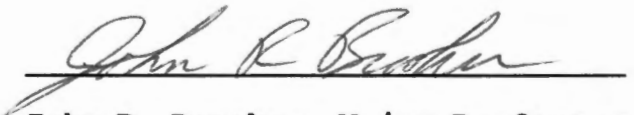
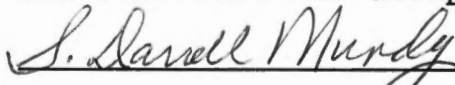
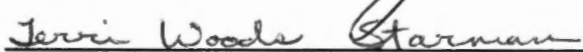


To the Graduate Council:

I am submitting herewith a thesis written by Charles Steven McSween entitled "An Economic Analysis of the Production and Marketing of Floricultural Crops in Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.


John R. Brooker, Major Professor

We have read this thesis
and recommend its acceptance:


 Starman

Accepted for the Council:


Associate Vice Chancellor
and Dean of The Graduate School

AN ECONOMIC ANALYSIS OF THE PRODUCTION AND
MARKETING OF FLORICULTURAL CROPS IN TENNESSEE

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Charles Steven McSween
May 1995

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Thesis
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DEDICATION

This thesis is dedicated especially to my parents Charles and Jean McSween, and to Donny, Sharon, LaVonda, Tom, Stephanie, and Wendell. Each of you had belief and provided encourgment. Your support was immeasurable and your confidence in me was often greater than my own.

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I also wish to express my gratitude to the Tennessee greenhouse managers who took time out of their busy spring schedules to participate in the research survey. They provided the information, I merely put it down on paper.

Abstract

The primary objective of this analysis was to provide Tennessee green industry farmers with information on the production and marketing of floriculture crops. An overview of U.S. national, southern regional and Tennessee green industry production and marketing characteristics was presented to describe the general production and marketing environment in which green industry farms operate. A mail survey of Tennessee greenhouses was conducted in 1994 and the data received from 83 greenhouses was analyzed to describe specific production and marketing activities among these farmers. The survey responses were stratified and compared according to greenhouse size in square feet, gross annual sales and region within Tennessee. Chi-square tests were used to determine the significance of the results.

Overall, greenhouse managers reported a total of 2.7 million square feet under greenhouse cover during the 1993 production period and 29.3 percent of managers planned to expand the size of their operations within the next two years. On average greenhouses employed 6.9 permanent employees and family members were an important source of labor among all strata of greenhouse operations.

Among all survey strata, greenhouses were most commonly constructed of double layer poly covering. Managers indicated a variety of current production technologies with larger firms generally using a wider variety of technologies to perform specific production tasks than did the smaller firms. Computerization was the most commonly reported technology adoption planned by managers within the next five years.

Retail sales accounted for the largest proportion of greenhouse market activity and, overall, the largest proportions of greenhouse advertising budgets were allocated to newspaper and radio advertising. Television was also an important advertising medium. Bedding plants contributed the largest proportion of annual sales although the sale of these plants was highly seasonal and confined primarily to the months of April and December.

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CHAPTER 1: INTRODUCTION

PART 1: GENERAL INTRODUCTION AND OVERVIEW OF THE GREEN INDUSTRY

Definitions of Terms

The "green industry" is a relatively new term that is being used by the USDA to encompass the diverse product categories that have traditionally been referred to as floriculture and ornamental horticulture (Johnson et al.:1993). Likewise, various industry associations and the USDA have begun to use the term "environmental" in place of the word ornamental. This change in terminology seems to have been motivated by the desire for a term that more accurately reflected the contribution of these products to society. The word ornamental suggests that the item is merely decorative and hence, relatively unimportant. Traditionally, ornamental horticulture has been used to refer to all greenhouse and nursery crops produced for landscaping and/or other aesthetic purposes. Johnson and Johnson have defined the green industry as being composed of two major subsectors -floriculture and environmental horticulture.

Floriculture products primarily include cut flowers, cut cultivated greens, bedding and garden plants, potted flowering plants, and potted foliage. These products are grown for indoor or patio use, or as seedlings for outdoor bed or garden transplanting. Examples of floriculture crops are cut roses, cut leatherleaf ferns, vegetable seedlings, poinsettias, and philodendrons.

Environmental horticulture products, on the other hand, are mostly perennials that are marketed primarily for landscape and interior-scape purposes. These crops include bulbs, nursery plants, sod (turfgrass), flower and vegetable seeds, cut Christmas trees, and unfinished plant materials. Examples are daylilies, dogwood trees, tall fescue, Douglas fir, and tissue-cultured plantlets.

Data Sources

The purpose of this introductory chapter is to develop an overview of the production and market structure for green industry products. In this section, national, regional, and state data have been summarized to describe the physical and economic characteristics of green industry farms at each aggregate level. Also, green industry physical and economic characteristics have been summarized with reference to specific crop types. Secondary data on green industry

characteristics were obtained from three sources: the 1987 U.S. Census of Agriculture, produced by the U.S. Department of Commerce, the Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-91, produced by the United States Department of Agriculture's (USDA) Economic Research Service, and Floriculture Crops, 1991 Summary, produced by the USDA's National Agricultural Statistics Service (NASS).

