panels, veneer logs, and other industrial products such as poles, posts, and mulch (Johnson and Becker 2007). Virginia mills produced 1.6 billion board feet of lumber in 2006, including nearly 8 percent of hardwood lumber in the nation, making it the third largest producer after Pennsylvania and Tennessee (U.S. Department of Commerce, U.S. Census Bureau 2006).

Virginia's forest resources are distributed throughout the state. Less forested areas are in the Washington, DC metropolitan area and the

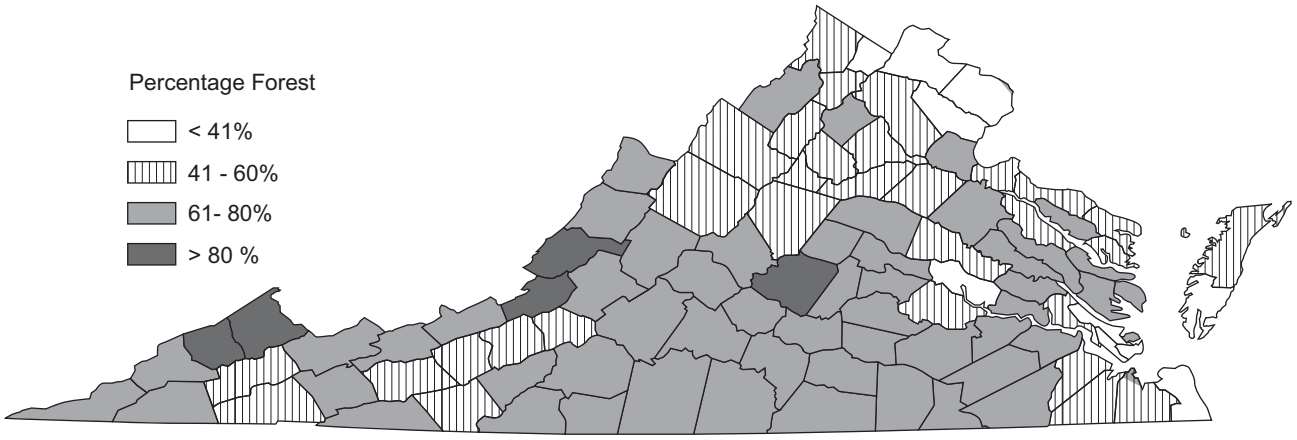
3 Since producer prices remained stagnant over the period, there is little difference between real and nominal values.

Figure 1.12 Virginia Real (2006 Dollars) and Nominal Stumpage Values, 1990-2006



Source: Unpublished data from Virginia Department of Forestry and Implan

Figure 1.13 Percentage of Total Acreage in Forest by Locality, 2001



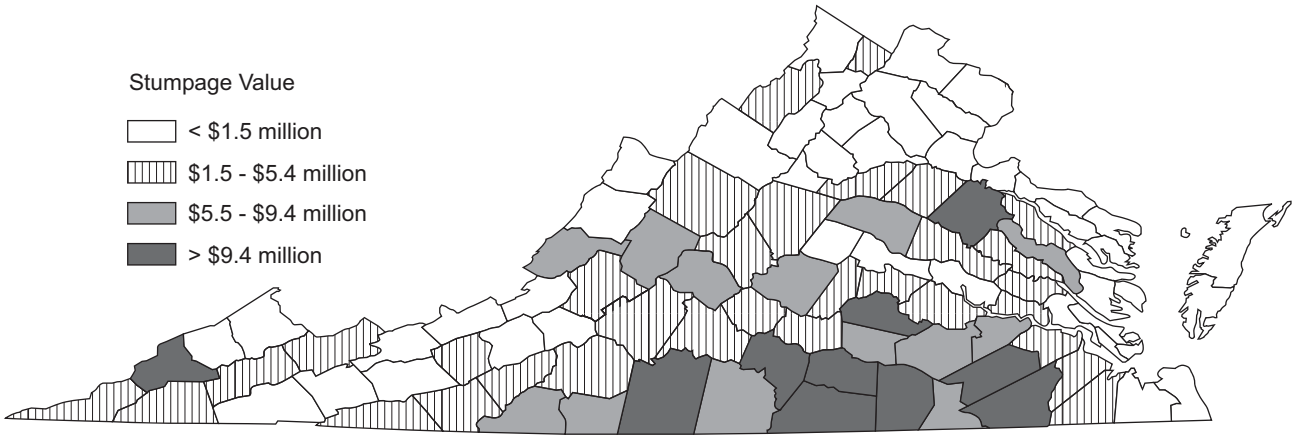
Source: Rose (2007)

eastern coast while more forested areas exist in the west and south (see **Figure 1.13**). However, stumpage is highest in the southern part of the state, perhaps partially reflecting the concentration of wood processing industry in the region (see **Figure 1.14**).

Virginia's forestry industry faces some of the same issues as agriculture in the future (see **Table 1.4**), stemming from changes in technology, consumer demand, energy prices, urban population growth, globalization, and government policy. Like agriculture, wood product manufacturing (i.e., primary wood product manufacturing, paper manufacturing, and furniture manufacturing) employment has not grown in recent years in part due to productivity increases attributable to consolidation and technological change. However, not all industries have kept pace with capital investment needs. Continued population growth will place growing pressure on forest land but may create new demand for building construction materials and outdoor recreation.

More so than agriculture, forestry faces some long-term resource management challenges. Plantation cultivation methods are increasingly being utilized for producing the state's softwoods. However, continued fragmentation of forest and new non-industrial ownership patterns point to

Figure 1.14 Value of Virginia Stumpage by Locality, 2006



Source: Unpublished data from Virginia Department of Forestry (2007)

Table 1.4 Factors Influencing Virginia Forestry

Factor	Opportunity	Challenge
Forest management	Increased use of plantation forest cultivation	Increased parcelization and fragmentation of forest ownership, increased mortality due to disease, insect, and weather disturbances
Production technology	Increased mechanization, adoption of new computer/electronic technology	Aging and inefficient capital equipment in some industries, availability of labor
Consumer demand	Increased demand for non-wood forestry products	Plastics, concrete and metal substitutes for some wood products, replacement of electronic products for paper, cyclical fall in new housing construction
Energy prices	Biomass-fired power generation industry opportunities, possible cellulose bio-fuels with technological breakthrough, increased costs of close substitutes like plastics, cement, and metals	Increased costs for inputs and distribution
Urban population growth	Increase in regional residential and commercial construction, increase in forest-related recreation	Urban encroachment on forest land, decreased rural political clout
Government policy	Increased measures such as conservation easements to protect rural areas and environment, creation of cap and trade markets	Increased environmental regulation of timbering, increased use of recycled paper products
Global economy	Decrease in value of dollar, increase in demand for certifiable wood products	Growth in production and quality of international hardwoods and softwoods, low cost and environmentally unsustainable competition in pulp paper and wood processing sectors from abroad

the possibility that the quality and availability of hardwood timber stocks may decrease and costs of harvesting may increase. 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 forest products industry has had to reckon with changing demand for its products in certain industries (Wear, Carter, and Prestemon 2007). Plastics, concrete, and metal, which can be close in appearance and more durable than wood, are increasingly being used in construction and manufacturing. Recycled paper has dampened demand for pulp paper products. The increasing popularity of online media is cutting into the market for newspaper and magazines. Moreover, wood products demand is very sensitive to changes in housing demand, and the current housing construction downturn will have serious repercussions. On the upside, demand has increased for higher value-added wood products, like cabinetry. Also, the market for non-timber forestry products such as medicinal and dietary supplements and edible forest commodities, though of small and uncertain size, is growing in response to increased demand by a health conscious American public and international consumers (Chamberlain, Bush, and Hammett 1998). Finally, the industry has created new products such as oriented strand board (OSB) and wood pellets, which make better use of waste.

Rising energy prices will mean both increased costs for inputs and higher transportation costs. They could also alter the competitiveness of

wood products favorably relative to close substitutes because those substitutes are more energy intensive (Wear, Carter, and Prestemon 2007). Since wood is also a fuel, energy price increases may stimulate additional use of biomass-fired power generation. A research and development breakthrough in producing cellulosic ethanol would also provide a sizeable boost in demand.

Low-cost international competitors in the developing world are carving out niches in the wood products industry in areas such as pulp paper (Wear, Carter, and Prestemon 2007) and wooden case goods (e.g., bedroom and dining room furniture, office furniture) that have had a clear impact on Virginia's employment (Drayse 2008), particularly in Southside. While certain industries such as flooring and cabinetry continue to do relatively well, the possibility exists that they too may come within the purview of overseas competitors. On the other hand, recent decreases in the dollar may bring a reprieve for some segments of the industry.

SECTION 2
REVIEW OF METHODOLOGICAL ISSUES

Input-Output Analysis and Multipliers

The method of choice in regional economic impact analysis is input-output analysis. Input-output models (see **Text Box 2.1**) are based on input-output tables, which show flows of purchases and sales among sectors of the economy. Economic multipliers are derivatives of these tables (Miller and Blair 1985).

Input-output multipliers allow one to measure the total effects of agricultural and forestry activities on the economy. These total effects originate from an initial injection of economic activity or spending, otherwise known as the "direct effects." Additional effects occur when money retained in the state circulates through the economy. For instance, state businesses provide some inputs such as supplies and services to agricultural and forestry industries. These businesses, in turn, purchase some inputs from other state firms in order to produce their products or services and this cascading sequence continues until the subsequent rounds of spending dissipate. These cumulative effects are referred to as "indirect impacts." In addition, the spending of new household income attributable to the direct and indirect effects of agriculture and forestry will induce subsequent rounds of spending. These cumulative effects are called "induced impacts."

