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Economic Impacts of Agriculture and Forestry in Tennessee, 2006



by

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Executive Summary

In 2006, the agro-forestry industrial complex contributed \$78.9 billion to the Tennessee economy, accounting for 16.2 percent of the economic activity conducted within the state, and employed over 502,000 individuals, or 13.8 percent of the total number of workers. In this study the agro-forestry industrial complex included the primary industries typically associated with agriculture and forest operations such as growing crops, the breeding and feeding of livestock, and the management and logging of trees. Also included in the industrial complex were input supply industries and value-added sub-sectors, which included food and beverage manufacturing, apparel and textiles, and forestry products manufacturing.

Agriculture, a subset of the agro-forestry industrial complex, includes farming and related industries, as well as value-added food and fiber production, processing and manufacturing. Agriculture accounted for 10.5 percent of the state's economy and generated \$51.4 billion in output. Agriculture employed close to 347,000 Tennesseans, with over 127,000 (both full- and part-time) in agricultural production. In addition,

- Agriculture input supplying industries – agricultural machinery and chemical products – generated nearly \$3.4 billion in cash receipts annually.
- Tennessee farmers earned more than 68.4 percent of their cash receipts from cattle and calves, broilers, cotton, greenhouse/nursery, and soybeans.
- Exports for Tennessee's forest products outside the United States for 2006 totaled \$881.0 million. Paper products had the highest export value at \$624.7 million, followed by wood products (\$137.2 million), furniture and related products (\$94.1 million), and forestry and logging (\$24.9 million).
- For the estimated 759 bioscience establishments in Tennessee for 2006, the industry contributed an estimated \$46.3 billion, or 9.5 percent, in total output to the state's economy.
- Major markets for Tennessee's exports of agricultural and livestock products included China, Mexico, Turkey, Indonesia, and Taiwan.
- Tennessee, one of the top hardwood lumber producing states, produced 970.0 million board feet of hardwood lumber and 31.0 million board feet of softwood lumber in 2006.

This analysis was conducted using the Tennessee Agri-Industry model (TNAIM) and the Impact Analysis for Planning (IMPLAN) model and databases. TNAIM, an input-output model for five trading regions within the state, traces transactions conducted within the economy and attempts to quantify the economic interdependencies within each region's economy for a given point in time. Through these interdependencies, one can evaluate the indirect and induced impacts that economic activity in one region might have on the entire state economy.

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Economic Impacts of Agriculture and Forestry in Tennessee

Introduction

Similar to previous reports (English, Jensen, and Menard, 2001; English, Jensen, and Menard, 2003; Menard, English, and Jensen, 2006) where the economic importance and impacts of agricultural and forestry industrial complexes on Tennessee's economy were examined using 1997, 2000, and 2003 data, respectively, this study uses an input-output model reflecting the state's 2006 economy to determine direct impacts on related input industries, and impacts through resulting expenditures by households and institutions at both the state and five-region level. The impacts were provided for four major indicators: total industry output, employment, labor income, and value-added.

Input-output model results for previous studies (English, Jensen, and Menard, 2001 and 2003) in this series were based on the Standard Industrial Classification (SIC) system as defined by the United States Census Bureau. Results for the 2006 (Menard, English, and Jensen) and this study are based on the North American Industrial Classification System (NAICS) (Census NAICS, 2002). The reader is cautioned to not compare industry sector level results from the previous studies using the SIC system with the results from this most recent study using NAICS. For readers who are interested in time series data, this creates a problem since many industries are grouped in different or entirely new categories.

For the purpose of this analysis, agriculture¹ and forestry includes the production and processing of agricultural and forest products and the input suppliers of these products. The objectives of this analysis are to: 1) provide an overview of Tennessee's agriculture and forestry resource base, 2) compare livestock and crop statistics for 2003 and 2006, 3) provide an

¹ In this report, forestry and the production of forest products were incorporated in agriculture and agribusiness, respectively.

overview of the United State's and Tennessee's bioscience industries, and 4) evaluate the economic importance and impacts of the agricultural and forestry industrial complex, including the bioscience industry, for the state and for specific consumption regions within the state.

This document is structured along the same theme as the objectives. First, an overview of Tennessee's agriculture and forestry is presented. Crop and livestock cash receipts, Tennessee's rank in the United States based on the production of agricultural products, exports for both agricultural and forestry products, plus agricultural and forestry manufacturing statistics are discussed. Next, a review of state level changes in livestock and crops for the years 2003 and 2006 is presented. Changes in livestock inventory, crop acreages, prices, including a brief discussion of rainfall by climate divisions in the state are discussed in the section. Further, a brief overview of the U.S. and Tennessee's bioscience industries is presented. A listing of industries by NAICS that comprise the bioscience subsectors, employment by bioscience subsectors, and growth in biosector establishments are discussed. Finally, the remaining part of the document evaluates the economic impacts and importance of the agricultural and forestry industrial complex for the state and specific consumption regions within the state with an input-output model. After the data and methodology section discussion, direct and total economic impact results are summarized.

Overview of Agriculture and Forestry in Tennessee

In 2006, 82,000 Tennessee farms used 11.4 million acres, or 43.2 percent of the state's land base. From 2001 to 2006, the number of farms in the state decreased an average of 1.4 percent annually. The average farm, in 2006, was 139 acres in size compared to 446 acres for the United States. Approximately 73.8 percent of the total number of farms had sales in the \$1,000-\$9,999 range, 21.3 percent in the \$10,000-\$99,999 range, and 4.9 percent had sales of \$100,000 or more (Tennessee Department of Agriculture, 2007).

Tennessee was ranked in the upper half of the nation in all of the major crops (rice and peanuts are not grown extensively in the state) (Table 1). Approximately 41.6 percent of Tennessee's total harvested cropland acreage (roughly 4.4 million acres) was in hay (all types), followed by soybeans (25.7 percent), cotton (15.8 percent), corn for grain (11.4 percent), and wheat (4.3 percent). For crops, cotton had the largest cash receipts, followed by soybeans, corn, tobacco, and vegetables. Tennessee's top crop counties included Robertson County for alfalfa hay, Greene County for all other hay, Robertson County for all tobacco, Obion County for both corn and soybeans, Haywood County for cotton, and Gibson County for wheat.

Table 1. Crops Harvested, Acreage, State Ranking, and Cash Receipts, 2006

Crops	Acreage (Thousand Acres)	State Ranking	Cash Receipts (Thousand \$)
Hay (all types)	1,830	--	\$47,764
Soybeans	1,130	15	\$251,572
Cotton, Lint	695	6	\$335,155
Corn for Grain	500	18	\$152,327
Winter Wheat	190	21	\$44,629
Corn for Silage	47	29	--
Tobacco (all types)	20	3	\$94,108
Vegetables*	14	--	\$70,857
Grain Sorghum	11	15	\$3,311

*Snap beans, squash, and tomatoes

Source: Tennessee Department of Agriculture, 2007

In terms of number of head, broilers, cattle and calves, chickens, hogs and pigs, equine, and milk cows were the predominant livestock in the state (Table 2). According to the Tennessee Department of Agriculture for 2007, cash receipts from farm marketing for these livestock products (except for beef cows and equine) totaled \$1.1 billion. Of that total, cattle and calves contributed 43.1 percent, broilers 36.9 percent, dairy products 13.2 percent, and hogs and pigs 3.7 percent. Tennessee is ranked second in the United States for the number of equine on farms, 9th for beef cows, 13th for broilers, 14th cattle and calves, 24th for hogs and pigs, and 28th for milk cows. Tennessee's top livestock counties included Greene County for all cattle, beef cows, and milk cows; Henry County for all hogs; and Rutherford County for all equine.

Table 2. Livestock Numbers, State Rankings, and Cash Receipts, 2006

Livestock	Inventory (Number)	State Ranking	Cash Receipts (Thousand \$)
Broilers	213,500,000	13	\$413,782
Cattle & Calves	2,240,000	14	\$483,160 ¹
All Chickens	1,889,000	34	\$34,835 ²
Beef Cows	1,110,000	9	--
Hogs & Pigs	190,000	24	\$41,332
Equine	155,000	2	--
Milk Cows	70,000	28	\$148,390 ³

¹Includes beef cows

²Includes eggs and farm chickens; excludes commercial broilers

³Dairy products

Source: Tennessee Department of Agriculture, 2007

Tennessee's more significant agricultural commodities in terms of dollar value, along with their corresponding U.S. market share, are shown in Table 3. In descending order they were cattle ranching and farming, poultry and egg production, cotton farming, greenhouse and nursery production, oilseed farming (primarily soybeans), all other crop farming (primarily hay and seed), and grain farming (barley, corn, oats, sorghum, and wheat). Tobacco and cotton had the largest U.S. market share at 12.6 percent and 4.8 percent respectively.

Table 3. State Value of Agricultural Commodities and U.S. Market Share, 2006

Commodity	Value (Million \$)	U.S. Market Share (Percent)
Cattle Ranching & Farming	\$675	0.89
Poultry & Egg Production	\$468	1.62
Cotton Farming	\$307	4.86
Greenhouse & Nursery Production	\$301	1.70
Oilseed Farming	\$237	1.35
All Other Crop Farming*	\$187	0.91
Grain Farming	\$170	0.59
Animal Production, except Cattle & Poultry & Eggs**	\$150	0.75
Tobacco Farming	\$139	12.65
Vegetable & Melon Farming	\$99	0.61
Hunting/Trapping	\$91	2.71
Fruit Farming	\$20	0.13
Fishing	\$7	0.22

*Primarily hay and seed farming

**Primarily hogs, sheep & goats, aquaculture, equine, and apiculture

Source: Minnesota IMPLAN Group, Inc., 2006

Tennessee's agricultural commodity exports in 2006 totaled \$923.5 million. The value of the more predominant commodities exported included cotton and cottonseed products at \$297.9 million, soybeans and products at \$114.7 million, wheat and products at \$64.4 million, unmanufactured tobacco at \$63.5 million, live animals and meat (excluding poultry) at \$51.6 million, feed grains and products at \$48.6 million, poultry and products at \$46.8 million, and feeds and fodders at \$37.8 million. Exports for the category "Other" totaled \$170.8 million, which included minor oilseeds, essential oils, beverages other than juice, nursery and greenhouse, wine and miscellaneous vegetable products (Tennessee Department of Agriculture, 2007). Major markets for Tennessee's exports of agricultural and livestock products included China, Mexico, Turkey, Indonesia, and Taiwan (U.S. Department of Commerce, 2006b).

In 2006, Tennessee's forest products (paper products, wood products, plus furniture and related products) exported outside the United States, including forestry and logging, totaled close to \$881.0 million. Paper products had the highest export value at \$624.7 million, followed by wood products (\$137.2 million), furniture and related products (\$94.1 million), and forestry and logging (\$24.9 million) (U.S. Department of Commerce, 2006b).

Tennessee is one of the top hardwood lumber producing states in the United States. In 2006, approximately 970.0 million board feet of hardwood lumber and 31.0 million board feet of softwood lumber were produced (U.S. Census Bureau, 2007). The majority of the forest cover in the state was hardwoods. White oak, red oak, hickory, yellow poplar, and maple were some of the more predominant hardwood species. For softwoods, loblolly pine, virginia pine, red cedar, and shortleaf pine were major species.

Agriculture and forestry manufacturing industries for the state (Figures 1 through 9) included food, beverage and tobacco products, textile mills, textile product mills, apparel, leather and allied products, wood products, paper, and furniture and related products. In 2006, close to

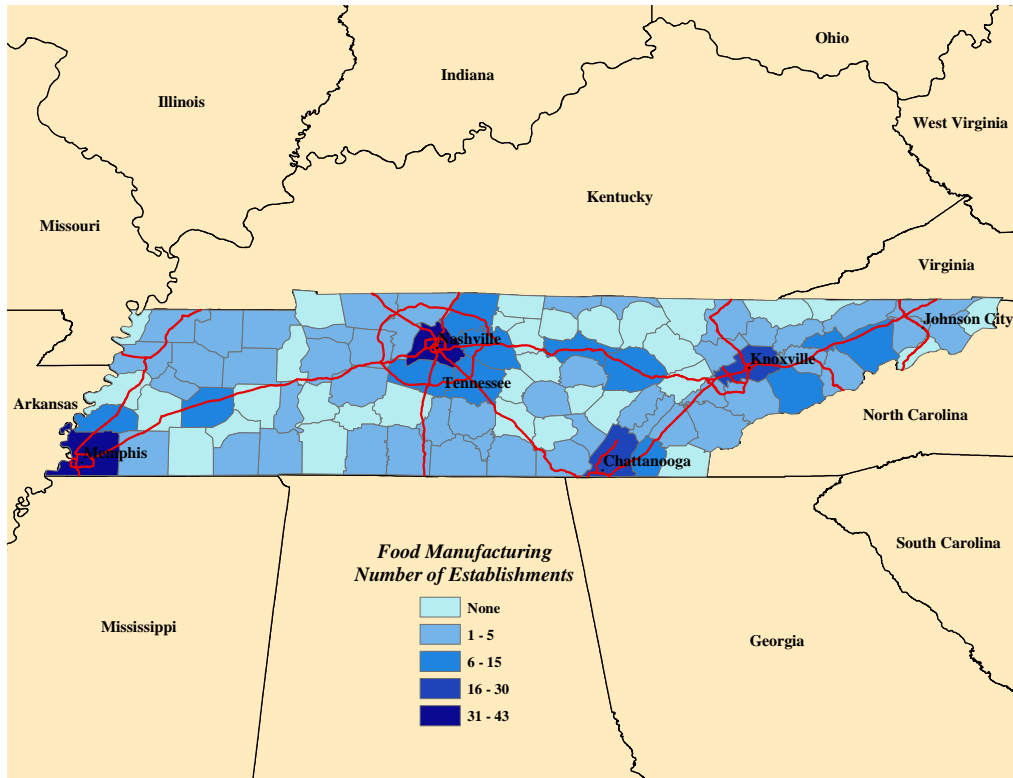


Figure 1. Number of Food Manufacturing Establishments in Tennessee, 2006.

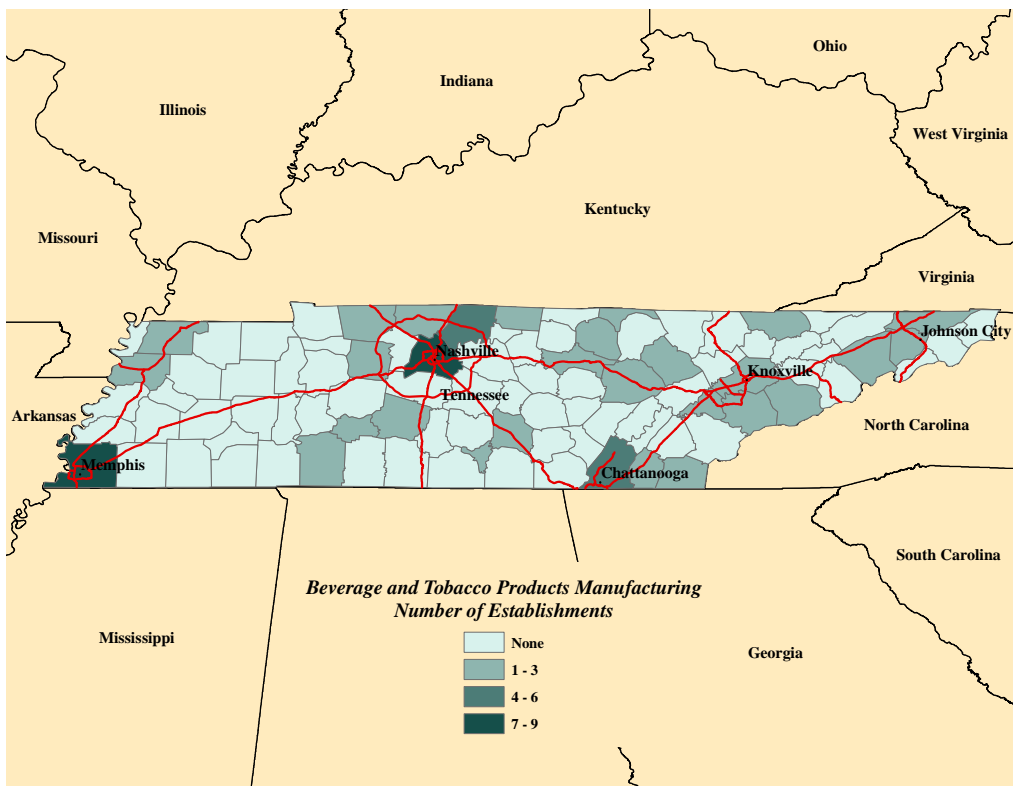


Figure 2. Number of Beverage and Tobacco Products Establishments in Tennessee, 2006.

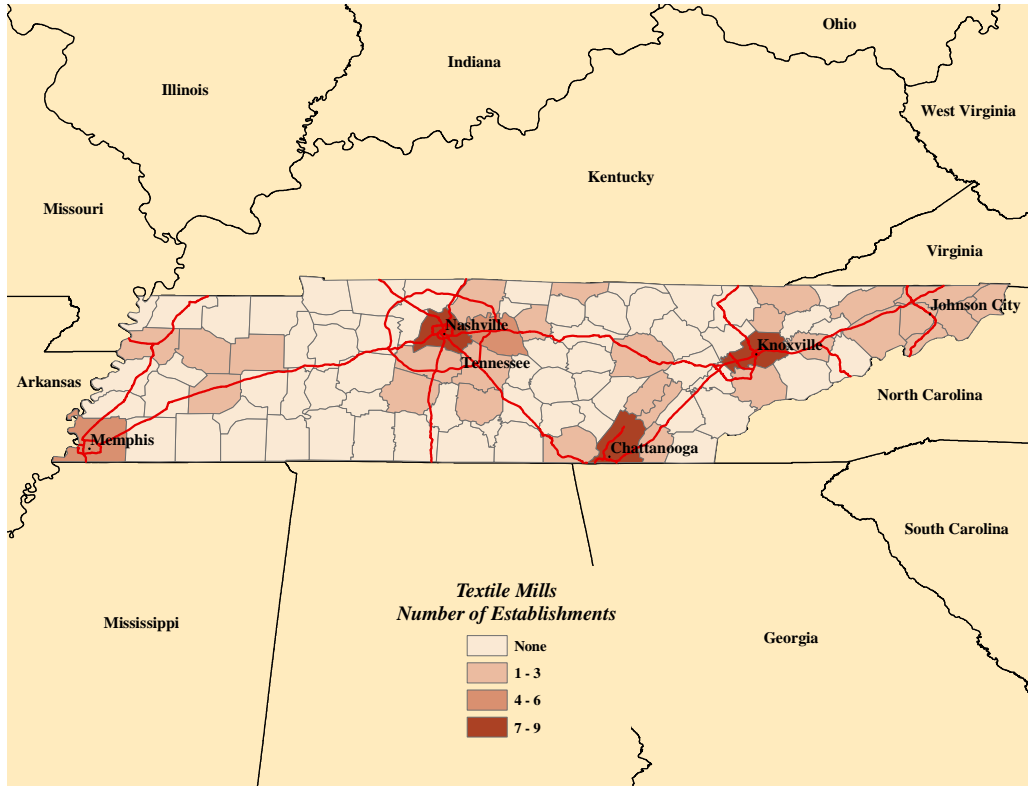


Figure 3. Number of Textile Mill Establishments in Tennessee, 2006.

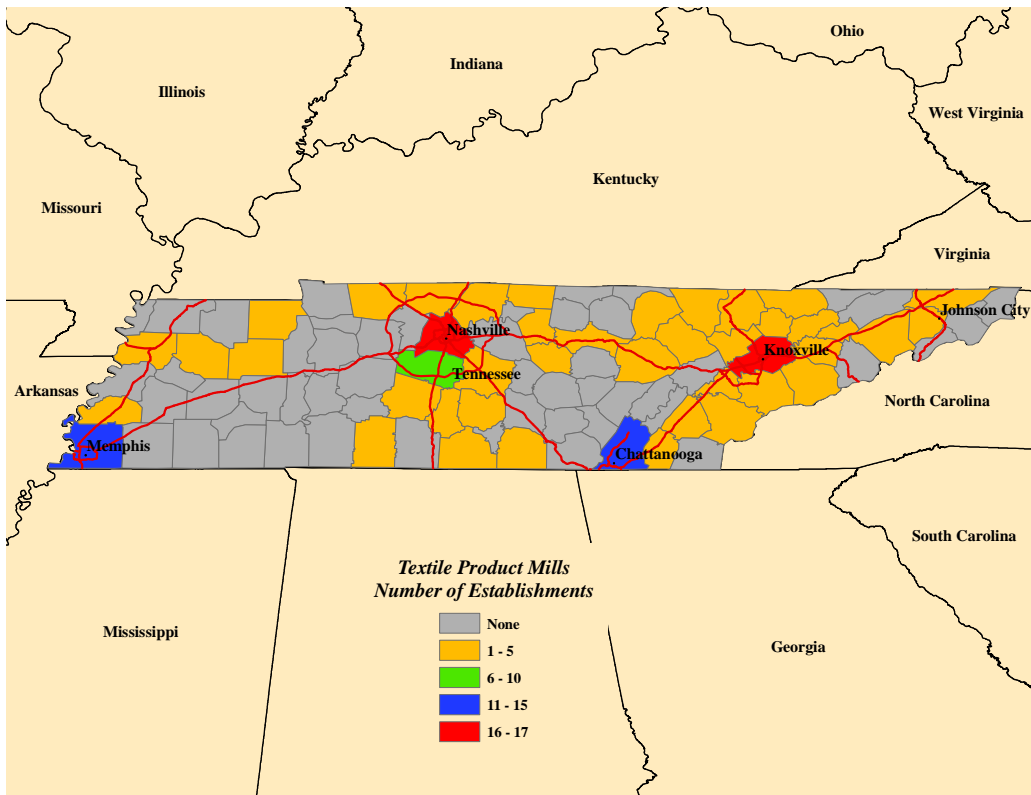


Figure 4. Number of Textile Product Mill Establishments in Tennessee, 2006.