The 1987 U.S. Census of Agriculture is the most complete reference for green industry physical and economic data. It summarizes data for all farms reporting floriculture and environmental horticulture crops sales of \$1,000 or more. The census of agriculture is conducted every five years, however, the results from a more recent census are not yet available. More recent financial data are provided by the results of the USDA's Farm Costs and Returns Survey (FCRS) as summarized in the Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-91. The FCRS is an annual survey of the USDA's Economic Research Service conducted in order to obtain data for the development of representative farm enterprise budgets. The FCRS data was of limited use in the present study because of the national perspective of FCRS reporting and due to the small FCRS sample sizes which prohibit disaggregation of the data into floriculture and environmental horticulture subsectors (Johnson et al.).

The USDA's NASS report, Floriculture Crops, 1991 Summary, provides physical and economic size data on 30 specific floriculture industry crops. The financial data are limited, however, to growers reporting \$100,000 or more in sales. Individually, none of these data sources is sufficient to provide a thorough, yet current overview of green industry physical and economic size characteristics. The goal of this introductory section was to combine information from these sources into a descriptive presentation that maximizes the contribution from each data source.

Distribution of Green Industry

Farms and Production Area

U.S. Regional Distribution

With reference to the most recent U.S. Census of Agriculture data, in 1987 there was a total of 37,298 green industry farms that cultivated 762 million square feet of growing area under covering or shade and 579 thousand acres in the open (Table 1). A regional distribution of farms indicated that the southern states contained the largest percentage of green industry farms (36 percent) as well as the largest percentages of total area under cover (34.9 percent)

Table 1. Regional distribution of U.S. green industry farms and production area, 1987

Region	Farms		Area under greenhouse cover			Acres in the open		
			Total area under cover		Average per farm	Total acres in the open		Average per farm
	number	percent	square feet	percent	square feet	acres	percent	acres
Northeast	7,559	20.3	132,885,687	17.5	17,536	73,750	12.8	9.7
North central	7,365	19.7	121,236,571	15.9	16,461	114,980	19.8	15.6
West	8,953	24.0	242,059,198	31.8	27,037	164,223	28.4	18.4
South	<u>13,421</u>	<u>36.0</u>	<u>265,816,996</u>	<u>34.9</u>	19,806	<u>226,005</u>	<u>39.1</u>	16.8
US total	37,298	100.0	761,998,452	100.1 ^a	20,430	578,958	100.1 ^a	15.5

^aNortheast states include: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

^bNorth central states include: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin

^cSouthern states include: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia

^dWestern states include: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming

^eDoes not equal 100.0 percent due to rounding error

Source: 1987 Census of Agriculture

and acres planted in the open (39.1 percent). Relative to other regions, however, western state farms had the largest average area under cover per farm (27,037 square feet) and the largest average number of acres planted in the open (18.4 acres).

Reduced-south Region and Tennessee Relative Distributions

When the contributions of Florida and Texas, two states in the southern region which rank second and third in U.S. green industry production, are excluded from the southern region total, this reduced-south region contained 55.7 percent of southern region green industry farms and cultivated 31.4 percent of all southern region production area under greenhouse covering or shade, and 44.5 percent of all open acreage planting (Table 2).

Tennessee green industry farms numbered 1,002 in 1987, or 13.4 percent of the reduced-south region total. These Tennessee farmers cultivated 10.2 percent of reduced-south region's total area under cover and 23.6 percent of all reduced-south region open acreage planting.

Table 2. Reduced-south region and Tennessee relative distributions of green industry farms and production area, 1987

Production characteristic	Southern region ^a	Reduced-south region ^b		Tennessee	
	Total	Total	Percent of south	Total	Percent of reduced-south
Number of farms	13,421	7,474	55.7	1,002	13.4
Area under cover in square feet	265,815,999	83,507,807	31.4	8,535,881	10.2
Acres in the open	226,005	110,236	44.5	23,637	23.6

^aSouthern region includes: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia

^bSouthern region excluding Florida and Texas

Source: Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-91

Distribution of Green Industry

Grower Cash Receipts

U.S. Regional Distribution

In 1991, the green industry earned \$8.7 billion in grower cash receipts and ranked sixth in value of grower cash receipts among major U.S. agricultural commodities following beef cattle, dairy products, corn, hogs, and soybean (Johnson et al.). Southern states contributed 37.4 percent, the largest share of all U.S. green industry cash receipts in 1991, followed by western region farmers (33.7 percent). Farmers in the north central and northeastern regions together contributed the remaining 28.9 percent, or about \$1.3 billion each (Table 3).