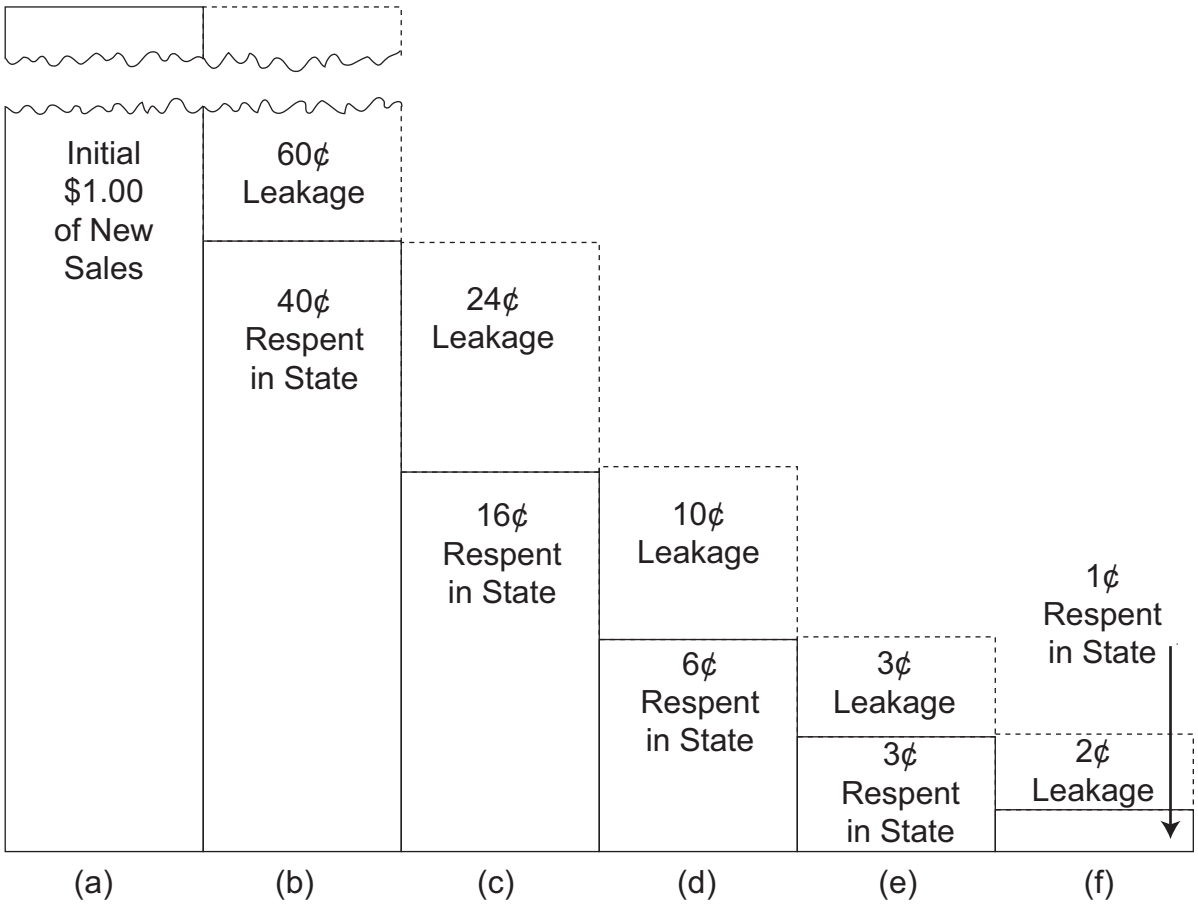
The incremental effect of each round of spending eventually dissipates because a portion of the spending leaks out of the economy into another state or another country. The sum of these various types of spending is referred to as a multiplier effect because the total effect is a multiple of the initial "direct" effect. The total impact will include the sum of direct, indirect, and induced impacts. For illustrative purposes, **Figure 2.1** depicts a situation in which $1.00 of new sales is re-spent in five stages in the state. At each stage, a leakage occurs (b)-(f). The summative effect of these rounds of spending is 1.66, which means the multiplier is 1.66. This figure is derived by adding the initial spending of $1.00 to the amount spent in the state in each round of spending ($1.00+$0.40+$0.16+$0.06+$0.03+$0.01).

Text Box 2.1 What is Input-Output Analysis?

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 an input-output transactions table that shows flows of goods and services among industries, households, and government. The table can be manipulated to show the aggregated effects of change in one industry's output or employment on industries that provide inputs and the effects of induced spending by workers, business owners and government. It does this by generating multipliers that show the total effects, including direct effects, indirect effects, and induced effects, of a dollar change in direct sales.

Tables of inputs and final demands can be represented in mathematical matrix form. The expression $X=AX+Y$ indicates that total output (X) is equivalent to the components of demand: the portion (A) of output that is used as an intermediate input multiplied by actual output (X) plus final demand (Y). This expression can be manipulated to provide the expression $X = (1-A)^{-1} Y$. The inverse $(I-A)^{-1}$ is termed the Leontief inverse and provides the economic multipliers. With this latter expression, one can analyze the multiplicative changes in a region's output when there are changes in regional demand. A more extensive presentation of this methodology can be found in Miller and Blair (1985).

Figure 2.1 Multiplier Effects of $1 of New Sales



Source: Figure from Lewis et al. (1979)

Multipliers are divided into three categories based on the extent to which they capture economy interactions. Type I multipliers measure direct and indirect effects. Type II multipliers measure direct, indirect, and induced effects stemming from employee and proprietor spending. Social Accounting Matrix (SAM) type multipliers include direct effects, indirect effects, and induced effects resulting from employee household spending as well as the induced effects of spending of firm profits, transfer payments, and other institutional transactions. A social accounting matrix is a macroeconomic accounting system that represents all of the institutions (firms, households, government, foreign importers and exporters) that purchase and sell within an economy (Minnesota Implan Group, Inc. 2004).

Sector Impact Measurement

Three general approaches using input-output methodology have been suggested to measure the impact of industry sectors on an overall economy (Sharma, Leung, and Nakamuto 1999). Each of these approaches relies on an input-output model. They include the final demand approach, the output-based approach, and the hypothetical extraction approach.

The final demand approach is a conventional straightforward implementation of input-output modeling. Expenditures for final demand for food and fiber products are used to estimate the

intermediate inputs required to produce the final demand.

The output-based approach identifies selected industries that have strong purchasing linkages with another industry. Once these industries are so defined, the contribution of inputs from other industries is measured.

The hypothetical extraction approach estimates the incremental impact of an industry as a residual. The residual is calculated by subtracting the impact estimated by assuming the industry of focus is removed (or "extracted") from the model from the impact estimates for a complete model containing all industries.

The U.S. Department of Agriculture (USDA) Economic Research Service (ERS) uses the final demand approach to estimate the impact of the agribusiness sector on the national economy or what it calls the Food and Fiber System (FFS) (Leones, Schluter, and Goldman 1994; Edmondson and Schluter 1998). The method starts with final demand (i.e., consumption expenditures on food, clothing, shoes, tobacco products, flowers, seeds, and potted plants, net agricultural and textile exports, changes in the value of farm commodity inventories, and changes in the values of non-farm private and government farm commodity stocks) and measures the magnitude of the indirect effects. "Induced" effects are not included in order to provide a conservative estimate.

Very few state and local studies have adopted the final demand approach. This approach requires current and reliable estimates of the components of final demand. However, state and local consumer expenditures, exports, and government spending are not routinely collected. The costs of obtaining these estimates by survey are often prohibitive and the reliability of the estimates might be questionable. Therefore, the output-based approach has been dominant. This is the approach that has been adopted in previous Virginia studies of agriculture and forestry.

The use of input-output analysis has been criticized on several grounds. One complaint is that state input-output tables are synthetic representations based on national data and imputation procedures that use limited state data.[1] Some researchers note that the method makes rather restrictive assumptions that are not met in practical applications, particularly when estimating the effect of large increments or decrements of expenditure or economic activity that occur when analyzing the impact of large sectors of the economy (Imerman et al. 2005). Among these assumptions are that prices are constant, supply is perfectly elastic, and that production technologies remain the same. If these assumptions are suspended by incorporating prices and allowing factor mobility or allowing economies of scale, impact estimates will be smaller. Another argument is that the method is improperly applied. Using output rather than final demand as the basis for an impact variable can result in some double counting (Sharma, Leung, and Nakamuto 1999).

Input-output analysis may also underestimate regional economic impacts. Most input-output applications use single region models that fail to capture interregional feedbacks. For illustrative purposes, imagine an increase in production of Virginia pulp paper mills, which results in increased purchases of North Carolina and West Virginia timber. In a single region model, these expenditures become "dead end" leakages that result in no additional rounds of spending within Virginia. However, it is more realistic to expect these out-of-state producers to purchase at least some inputs and labor from Virginia. The failure to include these interregional spillovers results in

1 Almost all state and local input-output models like the popular IMPLAN and RIMS II models are what are called non-survey models. That is to say, national input-output tables are "regionalized" using some regional information obtained from federal government agencies rather than being built from the ground up with survey data on individual industries collected from the region itself. Questions have been raised about the accuracy of these non-survey models (Round 1983; Rickman and Schwer 1995).

a smaller economic multiplier.[2] Moreover, input-output is not designed to measure non-monetary impacts. These impacts, while sometimes intangible, are real and may be sizeable. Unfortunately, they are difficult to determine because a market does not exist to gauge their values. For example, changes in quality of life and the environment that occur because of the presence of forests are not incorporated.

Defining the Scope of Agriculture and Forestry's Direct Effect

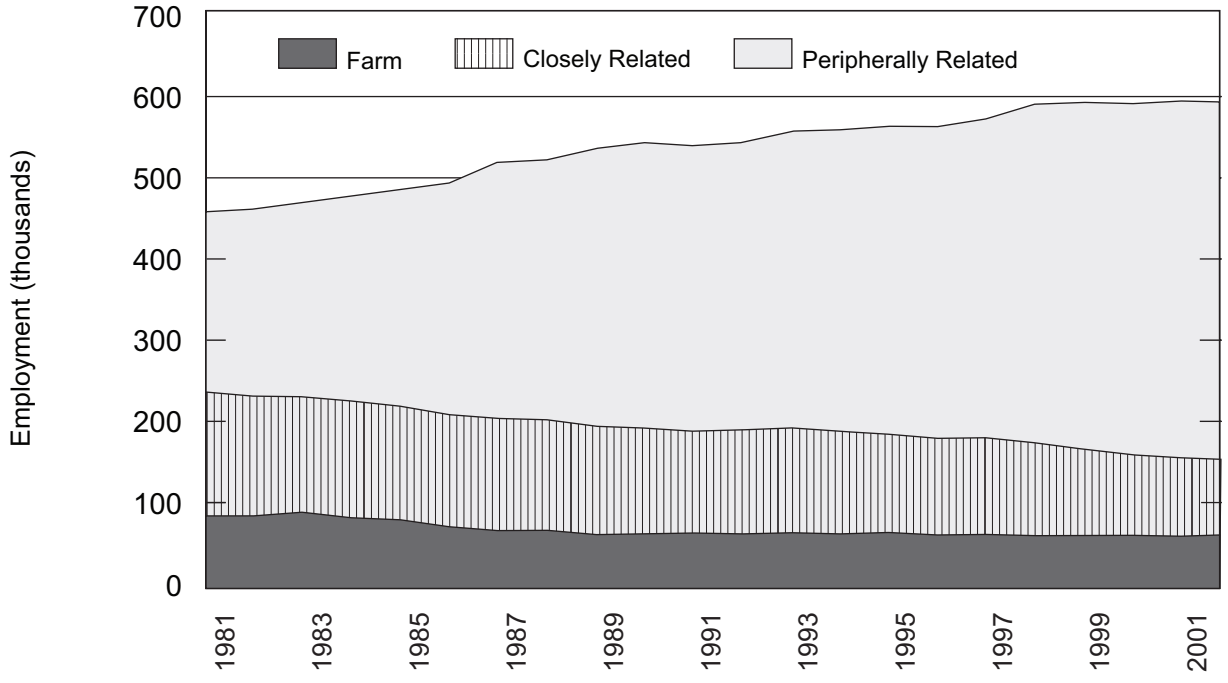
Industry-based or output-based studies of agriculture and forestry face the challenge of choosing which industries to include in the analysis. At one extreme, a "gate to plate" perspective would categorize every industry involved in producing to satisfy final demand for consumption of food, fiber, and wood in impact calculations. The most restrictive definition would limit the impact to the direct effect of farm and forestry production.

One way of operationalizing these concepts using an industry-based approach is offered by the USDA Economic Research Service Farm and Farm-Related (FFR) industry definition that categorizes industries by the degree to which the workforce of the industry is involved in meeting domestic final demand for food and fiber products.[3] Industries are classified as farm, "closely related" (i.e., 50 percent or more of the workforce is involved in meeting final demand) and "peripherally related" (i.e., 32-49 percent of the workforce is involved in meeting final demand). **Figure 2.2** shows how these alternative definitions affect the measurement of Virginia's agriculture sector over time.

2 The next generation of the IMPLAN input-output model currently in Beta testing is designed to capture these interregional feedbacks. The error caused by not including these effects has been estimated to range from 1 to 14 percent (Miller and Blair 1985).

3 This industry categorization is determined using information obtained from the Food and Fiber System input-output system. However, the industry definitions have not been updated since the early 1990s (Parker 2008).