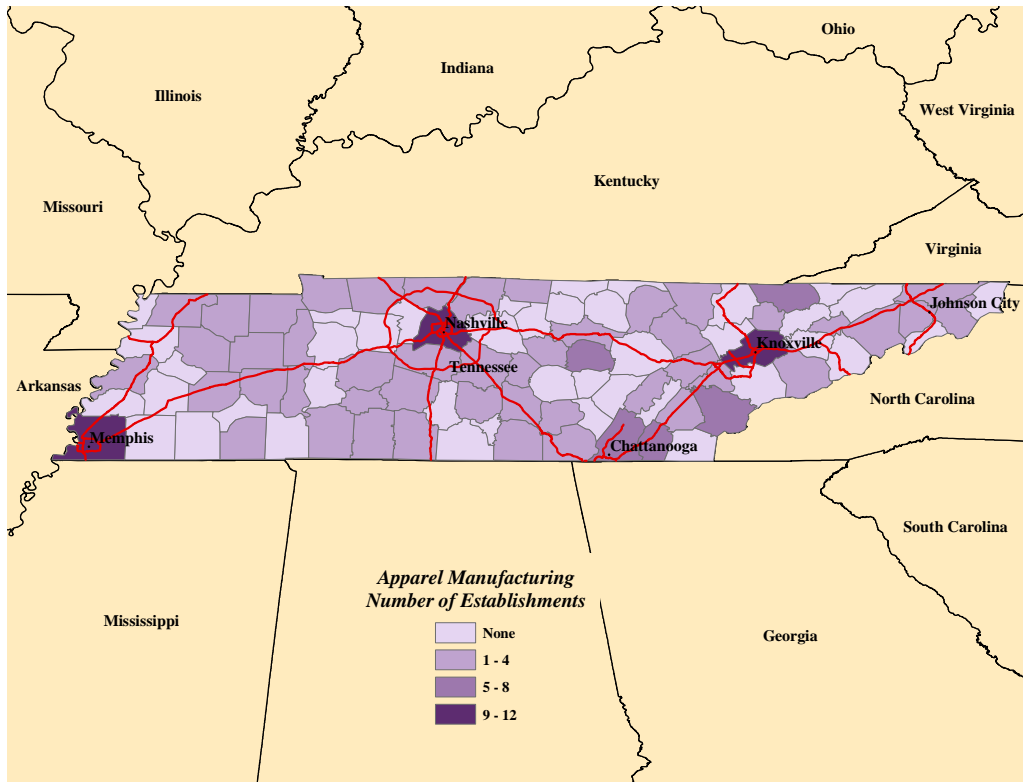


Figure 5. Number of Apparel Manufacturing Establishments in Tennessee, 2006.

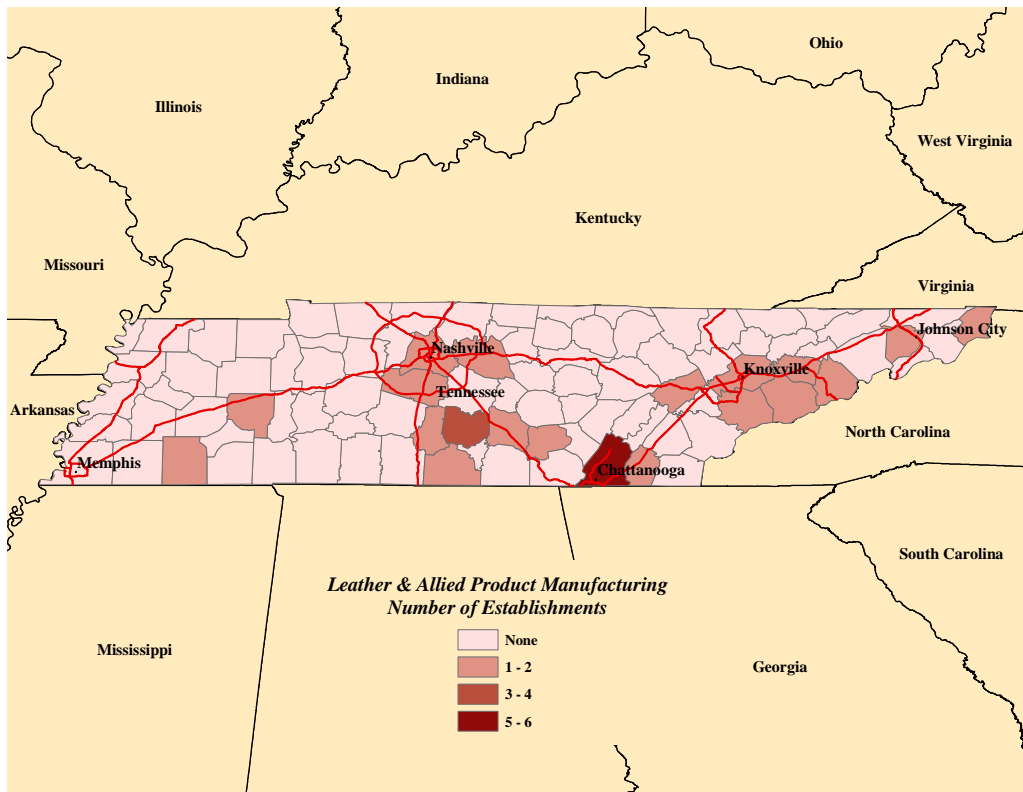


Figure 6. Number of Leather & Allied Product Establishments in Tennessee, 2006.

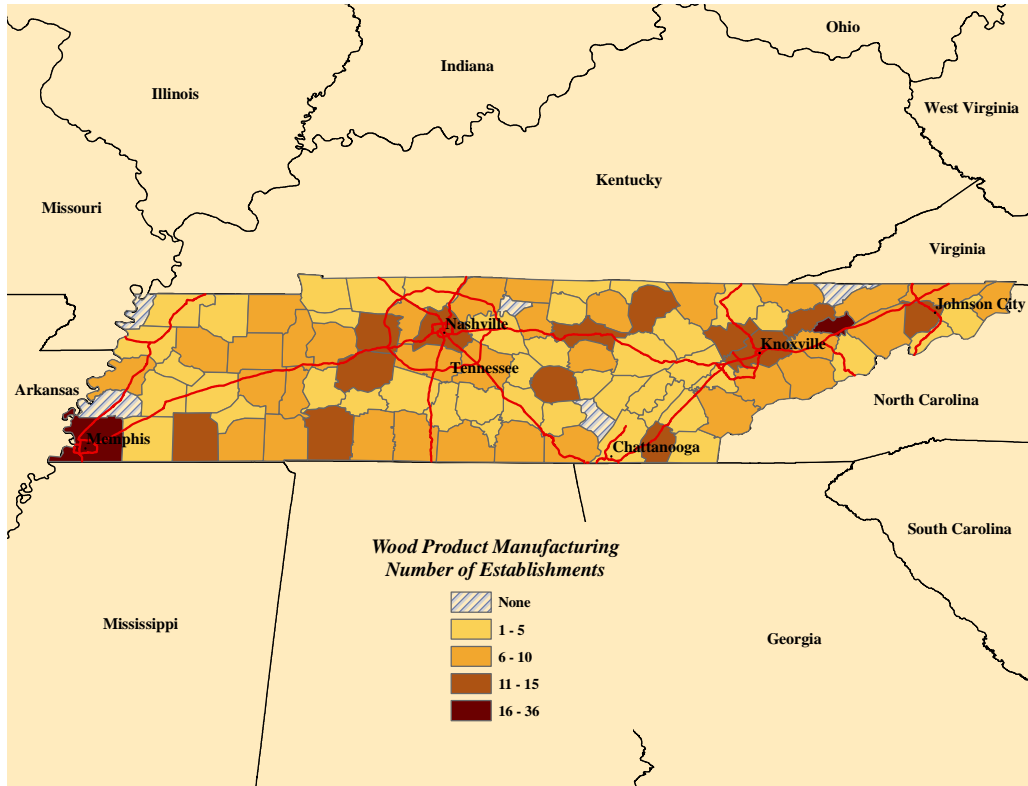


Figure 7. Number of Wood Product Manufacturing Establishments in Tennessee, 2006.

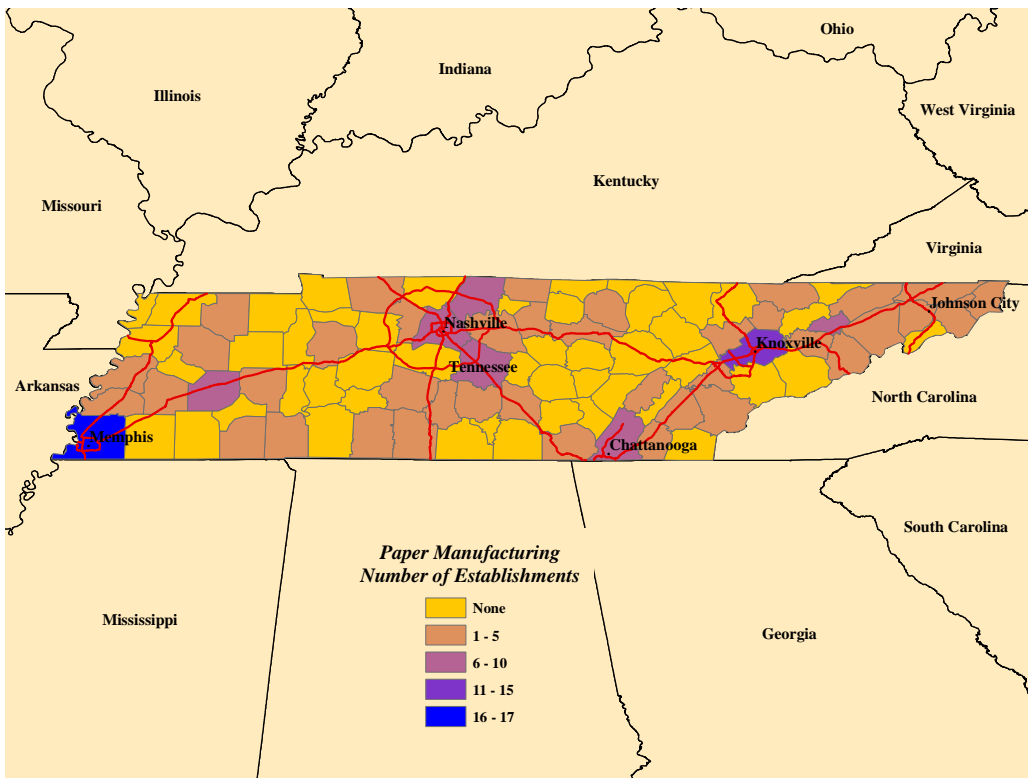


Figure 8. Number of Paper Manufacturing Establishments in Tennessee, 2006.

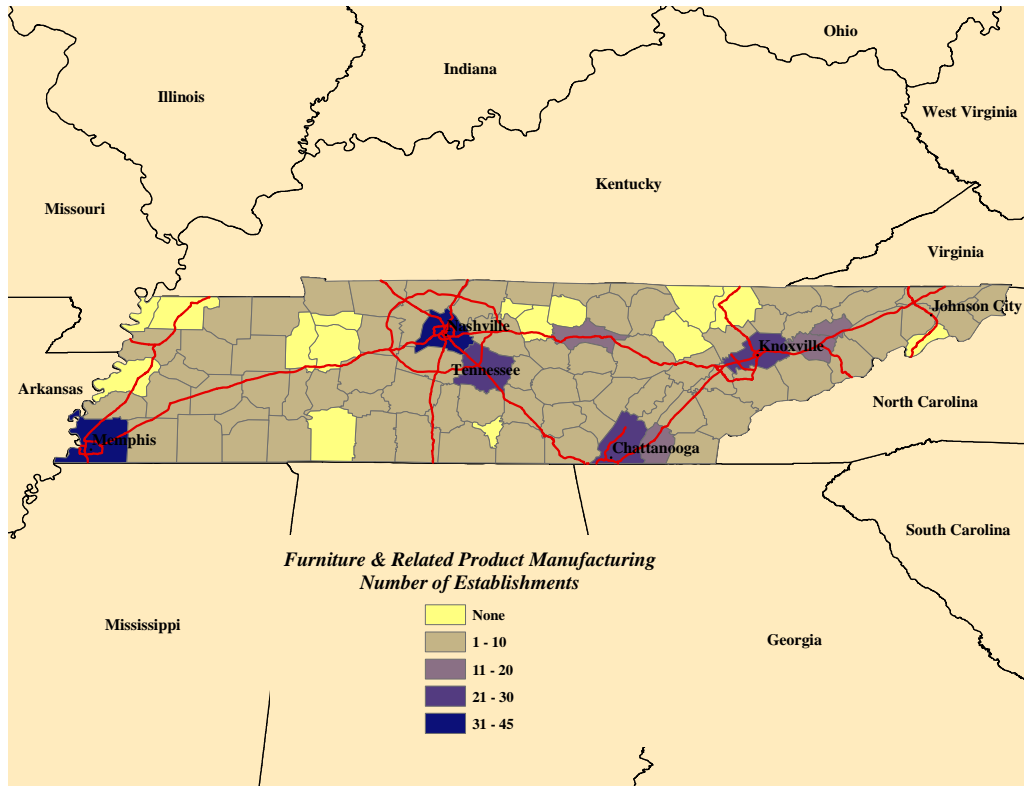


Figure 9. Number of Furniture & Related Products Establishments in Tennessee, 2006.

\$31.8 billion dollars of goods were shipped and close to 107,000 Tennesseans were employed with a payroll of close to \$3.8 billion (Table 4). Food manufacturing shipped the largest value of goods, over \$14.1 billion, followed by paper manufacturing at \$5.0 billion, and beverage and tobacco products at \$4.0 billion. As a group, textile mills, including textile product mills and apparel, shipped close to \$3.1 billion. For the forest products group, which included wood products manufacturing, paper manufacturing, and furniture and related products, close to \$10.4 billion of goods were shipped. Tennessee's national market share for value of shipments for food manufacturing was 2.6 percent, beverage and tobacco products at 3.3 percent, textile mills at 4.0 percent, textile product mills at 2.6 percent, apparel manufacturing at 2.2 percent, leather and allied products at 2.6 percent, wood product manufacturing at 2.6 percent, paper manufacturing at 3.0 percent, and furniture and related products at 2.9 percent (U.S. Census Bureau, 2006a and 2006b).

Table 4. Manufacturing Statistics for Tennessee, 2006

Manufacturing Industry/NAICS Code	Employees (Number)	Payroll (Thousand \$)	Establishments (Number)	Value of Shipments (Thousand \$)
Food (311)	39,321	\$1,398,390	321	\$14,120,493
Beverage & Tobacco Products (312)	3,287	\$147,498	62	\$4,063,730
Textile Mills (313)	4,397	\$171,398	68	\$1,557,102
Textile Product Mills (314)	4,199	\$140,554	135	\$851,967
Apparel (315)	6,210	\$145,432	142	\$672,959
Leather & Allied Products (316)	1,104	\$31,390	29	\$151,509
Wood Products (321)	15,668	\$497,863	597	\$2,899,610
Paper (322)	13,617	\$653,469	150	\$5,001,995
Furniture & Related Products (337)	18,887	\$561,735	443	\$2,485,411
Total	106,690	\$3,747,729	1,947	\$31,794,776

Source: U.S. Census Bureau, Annual Economic Surveys, 2006 Annual Survey of Manufacturers, Geographic Area Statistics; U.S Census Bureau, State and County *Quickfacts*, Tennessee *QuickLinks*, County Business Patterns Economic Profile, 2006.

In terms of employment, the forest products group (wood product manufacturing, paper manufacturing, and furniture and related products) employed the largest share at over 48,000. This was followed by food manufacturing employment at over 39,000 workers and textile mills and related products, including apparel, at 14,800 workers.

State Level Changes in Livestock and Crops: 2003 to 2006

Comparing 2003 and 2006 agricultural data for the state revealed an increase in the number of cattle and calves and broilers. Poultry, eggs, milk cows, and hogs production numbers decreased. Prices increased for most livestock products. Most of the traditional row crops grown in the state experienced reduced planted acreage except for cotton and soybeans. Crop prices were higher for most major crops grown in the state except for cotton, soybeans, and tobacco.

Precipitation for the state for the timeframe reviewed can be characterized as extreme. Above average rainfall for years 2003 and 2004 in many areas of the state followed by below average rainfall for year's 2005 and 2006 (see Figure 10) (U.S. Department of Commerce, 2006a).

Livestock Changes in Inventory and Prices

Compared to 2003 production levels, broilers had the largest increase in numbers (17.1 percent), followed by cattle (1.4 percent) (Table 5). The largest decrease in numbers was for poultry (16.4 percent), followed by hogs (15.6 percent), milk cows (11.4 percent), and eggs (0.3 percent). Milk production declined 12.9 percent over the timeframe. Livestock prices were higher for all livestock commodities. Poultry had the greatest price increase (24.6 percent), followed by cattle (22.3 percent), hogs (19.2 percent), broilers (11.8 percent), and eggs (6.1 percent).

Table 5. Comparison of Tennessee Livestock Numbers and Prices, 2003 and 2006*

Commodity	Inventory		Change %	Units 1,000	Price		Change %	Units
	2003	2006			2003	2006		
All Cattle & Calves	2,210	2,240	1.4	head	\$64.20	\$78.50	22.3	100 pounds
All Chickens	2,260	1,889	-16.4	no.	\$6.10	\$7.60	24.6	head
Broilers	182,300	213,500	17.1	no.	\$0.34	\$0.38	11.8	pound
Eggs	290,000	289,000	-0.3	no.	\$1.32	\$1.40	6.1	dozen
Milk Cows	79	70	-11.4	head	--	--	--	head
All Hogs	225	190	-15.6	head	\$36.00	\$42.90	19.2	100 pounds

Source: Tennessee Department of Agriculture, 2007

*Data in nominal values.

Crop Changes in Acres Planted and Prices

With the exception of cotton and soybeans, acres of traditional row crops harvested declined from 2003 to 2006 (Table 6). Grain sorghum had the largest decline in acres harvested at 72.5 percent, followed by tobacco (36.1 percent), wheat (29.6 percent), and corn (20.6 percent). Cotton harvested acres increased from 530 to 695 thousand acres, a 31.1 percent increase. Practically all the crop commodities experienced higher prices for the timeframe examined except for cotton, soybeans, and tobacco. The largest price increase was for peaches, followed by snap beans, corn, grain sorghum, tomatoes, and wheat.

Nursery producers and gross sales increased for all nursery categories from 2003 to 2006 (Table 7). For numbers sold, all categories increased except for deciduous shrubs. Major

Table 6. Comparison of Tennessee Crop Acreages and Prices, 2003 and 2006*

Commodity	Harvested Acres		Change	Price		Change	Units
	2003	2006		2003	2006		
	1,000 acres		%	\$/unit		%	
Hay, All	2,030	1,830	-9.9	\$55.45	\$56.80	2.4	ton
Corn	630	500	-20.6	\$2.35	\$2.85	21.3	bushel
Soybeans	1,120	1,130	0.9	\$7.25	\$6.30	-13.1	bushel
Cotton	530	695	31.1	\$0.59	\$0.47	-20.3	pound
Tobacco	31	19.8	-36.1	\$2.11	\$1.89	-10.3	pound
Grain Sorghum	40	11	-72.5	\$2.38	\$2.88	21.0	bushel
Wheat	270	190	-29.6	\$3.17	\$3.50	10.4	bushel
Tomatoes	3.5	3.9	11.4	\$37.00	\$42.02	13.6	cwt
Snap Beans	9.5	9.0	-5.3	\$29.00	\$38.00	31.0	cwt
Apples	1.1	0.9	-18.2	\$0.24	\$0.25	4.2	pound
Peaches	0.5	0.5	0.0	\$0.47	\$0.67	42.6	pound

Source: Tennessee Department of Agriculture, 2007

*Data in Nominal Values.

nursery categories include broadleaf and coniferous evergreens, deciduous shade and flowering trees, deciduous shrubs, fruit and nut plants, and propagative materials. Ornamental grasses and other woody ornamentals are also grown in the state. For 2006, the largest numbers of nursery producers are for the deciduous flowering (132 producers) and shade trees (131 producers) categories. These two nursery categories also had the largest gross sale values for this timeframe, \$35.5 million and \$42.7 million respectively. For numbers sold in 2006, deciduous flowering trees has the largest numbers sold (close to 3.1 million), followed by deciduous shrubs (close to 2.3 million), deciduous shade trees (2.1 million), broadleaf evergreens (roughly 2.1

Table 7. Comparison of Tennessee Nursery Statistics, 2003 and 2006

Category	Producers		Sold		Gross Sales		Change
	2003	2006	2003	2006	2003	2006	
	Number		Number (1,000)		\$1,000		%
Broadleaf Evergreens	103	114	1,546	2,060	\$11,591	\$14,737	27.1
Coniferous Evergreens	91	111	1,404	1,452	\$9,322	\$11,376	22.0
Deciduous Shade Trees	122	131	1,597	2,175	\$29,083	\$42,769	47.1
Deciduous Flowering Trees	130	132	2,926	3,075	\$27,235	\$35,554	30.5
Deciduous Shrubs	103	116	2,386	2,295	\$8,773	\$12,284	40.0
Fruits & Nut Plants	26	33	1,414	1,565	\$7,386	\$7,725	4.6
Propagative Materials	61	65	--	--	\$12,510	\$16,401	31.1

Source: Tennessee Agricultural Statistics Service, 2004; Tennessee Department of Agriculture, 2007

million), fruit and nut plants (1.5 million), and coniferous evergreens (1.4 million). Comparing gross sales for 2003 and 2006, deciduous shade trees had the largest increase at 47.1 percent, followed by deciduous shrubs (40.0 percent), propagative materials (31.1 percent), deciduous flowering trees (30.5 percent), broadleaf evergreens (27.1 percent), coniferous evergreens (22.0 percent), and fruit and nut plants (4.6 percent). In 2006, Tennessee was ranked 8th in total nursery production compared to other states in the U.S. (Tennessee Agricultural Statistics Service, 2004; Tennessee Department of Agriculture, 2007).