In addition to contributing the largest relative proportion of cash receipts in 1991, Southern growers also earned the largest share of green industry grower cash receipts during each year from 1987 through 1991. The southern market share decreased, however, in each of those years except 1990 (Figure 1). Western states earned the second largest share of green industry grower cash receipts during each year from 1987 through 1991 and exhibited a growth trend during each of the five years considered. Northeastern states ranked third in value of green industry grower cash

Table 3. Trend in regional shares of U.S. green industry grower cash receipts^a, 1987-91

Region	Year					1991
	1987	1988	1989	1990	1991	
	-----percent-----					(\$1,000)
South	39.3	39.2	38.5	38.7	37.4	3,258,544
West	31.4	31.9	32.8	33.5	33.7	2,935,823
N. Central	13.6	13.3	13.4	12.8	14.5	1,265,222
Northeast	<u>15.7</u>	<u>15.6</u>	<u>15.3</u>	<u>15.0</u>	<u>14.4</u>	<u>1,246,534</u>
US Total	100.0	100.0	100.0	100.0	100.0	8,706,123
Reduced-south region ^b as percentage of southern total	18.6	19.6	19.6	19.8	19.5	1,698,773
Tennessee as percent of reduced-south region	10.0	9.1	8.6	8.3	7.6	128,646

^aFarms reporting \$100,000 or more in sales

^bSouthern region excluding Florida and Texas

Source: Financial Performance of U.S. Floriculture and
Environmental Horticulture Farm Businesses, 1987-91

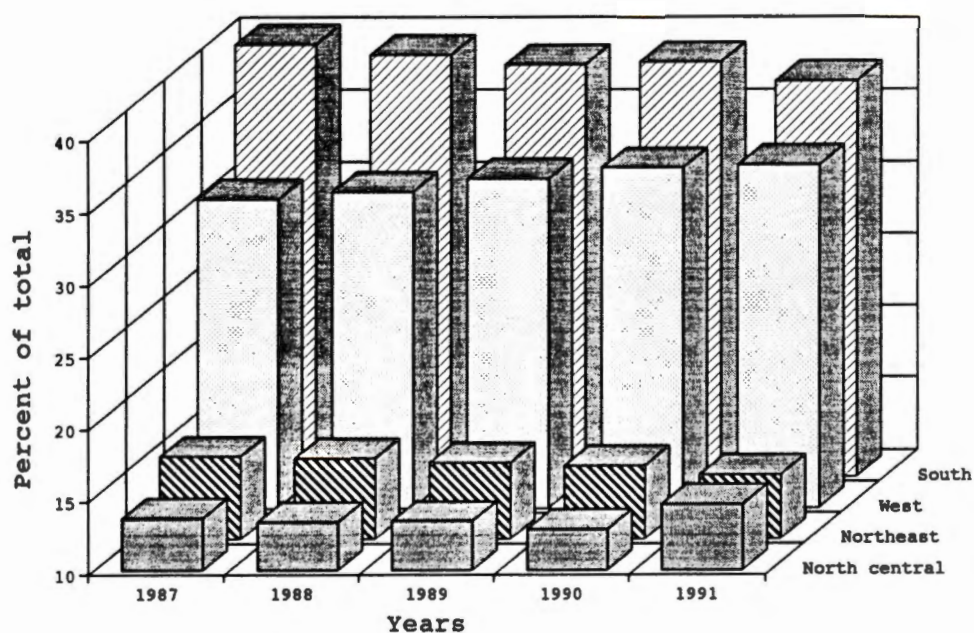


Figure 1. Regional distributions of U.S. green industry grower cash receipts, 1987-1991

Source: Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-1991

receipts in four out of the five years examined, and exhibited a decreasing share of grower cash receipts during each year considered. North central states contributed the least share of all U.S. green industry receipts in every year from 1987 through 1990.

This regional ranking by percentage of all U.S. grower cash receipts is not reflected in the geographic distribution of green industry firms, however. As shown in Figure 2, in 1991, western states contained only 14.9 percent of all green industry farms, yet contributed 33.7 percent of all green industry cash receipts. Southern states, on the other hand, contained 45.2 percent of the nation's green industry firms but contributed just 37.4 percent of the total value of U.S. grower cash receipts. The northeastern states region contained 27.5 percent of all U.S. green industry firms and contributed only 14.4 percent of the total value of all grower cash receipts and north central states, containing 12.4 percent of farms, contributed 14.5 percent.

Reduced-south Region and Tennessee Relative Distribution

The reduced-south region accounted for 19.5 percent of the value of all southern state green industry cash receipts in 1991 (Table 3). Interestingly, during the five year period from 1987 to 1991, the reduced-south region's share of the