Figure 2.2 Virginia Farm and Farm-Related Employment, 1981-2002



Source: U.S. Department of Agriculture, Economic Research Service (2005)

The most expansive definition shows farm and farm-related employment growing over time and representing approximately 13 percent of total employment in 2002. The "peripherally related" industries (mainly services) accounted for the lion's share of this employment. In contrast, farming and "closely related" industries (mainly processing) represent a rapidly shrinking portion of the overall economy.

Recognizing that there is a tradeoff between credibility and estimates of size that comes with including too much versus too little, most statewide studies have adopted an "intermediate" definition of agriculture and forestry which includes at least some processing industries but excludes services, trade, and distribution activities that would likely exist in the absence of these natural resources. However, even within this category, there is tremendous variation. These differences may stem from "differences between state economies, linkages between sectors, and the purpose of [the] studies" (Leones, Schluter, and Goldman 1994). Whatever the case may be, there is no standard template available to aid a researcher's selection.

Agricultural studies show the least amount of consistency in how they define agriculture and agriculture-related activities. Studies of Virginia agriculture took the broadest view and included many but not all of the Economic Research Service's farm and farm-related industries, including eating and drinking establishments (Johnson and Wade 1994; Lamie 1997). In contrast, many studies exclude trade, distribution, and service industries arguing that these industries would exist in much the same form if there were no state agriculture production and processing industries. For this reason, studies of the effects of agriculture in Louisiana (Hughes 1995) and Wisconsin (Deller 2004) include only farming and food and fiber processing industries. A study of Delaware used a more limited definition that restricted processing sectors to those having at least five percent of their production inputs derived from state agriculture. One drawback of this restrictive definition is that it may fail to include many agriculturally linked secondary processing industries, such as mayonnaise, dressing, and sauce manufacturing, which may use few raw agricultural inputs but may be heavily dependent on processed agricultural inputs that are derived from the state such as flavoring syrup and concentrate and rendering and meat byproducts.

One can find some heterogeneity in industry scope among forestry studies as well. The forestry, logging, wood products, and paper products industries are core sectors that can be found in most studies such as works for Texas (Xu 2002), Virginia (Becker 2006), Georgia (Riall 2002), West Virginia (Childs 2005), Florida (Hodges et al. 2005), Mississippi (Munn and Tilley 2007), Michigan (Berghorn 2005), and Missouri (Upendram). However, some studies expand this list to include support activities for forestry (Berghorn 2005; Becker 2006), construction (Becker 2006), wood chemical industries (Hodges et al. 2005), some miscellaneous manufacturing industries such as burial caskets and vaults (Riall 2002), paper and woodworking machinery (Riall 2002), wood related wholesale (Berghorn 2005), and forestry-related government and research employment (Becker 2006).

Complicating the identification of appropriate agriculture and forestry sectors for a state or locality is the fact that many intermediate inputs may be derived from outside the state or local area. That is to say, some processing and distribution sectors may be very heavily dependent on agriculture and forestry natural resources while others may purchase commodities from outside the state or country. In the latter case, one may not want to assign the size of the industry to the presence of regional inputs but rather to the

Text Box 2.2. Weber Location Triangle

Alfred Weber developed a theory of industrial production location for a firm that uses two natural resource inputs to produce a manufactured good. In the model, each of the inputs is produced at fixed points in space and has transportation costs associated with movement of the individual inputs to the manufacturing facility and a cost associated with transportation to market. Weber showed that the firm will locate close to the input sources when the transportation costs of inputs are high and close to market when the costs of transporting the manufactured product to market is high. If transport costs per unit distance are the same for inputs and output, the costs of transport to market will be higher if the product gains weight at the manufacturing site in which case the industry will then locate close to market. On the other hand, if the product loses weight at the site, it will locate close to the natural resource inputs.

effect of market demand based on the presence of population centers.

Industrial location theory developed by Alfred Weber (see **Text Box 2.2**) suggests that the nature of the production process means that some industries locate in close proximity to the natural resource while others will locate closer to population demand. When an industry takes a resource and processes it in a way that reduces physical weight or bulk (e.g., sawmills), perishability (e.g., food canning), fragility, or the hazard of shipping the product, then input transportation costs are high and production will tend to take place close to the resources (Hoover and Giarratani 1984). When production results in an increase in final product physical weight or bulk, transportation costs to market will be high and the industry will tend to locate close to population centers. For instance, soft drink bottling involves the mixture of processed syrups and widely available water, which results in production closer to market.

Previous Virginia studies of agriculture and forestry impact implicitly address the issue of economic linkages by segmenting the agriculture and forestry-related sectors in various ways. For instance, Johnson and Wade (1994) distinguish among production, processing and distribution (including transportation, wholesale trade, retail trade, and some eating and drinking establishment activities). These categories represent in a basic way the strength of the purchasing linkages (or dependence on food and fiber inputs) with processing being closest and distribution more remote. Becker (2006) divides forestry impact into primary processing (with the strongest local linkage because of the substantial weight and bulk reduction that occurs in manufacturing) and secondary processing with weaker linkages.

SECTION 3
STUDY DATA AND RESEARCH DESIGN

This study implements the general approach adopted by two studies conducted by Virginia Tech in the 1990s (Johnson and Wade 1994; Lamie 1997) of the economic impact of agriculture and agriculture-related industries in Virginia. Those studies used IMPLAN models (see **Text Box 3.1**) for structural linkage analyses of the agribusiness sectors.[1] The method is described as an "output-based" approach by Sharma et al. (1999). A similar research design has been used in studies of the Virginia forestry sector by the Virginia Department of Forestry (Becker 2006).

This study, however, has several significant differences from those studies. First, this study expands the scope of industries to include both the agricultural and the forestry sectors. Second, the sectors that are identified as agriculture-related and forestry-related differ. Third, the study divides forestry and agriculture impact measurements into several parts. These components are termed "production," "core processing," "extended processing," and "distribution" activities. These components reflect varying degrees of reliance on Virginia agricultural and forestry raw material inputs. Third, this study relies on some supplemental data from unpublished sources, adjustment factors, and an alternative data smoothing method to improve measurement in industries where undercounting of employment and output occurs and where industry output is highly variable. Fourth, the study takes into account government payments to the farm sector, which have grown in importance since the last study. These payments have been recognized as agriculture-related impacts in other statewide economic impact studies (McCorkle and Anderson 2007). Because of the clear break between the methodologies of this study and the previous ones, the studies and the resulting estimates of the size of the impact of agriculture and forestry should not be compared.

As with any study, it is not possible to measure every possible impact of agriculture. For instance, no attempt is made to directly measure the impacts of agriculture and forestry-related tourism in this study. However, some results from other studies are presented in section 5. Moreover, this study is an economic impact study

Text Box 3.1 What is IMPLAN?

IMPLAN (or for IMpact analysis for PLANning) is personal computer software that is used for regional economic analysis. It was created in the late 1970s for the USDA Forest Service to use in resource management planning but has evolved into a more comprehensive tool that is used to analyze local economic impacts. The Microsoft Windows menu-driven software simplifies regional input-output analysis for the nation as well as various types of sub-regions (state, county, and zip code areas). Since this study needed a Virginia input-output table, the IMPLAN software was used to update and "regionalize" an older national table (in this case, the 1997 United States Benchmark Table) using data produced by various federal government agencies. The result is an input-output table that is more appropriate for use in analyzing the Virginia economy. The software includes various methods for creating multipliers and estimating impacts. It also comes bundled with detailed regional economic data estimates that are imputed using data from the federal government.

1 Significant modifications in the IMPLAN model have been made since the time of these studies. For instance, the 525 sector model has been reduced to 509 sectors to parallel changes made in the benchmark BEA input-output tables, and the industry classification system has been changed from the Standard Industrial Classification (SIC) to the North American Industrial Classification System (NAICS).

rather than a social-cost benefit analysis. No attempt is made to gauge the wider social benefits and costs of agriculture and forestry. However, clearly these are important societal and ecological issues. Forests, in particular, provide benefits in the form of carbon sequestration, stabilization of soils, wildlife habitat and biodiversity, flood mitigation, and improved water quality. Scenic amenities may also improve quality of life. On the other side, poorly regulated agricultural and timbering activities can impose costs such as water quality degradation, noxious odors, and airborne pathogens.

Industries for Agriculture and Forestry Direct Effects

This study identifies several dozen industries with strong linkages to agriculture and forestry. These include agriculture and forestry production, wood and paper products manufacturing, food, textiles and apparel processing, forestry non-wood products such as hunting and trapping, and agricultural and forestry services. In addition, closely related warehousing, wholesale, and landscaping service industries are included.

The starting points for defining appropriate agriculture and forestry industries for Virginia are studies by the U.S. Department of Agriculture. Agriculture related industries are identified with the assistance of the Economic Research Service's list of farm and farm-related processing and marketing industries classified as being "closely related" to agriculture. They include manufacturing industries nested within three-digit North American Industrial Classification (NAICS)[2] codes of 311 (food manufacturing), 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. Packaging industries are excluded because they will be accounted for as backward linkages (see **Text Box 3.2**) in the input-output model and will be measured in the indirect effects. Lastly, one service industry, landscaping services, was added 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 information from a U.S. Forestry Service publication (U.S. Department of Agriculture 2004) that provides recommendations from a roundtable workshop about appropriate industries to include when measuring the direct and indirect employment effects of forestry.[3] Only wood and paper products and non-wood forest products are included. They include NAICS codes 113 (logging), 114 (hunting and trapping), 321 (wood product manufacturing), 322 (paper

Text Box 3.2 Backward versus Forward Linkages

Backward linkages are those industrial linkages that result from a given industry purchasing inputs. In turn, the industries supplying those inputs will need inputs and so forth. These linkages, represented by an economic multiplier, are what are measured by a straightforward application of input-output analysis. Forward linkages are industrial linkages that result from an industry providing outputs to other industries. Those industries will in turn sell their output to other industries and successive rounds of selling will occur. These linkages, represented by a supply-side multiplier, are measured by a supply-side input-output model (see Giarratani (1970) or Miller and Blair (1985) for more on this method).

2 The North American Industrial Classification System (NAICS) is a coding system for industries that has been adopted by the U.S. and its partners, Canada and Mexico, as part of the North American Free Trade Agreement.

3 This is provided as an addendum to the report for "Criterion 6. Indicator 44: Direct and Indirect Employment in the Forest Sector and the Forest Sector Employment as a Proportion of Total Employment."

manufacturing), and selected industries within 337 (furniture and related product manufacturing). In order to provide some symmetry with the treatment of the agricultural sector, closely related forest product wholesale and warehousing industries are also included.

Industries for both forestry and agriculture were further divided into production, core processing, extended processing, and distribution activities. "Production" activities are those industries associated with growing and harvesting basic farm commodities, timber, and non-timber commodities. "Core processing" industries are manufacturing industries that are heavily dependent on state commodity inputs as evidenced by strong forward linkages with production industries.[4] It is unlikely that these industries would exist within the state in anything like their current form if commodity production did not occur in the state. "Extended processing" industries are manufacturing industries that are somewhat less dependent on Virginia farm and forest commodity inputs. Core industries tend to be primary processing industries while extended industries tend to be secondary processing. Lastly, "distribution" industries are the remaining warehousing, wholesaling, and landscaping industries described earlier.

Using this classification scheme, industries are listed in **Table 3.1**.

Data

Data for this study are drawn primarily from three sources and aligned with the IMPLAN sectors. The most important is the Virginia Employment Commission (VEC) Quarterly Census of Employment and Wages (QCEW) for the second quarter of 2006, which is representative of annual employment. Industry employment figures are converted to sales/output equivalent figures by the model for use in generating model outcomes. 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 commodity production sectors. Therefore, these data were supplemented or corrected in a variety of ways.