Cotton, grain sorghum, tobacco, and wheat had an increase in yields per acre between 2003 and 2006 for the state, while corn and soybeans per acre yields decreased. One possible cause for the change in yields may be the weather. Precipitation values from 2003 to 2006 are shown in Figure 10. The values shown were departure from normal precipitation. For example,

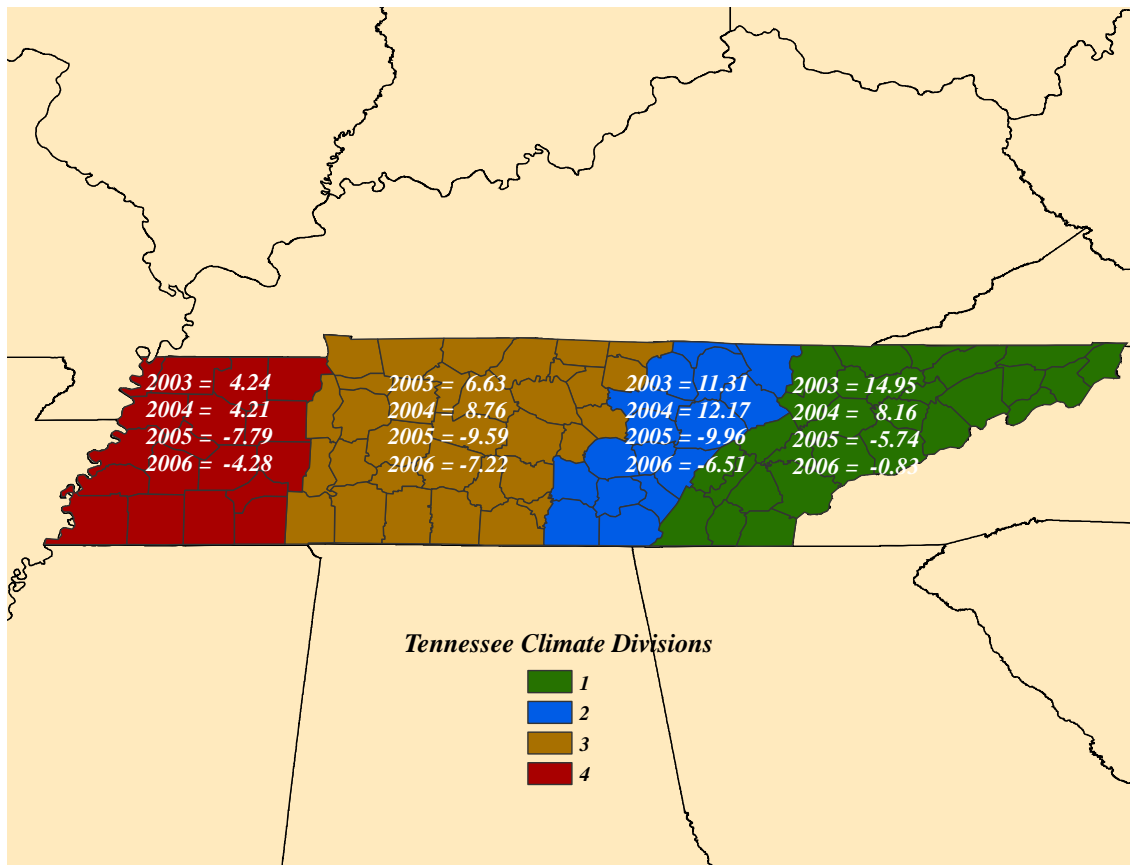


Figure 10. Departure from Normal Precipitation for Tennessee’s Climate Divisions.

for climate division four in 2006, rainfall was 4.28 inches below normal precipitation values. Likewise, for that same climate division for 2003, rainfall was 4.24 inches above normal. Rainfall for years 2003 and 2004 was above normal for all the climate divisions in the state. On the other hand, rainfall was below normal for all climate divisions for 2005 and 2006. Rainfall extremes were greater in the middle and eastern parts of the state compared to the western part.

Changes in acres, yields, and prices impacted the total industry output (value of production) contributed to the state's economy from crops. Of the five major crops, cotton, tobacco, and wheat had an increase in gross receipts comparing 2003 with 2006. Soybeans and corn gross receipts declined from 2003 to 2006 (Tennessee Agricultural Statistics Service, 2004; Tennessee Department of Agriculture, 2007).

United States and Tennessee's Bioscience Industries

The biosciences industries are important economic drivers in today's economy. Advances in human, plant, and animal biosciences have led to growth of companies focusing on new drug developments, molecular diagnostics, biomaterials and biocomposites, biofuels, along with other bio-related products. Applying this knowledge of the way in which plants, animals, and humans function provide a common link for defining the bioscience industries and its activities. States and regions throughout the U.S. have recognized the importance of these industries and have fostered business climates to support their specific needs. In general, the bioscience industries are comprised of the four following subsectors: 1) agriculture feedstocks and chemicals; 2) drugs and pharmaceuticals; 3) medical devices and equipment; and 4) research, testing and medical laboratories. The industries that comprise the bioscience subsectors by NAICS are listed in Table 8. For 2006, it is estimated that the total employment impact of the biosciences sector for the U.S. is 7.5 million jobs. This employment value is augmented when taking into account the additional jobs created in the economy as a result of the

Table 8. Industries Comprising the Bioscience Subsectors by NAICS Code

NAICS Code	Description
<i>Agricultural Feedstock & Chemicals</i>	
311221	Wet Corn Milling
311222	Soybean Processing
311223	Other Oilseed Processing
325193	Ethyl Alcohol Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325221	Cellulosic Organic Fiber Manufacturing
325311	Nitrogenous Fertilizer Manufacturing
325312	Phosphatic Fertilizer Manufacturing
325314	Fertilizer (mixing only) Manufacturing
325320	Pesticide & Other Agricultural Chemical Manufacturing
<i>Drugs & Pharmaceuticals</i>	
325411	Medicinal & Botanical Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing
325414	Other Biological Product Manufacturing
<i>Medical Devices & Equipment</i>	
334510	Electromedical Apparatus Manufacturing
334516	Analytical Laboratory Instrument Manufacturing
334517	Irradiation Apparatus Manufacturing
339111	Laboratory Apparatus & Furniture Manufacturing
339112	Surgical & Medical Instrument Manufacturing
339113	Surgical Appliance & Supplies Manufacturing
339114	Dental Equipment & Supplies Manufacturing
339115	Ophthalmic Goods Manufacturing
339116	Dental Laboratories
<i>Research, Testing, & Medical Laboratories</i>	
541380	Testing Laboratories
541710	R&D in the Physical, Engineering, & Life Sciences
621511	Medical Laboratories
621512	Diagnostic Imaging Centers

Source: Battelle Memorial Institute, 2008

sector's direct jobs (close to 1.3 million). Compared to the overall private sector, bioscience sector jobs in the U.S. grew 5.7 percent from 2001 to 2006 compared to 3.1 percent for the private sector. The largest overall job growth occurred in 2004. Average salaries in the bioscience sector were 68 percent higher (\$71,000) than the average private sector salary (\$42,000). For 2006, there were close to 43,000 bioscience business establishments in the United States, a 7.7 percent increase from 2003 levels. The subsector with the largest number of establishments experienced the largest growth since 2001 (32.7 percent) was research, testing,

and medical laboratories (22,857 establishments), followed by medical devices and equipment (0.3 percent growth) (15,215 establishments), drugs and pharmaceuticals (1.9 percent growth) (2,654 establishments), and agricultural feedstock and chemicals (3.8 percent growth) (2,183 establishments). Of these subsectors, the drugs and pharmaceuticals subsector offered the highest wage jobs (Battelle Memorial Institute, 2008; U.S Census Bureau, 2006b (2006 and 2003 data)).

For Tennessee in 2006, the number of bioscience establishments based on the NAICS codes listed in Table 8 is 759 (U.S Census Bureau, 2006b), a 7.7 percent increase compared to 2003. Research, testing, and medical laboratories have the largest number of establishments at 448, followed by medical devices and equipment (252), agriculture feedstocks and chemicals (40), and drugs and pharmaceuticals (19). Compared to 2003, the largest growth in number of establishments occurred in the research, testing, and medical laboratories subsector (12.6 percent), followed by the medical devices and equipment subsector. A decline in the number of establishments occurred in the drugs and pharmaceuticals and agricultural feedstocks and chemicals subsectors, 17.4 and 2.4 percent, respectively.

Input-Output Analysis: Data and Methods Used

The Tennessee Agri-Industry Model (TN-AIM) was used to model industry and institutional interrelationships in each of five regions within Tennessee. TN-AIM is based on the Impact Analysis for Planning (IMPLAN) model and databases (Olson and Lindall, 1999). The five regions followed those used by the Bureau of Economic Analysis to represent areas of economic consumption (consumption regions), as displayed in Figure 11 (for county listings, see Appendix A). Regional values were then aggregated to the state level.

IMPLAN employs a regional social accounting system and can be used to generate a set of balanced economic/social accounts and multipliers. The social accounting system is an

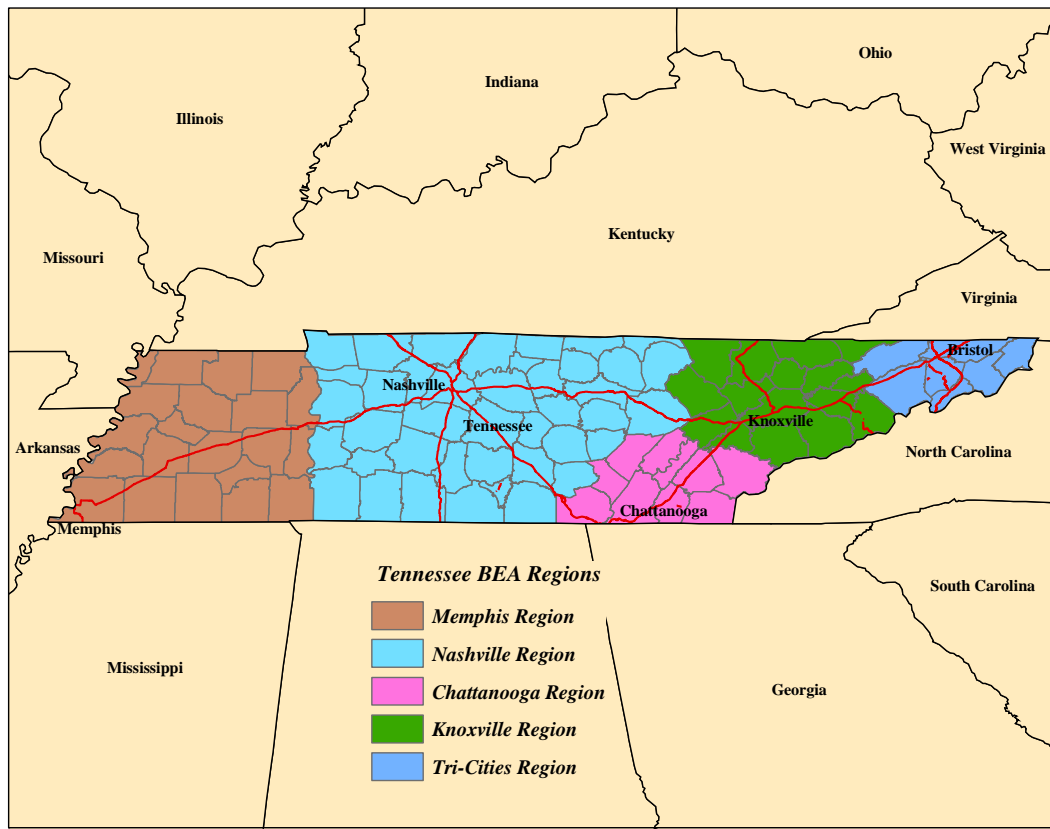


Figure 11. Tennessee Agri-Industry Model Analysis Regions.

extension of input-output analysis². Input-output analysis can provide important and timely information on the interrelationships in a regional economy and the impacts of changes on that economy. Input-output analysis has been expanded beyond market-based transaction accounting to include non-market financial flows by using a social accounting matrix or SAM framework (Pyatt and Round, 1985). The model describes the transfer of money between industries and institutions and contains both market-based transactions and non-market financial flows, such as inter-institutional transfers (see Figure 12). The ‘Make’ and ‘Use’ components of the SAM include the commodities made and used by industries. Factors represent the value-added by

² Input-output (I-O) analysis, also known as inter-industry analysis, is the name given to an analytical work conducted by Wassily Leontief (1936) in the late 1930’s. The fundamental purpose of the I-O framework is to analyze the interdependence of industries in an economy through market-based transactions.

	Industry	Commodity	Factors	Institutions	Enterprise	Capital	Trade	Total
Industry		Make					Exports	Total Industry Output
Commodity	Use			Consumption		Consumption		Total Commodity Output
Factors	Value Added						Exports	Total Factor Income
Institutions		Sales	Transfers	Transfers	Transfers		Exports	Total Institutional Income
Enterprises								Total Enterprise Income
Capital						Transfers	Exports	Total Capital Income
Trade	Imports		Factor Trade	Imports		Transfers	Exports	Total Trade Income
Total	Total Industry Outlay	Total Commodity Outlay	Total Factor Outlay	Total Institutional Outlay	Total Enterprise Outlay	Total Capital Outlay	Total Regional Exports	

Figure 12. Social Accounting Matrix Framework

Source: Olson and Lindall, 1999.

industries, including wages and compensation to workers, interest, profits, and indirect business taxes. Capital includes expenditures made by industries and institutions to obtain equipment and construction. The SAM takes into account corporate profits as 'Enterprises'. The SAM also accounts for non-industrial financial flows, including factor exports and imports, institution exports, factor distribution, and inter-institutional transfers. Factor exports include both payments reimbursed from outside the region for exports less the payments for imports. Institutional exports would include situations such as jobs commuting outside the region. Factor distributions are payments from the factor sectors to institutions, such as households or governments. Inter-institutional transfers include payments between institutions, such as federal government grants to state governments, welfare, social security payments, and taxes paid to governments.

The model uses regional purchase coefficients generated by econometric equations that predict local purchases based on a region's characteristics. Output from the model includes descriptive measures of the economy including total industry output, employment, and value-added for over 500 industries in the Tennessee economy. Total industry output is defined as the value of production by industry per year. Employment represents total wage and salary employees, as well as self-employed jobs in a region, for both full-time and part-time workers. Total value added is defined as all income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses. Not only can the model describe a regional economy, but the model also can be used for predictive purposes, by providing estimates of multipliers.

Multipliers measure the response of the economy to a change in demand or production. Multiplier analysis generally focuses on the impacts of exogenous changes on: a) output of the sectors in the economy, b) income earned by households because of new outputs, and

c) employment (in physical terms) that is expected to be generated because of the new outputs. The notion of multipliers rests upon the difference between the initial impact of an exogenous change (final demand) and the total impacts of a change. Direct impacts measure the response for a given industry given a change in final demand for that same industry. Indirect impacts represent the response by all local industries that occur as a result of a change in final demand for a specific industry. Induced impacts represent the response by all local industries caused by increased (decreased) expenditures of new household income and inter-institutional transfers generated (lost) from the direct and indirect impacts of the change in final demand for a specific industry. This study uses Type I and Type SAM (Social Accounting Matrix) multipliers. Type I multipliers are calculated by dividing direct plus indirect impacts by the direct impacts, where the Type SAM multipliers = (direct + indirect + induced impacts)/direct impacts. The Type SAM multipliers take into account the expenditures resulting from increased incomes of households as well as inter-institutional transfers resulting from the economic activity. Therefore, Type SAM multipliers assume that as final demand changes, incomes also increase along with inter-institutional transfers. As consumers and institutions increase expenditures this leads to increased demands from local industries.

Results

Economic Impacts at the State & In-State Region Levels

Direct economic activity for total industry output (TIO), employment, labor income, and total value-added (TVA) for agriculture and forestry for the state and by analysis regions within the state are presented in Table 9. In 2006, agriculture and forestry related industries contributed a total of \$43.5 billion in direct economic activity to the state of Tennessee, or 8.9 percent of the state's economy. Employment in agriculture and forestry related industries were over 221 thousand persons, or 6.1 percent of the workforce. Total value added was close to \$13

Table 9. Direct Economic Activity in Agriculture and Forestry

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
All Sectors (Including Non-Agricultural and Non-Forestry):								
State ^c	487,492		3,624,042		155,423		244,215	
Chattanooga	55,196	11.3	379,835	10.5	16,062	10.3	26,602	10.9
Knoxville	77,715	15.9	611,354	16.9	24,958	16.1	39,847	16.3
Memphis	128,633	26.4	986,763	27.2	43,434	27.9	67,662	27.7
Nashville	198,501	40.7	1,412,351	39.0	62,144	40.0	96,213	39.4
Tri-Cities	27,448	5.6	233,739	6.4	8,825	5.7	13,891	5.7
Bioscience:								
State ^c	23,346		94,678		7,195		9,612	
Chattanooga	1,421	6.1	7,091	7.5	427	5.9	522	5.4
Knoxville	8,442	36.2	25,708	27.2	2,027	28.2	3,020	31.4
Memphis	6,485	27.8	21,577	22.8	1,692	23.5	2,425	25.2
Nashville	5,889	25.2	36,280	38.3	2,749	38.2	3,202	33.3
Tri-Cities	1,109	4.8	4,022	4.2	300	4.2	442	4.6
Agriculture & Forestry:								
State ^c	43,561		221,880		7,091		12,801	
Chattanooga	6,666	15.3	28,659	12.9	1,225	17.3	2,056	16.1
Knoxville	6,082	14.0	33,035	14.9	1,116	15.7	1,734	13.5
Memphis	16,266	37.3	62,108	28.0	2,408	34.0	4,590	35.9
Nashville	12,390	28.4	80,859	36.4	1,996	28.2	3,836	30.0
Tri-Cities	2,157	5.0	17,218	7.8	347	4.9	585	4.6
Primary & Secondary Agriculture								
State ^c	28,201		161,983		3,753		7,520	
Chattanooga	4,683	16.6	20,443	12.6	773	20.6	1,364	18.1
Knoxville	3,608	12.8	18,793	11.6	463	12.3	826	11.0
Memphis	9,680	34.3	44,082	27.2	1,098	29.3	2,297	30.5
Nashville	9,025	32.0	64,908	40.1	1,250	33.3	2,734	36.4
Tri-Cities	1,205	4.3	13,757	8.5	169	4.5	299	4.0
Primary Agriculture								
State ^c	3,044		101,115		531		1,316	
Chattanooga	281	9.2	5,157	5.1	32	6.0	106	8.1
Knoxville	305	10.0	10,743	10.6	60	11.3	132	10.0
Memphis	1,004	33.0	28,912	28.6	210	39.5	455	34.6
Nashville	1,270	41.7	45,240	44.7	200	37.7	548	41.7
Tri-Cities	184	6.1	11,063	10.9	29	5.5	74	5.6
Secondary Agriculture								
State ^c	25,157		60,869		3,222		6,203	
Chattanooga	4,402	17.5	15,286	25.1	741	23.0	1,258	20.3
Knoxville	3,303	13.1	8,050	13.2	403	12.5	694	11.2
Memphis	8,676	34.5	15,170	24.9	889	27.6	1,842	29.7
Nashville	7,756	30.8	19,668	32.3	1,050	32.6	2,185	35.2
Tri-Cities	1,021	4.1	2,694	4.4	140	4.3	224	3.6
Primary & Secondary Forestry								
State ^c	15,360		59,897		3,339		5,282	

Table 9. Direct Economic Activity in Agriculture and Forestry (Cont.)