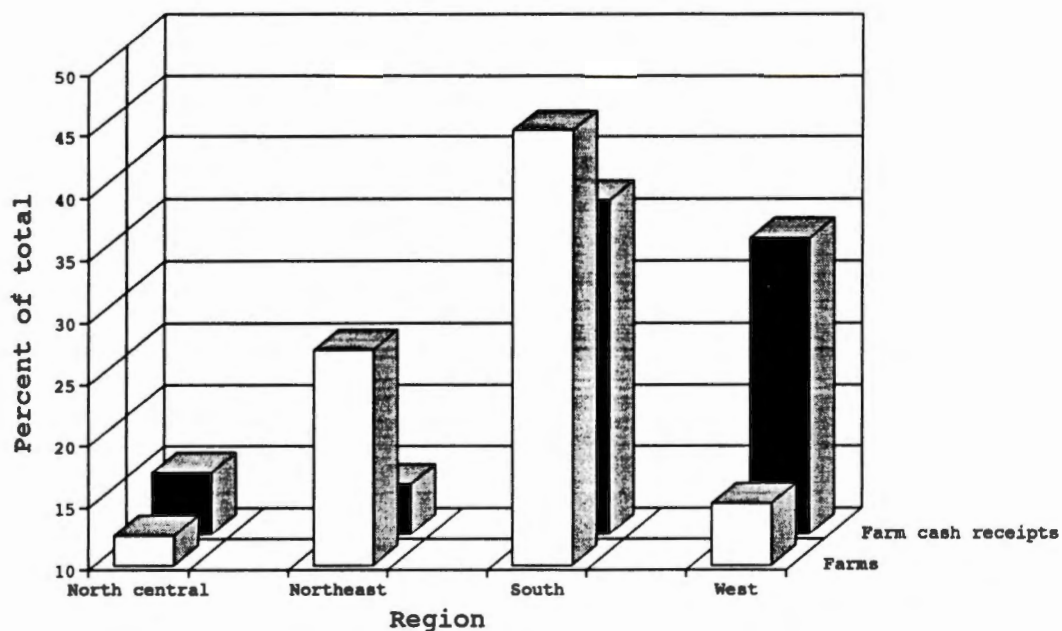


Figure 2. Regional distribution of green industry farms and grower cash receipts, 1991

Source: Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-1991

U.S. green industry cash receipts increased from 18.6 to 19.5 percent, while, at the same time, the market share for the entire southern region declined.

The sale of Tennessee's green industry crops earned cash receipts totalling \$128.6 million in 1991. This represents 7.6 percent of reduced-south region total (Table 3). Tennessee's market share relative to the reduced-south region total declined during each of the five years examined (Figure 3).

Economic Classification of U.S. Green Industry Farms

The U.S. Census Bureau disaggregates green industry firms into eight economic classes based on reported annual income. A simplified system, described by Johnson and Johnson, incorporates just three economic groups: small (less than \$100,000), medium (\$100,000-\$499,999) and large (more than \$500,000). For the purpose of this study, the data found in the eight U.S. Census economic classification groups was recombined into the three comprehensive groupings described by Johnson and Johnson. Arranged in this manner, the result indicated that in 1987, 78.2 percent of all U.S. green industry farms were economically classified as small with annual income of less than \$100,000; 15.4 percent of all U.S.

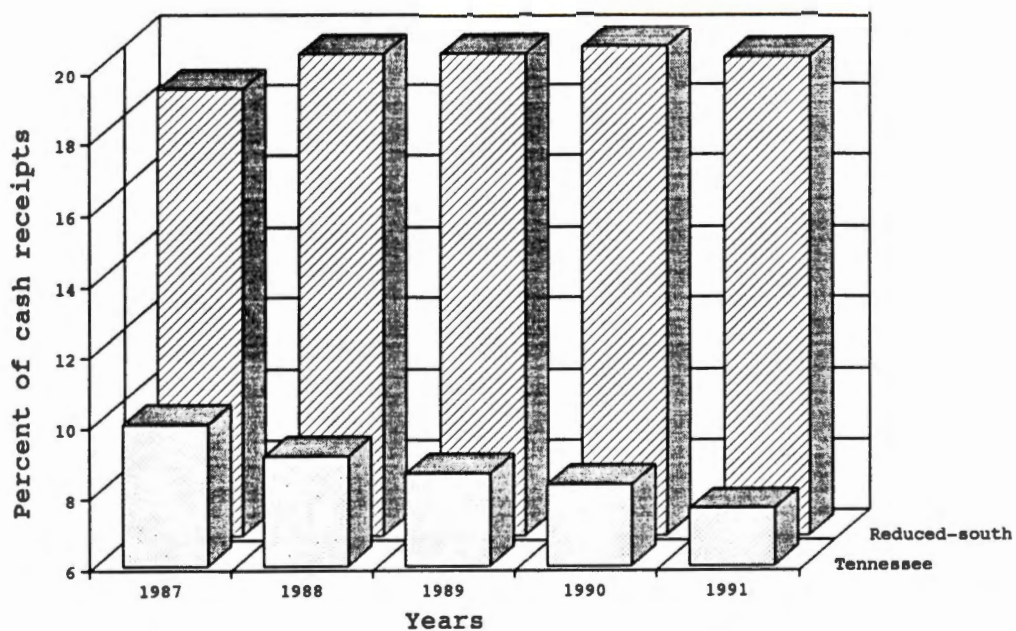


Figure 3. Comparative trends in reduced-south and Tennessee relative distributions of green industry grower cash receipts, 1987-1991

Source: Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-1991

green industry firms reported annual incomes of from \$100,000 to \$499,999 and were classified as medium; and 6.4 percent of all U.S. green industry firms reported incomes of more than \$500,000 and were classified as large. In general, there was a relatively even distribution of farms in each economic class across all regions, although the southern region had the largest percentage of farms in each class (Table 4).