U.S. Department of Agriculture National Agricultural Statistics Service (NASS) commodity cash receipts data were used for all agricultural commodity sectors (U.S. Department of Agriculture 2007).[5] However, since agricultural production data are volatile, a smoothed average value for each sector is generated using exponential smoothing for the period 1990-2006.[6] The raw data and smoothed values (identified by the label "smoothed average") are shown in Appendix A.2. Although the NASS cash receipts data are better than alternatives, they are far from perfect. For instance, cash receipts for some commodities

4 The Virginia IMPLAN input-output model was used to distinguish between "core" and "extended" processing sectors. Processing industries with corresponding supply multipliers for production activity that exceeded a threshold level were grouped as "core" industries. Supply multipliers are determined by basically transposing the columns of the input-output table. A fuller discussion of the methodology can be found in Giarratani (1976) and Miller and Blair (1985). An industry multiplier of .03 was selected as the threshold parameter because it provided a good approximation of what are considered primary and secondary processing industries. Three adjustments were made to the resulting lists. Wineries did not appear as a strongly forward linked industry because grape production is vertically integrated and appears largely as a winery rather than grape input into production. Although coffee and tea manufacturing and rice milling had output multipliers that met the threshold, these were judged to be anomalies due to the agriculture sectoral aggregation scheme used in the model. These commodities are not produced in Virginia. Therefore, they were removed from the "core" list and reassigned to the extended list.

5 In order to assign the NASS commodity cash receipts to the NAICS based IMPLAN sectors, it was necessary to create a bridge. It was not possible to create an exact correspondence between two NASS commodities and IMPLAN sectors. Therefore, all cash receipts for the commodity category miscellaneous fruits and nuts were assigned to fruit trees (IMPLAN Sector= 5). This was done because the overwhelming majority of production occurred for fruits according to the 2002 Census of Agriculture. Second, the commodity category "Other field Crops" was assigned to "grain farming" (IMPLAN Sector=2) because the main crops in this category are rye and dry beans.

6 Exponential smoothing was performed using a single-exponential smoothing procedure (tssmooth) in STATA statistical software.

Table 3.1 Virginia Agriculture and Forestry Sectors

Implan Sector	Agriculture Industry
Agriculture Production	
1	Oilseed farming
2	Grain farming
3	Vegetable & melon farming
4	Fruit farming
6	Greenhouse & nursery production
7	Tobacco farming
8	Cotton farming
10	All other crop farming
11	Cattle ranching & farming
12	Poultry & egg production
13	Animal production except cattle & poultry
18	Agriculture & forestry support activities
	NAICS 1151 Support activities for crop production
	NAICS 1152 Support activities for animal production
Agriculture Core Processing	
48	Flour milling
60	Frozen food manufacturing
62	Fluid milk manufacturing
64	Cheese manufacturing
65	Dry, condensed, & evaporated dairy products
66	Ice cream & frozen dessert manufacturing
67	Animal, except poultry, slaughtering
68	Meat processed from carcasses
69	Rendering & meat byproduct processing
70	Poultry processing
71	Seafood product preparation & packaging
78	Roasted nuts & peanut butter manufacturing
83	Spice & extract manufacturing
84	All other food manufacturing
87	Wineries
89	Tobacco stemming & redrying

Implan Sector	Forestry Industry
Forestry Production	
14	Logging
15	Forest nurseries, forest products, & timber tracts
17	Hunting & trapping
18	Agriculture & forestry support activities
	NAICS 1153 Support activities for forestry
Forestry Core Processing	
112	Sawmills
113	Wood preservation
114	Reconstituted wood product manufacturing
115	Veneer & plywood manufacturing
116	Engineered wood member & truss manufacturing
118	Cut stock, resawing lumber, & planing
119	Other millwork, including flooring
120	Wood container & pallet manufacturing
122	Prefabricated wood building manufacturing
123	Miscellaneous wood product manufacturing
125	Paper & paperboard mills

Table 3.1 Virginia Agriculture & Forestry Sectors (continued)

Implan Sector	Agriculture Industry	Implan Sector	Forestry Industry
Agriculture Extended Processing		Forestry Extended Processing	
46	Dog & cat food manufacturing	117	Wood windows & door manufacturing
47	Other animal food manufacturing	121	Manufactured home, mobile home manufacturing
49	Rice milling	126	Paperboard container manufacturing
54	Fats & oils refining & blending	127	Flexible packaging foil manufacturing
58	Confectionery manufacturing from purchased chocolate	128	Surface-coated paperboard manufacturing
59	Nonchocolate confectionery manufacturing	129	Coated & laminated paper & packaging material
61	Fruit & vegetable canning & drying	130	Coated & uncoated paper bag manufacturing
72	Frozen cakes & other pastries manufacturing	131	Die-cut paper office supplies manufacturing
73	Bread & bakery product, except frozen, manufacturing	132	Envelope manufacturing
74	Cookie & cracker manufacturing	135	All other converted paper product manufacturing
76	Dry pasta manufacturing	362	Wood kitchen cabinet & countertop manufacturing
77	Tortilla manufacturing	363	Upholstered household furniture manufacturing
79	Other snack food manufacturing	364	Non-upholstered wood household furniture manufacturing
80	Coffee & tea manufacturing	366	Institutional furniture manufacturing
81	Flavoring syrup & concentrate manufacturing	367	Other household & institutional furniture
82	Mayonnaise, dressing, & sauce manufacturing	368	Wood office furniture manufacturing
85	Soft drink & ice manufacturing	369	Custom architectural woodwork & millwork
86	Breweries	371	Showcases, partitions, shelving, & lockers
90	Cigarette manufacturing		
91	Other tobacco product manufacturing		
92	Fiber, yarn, & thread mills		
93	Broadwoven fabric mills		
94	Narrow fabric mills & schiffli embroidery		
96	Knit fabric mills		
97	Textile & fabric finishing mills		
105	Other hosiery & sock mills		
106	Other apparel knitting mills		
107	Cut & sew apparel manufacturing		
108	Accessories & other apparel manufacturing		
110	Footwear manufacturing		
111	Other leather product manufacturing		
Agriculture Distribution		Forestry Distribution	
390	Wholesale Trade	390	Wholesale Trade
	NAICS 4225 Farm product raw material wholesalers		NAICS 42131 Lumber, plywood, millwork, & wood panel wholesalers
400	Warehousing & storage	400	Warehousing & storage
	NAICS 49312 Refrigerated warehousing & storage		NAICS 49319 Other warehousing & storage
	NAICS 49313 Farm product warehousing & storage		
458	Services to buildings & dwellings		
	NAICS 561730 Landscaping services		

where there is a strong degree of vertical integration, such as poultry, may not adequately capture actual production because the processing firm owns or contracts with the farm to provide the commodity input.

Data on federal government cash payments for farmers participating in agricultural support programs[7] were obtained from the NASS (U.S. Department of Agriculture 2007) to measure the impact of these programs on the Virginia economy. These payments were assigned or distributed to farm commodity sectors likely to be impacted by the particular type of payment.

Data for several forestry sectors were supplemented or adjusted. Data from Virginia Department of Forestry product tax receipts were used to estimate production for Timber Tract Operations (NAICS code 1131). Virginia Employment Commission employment numbers were deemed to be inadequate because they do not adequately capture all timber sellers but focus on organized businesses. In addition, estimates of logging employment and hunting and trapping employment were inflated using data from IMPLAN Professional database to correct for the absence of proprietors in these figures.[8]

Model

This study uses the IMPLAN input-output model. This model has been used extensively in regional impact analysis to measure the economic effects of various kinds of events and public policies such as plant closures, the opening of sports stadiums, and energy policies. In addition, it has been used in many studies of the economic impact of the forestry and agriculture industries (Leones, Schluter, and Goldman 1994).

The model allows the user to choose from different types of economic multipliers, including type I, type II, and type SAM multipliers that were described in the last section. The multipliers selected here are type SAM multipliers. The model was closed with respect to all institutions (all household income categories, federal and state government, capital, and inventory) as has been done in other statewide impact studies (e.g., Spurlock 2003; Hodges et al. 2005; Becker 2006).[9] In order to avoid double-counting inputs, regional purchase coefficients (RPCs), which represent the portion of state demand purchased from state producers, were set to zero in each of the IMPLAN agriculture and forestry related sectors included in the model.[10] This method of suppressing double-counting is used in other agriculture and forestry impact studies (Tanjuakio, Hastings, and Tytus 1996).[11]

7 These programs included fixed direct payments, countercyclical payments, loan deficiency payments, milk income loss payments, tobacco payments, conservation programs, and other smaller programs.

8 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 – CEW), and Bureau of Economic Analysis (Regional Economic Information System). The imputed employment data reflect adjustments for proprietors by industry.

9 Closing with respect to these institutions accounts for savings leakages and social security and income leakages as well as institutional injections of spending. The amount of model closure will influence the magnitude of induced impacts.

10 Double counting occurs when you include the impact of a sector as a direct effect and then count it as the indirect effect of another sector because it serves as an input to that sector. For instance, the mayonnaise, dressing, and sauce manufacturing industry uses flavoring syrup and concentrate industry as an input. However, sales in that sector are already included as a direct effect. By counting it also as an input for the production of another agribusiness industry, you are double-counting. Forcing the RPC to be zero for these sectors ensures that only the direct effect will be counted for these industries.

11 The exceptions were the wholesale trade, warehousing and storage, and services to buildings and dwellings sectors where RPCs were reduced to minimize double counting for that portion of the sector that was agriculture and forestry related.

SECTION 4
RESULTS

Direct Impacts

Economic impacts are evaluated using three different measures: total industrial output (TIO), employment, and value-added (see **Text Box 4.1**). Employment includes full-time and part-time and the self-employed and is measured by place of work rather than residence.

Text Box 4.1 Value-Added versus Total Industry Output

Total industry output (TIO) represents the total value of industry production during a period. It includes the value of output that is used as an input for production (i.e., intermediate purchase) as well as value of purchases for final demand. Because it "double counts" production inputs that are not available for final use, it is not favored in most economic analysis. Value-added refers to the additional value created or "added" to a product at different stages of production. For example, fruit could be stewed and canned by a food processor to make the raw commodity more valuable. Value-added is calculated by subtracting the values of intermediate purchases such as tin cans and fuel from the value of products sold for final demand. It is equivalent (minus capital depreciation expenses) to the sum of employee compensation, proprietary income, other property type income (e.g., rents, dividends and undistributed profits), and indirect business taxes (i.e., sales and excise taxes). The value-added concept is measured by gross domestic product (GDP) and is available from the Bureau of Economic Analysis (BEA) for states and metropolitan areas.

The direct effect of Virginia agriculture and forest-related industries in 2006 by IMPLAN sector is reported in **Table 4.1**.[1] The industries accounted for $42 billion in total output, approximately 196,100 workers, and over $13 billion in value-added. The output, employment, and value-added direct effects are shown by their relative shares or the total direct effect for each agriculture and forestry component in **Figure 4.1**. Agriculture production is the largest component in terms of employment. However, agriculture extended processing accounts for over 40 percent of output and value-added.

Total Impacts

Table 4.2 presents the total economic impact of agriculture and forestry related industries. It indicates that the total industry output or sales (TIO) impact of agricultural and forestry industries in Virginia was $79 billion in 2006, employment was slightly over half a million, and value-added nearly $37 billion. This impact includes indirect impacts and induced impacts. The corresponding multipliers are 1.86 for output, 2.56 for employment, and 2.75 for value-added. Employment and value-added impacts were responsible for an estimated 10.3 percent of Virginia's total employment, and 9.9 percent of Virginia's Gross Domestic Product.