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Chattanooga	1,984	12.9	8,216	13.7	452	13.5	692	13.1
Knoxville	2,474	16.1	14,242	23.8	653	19.6	909	17.2
Memphis	6,585	42.9	18,026	30.1	1,309	39.2	2,293	43.4
Nashville	3,364	21.9	15,951	26.6	747	22.4	1,102	20.9
Tri-Cities	952	6.2	3,461	5.8	178	5.3	287	5.4
Primary Forestry								
State ^c	6,342		13,954		1,123		2,123	
Chattanooga	823	13.0	1,531	11.0	142	12.6	272	12.8
Knoxville	234	3.7	769	5.5	35	3.1	63	3.0
Memphis	4,053	63.9	7,475	53.6	757	67.4	1,441	67.9
Nashville	889	14.0	3,468	24.9	126	11.2	224	10.6
Tri-Cities	343	5.4	711	5.1	63	5.6	122	5.8
Secondary Forestry								
State ^c	9,017		45,943		2,215		3,159	
Chattanooga	1,161	12.9	6,685	14.6	310	14.0	420	13.3
Knoxville	2,240	24.8	13,473	29.3	618	27.9	845	26.8
Memphis	2,532	28.1	10,551	23.0	552	24.9	851	27.0
Nashville	2,475	27.4	12,484	27.2	621	28.0	878	27.8
Tri-Cities	609	6.8	2,750	6.0	115	5.2	165	5.2

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interest, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

^c State totals may not add due to rounding.

billion, with \$7.0 billion in labor income. Much of the industry output generated from agriculture and forestry was through secondary or manufactured products. For agriculture, approximately 37.6 percent of the workforce was employed in secondary industries (agriculture input supplying industries plus manufacturing) and the rest (62.4 percent) in primary industries (crop and livestock commodities). For forestry, however, 76.7 percent of the forestry workforce was employed in secondary industries (wood products manufacturing) and 23.3 percent in primary (logging; pulp, paper, and sawmills; and nursery/timber tracts).

Direct economic activity for the bioscience subsectors for the state and by analysis regions within the state is also presented in Table 9. In 2006, the bioscience industry contributed a total of \$23.3 billion in direct economic activity to the state. Employment was over 94

thousand persons. Total value added was over \$9.6 billion with over \$7.0 billion in labor income. The largest value of output originated in the Knoxville Region (36.2 percent), followed by the Memphis and Nashville Regions at 27.8 percent and 25.2 percent respectively. For employment, however, the largest value of output was from the Nashville Region (38.3 percent), followed by the Knoxville (27.2 percent) and Memphis Regions (22.8). This regional ranking held true for the values of labor income and total value added as well.

The largest value of output from primary agriculture, 41.7 percent, originated in the Nashville Region (Figure 11 on page 18), followed by the Memphis Region at 33.0 percent. For secondary agriculture, however, the largest value of output was from the Memphis Region (34.5 percent) followed by the Nashville Region (30.8 percent). The Tri-Cities Region contributed roughly the same value of output (6.1 to 4.1 percent) for both primary and secondary agriculture. For both primary and secondary forestry, the Memphis Region had the largest value of total industry output followed by the Nashville Region. The Nashville Region followed the Memphis Region in economic activity for primary forestry followed by the Chattanooga, Tri-Cities, and Knoxville Regions. For secondary forestry, the Knoxville Region had more jobs followed by the Nashville and Memphis Regions. Yet, total industry output was larger for the Memphis Region followed by the Nashville and Knoxville Regions.

Primary Agricultural Products:

The largest output value (23.1 percent) for the state from farm production was from cattle ranching and farming (Table 10), followed by poultry and egg production, cotton farming, greenhouse and nursery production, oilseed farming (primarily soybeans), all other crop farming (primarily hay farming), grain farming, and animal production, except for cattle and poultry and eggs (primarily hog and pig farming, sheep and goat farming, horses and equine production, and

Table 10. State Level: Direct Economic Activity in Farm Production

Rank	Sector	TIO ^a (Million \$)	Employment (Number)	Labor Income (Million \$)	TVA ^b (Million \$)
	All Farm Production	2,925	99,050	522	1,295
1	Cattle ranching & farming	675	21,663	33	68
2	Poultry & egg production	468	3,859	51	201
3	Cotton farming	307	6,744	48	133
4	Greenhouse & nursery production	301	11,054	116	244
5	Oilseed farming	237	10,065	26	129
6	Agriculture & forestry support activities	192	6,998	150	134
7	All other crop farming	187	4,093	28	95
8	Grain farming	170	11,198	19	82
9	Animal production, except for cattle/poultry/eggs	150	13,850	15	18
10	Tobacco farming	139	7,070	11	126

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

aquaculture). Primary agricultural products also included agriculture and forestry support activities (support activities for crop production [i.e., cotton ginning, soil preparation, planting, and cultivating; crop harvesting; and farm management services]; animal production [i.e., breeding services, pedigree record services, boarding horses, dairy herd improvement activities, livestock spraying, and sheep dipping and shearing], and forestry [i.e., estimating timber, forest fire fighting, forest pest control, and consulting on wood attributes and reforestation]). In terms of labor income, greenhouse and nursery production had the largest value followed by poultry and egg production, cotton farming, cattle ranching and farming, and all other crop farming (primarily hay and seed farming). The largest total value added contributors included greenhouse and nursery production followed by poultry and egg production and cotton farming.

The direct economic activity from farm production of the top ten sectors for each trading region within the state is summarized in Table 11. Poultry and egg production, cattle ranching and farming, vegetable and melon farming, and greenhouse and nursery production were primary contributors to total industry output from farm production in the Chattanooga Region. In the

Table 11. Region Level: Direct Economic Activity in Farm Production (Top Ten Sectors)

Rank	Sector	TIO ^a (Million \$)	Employment (Number)	Labor Income (Million \$)	TVA ^b (Million \$)
Chattanooga:					
1	Poultry & egg production	117	849	13	50
2	Cattle ranching & farming	82	1,765	3	8
3	Vegetable & melon farming	21	401	4	14
4	Greenhouse & nursery production	20	562	5	16
5	All other crop farming	14	211	2	7
6	Animal production, except for cattle and poultry & eggs	8	657	1	1
7	Agriculture & forestry support activities	5	226	4	3
8	Hunting & trapping	4	40	0 ^c	0 ^c
9	Tobacco farming	3	79	0 ^c	2
10	Oilseed farming	2	125	0 ^c	1
Knoxville:					
1	Cattle ranching & farming	95	2,983	5	10
2	Greenhouse & nursery production	52	2,180	23	42
3	Poultry & egg production	40	507	6	17
4	All other crop farming	28	624	4	14
5	Vegetable & melon farming	20	482	4	13
6	Tobacco farming	17	720	1	16
7	Animal production, except for cattle and poultry & eggs	17	2,029	2	2
8	Agriculture & forestry support activities	16	562	13	11
9	Hunting & trapping	11	87	0 ^c	3
10	Fruit farming	4	190	1	2
Memphis:					
1	Cotton farming	296	6,187	46	128
2	Oilseed farming	187	6,416	21	102
3	Agriculture & forestry support activities	122	4,361	95	85
4	Grain farming	116	5,619	13	56
5	Cattle ranching & farming	70	1,298	3	7
6	Animal production, except for cattle and poultry & eggs	51	2,697	5	6
7	Hunting & trapping	48	456	1	4
8	Greenhouse & nursery production	29	808	12	23
9	Poultry & egg production	25	74	3	11
10	All other crop farming	23	302	3	12
Nashville:					
1	Cattle ranching & farming	352	11,618	17	35
2	Poultry & egg production	262	2,010	26	113
3	Greenhouse & nursery production	183	6,010	69	148
4	All other crop farming	102	2,232	15	52

Table 11. Region Level: Direct Economic Activity in Farm Production (Top Ten Sectors) (Cont.)

Rank	Sector	TIO ^a (Million \$)	Employment (Number)	Labor Income (Million \$)	TVA ^b (Million \$)
5	Tobacco farming	90	3,933	7	82
6	Animal production, except for cattle and poultry & eggs	69	7,315	7	8
7	Grain farming	49	5,030	5	24
8	Oilseed farming	46	3,379	5	25
9	Agriculture & forestry support activities	46	1,728	36	32
10	Vegetable & melon farming	27	771	7	18
Tri-Cities:					
1	Cattle ranching & farming	76	3,999	6	8
2	Poultry & egg production	25	418	3	11
3	Tobacco farming	23	2,264	2	21
4	All other crop farming	20	724	4	10
5	Greenhouse & nursery production	18	1,495	8	15
6	Vegetable & melon farming	9	544	3	6
7	Animal production, except for cattle and poultry & eggs	5	1,151	1	1
8	Hunting & trapping	3	27	0 ^c	0 ^c
9	Agriculture & forestry support activities	3	121	2	2
10	Fruit farming	2	122	0 ^c	1

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

^c Values of 0 are nonzero values that are less than 1.

Knoxville Region, cattle ranching and farming, greenhouse and nursery production, poultry and egg production, and all other crop farming were important sectors. For the Memphis Region, cotton farming, oilseed, farming, agriculture and forestry support activities, and grain farming had the largest total industry output, while in the Nashville Region the greatest total industry output values were from cattle ranching and farming, poultry and egg production, greenhouse and nursery production, all other crop farming, and tobacco farming. Cattle ranching and farming, poultry and egg production, tobacco farming, and all other crop farming were important contributors to total industry output for the Tri-Cities Region. For all regions except Memphis,

cattle ranching and farming employed the largest number of workers. For the Memphis Region, oilseed farming employed the largest numbers, followed by cotton and grain farming.

Secondary Agricultural Products:

Among secondary agricultural products, food manufacturing contributed the largest total industry output, followed by beverage manufacturing, tobacco products manufacturing, textile mills, apparel manufacturing, agricultural chemicals, agricultural machinery, textile product mills, and leather and allied product manufacturing (Table 12). Approximately 58.8 percent of the value of total industry output from processed agricultural products came from food manufacturing. In addition, food manufacturing employed the largest number of workers, had

Table 12. Direct Economic Activity in Secondary Agricultural Products

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Food Manufacturing:								
State ^c	14,795		34,323		1,731		3,131	
Chattanooga	2,575	17.4	8,523	24.8	404	23.3	791	25.3
Knoxville	2,321	15.7	4,702	13.7	247	14.3	449	14.3
Memphis	5,570	37.6	9,018	26.3	534	30.9	1,015	32.4
Nashville	4,000	27.0	11,523	33.6	515	29.7	819	26.1
Tri-Cities	331	2.2	558	1.6	31	1.8	57	1.8
Beverage Manufacturing:								
State ^c	3,319		4,409		419		927	
Chattanooga	654	19.7	997	22.6	74	17.7	121	13.1
Knoxville	536	16.1	827	18.8	63	15.0	102	11.0
Memphis	1,094	33.0	1,455	33.0	135	32.3	294	31.7
Nashville	883	26.6	903	20.5	127	30.4	379	40.8
Tri-Cities	153	4.6	227	5.2	19	4.6	31	3.3
Tobacco Products Manufacturing:								
State ^c	1,485		907		83		561	
Chattanooga	0	0.0	0	0.0	0	0.0	0	0.0
Knoxville	0	0.0	0	0.0	0	0.0	0	0.0
Memphis	265	17.8	147	16.2	16	19.0	98	17.5
Nashville	1,220	82.2	760	83.8	67	81.0	463	82.5
Tri-Cities	0	0.0	0	0.0	0	0.0	0	0.0
Textile Mills:								
State ^c	1,454		5,281		299		397	
Chattanooga	531	36.5	2,078	39.4	110	37.0	129	32.6
Knoxville	25	1.7	146	2.8	4	1.4	5	1.2
Memphis	133	9.1	524	9.9	24	8.2	30	7.6

Table 12. Direct Economic Activity in Secondary Agricultural Products (Cont.)

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Nashville	471	32.4	1,435	27.2	102	34.0	151	37.9
Tri-Cities	294	20.2	1,098	20.8	58	19.5	82	20.7
Apparel Manufacturing:								
State ^c	1,192		8,122		322		439	
Chattanooga	393	33.0	2,627	32.3	105	32.6	141	32.1
Knoxville	145	12.2	1,107	13.6	34	10.5	47	10.6
Memphis	236	19.8	1,623	20.0	64	19.7	87	19.8
Nashville	382	32.1	2,511	30.9	110	34.1	152	34.6
Tri-Cities	36	3.0	254	3.1	10	3.1	13	2.9
Agricultural Chemicals:								
State ^c	981		662		59		283	
Chattanooga	47	4.8	30	4.5	3	4.6	14	4.8
Knoxville	54	5.5	20	3.0	6	9.4	27	9.6
Memphis	730	74.5	519	78.4	41	69.2	195	68.8
Nashville	146	14.9	91	13.8	10	16.1	46	16.2
Tri-Cities	3	0.3	1	0.2	0 ^d	0.8	2	0.6
Agricultural Machinery:								
State ^c	922		2,220		87		164	
Chattanooga	34	3.7	85	3.8	4	4.4	7	4.5
Knoxville	52	5.6	128	5.8	6	6.4	11	6.5
Memphis	582	63.1	1,405	63.3	53	60.8	99	60.8
Nashville	79	8.6	185	8.3	9	10.4	17	10.4
Tri-Cities	174	18.9	417	18.8	16	18.0	29	17.9
Textile Product Mills:								
State ^c	793		3,555		150		220	
Chattanooga	135	17.0	766	21.6	30	20.3	42	19.1
Knoxville	138	17.4	924	26.0	31	20.5	37	17.0
Memphis	27	3.4	174	4.9	8	5.0	9	4.1
Nashville	464	58.5	1,563	44.0	76	50.8	122	55.1
Tri-Cities	28	3.6	127	3.6	5	3.3	10	4.7
Leather & Allied Product Manufacturing:								
State ^c	217		1,390		73		81	
Chattanooga	34	15.5	180	12.9	10	14.1	12	15.0
Knoxville	32	14.7	196	14.1	13	18.3	16	19.8
Memphis	39	18.1	306	22.0	14	19.3	14	16.9
Nashville	111	51.1	697	50.2	35	47.6	39	47.7
Tri-Cities	1	0.6	11	0.8	1	0.7	1	0.6

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

^c State totals may not add due to rounding.

^d Values of 0 are nonzero values that are less than 1.

the largest amount of labor income, and contributed the largest amount in total value added. A more detailed presentation of the total industry output from processing by sub-sector is shown in Appendixes B and C.

Primary Forest Products:

The largest output value for primary forest products was from paper and paperboard mills, followed by sawmills; logging; pulp mills; and forest nurseries, forest products, and timber tracts (i.e., growing trees for reforestation; gathering forest products, such as gums, barks, balsam needles, rhizomes, fibers, and ginseng; and timber tracts for selling timber) (Table 13). The Memphis Region had the largest output value for paper and paperboard mills at \$3.1 billion or 76.2 percent of the output value for the state. Likewise, for employment, paper and paperboard mills employed the largest number of individuals again with the Memphis Region employing the largest number. The Nashville Region had the largest output value for sawmills. For logging, the Memphis and Nashville Regions had the largest output values. For pulp mills, 67.6 percent of the economic activity originates from the Memphis Region. For forest nurseries, forest products, and timber tracts, the Knoxville Region had the largest output values.

Table 13. Direct Economic Activity in Primary Forest Products

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Paper & Paperboard Mills:								
State ^c	4,018		5,935		750		1,491	
Chattanooga	576	14.3	859	14.5	105	14.0	211	14.2
Knoxville	41	1.0	54	0.9	10	1.3	17	1.1
Memphis	3,062	76.2	4,531	76.3	570	76.0	1,134	76.1
Nashville	84	2.1	134	2.3	14	1.9	28	1.9
Tri-Cities	255	6.4	358	6.0	51	6.8	100	6.7
Sawmills:								
State ^c	1,116		4,463		155		283	
Chattanooga	100	9.0	365	8.2	17	11.0	31	11.0
Knoxville	102	9.2	414	9.3	14	8.9	25	8.9
Memphis	225	20.2	915	20.5	30	19.3	55	19.3
Nashville	624	55.9	2,511	56.3	86	55.1	156	55.1
Tri-Cities	65	5.8	258	5.8	9	5.8	16	5.8

Table 13. Direct Economic Activity in Primary Forest Products (Cont.)

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Logging:								
State ^c	787		2,936		152		246	
Chattanooga	26	3.3	117	4.0	4	2.8	6	2.5
Knoxville	55	7.0	246	8.4	8	5.3	13	5.1
Memphis	504	64.0	1,660	56.5	110	72.3	182	74.0
Nashville	181	23.0	823	28.0	26	17.4	40	16.5
Tri-Cities	20	2.6	90	3.1	3	2.2	5	2.0
Pulp Mills:								
State ^c	372		543		62		92	
Chattanooga	120	32.4	190	35.1	15	24.9	23	25.1
Knoxville	0	0.0	0	0.0	0	0.0	0	0.0
Memphis	251	67.6	352	64.9	47	75.1	69	74.9
Nashville	0	0.0	0	0.0	0	0.0	0	0.0
Tri-Cities	0	0.0	0	0.0	0	0.0	0	0.0
Forest Nurseries/Forest Products/Timber Tracts:								
State ^c	50		77		4		11	
Chattanooga	0	0.0	0	0.0	0	0.0	0	0.0
Knoxville	36	73.2	56	72.4	3	74.5	9	75.2
Memphis	10	21.1	16	21.3	1	21.9	2	20.5
Nashville	0	0.0	0	0.0	0	0.0	0	0.0
Tri-Cities	3	5.7	5	6.3	0 ^d	3.6	0 ^d	4.3

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

^c State totals may not add due to rounding.

^d Values of 0 are nonzero values that are less than 1.

Secondary Forest Products:

The largest output value for secondary forest products was produced by the paper manufacturing sector, followed by furniture and related product manufacturing; millwork; manufactured home manufacturing; other wood product manufacturing; and veneer, plywood, and engineered wood product manufacturing (Table 14). Furniture and related product manufacturing for this analysis was comprised of household and institutional, office, and other (mattress, blind and shades) furniture categories. The other wood product manufacturing category was comprised of wood preservation, wood containers and pallets, miscellaneous wood

Table 14. Direct Economic Activity in Secondary Forest Products

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Paper Manufacturing:								
State ^c	3,932		11,668		790		1,108	
Chattanooga	389	9.9	1,273	10.9	85	10.8	102	9.2
Knoxville	521	13.2	1,819	15.6	114	14.4	141	12.7
Memphis	1,526	38.8	3,835	32.9	280	35.5	460	41.5
Nashville	1,114	28.3	3,514	30.1	251	31.7	318	28.7
Tri-Cities	383	9.7	1,227	10.5	60	7.6	87	7.8
Furniture & Related Product Manufacturing:								
State ^c	2,159		15,433		667		942	
Chattanooga	531	24.6	4,101	26.6	171	25.6	209	22.1
Knoxville	811	37.6	6,054	39.2	258	38.7	343	36.4
Memphis	277	12.8	1,974	12.8	90	13.5	133	14.1
Nashville	507	23.5	3,095	20.1	139	20.9	243	25.8
Tri-Cities	33	1.5	208	1.3	9	1.3	14	1.5
Millwork:								
State ^c	981		6,004		241		312	
Chattanooga	8	0.8	50	0.8	2	0.7	2	0.7
Knoxville	223	22.7	1,382	23.0	55	22.8	67	21.6
Memphis	364	37.1	2,179	36.3	86	35.7	126	40.3
Nashville	319	32.5	1,972	32.8	82	34.0	98	31.5
Tri-Cities	67	6.9	421	7.0	16	6.8	18	5.9
Manufactured Home Manufacturing:								
State ^c	767		4,678		210		312	
Chattanooga	9	1.2	59	1.3	2	1.1	3	1.0
Knoxville	496	64.7	2,982	63.7	137	65.4	206	65.9
Memphis	118	15.4	731	15.6	32	15.2	48	15.3
Nashville	142	18.5	897	19.2	38	18.1	55	17.7
Tri-Cities	1	0.2	9	0.2	0 ^d	0.2	0 ^d	0.1
Other Wood Product Manufacturing:								
State ^c	766		6,249		218		300	
Chattanooga	96	12.5	825	13.2	28	12.8	37	12.3
Knoxville	105	13.7	850	13.6	32	14.8	45	14.9
Memphis	149	19.4	1,273	20.4	42	19.2	56	18.7
Nashville	349	45.5	2,761	44.2	100	46.0	142	47.1
Tri-Cities	68	8.9	540	8.6	16	7.1	21	6.9
Veneer, Plywood, & Engineered Wood Product Manufacturing:								
State ^c	412		1,911		90		185	
Chattanooga	129	31.2	377	19.7	22	24.6	68	36.6
Knoxville	84	20.3	386	20.2	22	24.3	43	23.3
Memphis	98	23.9	558	29.2	22	23.9	29	15.5
Nashville	45	10.8	244	12.8	11	12.1	21	11.3
Tri-Cities	57	13.7	346	18.1	14	15.1	25	13.3

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

^c State totals may not add due to rounding.

^d Values of 0 are nonzero values that are less than 1.

products, and kitchen cabinets. The Memphis Region had the largest values for output, employment, labor income, and value added for paper manufacturing. The Knoxville Region had the largest output values for furniture and manufactured home manufacturing, with the latter category being an important industry for the state. Economic activity was the largest for the Memphis and Nashville Regions for millwork, and the Nashville Region for other wood product manufacturing. For the veneer, plywood, and engineered wood product manufacturing category, the Memphis Region had the largest output value, followed by the Knoxville, Nashville, Chattanooga, and Tri-Cities Regions.