The reduced-south region contained about half of the total number of southern state firms in each economic classification group (Table 5). When examined with reference the individual groups, however, it is evident that the reduced-south region was most heavily concentrated with a distribution of smaller sized firms. Tennessee farms reported from 13 percent to 15 percent of the reduced-south region farms in each economic classification group.

Green Industry Average Net Cash Farm Incomes

Net farm income is a basic measurement of the profit or loss associated with current production and is calculated by as an adjustment to the gross cash income. Basically it is an adjustment that reflects changes in farm inventory value, while at the same time incorporating non-money income components (Johnson et al.). Among the ten U.S.commodities that were examined by the U.S.D.A.'s Farm Costs and Returns

Table 4. Regional distribution of green industry farms by gross annual income, 1987

Geographic region	Annual income ^a							
	Less than \$100,000		\$100,000-\$499,999		\$500,000 or more		Overall	
	number	percent	number	percent	number	percent	number	percent
Northeast	6,222	17.4	993	2.8	363	1.0	7,578	21.2
North central ^b	5,546	15.5	1,096	3.1	360	1.0	7,002	19.6
South	10,658	29.8	1,996	5.6	773	2.2	13,427	37.6
West ^c	<u>5,513</u>	<u>15.4</u>	<u>1,429</u>	<u>4.0</u>	<u>780</u>	<u>2.2</u>	<u>7,722</u>	<u>21.6</u>
Total ^d	27,939	78.2	5,514	15.4	2,276	6.4	35,729	100.0

^aFarm reporting \$1,000 or more in sales. Includes nursery and greenhouse crops, mushrooms, and sod grown for sale

^bInformation not published for North Dakota and South Dakota

^cInformation not published for Nevada and Wyoming

^dDoes not include information from some states

Source: 1987 Census of Agriculture

Table 5. Relative distributions of reduced-south region and Tennessee green industry farms by gross annual income, 1987

Gross annual sales ^a	South ^b	Reduced-south ^c		Tennessee	
	Farms	Farms	Percent of south	Farms	Percent of reduced-south
Less than \$100,000	10,658	6,232	58.5	839	13.5
\$100,000-\$499,999	1,996	860	43.1	115	13.4
More than \$500,000	773	320	41.1	48	15.0
Total	13,427	7,412	55.2	1,002	13.5

^aFarms reporting \$1,000 or more in sales. Includes nursery and greenhouse crops, mushrooms, and sod grown for sale

^bSouthern region includes: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia

^cSouthern region excluding Florida and Texas

Source: 1987 U.S. Census of Agriculture

Survey (FCRS), farms that marketed floriculture and environmental horticulture products reported the highest average net cash incomes in 1990 (Figure 4). Among the top ten net cash farm income earners, only the net cash incomes to green industry farmers and tobacco farmers increased during every year from 1987 through 1990 (Figure 5).

Tennessee Green Industry

In 1987 a total of 1,002 Tennessee farms marketed green industry products (1987 U.S. Census of Agriculture). Tennessee green industry farmers cultivated 8.6 million square feet under covering or shade and 24 thousand acres in the open. Table 6 organizes the distributions of Tennessee green industry farms, production area and grower cash receipts by number of counties.

The Distribution of Green Industry Farms by County

Only one Tennessee county totalled more than 100 green industry farms in 1987 (Figure 6). During 1987, Warren county reported a total of 344 green industry farms, or 34 percent of all green industry farms in the state. Two counties, De Kalb and Shelby, each contained between 50 and 99 farms, and four counties, Franklin, Grundy, Knox, and Williamson contained 25

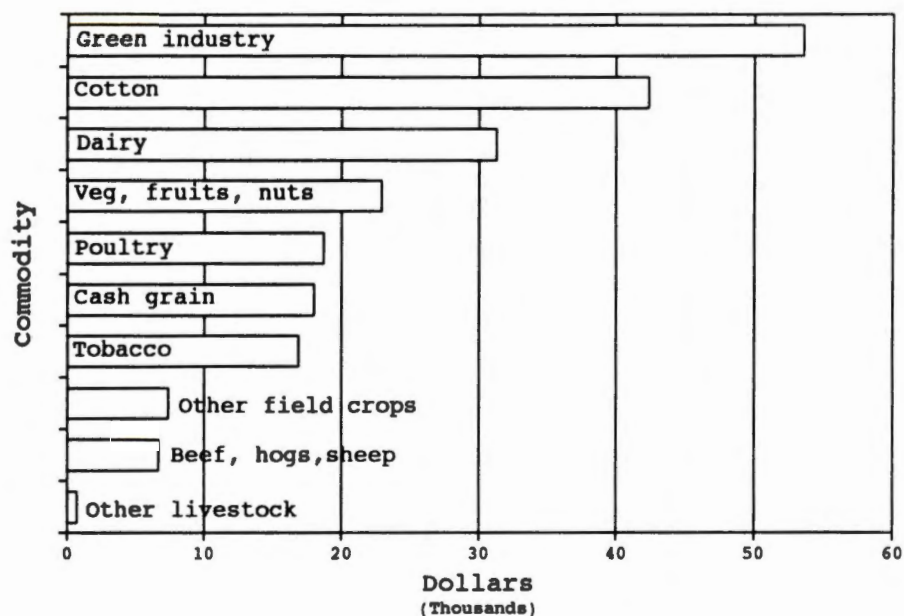


Figure 4. Average net farm incomes among the ten highest earning U.S. agricultural commodities, 1990