1 These direct effect figures were generated from sales and employment data described in the previous section and value-added, output, and employment conversion factors from the IMPLAN database.

Table 4.1 Virginia Agriculture and Forestry Industries Direct Output, Employment, and Value-added, 2006

Implan Industry	Output (Millions $)	Employment	Value-added (Millions $)
Agriculture			
Production	2,890.9	55,085	1,333.1
Core processing	6,954.4	21,755	1090.7
Extended processing	17,472.1	27,550	5661.8
Distribution	1,443.1	26,648	761.3
Government payments	176.6	4,808	120.9
Forestry			
Production	1,601.4	6,931	464.1
Core processing	6,108.1	21,479	1,777.9
Extended processing	4,854.1	27,309	1,585.2
Distribution	757.8	4,528	516.9
Total	42,258.6	196,093	13,311.9

Table 4.2 also breaks down the direct, indirect, induced, and total impacts separately for the agriculture and forestry sectors. The agriculture sector accounted for $55 billion in total industry output, approximately 357,100 jobs, and nearly $26 billion in value-added. The forestry sector had a total impact of approximately $23 billion in total industry output, approximately 144,400

Figure 4.1 Virginia Direct Effects by Agriculture and Forestry Component, 2006

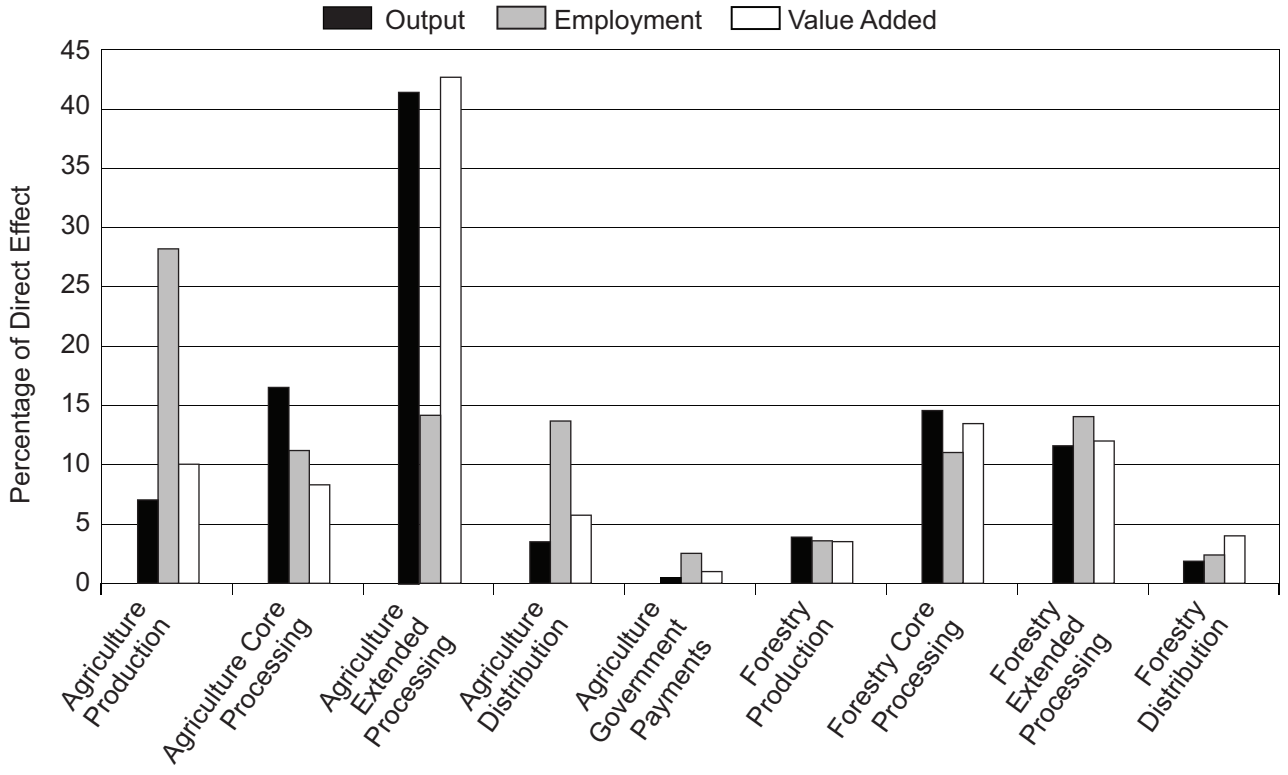


Table 4.2 Virginia Total, Direct, Indirect, and Induced Impacts of Agriculture and Forestry, 2006.

	Output (Million $)	Employment	Value-added (Million $)
Agriculture and Forestry			
Direct	42,258.6	196,093	13,311.9
Indirect	11,817.2	74,970	6,868.7
Induced	24,526.4	230,420	16,373.0
Total	78,602.2	501,485	36,553.5
Multiplier	1.86	2.56	2.75
Agriculture			
Direct	28,937.1	135,846	8,967.7
Indirect	8,859.1	56,603	5,212.4
Induced	17,377.9	164,656	11,639.7
Total	55,174.1	357,105	25,819.9
Multiplier	1.91	2.63	2.88
Forestry			
Direct	13,321.5	60,247	4,344.1
Indirect	2,958.1	18,367	1,656.3
Induced	7,148.6	65,766	4,733.3
Total	23,428.2	144,380	10,733.7
Multiplier	1.76	2.40	2.47

jobs, and nearly $11 billion in value-added. The multipliers associated with agriculture were slightly larger than those for forestry.

The impacts of agriculture and forestry were felt in other sectors of the economy (see **Table 4.3** and **Figure 4.2**). The largest effects were in manufacturing and agriculture, forestry, fishing, and hunting where direct effects were dominant. However, agriculture and forestry stimulated large public and private services responses 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. For some industries, such as transportation and warehousing and management of companies, the impacts were primarily indirect. For others, such as construction, retail trade, health and social services, and government, the impacts were chiefly induced.

Impacts by Industry Components

The impacts were further broken down into their production, core processing, extended processing, distribution, and government payments (agricultural support) components. Impacts are shown for output (**Table 4.4**), employment (**Table 4.5**), and value-added (**Table 4.6**).

Results indicate that agriculture-related activities account for approximately 70 percent of total agriculture and forestry output, employment and value-added impacts with forestry related activities making up the remainder.[2] Relative to the

2 Christmas tree farming is often claimed by both the agriculture and forestry industries. This industry is very conservatively estimated to have generated $10,000,000 in cash receipts which translates into 204 direct jobs. Based on these numbers, the total impacts are $20,514,919 in output, 296 in employment, and $14,058,644 in value-added. Because this industry is incompletely measured by the Census of Agriculture, it is recognized that the actual impact may be several multiples of this amount. For instance, a West Virginia study (Childs 2005) found that Census of Agriculture figures represented only about 40 percent of actual sales.

Table 4.3 Total Impact of Virginia's Agriculture and Forestry by Major Industry, 2006

	Output (Million $)	Employment	Value-added (Million $)
Agriculture, forestry, fishing & hunting	4,672.9	66,931	1,919.4
Mining	111,3	372	43.0
Utilities	1,035	1,194	642.0
Construction	2,514.1	22,150	1,215.7
Manufacturing	37,759.4	105,788	10,832.7
Wholesale trade	3,070.6	17,147	2,098.9
Transportation & warehousing	2,107.2	20,232	1,143.2
Retail trade	2,445.6	36,748	1,552.6
Information	1,441,1	5,008	684.8
Finance & insurance	2,212.5	10,683	1,329.5
Real estate & rental	1,904.1	9,318	1,291.5
Professional, scientific, & technical services	3,906.3	30,018	2,521.2
Management of companies	2,170.3	10,103	1,396.4
Administrative & waste services	2,173.0	40,730	1,209.3
Educational services	239.4	4,337	145.6
Health & social services	2,214.0	27,185	1,354.9
Arts, entertainment, & recreation	246.3	6,245	140.6
Accommodation & food services	237.3	3,184	152.4
Other services	1,560.9	21,847	889.5
Government & other [1]	6,581.2	62,264	5,990.5
Total	78,602.2	501,484	36,553.5

[1] Imputed rental payments for owner-occupied dwellings is captured in output and value-added impacts.

state economy, agriculture-related industry impacts represent approximately 7 percent of employment and value-added represents approximately 7 percent of Virginia's GDP. Forestry-related industry represents 3 percent of each.

Looking at the value-chain components, production industry impacts (see **Figure 4.3**) make up 17 percent of the total employment impact but a considerably smaller share, 10 percent, of value-added and output impacts. This reflects the presence of many part-time farmers and seasonal employees in the sector. Core processing makes up 23 percent of the employment and value-added impacts but 27 percent of output impact. Extended processing is the largest impact category, constituting 47 percent of the employment

Table 4.4 Total Impact of Virginia's Agriculture and Forestry by Component, Output in Millions of Dollars, 2006

	Agriculture	Forestry
Production	5,042.1	2,331
Processing core	10,821.0	10,770.2
Processing extended	35,759.8	8,602.8
Distribution	3,210.1	1,724.2
Government payments	341.1	
Total	55,174.1	23,428.2

Figure 4.2 Distribution of Virginia's Direct, Indirect, and Induced Employment Impacts by Industry, 2006