Estimated Total Economic Impacts of Agriculture and Forestry:

The estimated total economic impacts of agriculture and forestry included not only the direct impacts from the industry, but also the impacts the industry had on input supplying industries (indirect impacts) and on expenditures by households and other institutions (induced impacts). The total economic impacts from agriculture and forestry included direct, indirect, and induced impacts. Values for total industry output, employment, labor income, and value added resulting from agriculture and forestry, including each of these impacts, are shown in Table 15. Agriculture and forestry contributed an estimated value of over \$78.9 billion to Tennessee's \$487.5 billion economy in 2006. An estimated 65.2 percent of the total economic impacts came from primary and secondary agriculture, while forest operations and forest products contributed about 34.8 percent. Employment in both agriculture and forestry totaled over 502 thousand workers. Of that value, 69.0 percent were related with primary and secondary agriculture production, with 31.0 percent from primary and secondary forest products production. Intrastate trade represented values purchased or imported from outside the regions but within the state. A

Table 15. Estimated Total Economic Impacts from Agriculture and Forestry

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Agriculture & Forestry:								
State	78,903		502,432		18,767		31,958	
Chattanooga	10,934	13.9	63,625	12.7	2,595	13.8	4,333	13.6
Knoxville	10,678	13.5	72,452	14.4	2,661	14.2	4,306	13.5
Memphis	28,168	35.7	156,991	31.2	6,501	34.6	11,198	35.0
Nashville	21,935	27.8	157,775	31.4	5,125	27.3	8,956	28.0
Tri-Cities	3,250	4.1	27,959	5.6	702	3.7	1,181	3.7
Intrastate Trade	3,938	5.0	23,630	4.7	1,182	6.3	1,984	6.2
Primary & Secondary Agriculture								
State	51,476		346,903		11,453		20,098	
Chattanooga	7,710	9.8	45,406	13.1	1,748	15.3	2,972	14.8
Knoxville	6,429	8.1	42,619	12.3	1,408	12.3	2,394	11.9
Memphis	16,848	21.4	101,412	29.2	3,592	31.4	6,305	31.4
Nashville	16,208	20.5	123,224	35.5	3,597	31.4	6,562	32.6
Tri-Cities	1,800	2.3	19,990	5.8	359	3.1	618	3.1
Intrastate Trade	2,481	3.1	14,250	4.1	750	6.5	1,248	6.2
Primary Agriculture								
State	5,430		127,545		1,296		2,612	
Chattanooga	463	8.5	7,079	5.5	83	6.4	197	7.6
Knoxville	540	9.9	13,710	10.7	132	10.2	260	9.9
Memphis	1,723	31.7	36,918	28.9	474	36.6	870	33.3
Nashville	2,271	41.8	57,261	44.9	499	38.5	1,066	40.8
Tri-Cities	297	5.5	13,153	10.3	64	4.9	135	5.2
Intrastate Trade	136	2.5	-576	-0.5	45	3.5	85	3.2
Secondary Agriculture								
State	46,046		219,358		10,157		17,486	
Chattanooga	7,247	15.7	38,328	17.5	1,665	16.4	2,774	15.9
Knoxville	5,889	12.8	28,909	13.2	1,275	12.6	2,134	12.2
Memphis	15,126	32.8	64,494	29.4	3,118	30.7	5,434	31.1
Nashville	13,937	30.3	65,963	30.1	3,098	30.5	5,496	31.4
Tri-Cities	1,503	3.3	6,838	3.1	296	2.9	483	2.8
Intrastate Trade	2,345	5.1	14,826	6.8	705	6.9	1,164	6.7
Primary & Secondary Forestry								
State	27,427		155,529		7,313		11,860	
Chattanooga	3,224	11.8	18,218	11.7	847	11.6	1,361	11.5
Knoxville	4,249	15.5	29,833	19.2	1,254	17.1	1,912	16.1
Memphis	11,320	41.3	55,579	35.7	2,909	39.8	4,893	41.3
Nashville	5,726	20.9	34,551	22.2	1,529	20.9	2,395	20.2
Tri-Cities	1,451	5.3	7,969	5.1	343	4.7	563	4.8
Intrastate Trade	1,457	5.3	9,380	6.0	432	5.9	736	6.2
Primary Forestry								
State	11,202		52,044		2,692		4,711	
Chattanooga	1,330	11.9	5,464	10.5	300	11.1	538	11.4
Knoxville	375	3.4	2,115	4.1	83	3.1	140	3.0

Table 15. Estimated Total Economic Impacts from Agriculture and Forestry (Cont.)

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Memphis	6,995	62.4	30,757	59.1	1,738	64.6	3,034	64.4
Nashville	1,422	12.7	7,620	14.6	294	10.9	501	10.6
Tri-Cities	536	4.8	2,413	4.6	125	4.7	227	4.8
Intrastate Trade	544	4.9	3,674	7.1	153	5.7	271	5.8
Secondary Forestry								
State	16,225		103,485		4,621		7,150	
Chattanooga	1,894	11.7	12,754	12.3	547	11.8	823	11.5
Knoxville	3,873	23.9	27,718	26.8	1,171	25.3	1,171	16.4
Memphis	4,325	26.7	24,821	24.0	1,170	25.3	1,859	26.0
Nashville	4,304	26.5	26,931	26.0	1,235	26.7	1,894	26.5
Tri-Cities	914	5.6	5,556	5.4	218	4.7	337	4.7
Intrastate Trade	914	5.6	5,705	5.5	280	6.1	1,066	14.9

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

more detailed total impact presentation of output, employment, labor income, and value added by sub-sector is shown in Appendix C.

Primary Agriculture Products Total Impacts:

Figures 13 through 17 show the estimated direct, indirect, and induced impacts for cattle ranching and farming; poultry and egg production; cotton farming; greenhouse and nursery production; oilseed farming; all other crop farming; grain farming; animal production, except for cattle and poultry and eggs; tobacco farming; and vegetable and melon farming agricultural sectors. The top ten indirect and induced sectors based on output value are also listed. Using cattle ranching and farming as an example, indirect impacts (input supplying industries) explained 32.2 percent (\$434.6 million) of the total impact on output for the state. The sectors most impacted in descending order included all other crop farming; cattle ranching and farming; real estate; wholesale trade; veterinary services; petroleum refineries; agriculture and forestry support activities; truck transportation; insurance carriers; federal electric utilities. Likewise, induced impacts (expenditures by households and other institutions) explained 17.7 percent

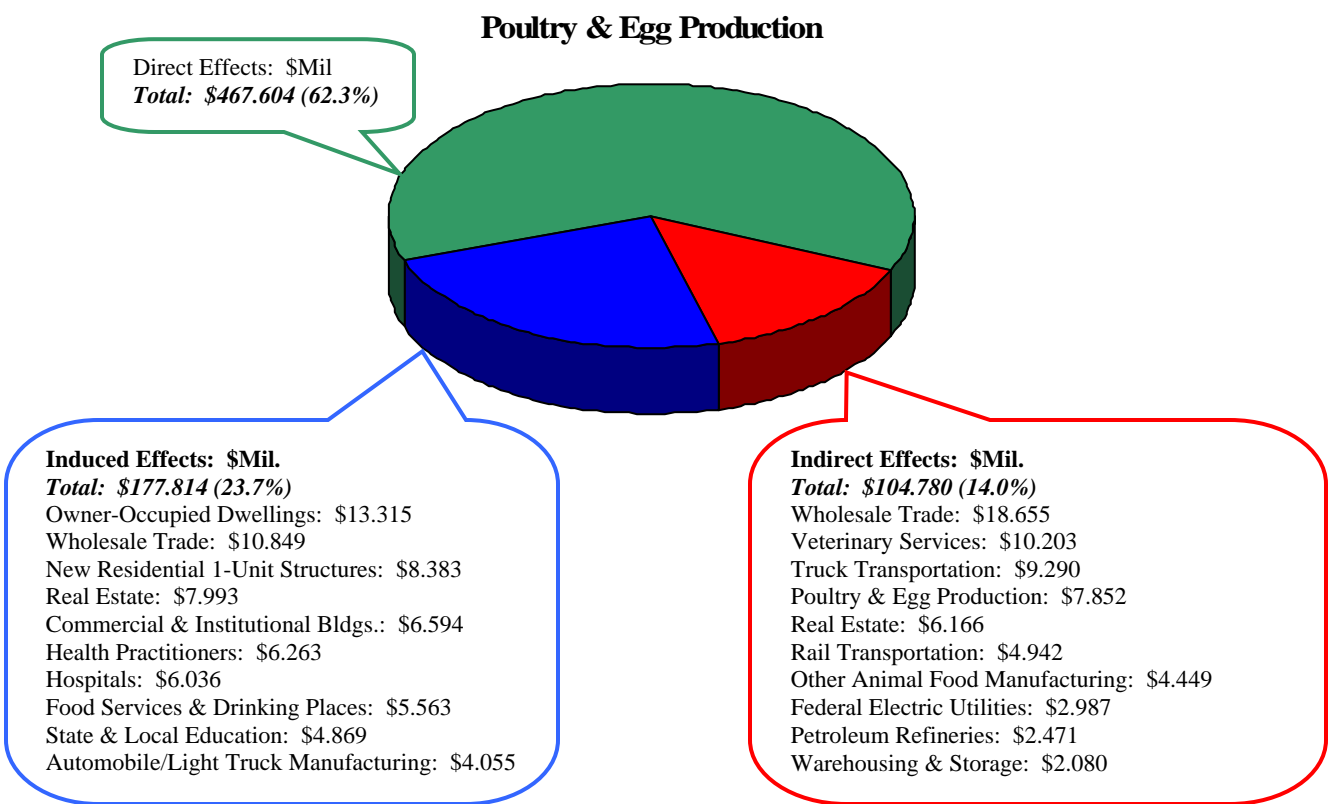
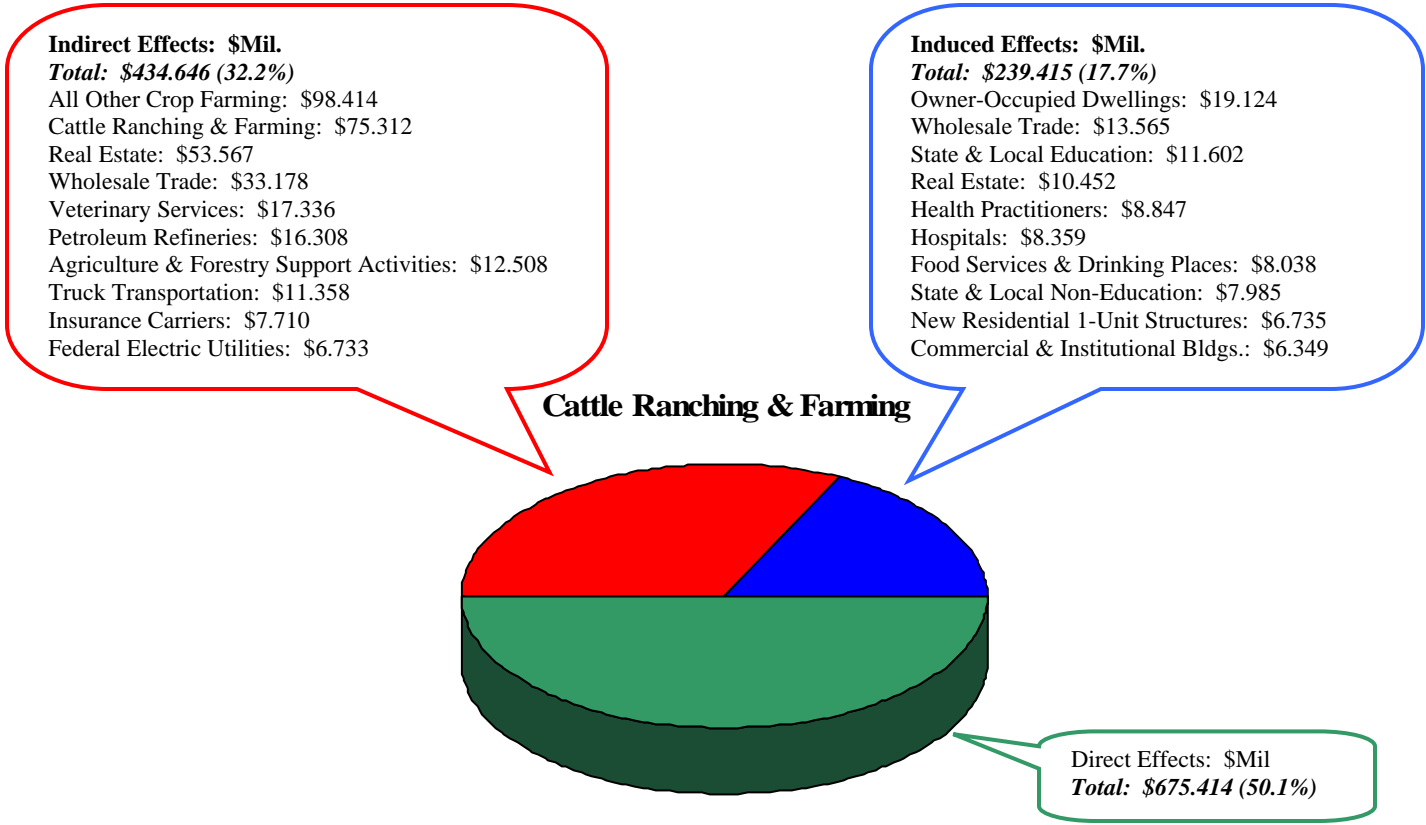


Figure 13. Estimated Direct, Indirect, and Induced Impacts for Cattle Ranching & Farming and Poultry & Egg Production.

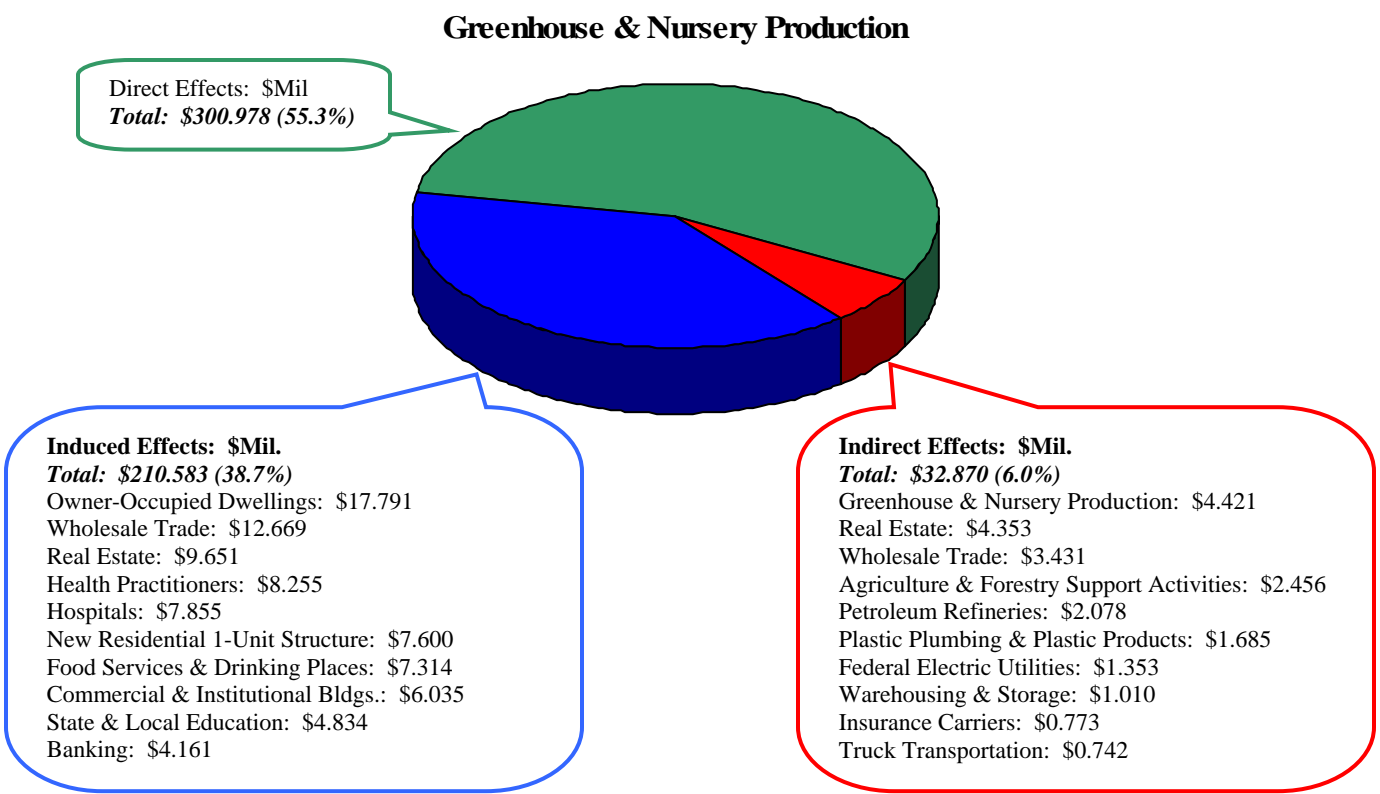
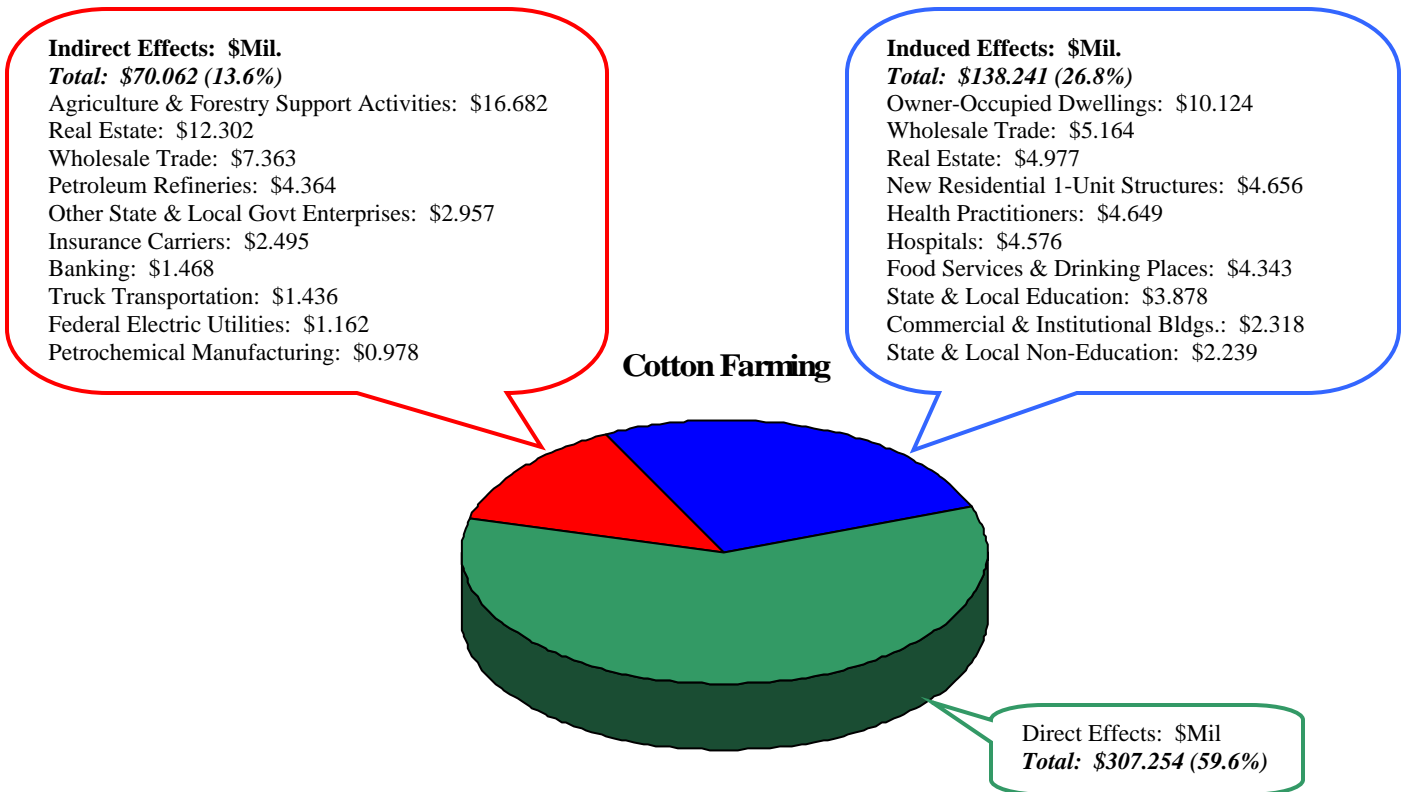


Figure 14. Estimated Direct, Indirect, and Induced Impacts for Cotton Farming and Greenhouse & Nursery Production.