Source: Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-1991

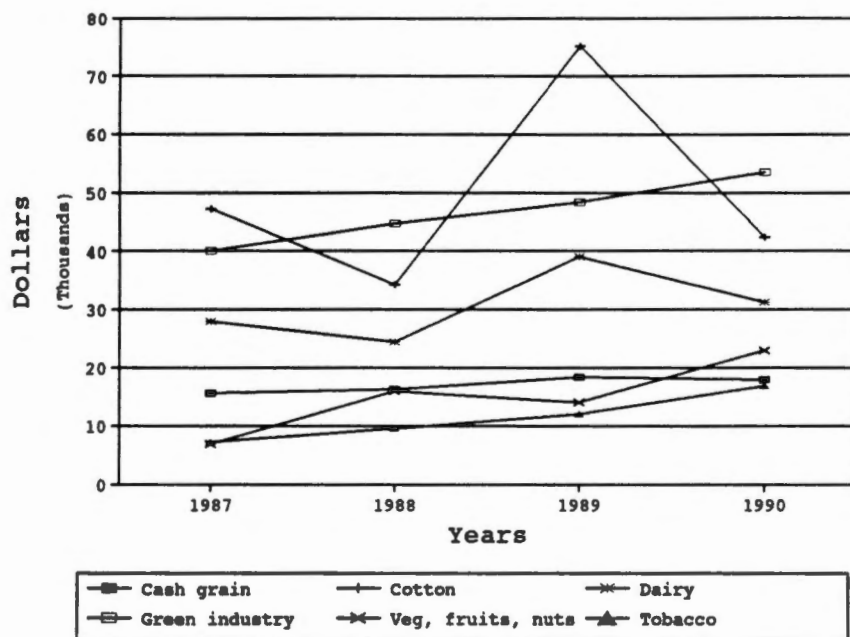


Figure 5. Average net farm incomes for six selected U.S. agricultural commodities, 1987-1990

Source: Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-1991

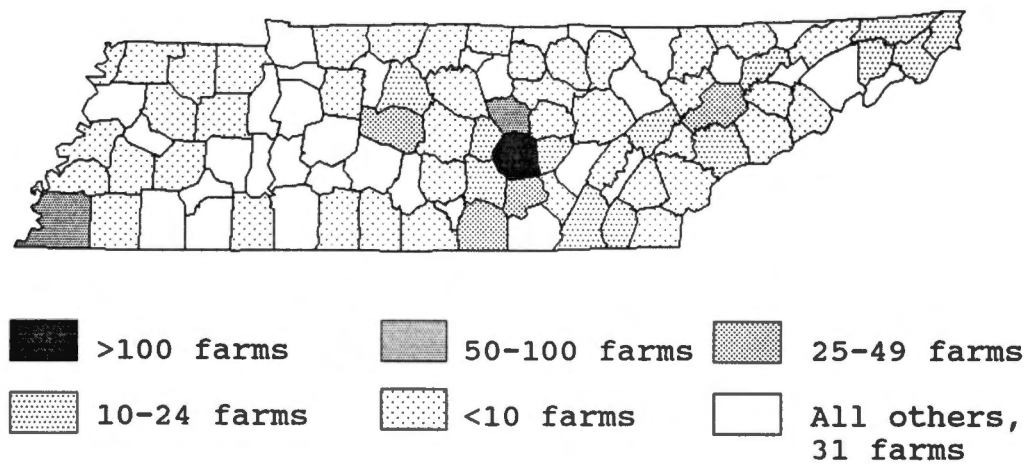


Figure 6. Distribution of Tennessee green industry farms by county, 1987

Source: 1987 U.S. Census of Agriculture

to 49 farms each. Thirteen Tennessee counties reported total green industry farms of between 10 and 24 each, and 41 counties had less than 10 green industry farms. The 34 counties for which individual information was not available reported a total of 31 green industry farms (Table 6).

Distribution of Greenhouse Space by County

Twelve Tennessee counties reported a total of more than 100,000 square feet of green industry cultivation under greenhouse covering or shade in 1987 (Table 6). Four counties reported covered areas of 50,000 to 99,999 square feet, and five counties reported greenhouse covering or shaded areas of 1 to 49,999 square feet. Information was not available for 39 counties, and the remaining 34 counties reported a total 210,710 square feet (Table 6). Figure 7 illustrates the distribution of greenhouse production area in Tennessee.