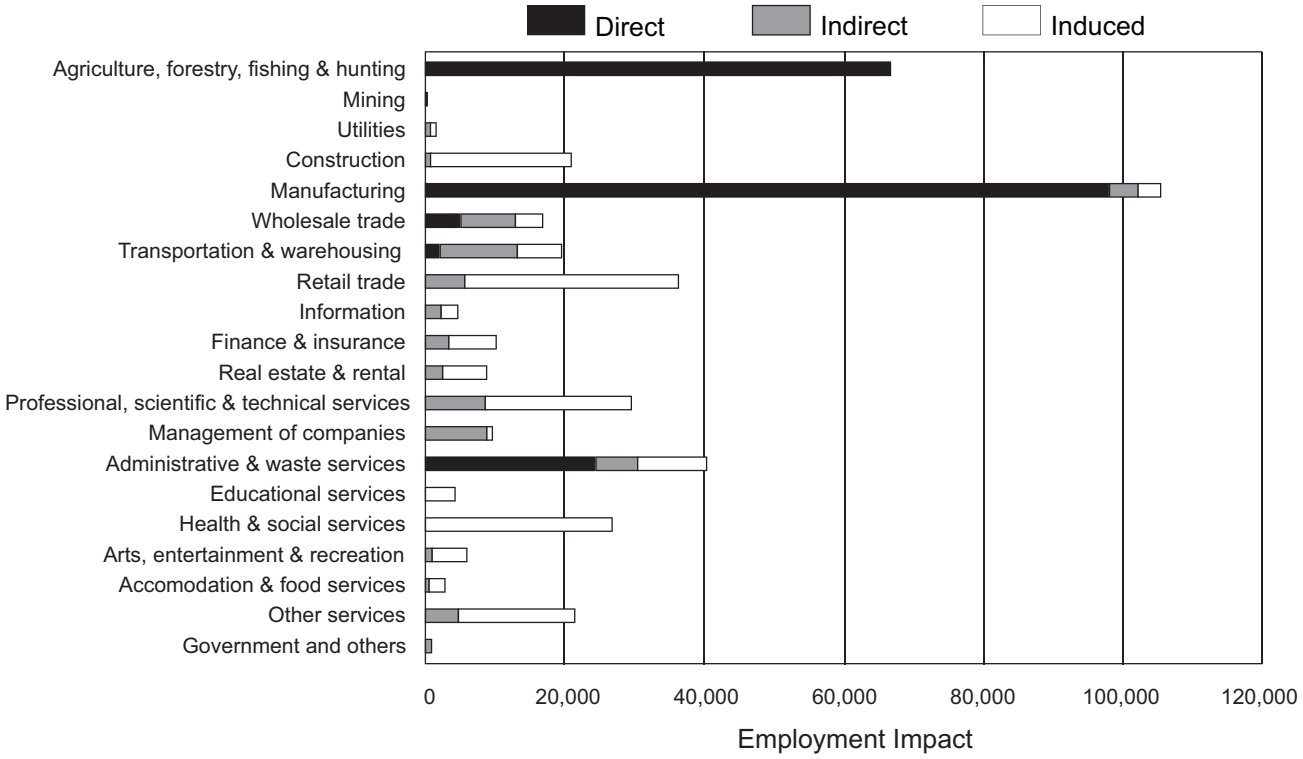


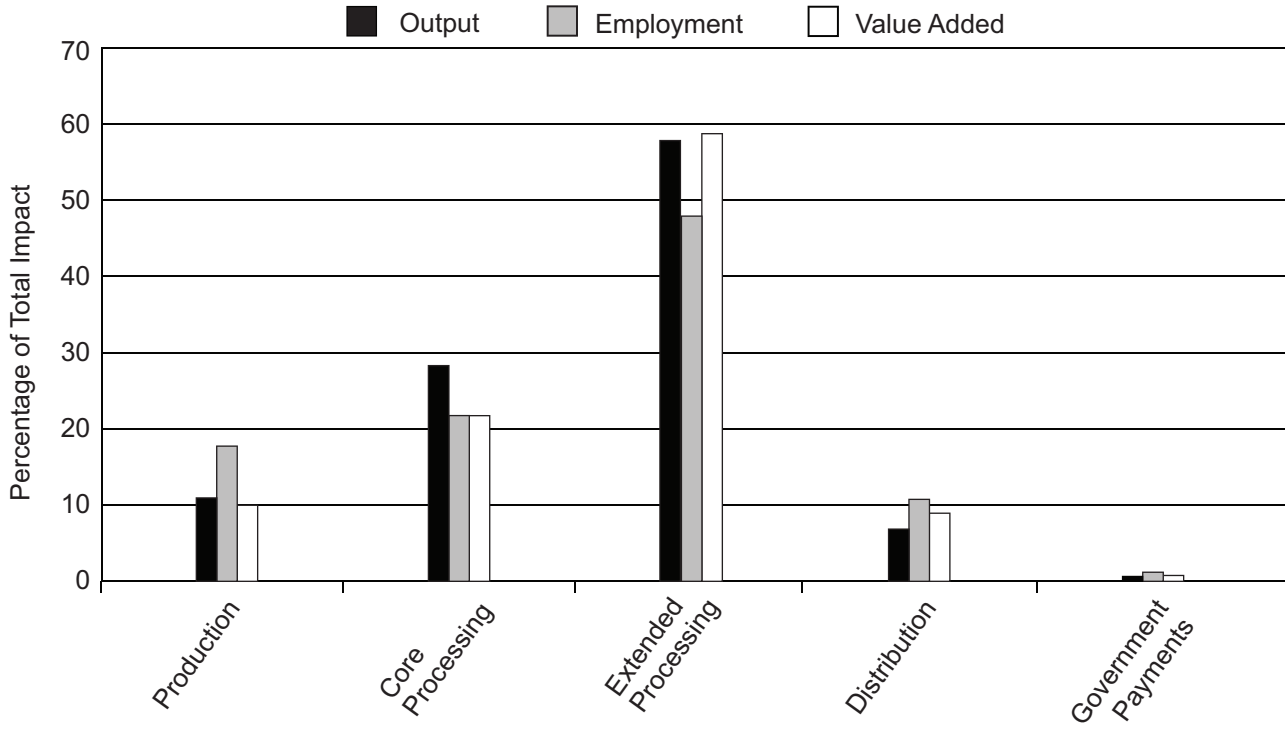
Table 4.5 Total Impact of Virginia's Agriculture and Forestry, Employment, 2006

	Agriculture	Impact as Percentage of Total Employment	Forestry	Impact as Percentage of Total Employment
Production	73,613	1.51	13,336	0.27
Processing core	53,205	1.09	59,242	1.22
Processing extended	180,701	3.72	58,290	1.20
Distribution	43,336	0.89	13,512	0.28
Government payments	6,249	0.13		
Total	357,104	7.35	144,380	2.97

Table 4.6 Total Impact of Virginia's Agriculture and Forestry, Value-Added in Millions of Dollars, 2006

	Agriculture	Impact as Percentage of GSP	Forestry	Impact as Percentage of GSP
Production	2,721.4	0.74	936.9	0.25
Processing core	3,539.5	0.96	4,700.7	1.27
Processing extended	17,428.0	4.72	3,941.0	1.07
Distribution	1,903.4	0.52	1,155.0	0.31
Government Payments	227.6	0.06		
Total	25,819.9	6.99	10,733.6	2.91

Figure 4.3 Virginia Total Impacts by Agriculture and Forestry Component, 2006



impact, 56 percent of output impact, and 58 percent of value-added impact. Distribution activities account for 11 percent of the employment impact, 8 percent of value-added impact, and 6 percent of output impact. Government payments account for approximately 1 percent of each.

Impacts by Region

Impacts were estimated for the seven NASS agricultural statistic areas.[3] There are large regional differences in the absolute and relative sizes of agriculture and forestry-related industries. The largest direct employment impact is in the highly populated Northern district. However, the largest direct value-added and output impacts are in the Central district because of the stronger presence of processing industries (see **Table 4.6**). The largest total output, employment, and value-added impacts are achieved in the Central district where multiplier effects are more pronounced (see **Table 4.7**). Approximately 3.4 percent of employment, 5.6 percent of output, and 8.7 percent of value-added total impacts are realized outside the district where the direct impacts occur. These impacts are referenced as "intra-state" in the table.

Impacts as a percentage of estimated total employment range from a low of approximately 5 percent of total employment in the more urbanized and diversified economy of Northern Virginia to nearly one in four employees in

3 These estimates were generated using input-output tables that were regionalized for each of the seven agricultural statistic areas. The intrastate impact estimates were computed as a residual of the statewide impact estimates.

Table 4.7 Direct Impact of Virginia Agriculture and Forestry by District, 2006

	Output (Million $)	Employment	Value-added (Million $)
Northern	6,621.7	47,533	2,113.5
Eastern	3,535.8	18,473	1,090.4
Western	3,940.4	16,339	1,117.7
Southern	3,923.4	23,275	1,205.1
Southwestern	2,810.6	22,211	796.1
Central	15,835.1	41,465	5,565.6
Southeastern	5,591.6	26,797	1,423.5
Total	42,258.6	196,093	13,311.9

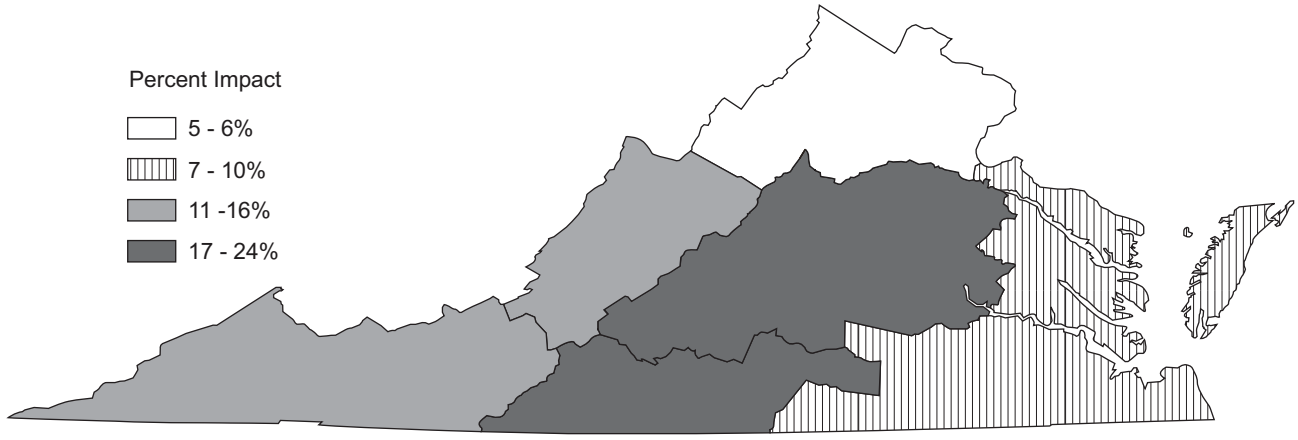
the Southern district centered on Danville (see **Figure 4.4**). Unlike the rest of the state, where agriculture-related impacts form the largest share, the bulk of total economic impact in the Southern district can be attributed to forestry-related industries.

Although this study does not examine the distribution of intraregional impacts by district, other researchers have found that that these impacts vary with direct production and processing impacts felt primarily in rural counties while the service-related indirect and induced impacts are concentrated in more urbanized counties (Hughes and Litz 1996).

Table 4.8 Total Impact of Virginia Agriculture and Forestry by District, 2006

	Output (Million $)	Employment	Value-added (Million $)
Northern	11,874.2	93,539	5,596.2
Eastern	5,694.9	38,595	2,450.1
Western	6,342.3	37,768	2,519.8
Southern	5,346.2	36,620	2,051.4
Southwestern	3,952.6	32,627	1,410.6
Central	31,603.0	183,576	15,446.8
Southeastern	9,367.2	61,596	3,892.3
Intra-state	4,421.8	17,164	3,186.2
Total	78,602.2	501,485	36,553.5

Figure 4.4 District Employment Impact as Percentage of Total Employment by District, 2006



SECTION 5
AGRICULTURAL AND FORESTRY TOURISM IMPACTS

Many forestry and agriculture impacts are not captured by the previous estimates. For instance, recreation and tourism are not fully included in part because of the difficulty of measuring the volume of specific activities and assigning them to the presence of forests and agriculture.[1] However, some estimates of the tourism contribution of agriculture and forestry are available from other studies.[2] These impacts are discussed for wildlife related recreation, the horse industry, wineries, and non-winery agri-tourism, festivals, and fairs.

Wildlife Recreation

Wildlife associated recreation is connected to the presence of forest. In 2001, there were 1,137,000 sportspersons (fishers and hunters) and 2,460,000 wildlife-watching participants in Virginia (U.S. Department of the Interior and U.S. Department of Commerce 2001). The total multiplier effects (direct, indirect, and induced) of forestry-related sporting, spending, and traveling (freshwater fishing and hunting) alone generated approximately $1.5 billion in output and over 13,000 in employment (see **Table 5.1**). Camping, hiking, boating, swimming, and other activities might be expected to have similar impacts but estimates are not available. However, in 2006, there were an estimated 22,943,728 visits to national parks and 6,651,787 visits to state parks in Virginia (Virginia Tourism Corporation 2008). Moreover, outdoor-related activities related to "mountains," "scenic drive," "national and state parks," and "hiking" rank among the most popular activities for Virginia visitors (Virginia Tourism Corporation 2008).

1 Tourism and timbering are often mutually exclusive activities such as when clear cutting is used.

2 Virginia agricultural commodities sold on farms is captured in the previous analysis. However, tourism expenditures on transportation, lodging, and other products and services are not.