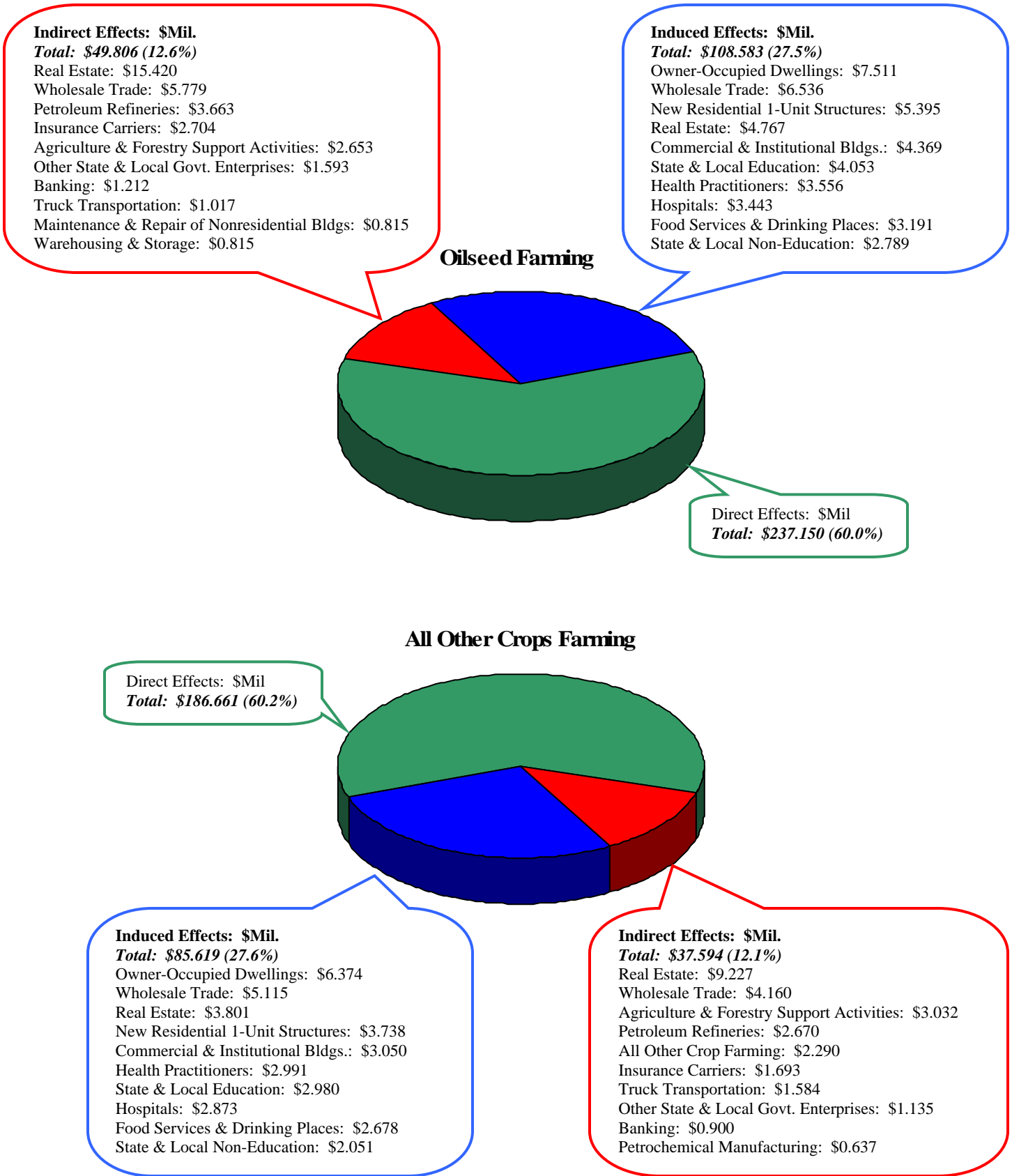
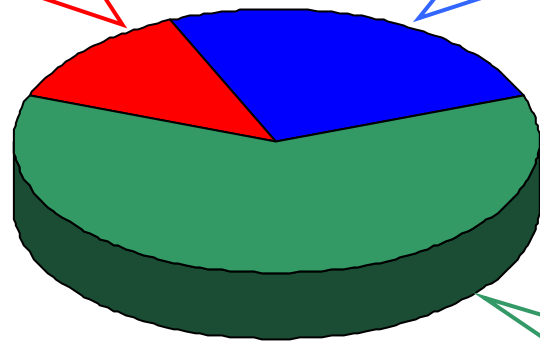


Figure 15. Estimated Direct, Indirect, and Induced Impacts for Oilseed Farming and All Other Crop Farming.

Indirect Effects: \$Mil.
Total: \$35.313 (12.7%)
 Real Estate: \$9.397
 Wholesale Trade: \$4.445
 Agriculture & Forestry Support Activities: \$3.407
 Petroleum Refineries: \$2.553
 Insurance Carriers: \$1.682
 Truck Transportation: \$1.059
 Other State & Local Govt. Enterprises: \$1.031
 Banking: \$0.696
 Petrochemical Manufacturing: \$0.599
 Rail Transportation: \$0.500

Induced Effects: \$Mil.
Total: \$72.736 (26.1%)
 Owner-Occupied Dwellings: \$5.190
 Wholesale Trade: \$4.360
 New Residential 1-Unit Structures: \$3.418
 Real Estate: \$3.206
 Commercial & Institutional Bldgs.: \$2.782
 State & Local Education: \$2.665
 Health Practitioners: \$2.447
 Hospitals: \$2.361
 Food Services & Drinking Places: \$2.195
 State & Local Non-Education: \$1.834

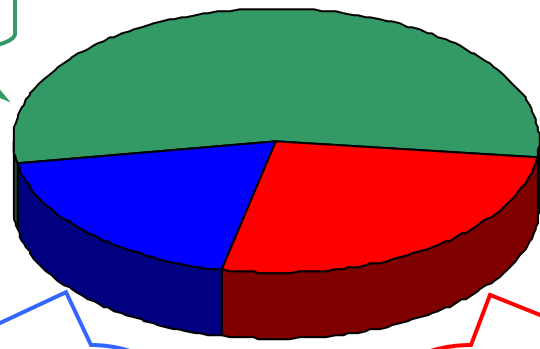
Grain Farming



Direct Effects: \$Mil
Total: \$170.107 (61.2%)

Animal Production

Direct Effects: \$Mil
Total: \$150.081 (54.8%)



Induced Effects: \$Mil.
Total: \$51.890 (18.9%)
 Owner-Occupied Dwellings: \$4.447
 Wholesale Trade: \$2.933
 Real Estate: \$2.310
 State & Local Education: \$2.172
 Health Practitioners: \$2.046
 Hospitals: \$1.925
 Food Services & Drinking Places: \$1.846
 State & Local Non-Education: \$1.495
 New Residential 1-Unit Structures: \$1.241
 Commercial & Institutional Bldgs.: \$1.174

Indirect Effects: \$Mil.
Total: \$71.924 (26.3%)
 All Other Crop Farming: \$16.893
 Real Estate: \$9.454
 Wholesale Trade: \$7.460
 Truck Transportation: \$4.014
 Animal Production*: \$2.925
 Petroleum Refineries: \$2.915
 Insurance Carriers: \$1.694
 Rail Transportation: \$1.620
 Agriculture & Forestry Support Activities: \$1.608
 Federal Electric Utilities: \$1.602

Figure 16. Estimated Direct, Indirect, and Induced Impacts for Grain Farming and Animal Production, except Cattle and Poultry & Eggs.

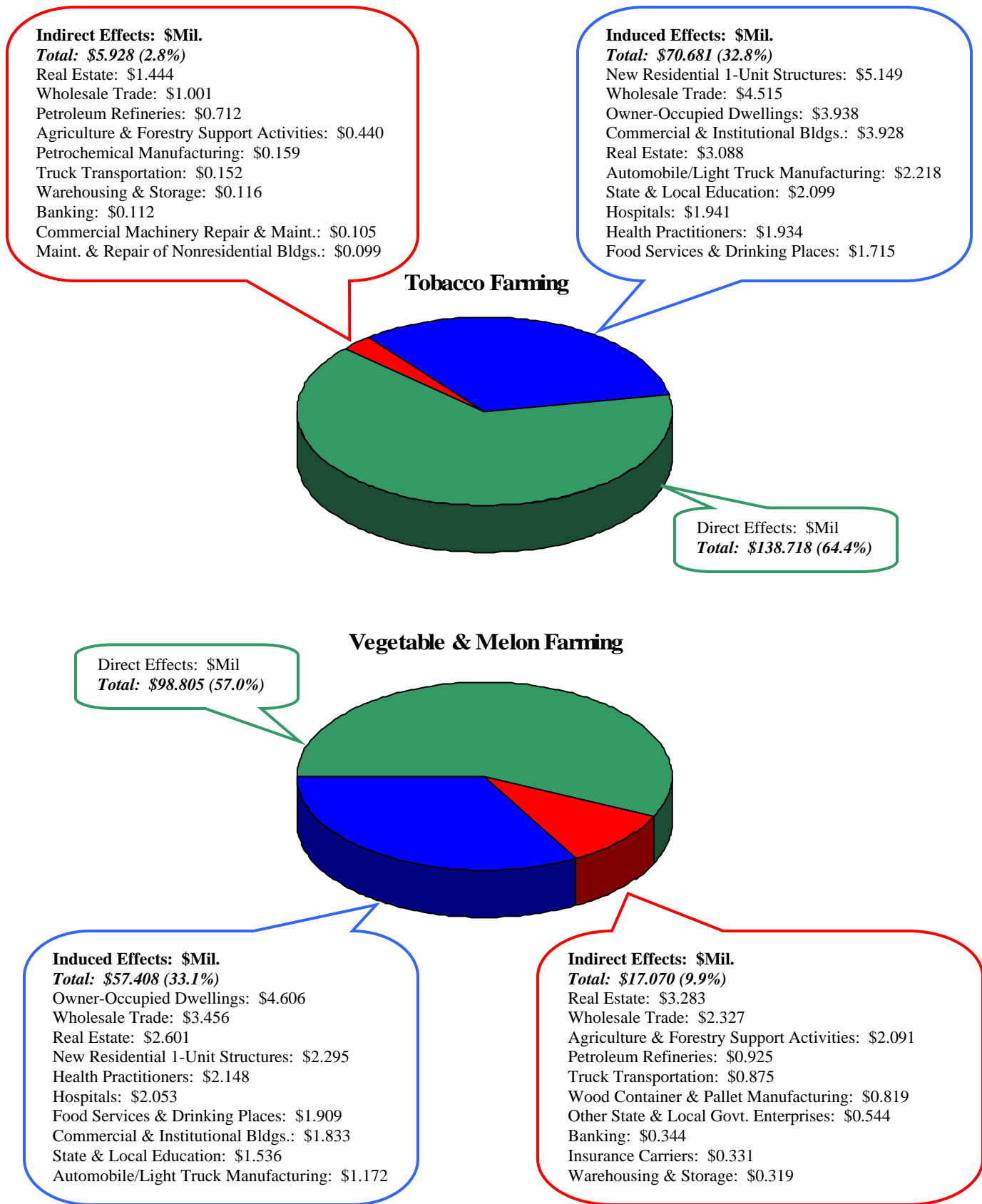


Figure 17. Estimated Direct, Indirect, and Induced Impacts for Tobacco Farming and Vegetable & Melon Farming.

(\$239.4 million) of the total impact on output. Again in descending order the sectors most impacted based on output value included owner-occupied dwellings; wholesale trade; state and local education; real estate; health practitioners; hospitals; food services and drinking places; state and local non-education; new residential one-unit structures; and commercial and institutional buildings.

Secondary Agriculture Products Total Impacts:

Table 16 shows the estimated total economic impacts from secondary agricultural products. For all categories (output, employment, labor income, and value added), food manufacturing contributed the greatest total economic impact values for secondary agricultural products. The Memphis Region (primarily from grain and oilseed milling; animal, except poultry, slaughtering; snack foods, and frozen foods), followed by the Nashville Region (primarily from animal slaughtering and processing, fluid milk, and snack foods), had the largest output values for each of the categories analyzed for this sector. The Memphis Region also had the largest output values for beverage manufacturing (primarily from soft drinks and ice, and breweries), agricultural chemicals (primarily from pesticide and other agricultural chemicals manufacturing), and agricultural machinery (lawn and garden equipment). The Nashville Region had large output values for beverage manufacturing (primarily from distilleries and soft drinks and ice), tobacco products, apparel manufacturing (primarily from cut and sew apparel), textile product mills (primarily from tire cord and fabric mills, and carpet and rug mills), and leather and allied product manufacturing (primarily from footwear). Food manufacturing (primarily from grain and oilseed milling, fruit and vegetable canning and drying, and animal slaughtering and processing) and beverage manufacturing (primarily from soft drinks and ice) are important industries for the Knoxville Region. The Chattanooga Region had significant economic activity for food manufacturing (primarily from cookies and crackers manufacturing, animal slaughtering

Table 16. Estimated Total Economic Impacts from Secondary Agricultural Products

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Food Manufacturing:								
State	26,933		125,712		5,749		9,643	
Chattanooga	4,270	15.9	22,194	17.7	952	16.6	1,685	17.5
Knoxville	4,197	15.6	19,734	15.7	882	15.3	1,495	15.5
Memphis	9,608	35.7	40,366	32.1	1,953	34.0	3,296	34.2
Nashville	7,024	26.1	33,605	26.7	1,492	26.0	2,385	24.7
Tri-Cities	477	1.8	1,711	1.4	75	1.3	130	1.3
Intrastate Trade	1,357	5.0	8,103	6.4	394	6.9	652	6.8
Beverage Manufacturing:								
State	6,264		28,106		1,446		2,584	
Chattanooga	1,040	16.6	4,128	14.7	201	13.9	334	12.9
Knoxville	929	14.8	3,947	14.0	191	13.2	318	12.3
Memphis	1,987	31.7	8,475	30.2	449	31.0	800	31.0
Nashville	1,697	27.1	8,215	29.2	444	30.7	865	33.5
Tri-Cities	232	3.7	932	3.3	46	3.2	76	2.9
Intrastate Trade	378	6.0	2,409	8.6	115	7.9	191	7.4
Tobacco Products:								
State	2,913		10,959		535		1,330	
Chattanooga	0	0.0	0	0.0	0	0.0	0	0.0
Knoxville	0	0.0	0	0.0	0	0.0	0	0.0
Memphis	493	16.9	1,802	16.4	92	17.3	227	17.1
Nashville	2,388	82.0	8,595	78.4	429	80.2	1,078	81.1
Tri-Cities	0	0.0	0	0.0	0	0.0	0	0.0
Intrastate Trade	32	1.1	562	5.1	13	2.5	25	1.9
Textile Mills:								
State	2,483		13,393		646		969	
Chattanooga	820	33.0	4,503	33.6	208	32.1	293	30.2
Knoxville	41	1.7	277	2.1	9	1.4	13	1.4
Memphis	233	9.4	1,284	9.6	58	8.9	83	8.6
Nashville	783	31.5	3,841	28.7	205	31.8	322	33.2
Tri-Cities	438	17.6	2,390	17.8	106	16.4	163	16.8
Intrastate Trade	168	6.8	1,098	8.2	60	9.2	95	9.9
Apparel Manufacturing:								
State	2,260		16,685		683		1,029	
Chattanooga	709	31.4	5,209	31.2	206	30.2	305	29.7
Knoxville	252	11.2	2,041	12.2	71	10.4	108	10.5
Memphis	416	18.4	3,118	18.7	127	18.7	191	18.6
Nashville	706	31.2	5,084	30.5	219	32.1	332	32.3
Tri-Cities	56	2.5	446	2.7	17	2.5	24	2.4
Intrastate Trade	120	5.3	788	4.7	42	6.2	68	6.6
Agricultural Chemicals:								
State	1,790		6,337		312		689	
Chattanooga	77	4.3	237	3.7	11	3.7	28	4.0
Knoxville	88	4.9	313	4.9	17	5.6	46	6.7

Table 16. Estimated Total Economic Impacts from Secondary Agricultural Products (Cont.)

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Memphis	1,288	72.0	4,339	68.5	218	70.0	479	69.4
Nashville	247	13.8	836	13.2	43	13.7	99	14.3
Tri-Cities	5	0.3	17	0.3	1	0.3	3	0.4
Intrastate Trade	85	4.7	594	9.4	21	6.7	36	5.2
Agricultural Machinery:								
State	1,591		7,028		298		505	
Chattanooga	54	3.4	232	3.3	10	3.3	17	3.4
Knoxville	84	5.3	396	5.6	17	5.6	29	5.7
Memphis	978	61.4	4,181	59.5	180	60.2	303	60.0
Nashville	127	8.0	552	7.9	25	8.4	43	8.5
Tri-Cities	250	15.7	1,069	15.2	40	13.6	69	13.7
Intrastate Trade	98	6.2	597	8.5	27	8.9	44	8.7
Textile Product Mills:								
State	1,377		8,093		345		540	
Chattanooga	219	15.9	1,452	17.9	58	16.8	88	16.3
Knoxville	238	17.3	1,773	21.9	65	18.9	94	17.5
Memphis	49	3.6	345	4.3	15	4.3	21	3.9
Nashville	753	54.7	3,774	46.6	172	49.9	279	51.6
Tri-Cities	42	3.1	254	3.1	10	2.8	18	3.3
Intrastate Trade	75	5.5	494	6.1	25	7.3	40	7.3
Leather & Allied Product Manufacturing:								
State	435		3,047		143		197	
Chattanooga	58	13.3	372	12.2	18	12.5	25	12.7
Knoxville	59	13.5	430	14.1	22	15.7	31	15.9
Memphis	73	16.8	583	19.1	26	18.2	33	16.9
Nashville	212	48.7	1,462	48.0	68	47.4	93	47.3
Tri-Cities	2	0.5	19	0.6	1	0.6	1	0.5
Intrastate Trade	31	7.1	181	5.9	8	5.7	13	6.6

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

and processing, sugar and confectionary products), beverage manufacturing (primarily from soft drinks and ice), textile mills (primarily from fiber, yarn, and thread mills), and apparel manufacturing (primarily from cut and sew apparel and other hosiery and sock mills). Food manufacturing (primarily from dairy products), textile mills (primarily from fabric coating mills and fiber, yard, and thread mills), and agricultural machinery (primarily from lawn and garden equipment) are important industries in the Tri-Cities Region.

Primary Forest Products Total Impacts:

Pulp and paperboard mills contributed the largest values for all the categories analyzed compared to the other four primary forest products sectors combined (Table 17). The Memphis Region dominated all value categories for this sector, with the Chattanooga Region having the next largest values followed by the Tri-Cities Region. The Memphis Region also had the largest values for logging and pulp mills. The Nashville Region had the largest output values for sawmills. The Knoxville Region had the largest output values for forest nurseries, forest products, and timber tracts.

Table 17. Estimated Total Economic Impacts from Primary Forest Products

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Pulp & Paperboard Mills:								
State	7,295		30,802		1,804		3,242	
Chattanooga	945	13.0	3,724	12.1	221	12.2	407	12.5
Knoxville	72	1.0	314	1.0	20	1.1	35	1.1
Memphis	5,279	72.4	21,538	69.9	1,306	72.4	2,339	72.1
Nashville	152	2.1	626	2.0	35	2.0	64	2.0
Tri-Cities	411	5.6	1,681	5.5	101	5.6	185	5.7
Intrastate Trade	435	6.0	2,918	9.5	121	6.7	213	6.6
Sawmills:								
State	1,765		9,554		366		631	
Chattanooga	148	8.4	756	7.9	32	8.8	57	9.0
Knoxville	156	8.8	866	9.1	31	8.6	54	8.6
Memphis	342	19.4	1,841	19.3	69	18.8	118	18.7
Nashville	976	55.3	5,180	54.2	198	54.0	341	54.1
Tri-Cities	92	5.2	499	5.2	18	4.8	31	4.9
Intrastate Trade	52	2.9	411	4.3	18	4.9	29	4.7
Logging:								
State	1,371		8,054		341		548	
Chattanooga	36	2.7	211	2.6	7	2.2	11	2.1
Knoxville	91	6.6	554	6.9	19	5.5	30	5.4
Memphis	915	66.8	5,399	67.0	249	73.2	400	73.0
Nashville	293	21.4	1,813	22.5	61	17.9	95	17.4
Tri-Cities	29	2.1	187	2.3	6	1.8	9	1.7
Intrastate Trade	6	0.4	-111	-1.4	-2	-0.6	2	0.3
Pulp Mills:								
State	678		2,816		159		252	
Chattanooga	200	29.5	773	27.5	39	24.8	64	25.2
Knoxville	0	0.0	0	0.0	0	0.0	0	0.0

Table 17. Estimated Total Economic Impacts from Primary Forest Products (Cont.)