Distribution of Production Acres in the Open by County

Warren county cultivated 14,148 acres, or 59.8 percent of all Tennessee green industry open field planting (1987 U.S. Census of Agriculture). It was the only county for which more than 2,000 acres of open field cultivation was reported (Figure 8). Seven Tennessee counties reported from 100 to

Table 6. Distribution of specific green industry characteristics among Tennessee counties, 1987

Number of green industry farms ^a	Number of counties	Number of sq. ft. under greenhouse covering or shade ^a	Number of counties	Number of acres in the open ^a	Number of counties	Total sales ^a	Number of counties
	number		number		number		number
more than 100	1	100,000 or more	12	more than 2,000	1	more than \$10 million	1
50-99	2	50,000-99,999	4	100-2000	7	\$5 million-\$9.9 million	3
25-49	4	1-49,999	5	25-99	18	\$1 million-4.9 million	6
10-24	13			less than 25	7	\$500,000-\$999,999	5
less than 10	41			0	3	\$100,000-\$499,999	10
						less than \$100,000	13
		--	40	--	40	--	23
All others	<u>34</u>	All others	<u>34</u>	All others	<u>19</u>	All others	<u>37</u>
Total	95	Total	95	Total	95	Total	95

^a-- indicates that the information was not available
^aFarms reporting \$1,000 or more in sales

Source: 1987 U.S. Census of Agriculture

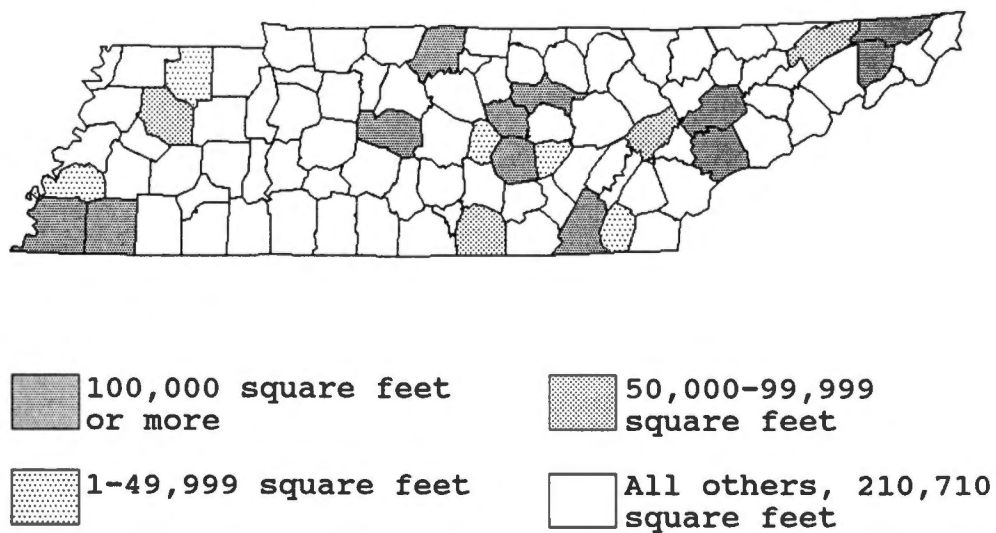


Figure 7. Distribution of Tennessee greenhouse covering and shade by county, 1987

Source: 1987 U.S. Census of Agriculture

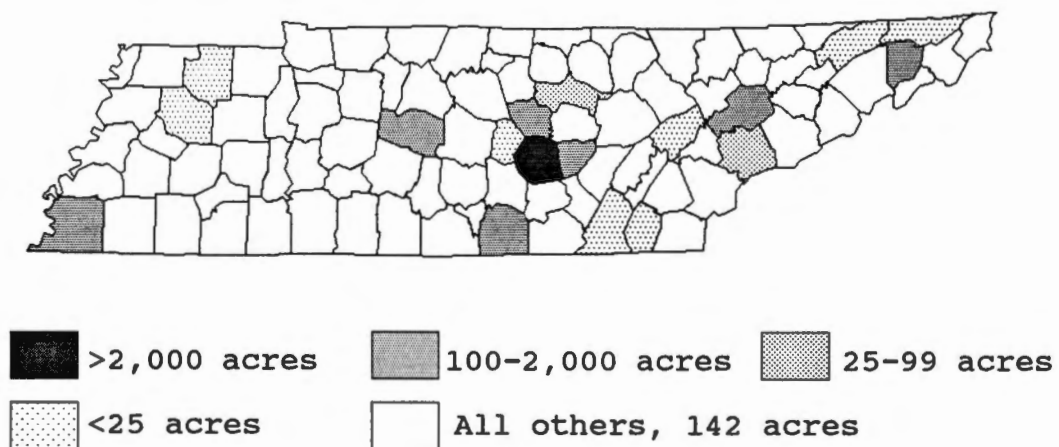


Figure 8. Distribution of Tennessee green industry cultivation in the open, 1987

Source: 1987 U.S. Census of Agriculture

2000 acres of open area green industry cultivation (Table 6). Eighteen counties reported open field cultivation of 29 to 99 acres, seven counties reported less than 25 acres and three counties reported zero acres, or no green industry cultivation in the open. Information was not available for 40 counties and all other counties, 19 in number, reported a total of 142 acres of cultivation in the open.