Equine Industry

Although agriculture impacts derived from equine sales are accounted for in the previous section and reflect the effects of purchases of inputs in equine production such as grooming, feeding, sheltering, and veterinarian care, such specific impacts do not capture the full impact of the industry. An important part of the impact can be attributed to recreation and tourism activities such as trail riding, competitions and shows, and racing. According to a study completed for the Virginia Equine Educational Foundation, over 800,000 people participated in or attended approximately 700 equine events in 2001 and spent $167 million (The Wessex Group 2003). A study of the Virginia Horse Center in Lexington estimated direct expenditures by participants and the Horse Center totaled $38.9 million and generated a total impact on output in Virginia of $53.3 million, $33.3 million of value-added, and 855 jobs (Knapp 2005).

Table 5.1 Wildlife Recreation Impacts in Virginia, 2001

Activity	Total Output ($)	Employment
Freshwater fishing	734,968,076	6,824
Hunting	724,962,684	6,641
Total	1,459,930,760	13,465

Source: American Sportfishing Association (2002) and International Association of Fish and Wildlife Agencies (2002)

Wineries

According to the July 2007 issue of *Travel + Leisure* magazine, Virginia is one of the top five "newest, ready-for-primetime wine regions from around the world." Virginia is currently home to approximately 130 wineries dispersed throughout the state. In addition to offering wine products, wineries present entertainment and cultural events with tasting rooms forming the focus of

many activities. Winery festivals are also a significant tourism draw. According to a study of the Virginia Wine industry in 2005 for the Virginia Vineyards Association, the wine grape producers had a $347 million economic impact (Morris 2007). Most of this impact is visitor related.

Other Agritourism, Agricultural Festivals, and Agricultural Fairs

Many Virginia farms supplement their income by offering visitor attractions such as on-farm festivals, on-farm markets, pick-your own, hayrides, corn mazes, pumpkin patches, tours, petting zoos, food services, and lodging services. Although reliable visitorship figures are not available for Virginia, farm survey data suggest that the number of farms involved in agritourism may run in the hundreds (McGehee and Kim 2004). Thus, Virginia agritourism impacts may be similar in magnitude to nearby states such as Tennessee, where farm visitor expenditures for an estimated 379 non-winery agritourism attractions support approximately 500 jobs and 12 million in value-added (Jensen et al. 2006).

Finally, some amusement and entertainment services can be tied indirectly to agriculture and forestry resources. For instance, zoos and botanical gardens provide employment to hundreds of Virginians but their economic impacts are not counted. The golf industry is often considered a "green industry" because of the importance of turfgrass installation and maintenance.[3] One statewide study estimates the economic impact of Virginia golf course operations (which includes golf equipment, vendors, food and beverages, and turfgrass maintenance) is nearly $1.5 billion in output (Virginia Golf Council 2006).

Virginia hosts dozens of agricultural festivals each year also, including festivals celebrating farm commodities as varied as apples, peaches, peanuts, garlic, ramps, blackberries, and dairy products. Moreover, state and county fairs, which have a strong agricultural component, including livestock and agricultural competitions, generate hundreds of thousands of visitors.

3 Likewise, no effort was made to estimate the full impact of the turfgrass industry which would include the direct effects of growers, installation and maintenance services, and merchandising activities. However , recent impact estimates of the industry are available in Beddow et al. (2001).

SECTION 6
SUMMARY AND CONCLUSION

In 2006, an estimated $2.7 billion in cash receipts were generated by Virginia's farms and nearly $350 million was received by forest landowners for harvested timber. However, the economic effects of these activities are felt far beyond the farm and the timber tract. The agriculture and forestry production industries purchase inputs from other industries, generate wages and income for workers and owners who spend the income in the state economy, and contribute to the viability of processing industries that might not exist without the local availability of agriculture and forestry raw materials.

When these effects are gauged, the total economic impact of agriculture and forestry related industries is $79 billion in total industry output or sales, $37 billion of value-added (which is 9.9 percent of Virginia's GDP), and 501,500 jobs (which is 10.3 percent of state employment). Results indicate that agriculture-related activities account for approximately 70 percent of agriculture and forestry total output, employment and value-added impacts with forestry related activities making up the remainder. The bulk of the impact, however, is attributable to a subset of manufacturing industries that has a somewhat weaker reliance on Virginia's farm commodities and timber.

The impacts of agriculture and forestry are felt in other sectors of the economy. The largest effects are in the manufacturing and agriculture, forestry, fishing, and hunting industries where direct effects are dominant. However, agriculture and forestry stimulate large public and private services responses through indirect and induced spending. The effects branch throughout the economy affecting every sector.

Impact estimates for Virginia's regions indicate sizeable differences in the absolute and relative sizes of agriculture and forestry related industries. The largest total impact occurs in Central Virginia. Impacts as a percentage of estimated total employment range from a low of approximately 5 percent of total employment in heavily populated and economically diversified Northern Virginia to nearly one in four employees in the Southern district centered on Danville, which is very dependent on forest products industries.

The agriculture and forestry industries also impact the economy in ways that are not measured here. For instance, this study did not compute estimates of agritourism and forest recreation's impact. These activities include freshwater fishing, hunting, hiking and backpacking, camping, wildlife watching, equine events and horseback riding, wineries and other agritourism, agricultural festivals, and state and county fairs. Studies reviewed here that examine just a few of these activities are suggestive that this impact may amount to several billions of dollars. Therefore, agriculture and forestry are important components of Virginia tourism.

In addition, no attempt is made to gauge the wider social benefits and costs of agriculture and forestry. However, these are important societal and ecological issues. Forests, in particular, provide benefits in the form of carbon sequestration, stabilization of soils, wildlife habitat and biodiversity, flood mitigation and improved water quality. Scenic amenities may also improve quality of life. Poorly regulated agricultural and timbering activities can impose costs such as water quality degradation, noxious odors, and airborne pathogens.

Although the agriculture and forestry sectors have had fairly steady production in recent years, both sectors face opportunities and challenges in the process of maintaining their absolute and relative positions within the economy. These positions will be shaped by numerous factors in the areas of production technology, consumer demand, energy prices, urban population growth, government policy, and the global economy. By gauging the size of forestry and agriculture sectors now and in the future, it will be possible to benchmark and gauge how these developments are affecting the role of agriculture and forestry in Virginia's economy.

The input-output model used here suggests additional forces that determine the overall impacts of these renewable natural resources. It is not only increasing the volume of final demand by offering competitively priced, quality products that satisfy consumer tastes that is important. Creating higher-value-added products through innovation and product upgrading can lead to larger economic impacts as well. The density of the trading interrelationships among agriculture and forestry related sectors and other sectors and institutions within the economy is also significant because it helps to determine the magnitude of the indirect and induced effects. Therefore, strengthening linkages among industries in the agriculture and forestry value chain, substituting local products for imports, and improving linkages among all local industries and local consumers have a role to play in determining the future magnitude of these industries on Virginia's economy.

REFERENCES

American Sportfishing Association. 2002. *Sportfishing in America*. Alexandria, VA.

Becker, Charles W. 2006. *Virginia's forests, our common wealth : an economic study of the forest in Virginia*. Charlottesville, VA: Virginia Department of Forestry.

Beddow, Jason, Eluned Jones, David Lamie, Karen Mundy, and David Chalmers. 2001. *The economics of turfgrass in the Commonwealth of Virginia*. Bulletin 01-2, Blacksburg, VA: Virginia Tech.

Berghorn, George H. 2005. *Trends in Michigan's forest products industry, 2000-2004*. Lansing, MI: Michigan Forest Products Council.

Chamberlain, Jim, Robert Bush, and A. L. Hammett. 1998. Non-timber forest products: the other forest products. *Forest Products Journal* 48, 10: 10-19.

Childs, Randall. 2005. *West Virginia's forests: growing West Virginia's future*. Morgantown, WV: West Virginia University, Bureau of Business and Economic Research.

Deller, Steven C. 2004. *Wisconsin and the agricultural economy*. Madison, WI: University of Wisconsin-Madison, Department of Agricultural and Applied Economics.

Drayse, Mark H. 2008. Globalization and regional change in the U.S. furniture industry. *Growth and Change* 39, 2: 252-262.

Edmondson, William and Gerald Schluter. 1998. A procedure for determining food and fiber output, employment, and value-added by agricultural sector. Twelfth International Conference on Input-Output Techniques. New York.

Fuglie, Keith O., James M. MacDonald, and Eldon Ball. 2007. *Productivity growth in U.S. agriculture*. Washington, DC: U.S. Department of Agriculture.

Gelhlar, Mark, Erik Dohlman, Nora Brooks, Alberto Jerardo, and Thomas Vollrath. 2007. *Global growth, macroeconomic change, and U.S. agricultural trade*. Washington, DC: U.S. Department of Agriculture.

Giarratani, Frank. 1976. Application of an interindustry supply model to energy issues. *Environment and Planning A* 8, 4: 447-54.

Hodges, Alan W., W. David Mulkey, Janaki R. Alavalapati, Douglas R. Carter, and Clyde F. Kiker. 2005. *Economic impacts of the forest industry in Florida, 2003*. University of Florida, IFAS Extension.

Hoover, Edgar M. and Frank Giarratani. 1984. *An introduction to regional economics*. New York: Alfred A Knopf.

Hughes, David W. 1995. *Measuring the effect of Louisiana agriculture on the state economy through multiplier and impact analysis*. Baton Rouge, LA: Louisiana State University, Louisiana Agricultural Experiment Station.

Hughes, David W. and Vaneska N. Litz. 1996. Rural-urban economic linkages for agriculture and food processing in the Monroe, Louisiana, functional economic area. *Journal of Agricultural & Applied Economics* 28, 2: 337-55.

Imerman, Mark, David Swenson, Liesl Eathington, and Daniel Otto. 2005. *The economic importance of agri-food industries in Iowa*. Ames, IA: Iowa State University, Department of Economics.

International Association of Fish and Wildlife Agencies. 2002. *Economic importance of hunting in America*. Washington, DC.

Jensen, Kim, Chris Lindborg, Burton English, and Jamey Menard. 2006. *Visitors to Tennessee agri-tourism attractions*. Knoxville, TN: University of Tennessee, Department of Agricultural Economics.

Johnson, Thomas G. and Ernie W. Wade. 1994. *The economic impact of agriculture in Virginia*. Blacksburg, VA: Virginia Polytechnic Institute and State University, Rural Economic Analysis Program.

Johnson, Tony G. and Charles W. Becker. 2007. *Virginia's timber industry--an assessment of timber product output and use, 2005*. Resource Bulletin SRS-12S Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. http://www.srs.fs.usda.gov/pubs/rb/rb_srs125.pdf (Accessed June 4, 2008).

Kandel, William. 2008. Hired farmworkers a major input for some U.S. farm sectors. *Amber Waves* 6, 2:11-15.

Key, Nigel and William McBride. 2007. *The changing economics of U.S. hog production*. Washington, DC: U.S. Department of Agriculture.

Knapp, John L. 2005. *The Virginia horse center's economic impact in 2004: an update of the 2001 study*. Charlottesville, VA: University of Virginia.

Lamie, R. David. 1997. *The economic impact of agriculture and ag-related industries on the Commonwealth of Virginia*. Blacksburg, VA: Virginia Polytechnic Institute and State University, Rural Economic Analysis Program.

Leones, Julie, Gerald Schluter, and George Goldman. 1994. Redefining agriculture in interindustry analysis. *American Journal of Agricultural Economics* 76, 5: 1123-1129.

Lewis, Eugene, Russell Youmans, George Goldman, and Garnet Premer. 1979. *Economic multipliers: can a rural community use them?* Coping with Growth Series, WREP-24. Corvalis, OR: Western Rural Development Center.