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Memphis	437	64.4	1,747	62.0	107	67.3	167	66.3
Nashville	0	0.0	0	0.0	0	0.0	0	0.0
Tri-Cities	0	0.0	0	0.0	0	0.0	0	0.0
Intrastate Trade	41	6.1	295	10.5	12	7.9	21	8.5
Forest Nurseries/Forest Products/Timber Tracts:								
State	92		818		24		37	
Chattanooga	0	0.0	0	0.0	0	0.0	0	0.0
Knoxville	56	61.3	380	46.5	12	51.8	21	56.7
Memphis	22	23.5	231	28.3	6	27.6	9	25.2
Nashville	0	0.0	0	0.0	0	0.0	0	0.0
Tri-Cities	4	4.8	45	5.6	1	3.8	1	4.0
Intrastate Trade	10	10.3	161	19.7	4	16.8	5	14.1

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

Secondary Forest Products Total Impacts:

Secondary forest products estimated total impacts are shown in Table 18. Paper manufacturing and furniture and related product manufacturing were the largest contributors for all categories. The Memphis and Nashville Regions had the largest output value for the paper manufacturing sector (for Memphis, primarily from paperboard containers manufacturing and sanitary paper products; for Nashville, from paperboard containers; coated, laminated paper, and packaging materials; and coated and uncoated paper bags). For furniture, the Knoxville (primarily from upholstered household furniture, institutional furniture, and other household and institutional furniture), Chattanooga (upholstered household furniture), and Nashville (showcases, partitions, shelving, and lockers; and mattresses) Regions were the leaders. The Knoxville Region also had the largest output values for manufactured home manufacturing. For millwork, both the Memphis and Nashville Regions had the largest values followed by the Knoxville Region. The Nashville (primarily from wood kitchen cabinets and countertops, wood containers and pallets, and all other miscellaneous wood products—NAICS 321999) and

Table 18. Estimated Total Economic Impacts from Secondary Forest Products

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Paper Manufacturing:								
State	6,786		34,205		1,748		2,684	
Chattanooga	582	8.6	2,913	8.5	150	8.6	210	7.8
Knoxville	852	12.6	4,700	13.7	228	13.0	332	12.4
Memphis	2,570	37.9	11,999	35.1	639	36.6	1,041	38.8
Nashville	1,876	27.6	9,483	27.7	508	29.1	742	27.7
Tri-Cities	567	8.3	2,886	8.4	122	7.0	189	7.1
Intrastate Trade	340	5.0	2,225	6.5	101	5.8	169	6.3
Furniture & Related Product Manufacturing:								
State	4,163		31,427		1,325		2,041	
Chattanooga	931	22.4	7,367	23.4	298	22.5	425	20.8
Knoxville	1,473	35.4	11,797	37.5	479	36.1	715	35.0
Memphis	494	11.9	3,767	12.0	165	12.5	257	12.6
Nashville	924	22.2	6,355	20.2	276	20.8	470	23.0
Tri-Cities	53	1.3	389	1.2	15	1.2	25	1.2
Intrastate Trade	289	6.9	1,751	5.6	92	7.0	149	7.3
Millwork:								
State	1,795		12,565		516		770	
Chattanooga	12	0.7	88	0.7	3	0.6	5	0.6
Knoxville	384	21.4	2,788	22.2	110	21.3	160	20.8
Memphis	646	36.0	4,432	35.3	184	35.6	286	37.1
Nashville	561	31.3	3,909	31.1	164	31.9	236	30.6
Tri-Cities	104	5.8	766	6.1	29	5.6	40	5.1
Intrastate Trade	87	4.9	582	4.6	26	5.0	44	5.7
Other Wood Product Manufacturing:								
State	1,417		11,545		437		668	
Chattanooga	157	11.1	1,351	11.7	48	11.0	72	10.8
Knoxville	187	13.2	1,578	13.7	60	13.8	92	13.8
Memphis	257	18.1	2,173	18.8	80	18.3	119	17.8
Nashville	625	44.1	4,989	43.2	194	44.3	297	44.5
Tri-Cities	104	7.3	878	7.6	28	6.4	41	6.2
Intrastate Trade	87	6.1	575	5.0	27	6.2	46	6.9
Manufactured Home Manufacturing:								
State	1,362		9,492		407		640	
Chattanooga	14	1.1	106	1.1	4	1.0	6	1.0
Knoxville	838	61.5	5,968	62.9	253	62.1	398	62.2
Memphis	197	14.4	1,381	14.6	59	14.5	92	14.3
Nashville	242	17.8	1,701	17.9	71	17.5	110	17.3
Tri-Cities	2	0.2	16	0.2	1	0.1	1	0.1
Intrastate Trade	69	5.1	321	3.4	19	4.7	33	5.1
Veneer, Plywood, & Engineered Wood Product Manufacturing:								
State	702		4,251		187		346	
Chattanooga	197	28.0	929	21.9	44	23.4	105	30.3
Knoxville	139	19.9	888	20.9	41	22.0	75	21.7

Table 18. Estimated Total Economic Impacts from Secondary Forest Products (Cont.)

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Memphis	163	23.2	1,069	25.1	43	23.2	64	18.6
Nashville	75	10.8	493	11.6	21	11.4	38	11.0
Tri-Cities	85	12.1	620	14.6	23	12.5	41	11.8
Intrastate Trade	42	6.0	251	5.9	14	7.4	23	6.6

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

Memphis Regions (wood containers and pallets and wood kitchen cabinets and countertops)

were the leaders in all categories for other wood product manufacturing. Veneer, plywood, and engineered wood product manufacturing economic activity were the largest in the Chattanooga Region followed by the Memphis Region.

The output and employment multipliers for 2006 for primary agricultural and forestry activities ranged from 1.55 to 2.27 for total industrial output and 1.09 to 10.62 for employment (Table 19). For instance, if pulp mills increased total industry output by \$1 million, the state's economy would increase by an estimated \$.83 million overall and for each job created in this same industry an estimated 4.19 additional jobs would be added. Soybean farmers (oilseed farming) that produce \$1 million of total industry output generated an additional \$.21 million indirectly through the purchase of inputs and \$.67 million in total economic activity within the state.

Estimated Total Economic Impacts from Bioscience Subsectors:

The estimated total economic impacts of the bioscience industry included not only the direct impacts from the industry, but also the impacts the industry had on input supplying industries (indirect impacts) and on expenditures by households and other institutions (induced impacts). The total economic impacts from the bioscience industry included direct, indirect, and induced impacts. The total industry output, employment, labor income, and value added

Table 19. Primary Agriculture and Forestry Output and Employment Multipliers

IMPLAN Sector	TIO ^a		Employment	
	Indirect	Indirect & Induced	Indirect	Indirect & Induced
Oilseed farming	1.21	1.67	1.04	1.14
Grain farming	1.21	1.64	1.03	1.09
Vegetable & melon farming	1.17	1.75	1.07	1.28
Tree nut farming	1.18	1.76	1.07	1.23
Fruit farming	1.18	1.74	1.05	1.16
Greenhouse & nursery production	1.11	1.81	1.04	1.21
Tobacco farming	1.04	1.55	1.01	1.09
Cotton farming	1.23	1.68	1.15	1.34
All other crop farming	1.20	1.66	1.09	1.28
Cattle ranching & farming	1.64	2.00	1.32	1.43
Poultry & egg production	1.22	1.60	1.22	1.63
Animal production, except cattle/poultry/eggs	1.48	1.82	1.08	1.11
Fishing	1.70	2.27	1.12	1.26
Hunting & trapping	1.52	1.96	2.37	2.83
Agriculture & forestry support activities	1.13	2.05	1.06	1.29
Logging	1.31	1.74	1.70	2.74
Sawmills	1.25	1.58	1.40	2.14
Pulp mills	1.41	1.83	2.61	5.19
Paper & paperboard mills	1.35	1.82	2.37	5.19
Forest nurseries/forest products/timber tracts	1.37	1.86	7.60	10.62

^a Total Industry Output – annual value of production by industry.

resulting from the bioscience industry, including each of these impacts, are shown in Table 20.

The bioscience industry contributed an estimated value of over \$46.3 billion to Tennessee's \$487.5 billion economy annually. Employment totaled over 287 thousand workers. Intrastate

Table 20. Estimated Total Economic Impacts from Bioscience Subsectors

Sector	TIO ^a		Employment		Labor Income		TVA ^b	
	(Million \$)	%	(Number)	%	(Million \$)	%	(Million \$)	%
Bioscience:								
State	46,340		287,386		14,884		22,344	
Chattanooga	2,539	5.5	16,650	5.8	786	5.3	1,124	5.0
Knoxville	15,117	32.6	85,338	29.7	4,293	28.8	6,831	30.6
Memphis	11,664	25.2	66,609	23.2	3,492	23.5	5,378	24.1
Nashville	12,438	26.8	91,218	31.7	5,040	33.9	6,917	31.0
Tri-Cities	1,801	3.9	10,913	3.8	538	3.6	838	3.8
Intrastate Trade	2,781	6.0	16,658	5.8	735	4.9	1,256	5.6

^a Total Industry Output – annual value of production by industry.

^b Total Value Added – income to workers paid by employers; self-employed income; interests, rents, royalties, dividends, and profit payments; and excise and sales taxes paid by individuals to businesses.

trade represented values purchased or imported from outside the regions but within the state. The Knoxville Region, followed by the Nashville and Memphis Regions had the largest output values. For the remaining categories (employment, labor income, and total value added), the Nashville Region, followed by the Knoxville and Memphis Regions had the largest values.

Figures 18 through 23 show the estimated direct and total level of economic activity derived from agriculture, forestry, and both agriculture and forestry combined by county for Tennessee. These values were based on total industry output and were compared to the total level of economic activity for each county. Direct agriculture included crop production and livestock breeding and feeding, whereas direct forestry included the management and logging of trees. Total agriculture included direct agriculture, plus the input supplying industries and secondary agriculture, which included manufacturing. Likewise, total forestry included direct forestry, plus input supplying industries and secondary forestry. Grundy County in the

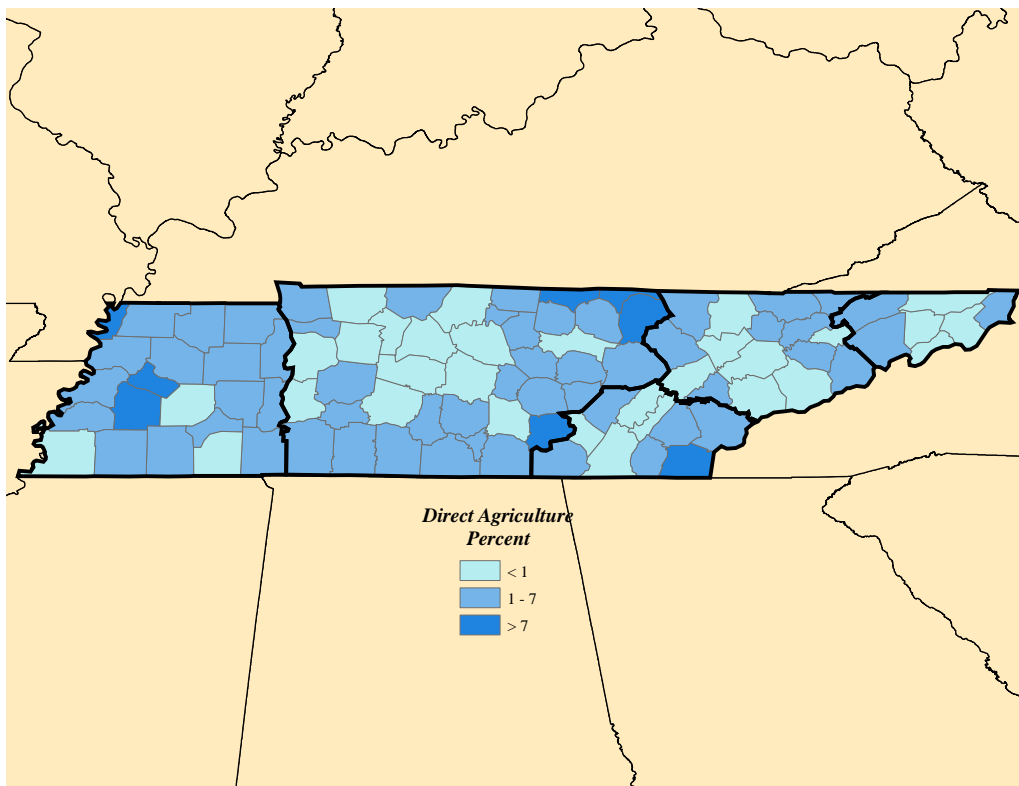


Figure 18. Percent of Economic Activity from Direct Agriculture, 2006.

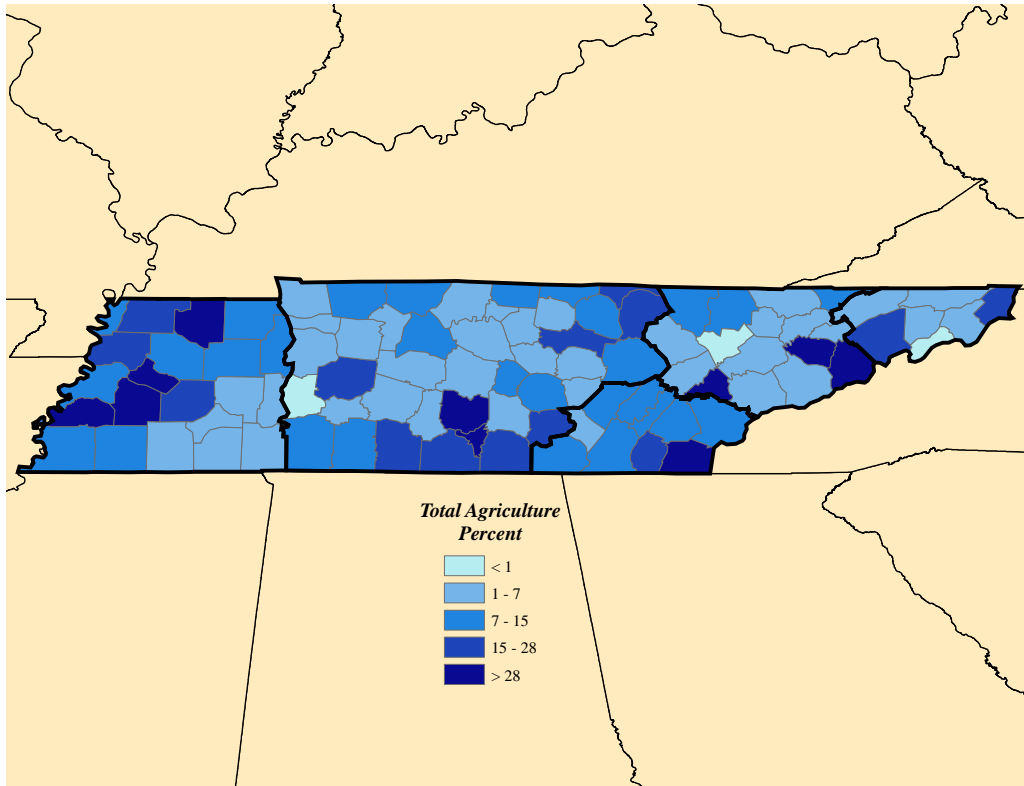


Figure 19. Percent of Economic Activity from Total Agriculture, 2006.

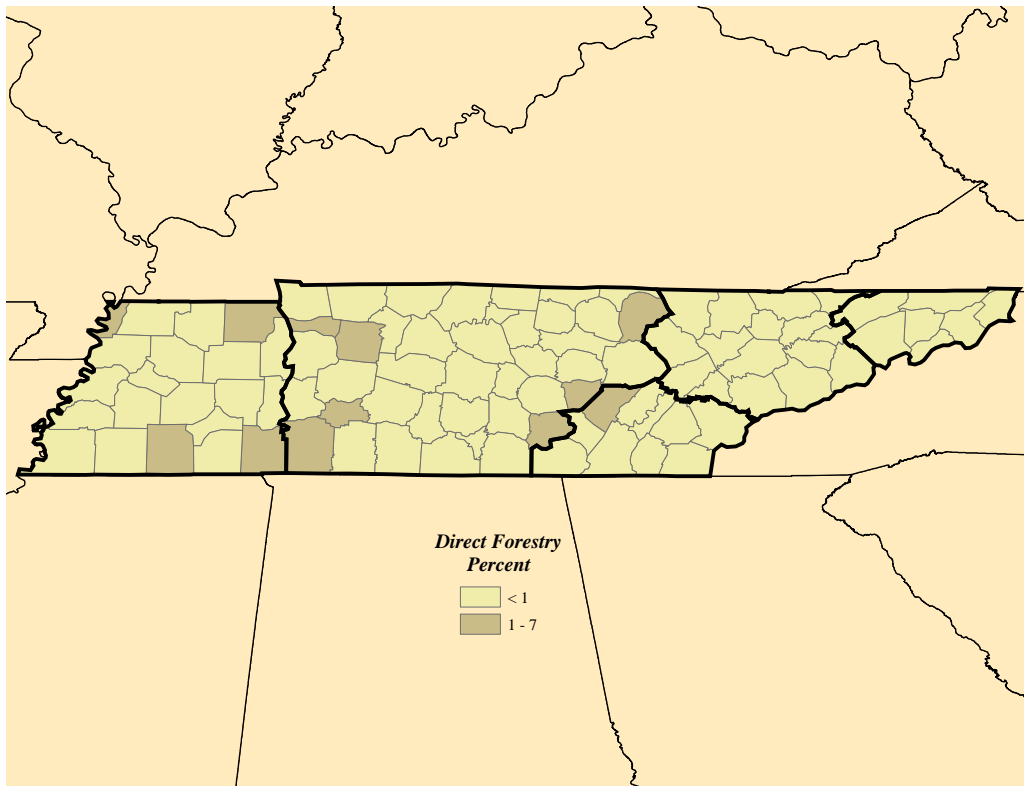


Figure 20. Percent of Economic Activity from Direct Forestry, 2006.

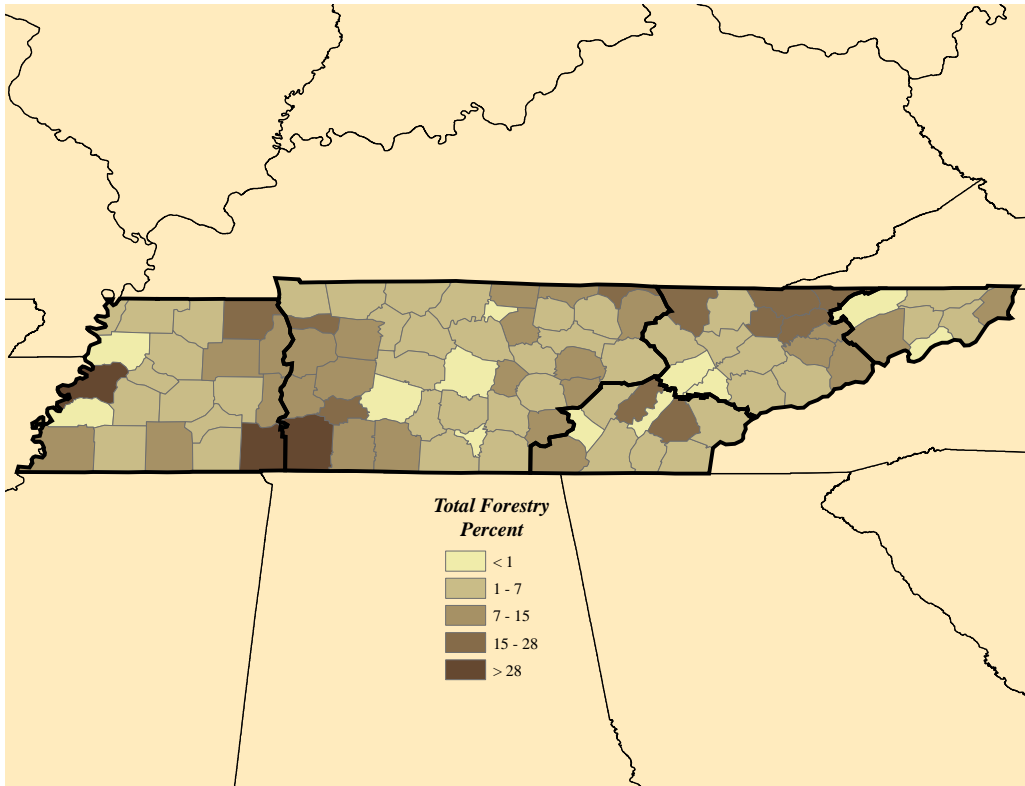


Figure 21. Percent of Economic Activity from Total Forestry, 2006.

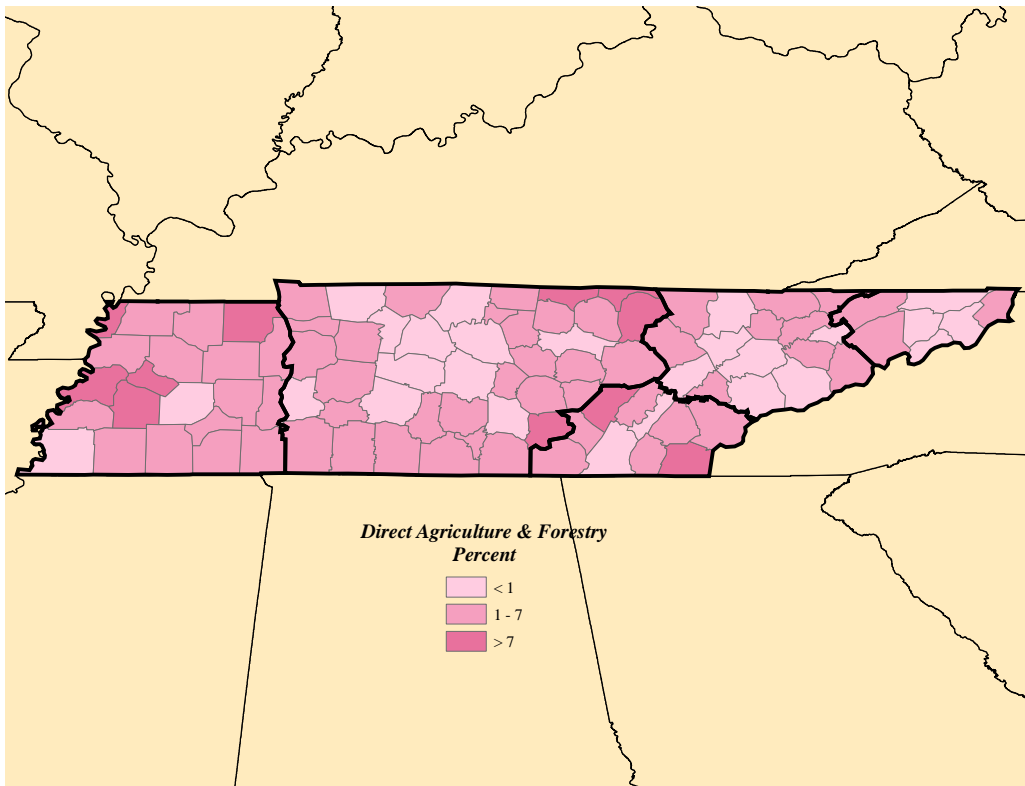


Figure 22. Percent of Economic Activity from Direct Agriculture and Forestry, 2006.