Lubowski, Ruben N., Marlow Vesterby, Shawn Bucholtz, Alba Baez, and Michael J. Roberts. 2006. *Major uses of land in the United States, 2002*. Washington, DC: U.S. Department of Agriculture.

MacDonald, James M., Erik J. O'Donoghue, William D. McBride, Richard F. Nehring, Carmen L. Sandretto, and Roberto Mosheim. 2007. *Profits, costs, and the changing structure of dairy farming*. Washington, DC: U.S. Department of Agriculture.

Martinez, Steve W. 2007. *The U.S. food marketing system: recent developments, 1997-2006*. Washington, DC: U.S. Department of Agriculture.

McCorkle, Dean and David Anderson. 2007. *The food and fiber system and production agriculture's contributions to the Texas economy*. College Station, TX: Texas A&M University, Texas Agricultural Experiment Station.

McGehee, Nancy G. and Kyungmi Kim. 2004. Motivation for agri-tourism entrepreneurship. *Journal of Travel Research* 43: 161-170

Miller, Ronald E. and Peter D. Blair. 1985. *Input-output analysis: foundations and extensions*. Englewood Cliffs, NJ: Prentice-Hall.

Minnesota Implan Group, Inc. 2004. *Implan professional version 2.0: user's guide, analysis guide, and data guide*. Stillwater, MN.

Morris, Rob. 2007. Economic impact of Virginia wine, 2005: preliminary findings. http://www.virginiavineyardsassociation.com/presentations/MKF_Rob%20Morris.pdf (Accessed February 6, 2008).

Munn, I. A. and B. K. Tilley. 2007. *Forestry in Mississippi: the impact of the forest products industry on the Mississippi economy: an input-output analysis*. Mississippi State, MS: Mississippi State University.

Parker, Tim. 2008. Sociologist, U.S. Department of Agriculture, Economic Research Service. Interview by Terance Rephann on January 10, 2008. Washington, DC.

Pease, James, Wayne Purcell, George McDowell, Pamela Gibson, and Karen Mundy. 2005. *An introduction to Virginia issues: information and analysis*. Blacksburg, VA: Virginia Polytechnic Institute and State University, Rural Economic Analysis Program.

Purcell, Wayne. 2001. *The economic position of Virginia agriculture 2001*. Blacksburg, VA: Virginia Polytechnic Institute and State University, Rural Economic Analysis Program.

Riall, B. William. 2002. *Economic benefits of the forestry industry in Georgia: 2001*. Atlanta, GA: Georgia Institute of Technology, Economic Development Institute.

Rickman, Dan S. and R. Keith Schwer. 1995. A comparison of the multipliers of IMPLAN, REMI, and RIMS II: benchmarking ready-made models for comparison. *The Annals of Regional Science* 29, 4: 363-374.

Rose, Anita K. 2007. *Virginia's forests, 2001*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Round, Jeffrey. 1983. Nonsurvey techniques: a critical review of the theory and the evidence. *International Regional Science Review* 8, 3: 189-212.

Shane, Mathew and William Liefert. 2007. Weaker dollar strengthens U.S. agriculture. *Amber Waves* 5, 1: 16-21.

Sharma, Khem R., PingSun Leung, and Stuart T. Nakamoto. 1999. Accounting for the linkages of agriculture in Hawaii's economy with an input-output model: a final demand-based approach. *The Annals of Regional Science* 33, 1: 123-140.

Spurlock, Stan R. 2003. *Economic impacts from agricultural production in Mississippi*. Mississippi State, MS: Mississippi State University, Department of Agricultural Economics.

Tanjuakio, Rodolfo V., Steven E. Hastings, and Peter J. Tytus. 1996. The economic contribution of agriculture in Delaware. *Agricultural and Resource Economics Review* 25, 1: 46-53.

The Wessex Group, LTD. 2003. *2001-2002 study of the economic impact of the equine industry in Virginia*. Virginia Equine Educational Foundation.

U.S. Department of Agriculture, Forest Service. 2004. *National report on sustainable forests--2003*. Asheville, NC: Southern Research Station.

U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *2002 Census of agriculture, Virginia state and county data*. Volume 1, Geographic Area Series, Part 46. Washington, DC.

U.S. Department of Agriculture, Economic Research Service. 2005. Farm and Farm-Related Employment. http://www.ers.usda.gov/data/farmandrelatedemployment/ (Accessed January 10, 2007)

U.S. Department of Agriculture, Economic Research Service. 2007. Farm Income: Data Files. http://www.ers.usda.gov/Data/FarmIncome/finfidmuxls.htm (Accessed November 15, 2007).

U.S. Department of Commerce, U.S. Census Bureau. 2006. *Lumber production and mill stocks*. Current Industrial Reports, MA 321T(06)-1. Washington, DC. http://www.census.gov/industry/1/ma321t06.pdf (Accessed February 5, 2008).

U.S. Department of Commerce, Bureau of Economic Analysis. 2007. Gross domestic product by state. http://www.bea.gov/regional/gsp/ (Accessed December 5, 2007).

U.S. Department of Commerce, Bureau of Economic Analysis. 2008. Local area personal income. http://www.bea.gov/regional/reis/ (Accessed May 20, 2008).

U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. 2001. *2001 national survey of fishing, hunting, and wildlife-associated recreation*. Washington DC.

Upendram, Sreedhar. *Economic impacts of forest products industry: forest products in Missouri*. Missouri Economic Research and Information Center Research Brief, Missouri Department of Economic Development.

Virginia Department of Agriculture and Consumer Services. 2005. *The study of Virginia's equine industry*. Senate Document No. 22. Richmond, VA.

Virginia Department of Forestry. 2007. Virginia's eighth forest survey. http://www.dof.virginia.gov/resinfo/fia-2007-key-stats.shtml (Accessed February 1, 2008).

Virginia Golf Council. 2006. *Virginia's golf economy, 2005*. Prepared by SRI International.

Virginia Tourism Corporation. 2008. Virginia Tourism Monitor. http://vatc.org/research/MonitorHomepage.asp (Accessed February 6, 2008).

Wear, David. N., Douglas R. Carter, and Jeffrey Prestemon. 2007. *The U.S. South's timber sector in 2005: a prospective analysis of recent changes* Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Westcott, Paul C. 2007. *Ethanol expansion in the United States: how will the agricultural sector adjust?* Washington, DC: U.S. Department of Agriculture.

Westcott, Paul C., C. Edwin Young, and Michael J. Price. 2002. *The 2002 farm act: provisions and implications for commodity markets*. Washington, DC: U.S. Department of Agriculture.

Xu, Weihuan. 2002. *Economic impact of the Texas forest sector*. Publication 161. College Station, TX: Texas A&M University, Texas Forest Service.

APPENDIX

Appendix A.1 Agricultural Statistic Districts

Northern	Eastern	Western	Southern	Southwestern	Central	Southeastern
Alexandria City	Accomack	Alleghany	Charlotte	Bland	Albemarle	Brunswick
Arlington	Charles City County	Augusta	Danville City	Bristol City	Amelia	Chesapeake City
Clarke	Essex	Bath	Franklin County	Buchanan	Amherst	Dinwiddie
Culpeper	Gloucester	Botetourt	Halifax	Carroll	Appomattox	Emporia City
Fairfax City	Hampton City	Buena Vista City	Henry	Dickenson	Bedford City	Franklin City
Fairfax County	James City County	Covington City	Lunenburg	Floyd	Bedford County	Greensville
Falls Church City	King & Queen	Craig	Martinsville City	Galax City	Buckingham	Isle of Wight
Fauquier	King George	Highland	Nottoway	Giles	Campbell	Mecklenburg
Frederick	King William	Lexington City	Patrick	Grayson	Caroline	Norfolk City
Harrisonburg City	Lancaster	Roanoke City	Pittsylvania	Lee	Charlottesville City	Portsmouth City
Loudoun	Mathews	Roanoke County		Montgomery	Chesterfield	Prince George
Madison	Middlesex	Rockbridge		Norton City	Col. Heights City	Southampton
Manassas City	New Kent	Salem City		Pulaski	Cumberland	Suffolk City
Manassas Park City	Newport News City	Staunton City		Radford City	Fluvanna	Surry
Page	Northampton	Waynesboro City		Russell	Fredericksburg City	Sussex
Prince William	Northumberland			Scott	Goochland	Virginia Beach City
Rappahannock	Poquoson City			Smyth	Greene	
Rockingham	Richmond County			Tazewell	Hanover	
Shenandoah	Westmoreland			Washington	Henrico	
Stafford	Williamsburg City			Wise	Hopewell City	
Warren	York			Wythe	Louisa	
Winchester City					Lynchburg City	
					Nelson	
					Orange	
					Petersburg City	
					Powhatan	
					Prince Edward	
					Richmond City	
					Spotsylvania	

Appendix A.2 Virginia Agricultural Cash Receipts by IMPLAN Sector, 1990-2006 ($ Thousands)

	IMPLAN Sector											
Year	Oilseed Farming	Grain Farming	Vegetable and Melon Farming	Fruit Farming	Greenhouse and Nursery Farming	Tobacco Farming	Cotton Farming	All Other Crop Farming	Cattle Ranching and Farming	Poultry and Egg Production	Animal Production, Except Cattle, Poultry, and Eggs	Total
1990	101,490	97,929	113,674	32,402	113,348	182,793	1,828	134,085	691,930	503,212	174,046	2,146,737
1991	85,953	84,621	100,188	53,980	117,551	197,171	5,614	114,834	656,528	516,917	176,602	2,109,959
1992	80,111	123,328	104,231	47,533	127,163	189,667	7,720	110,393	628,259	555,473	170,829	2,144,707
1993	77,608	93,293	83,343	44,430	134,023	180,807	9,364	83,097	610,275	618,058	192,619	2,126,917
1994	80,549	104,415	109,517	43,905	137,951	168,590	25,698	107,047	570,069	663,504	180,352	2,191,597
1995	79,782	146,114	105,119	49,899	139,287	174,906	42,072	92,765	511,915	703,456	184,034	2,229,349
1996	94,464	187,638	68,047	45,058	147,139	187,793	53,690	104,361	510,492	787,263	204,455	2,390,400
1997	99,405	137,347	94,638	42,903	160,235	190,781	48,764	92,514	609,280	734,824	200,902	2,411,593
1998	64,027	85,678	90,549	47,499	162,660	173,551	50,075	90,988	590,358	790,877	184,164	2,330,426
1999	50,326	71,822	76,610	63,275	170,662	155,883	39,038	83,377	616,252	786,825	175,485	2,289,555
2000	66,135	102,054	74,332	44,907	188,117	132,064	33,968	88,636	588,725	773,789	206,990	2,299,717
2001	76,073	107,475	85,960	45,760	104,357	124,374	37,407	95,987	667,993	816,492	217,284	2,379,162
2002	66,429	94,039	110,363	46,614	228,676	121,995	23,478	63,494	589,717	651,898	239,800	2,236,503
2003	80,313	100,380	113,071	41,023	225,283	89,521	39,194	64,219	583,926	732,073	255,088	2,324,091
2004	126,456	145,259	145,159	47,663	234,880	112,920	31,975	65,896	626,094	882,959	276,502	2,695,763
2005	102,349	123,663	145,083	54,975	235,778	60,527	43,593	58,120	705,950	910,019	265,136	2,705,193
2006	86,439	135,689	166,015	41,671	237,400	71,595	43,325	51,919	692,299	874,652	287,665	2,688,669
Smoothed average	111,042	123,965	138,709	52,638	225,338	66,134	40,241	62,909	681,642	898,468	276,172	2,677,258