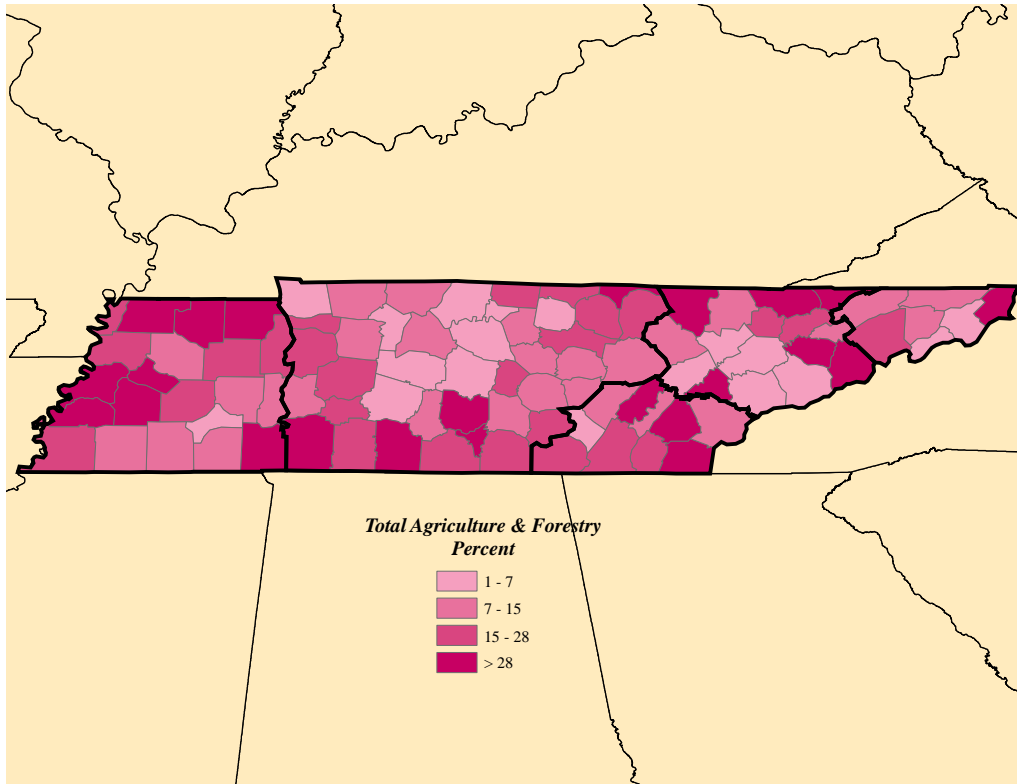


Figure 23. Percent of Economic Activity from Total Agriculture and Forestry, 2006.

Nashville Region and Crockett County in the Memphis Region has the highest level of economic activity for direct agriculture at 12.0 percent (Table 21); for total agriculture, Moore County in the Nashville Region had the highest level at 87.8 percent. For direct forestry, Henry County in the Memphis Region had the highest level of economic activity at 5.4 percent; for total forestry, Hardin County in the Memphis Region had the highest level at 43.2 percent. Likewise, for both

Table 21. Counties with the Highest Levels of Economic Activity for Agriculture and Forestry by Analysis Region, 2006

	Region and County									
	Chattanooga	%	Knoxville	%	Memphis	%	Nashville	%	Tri-Cities	%
Agriculture:										
Direct	Polk	7.3	Hancock	6.1	Crockett	12.3	Grundy	12.3	Johnson	2.5
Total	Polk	31.5	Loudon	41.0	Crockett	51.2	Moore	87.8	Johnson	25.3
Forestry:										
Direct	Bledsoe	1.0	Claiborne	0.9	Henry	5.4	VanBuren	4.3	Johnson	0.9
Total	McMinn	27.6	Scott	26.0	Hardin	43.2	Wayne	32.7	Johnson	14.7
Combined:										
Direct	Bledsoe	7.9	Hancock	6.3	Lake	13.3	Grundy	14.2	Johnson	3.4
Total	Rhea	38.5	Cocke	53.9	Crockett	52.9	Moore	88.5	Johnson	40.0

agriculture and forestry combined, Grundy (14.2 percent direct) and Moore (88.5 percent total) Counties in the Nashville Region had the largest levels of economic activity.

Some state bioenergy investments for Tennessee include a University of Tennessee biofuels initiative that included funding for a pilot cellulosic ethanol project. In addition, a joint research institute between the University of Tennessee and the Oak Ridge National Laboratory has been established along with state faculty development programs that include the Governor's Chair Program and Chairs of Excellence Program (Battelle Memorial Institute, 2008). Figures 24 through 27 show the location of Tennessee's four aggregated biosciences sector establishments throughout the state based on 2006 data.

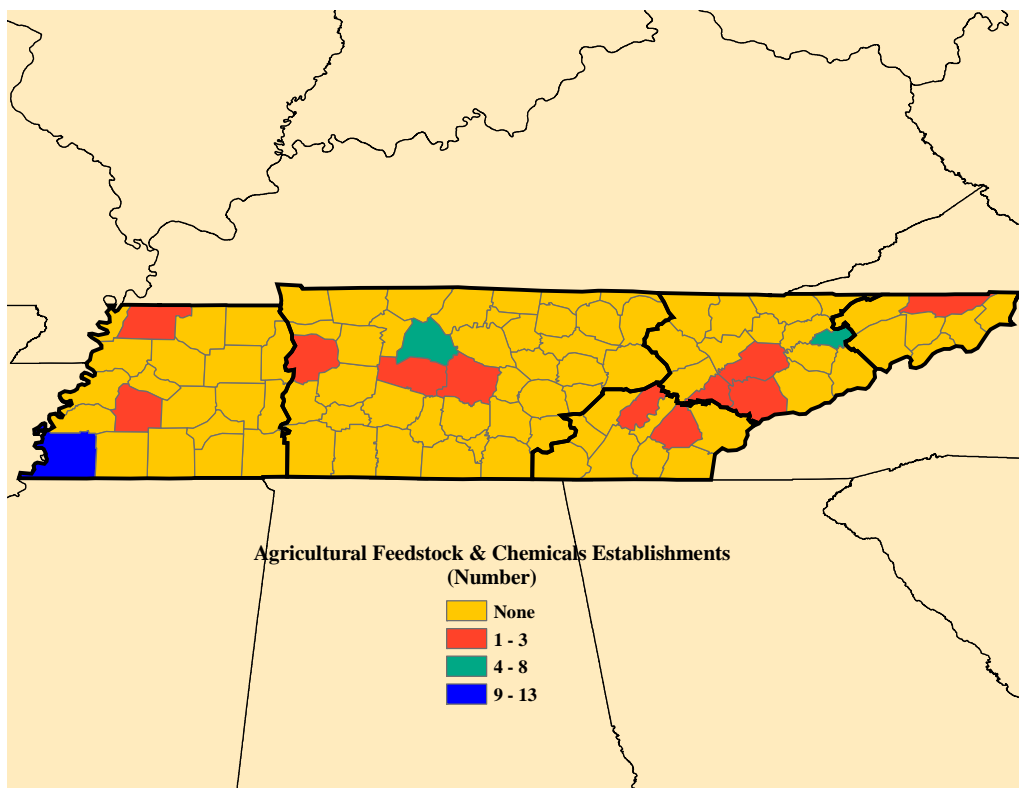


Figure 24. Number of Agricultural Feedstock and Chemical Establishments in Tennessee, 2006.

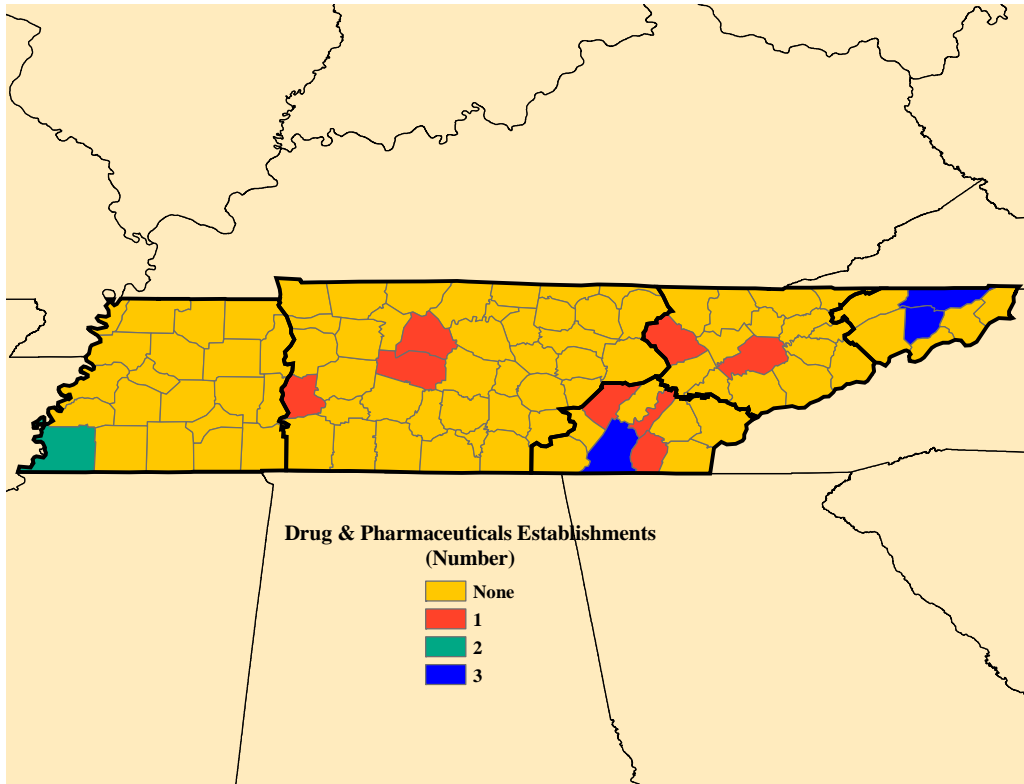


Figure 25. Number of Drug and Pharmaceuticals Establishments in Tennessee, 2006.

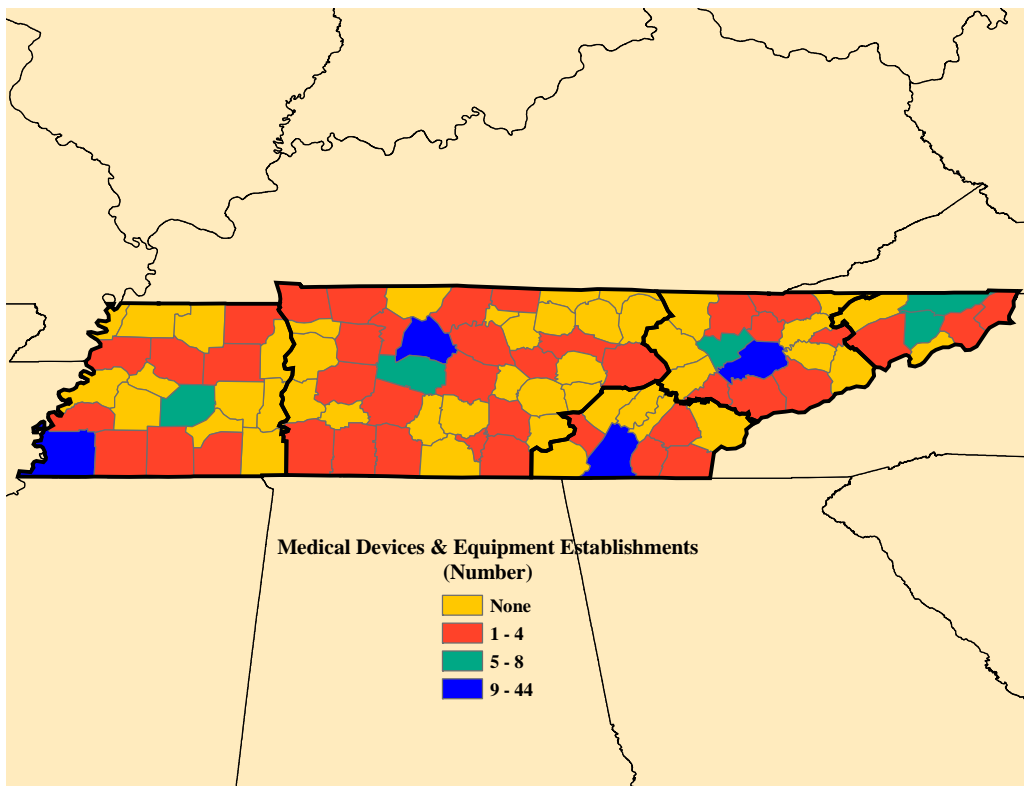


Figure 26. Number of Medical Devices and Equipment Establishments in Tennessee, 2006.

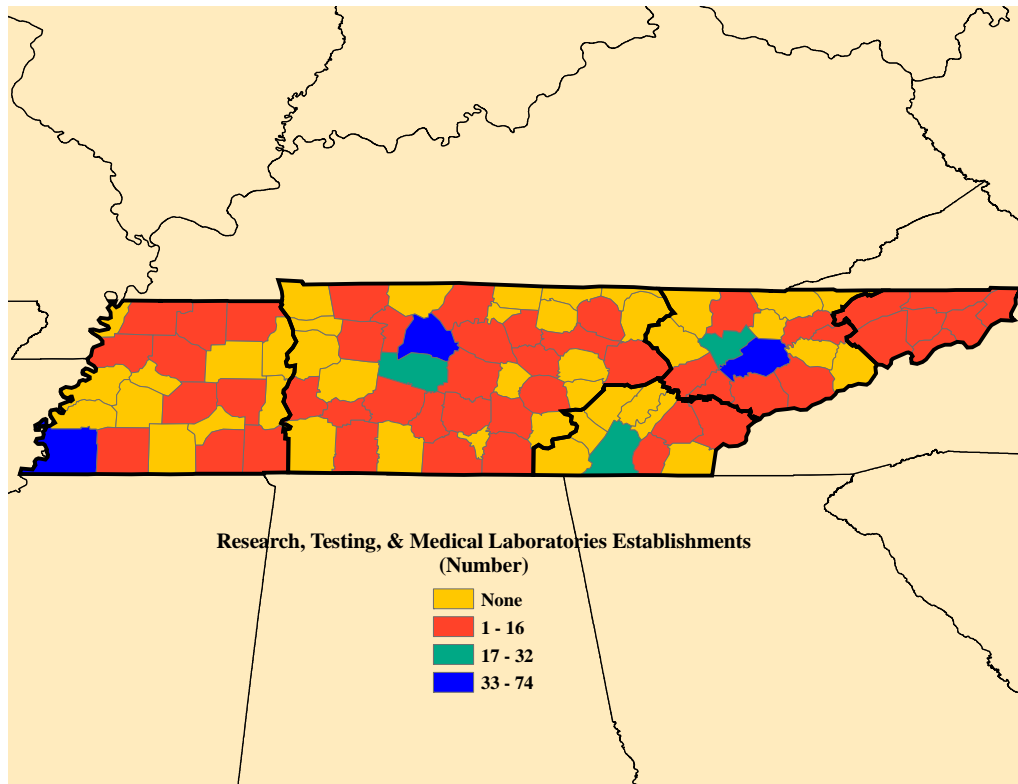


Figure 27. Number of Research, Testing, and Medical Laboratories Establishments in Tennessee, 2006.

Summary and Conclusion

Input-output modeling is useful for evaluating and analyzing information on the interrelationships of a regional economy and impacts of changes on that economy. The model is a useful planning tool for policy-makers in evaluating potential impacts of their decisions concerning agriculture and forestry industries for the state. For this analysis, a baseline for 2006 was developed using Tennessee Agricultural Statistics Service information, along with the Minnesota IMPLAN Group's input-output model information. The state was divided into five trade regions. These five regions will be used in future analyses to gauge the performance of individual sectors and the impacts of new sectors to the state's agro-forestry industrial complex.

Comparing agricultural data for 2003 and 2006 revealed that most of Tennessee's traditional row crops acreage declined except for cotton and soybeans. Crop prices increased for

corn, grain sorghum, and wheat but declined for soybeans, cotton, and tobacco. Livestock numbers increased for cattle and calves and broilers, but declined for all other traditional livestock commodities during that timeframe. Livestock prices increased for all traditional livestock commodities (Table 5). Precipitation for the state for the timeframe reviewed can be characterized as unpredictable. Above average rainfall for both years 2003 and 2004 was followed by drought conditions for years 2005 and 2006.

Agriculture and forestry were very important to the Tennessee's economy with a contributing share of 16.2 percent to the state's total economy. The agro-forestry industrial complex included the primary industries typically associated with agriculture and forest operations such as crop production, livestock breeding and feeding, and the management and logging of trees. Also included in the industrial complex were the input supplying industries and value-added subsectors, which included food and beverage manufacturing, apparel and textiles, and forestry products manufacturing. In 2006, the agro-forestry industrial complex contributed \$78.9 billion to the Tennessee economy and employed over 502,000 individuals.

Agriculture, a subset of the agro-forestry industrial complex in Tennessee, included farming and related industries, as well as value-added food and fiber production, processing and manufacturing. Agriculture accounted for 10.6 percent of the state's economy and generated \$51.4 billion in output. Close to 347,000 Tennesseans, with over 127,000 in the production sector (both full- and part-time), were employed in agriculture.

Forestry included the management and logging of trees; sawmills (primary forestry products), including pulp and paper mills, plus forestry products manufacturing (secondary forestry products). Forestry accounted for 5.6 percent of the state's economy, employed over 155,000 Tennesseans, and generated \$27.4 billion in output.

From a regional perspective, the agro-forestry industrial complex was more important to the Memphis and Chattanooga regions relative to other regions in the state followed by the Knoxville, Tri-Cities, and Nashville regions (Table 22). The Memphis Region contributed the largest amount of economic activity, \$28.1 billion, representing 22 percent of the total for the region.

Table 22. Regional Importance of Agriculture to that Region’s Economy, 2006

Location	Total Economic Activity (Million \$)	Estimated Agro-Forestry Industrial Complex Contributions to the State’s Economy (Million \$)	Proportion (Ratio)
State	487,492	78,903	0.16
Chattanooga	55,196	10,934	0.20
Knoxville	77,715	10,678	0.14
Memphis	128,633	28,168	0.22
Nashville	198,501	21,935	0.11
Tri-Cities	27,448	3,250	0.12

Source: Minnesota IMPLAN Group, Inc.

When comparing county level total economic activity (across all industries) with county level agricultural economic activity, the counties with the highest percentage levels were Moore (87.8 percent) in the Nashville Region, Crockett (51.2 percent) in the Memphis Region, Loudon (41.0 percent) in the Knoxville Region, Polk (31.5 percent) in the Chattanooga Region, and Johnson (25.3 percent) in the Tri-Cities Region. Likewise, for forestry, Hardin County (43.2 percent) had the highest level of forestry economic activity percentage in the Memphis Region, followed by Wayne County (32.7 percent) in the Nashville Region, McMinn County (27.6 percent) in the Chattanooga Region, Scott County (26.0 percent) in the Knoxville Region, and Johnson County (14.7 percent) in the Tri-Cities Region. Combining both agriculture and forestry economic activity levels and comparing to the total, the counties with the highest percentages were Moore (88.5 percent) in the Nashville Region, Cocke (53.9 percent) in the

Knoxville Region, Crockett (52.9 percent) in the Memphis Region, Johnson (40.0 percent) in the Tri-Cities Region, and Rhea (38.5 percent) in the Chattanooga Region.

The biosciences industries are important to Tennessee's economy. The industry is comprised of the agriculture feedstocks and chemicals; drugs and pharmaceuticals; medical devices and equipment; and research, testing and medical laboratories subsectors. For 2006, it is estimated that the total employment impact of the biosciences sector for the U.S. is 7.5 million jobs. For 2006, there were close to 43,000 bioscience business establishments in the United States, a 7.7 percent increase from 2003 levels. For Tennessee in 2006, the number of bioscience establishments is estimated at 759, also a 7.7 percent increase compared to 2003. Research, testing, and medical laboratories have the largest number of establishments, followed by medical devices and equipment, agriculture feedstocks and chemicals, and drugs and pharmaceuticals. In 2006, the bioscience industry contributed a total of \$23.3 billion in direct economic activity to the state of Tennessee and employed over 94 thousand persons. The estimated total economic impact of the bioscience industry was valued over \$46.3 billion to Tennessee's \$487.5 billion economy.

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Appendix A: County Region Identification Table

Table A.1. County Assignment to TNAIM’s Modeling Regions

Memphis	Nashville		Chattanooga	Knoxville	Tri-Cities
Benton	Bedford	Macon	Bledsoe	Anderson	Carter
Carroll	Cannon	Marshall	Bradley	Blount	Greene
Chester	Cheatham	Maury	Hamilton	Campbell	Hawkins
Crockett	Clay	Montgomery	McMinn	Claiborne	Johnson
Decatur	Coffee	Moore	Marion	Cocke	Sullivan
Dyer	Cumberland	Overton	Meigs	Grainger	Unicoi
Fayette	Davidson	Perry	Monroe	Hamblen	Washington
Gibson	DeKalb	Pickett	Polk	Hancock	
Hardeman	Dickson	Putnam	Rhea	Jefferson	
Hardin	Fentress	Robertson	Sequatchie	Knox	
Haywood	Franklin	Rutherford		Loudon	
Henderson	Giles	Smith		Morgan	
Henry	Grundy	Stewart		Roane	
Lake	Hickman	Sumner		Scott	
Lauderdale	Houston	Trousdale		Sevier	
McNairy	Humphreys	Vanburen		Union	
Madison	Jackson	Warren			
Obion	Lawrence	Wayne			
Shelby	Lewis	White			
Tipton	Lincoln	Williamson			
Weakley		Wilson			