Economic Classification of Tennessee's Green Industry Farms

In 1987, Tennessee green industry farmers reported grower cash receipts valued at \$108.8 million. Green industry crops ranked eighth in value among Tennessee farm commodities following cattle and calves, dairy products, cotton, hogs, soybean, poultry and poultry products, and tobacco (1987 U.S. Census of Agriculture).

In 1987, only Warren county reported a value of total sales that exceeded \$10 million (Figure 9). Total sales for Warren county were \$36.9 million, or about 34 percent of the value of all Tennessee green industry sales (1987 U.S. Census of Agriculture). Three Tennessee counties reported green industry sales of \$5 million to \$9.9 million (Table 6), and six counties reported total sales valued at \$1 million to \$4.9

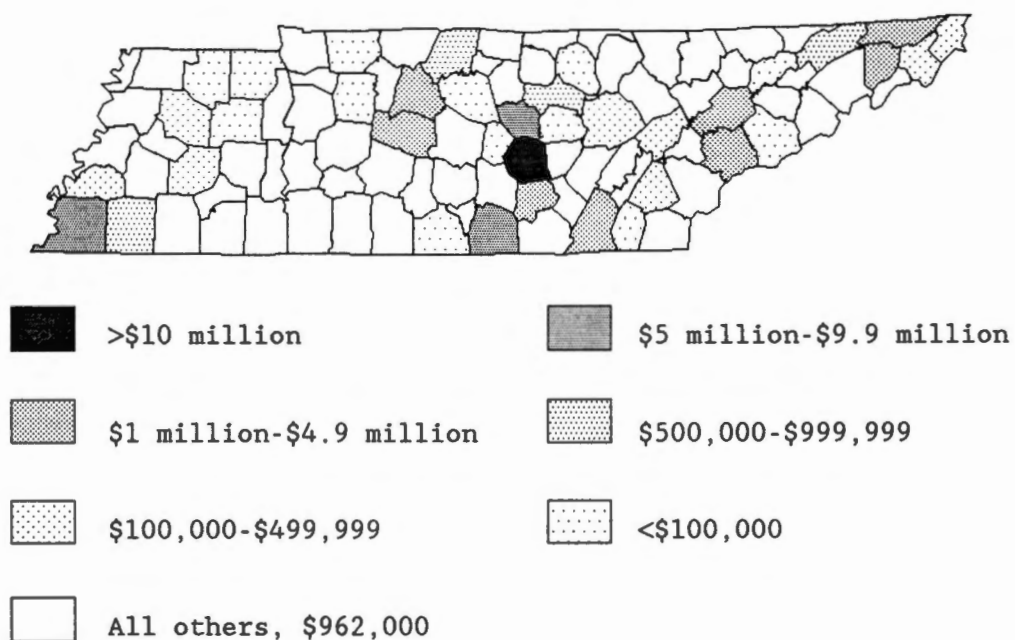


Figure 9. Total value of Tennessee green industry product sales by county, 1987

Source: 1987 U.S. Census of Agriculture

million. Annual green industry sales for 1987 was recorded at from \$500,000 to \$999,999 for five counties, with ten counties reporting a total sales value of \$100,000 to \$499,999, and thirteen counties with less than \$100,000. Sales information was not available for 23 counties and a total of \$962,000 was reported for the remaining 37 counties for which individual information was not reported.

Distribution of Tennessee Green Industry Farms and Production Area by Type of Crop

The 1987 U.S. Census of Agriculture summarized production and marketing statistics separately for each the various product groups that make up the Tennessee green industry. In other words, the statistics for those farms that reported the production and marketing of nursery crops were given separately and without relation to the statistics provided for bedding plant farms, for example. Other product groups were likewise considered as separate, discrete units. Thus, the statistics for each of these separate product groups can be compared to the totals given for the entire US green industry, but because farms that produced and marketed crops in several groups were included in the statistics given for each of those groups, a double counting problem prevents these percentages from being summed to 100 percent (Table 7).

Table 7. Distribution of Tennessee's green industry farms and production area by product group, 1987

Subsector	Total farms reporting sales ^a		Total area for floriculture and environmental horticulture			
			under cover		in the open	
	number	percent ^b	square feet	percent ^b	acres	percent ^b
Floriculture:						
Bedding plants	223	22.3	3,647,052	42.7	261	1.1
Flowering potted	117	11.7	3,546,961	41.5	515	2.2
Foliage	92	9.2	2,391,827	28.0	218	0.9
Cut flowers/greens	30	3.0	414,167	4.8	140	0.6
Environmental horticulture:						
Nursery plants	663	66.3	2,982,341	35.0	22,322	94.5
Bulbs	-	-	-	-	-	-
Flower/veg. seeds	-	-	-	-	-	-
Sod (turfgrass)	-	-	-	-	-	-
Other products	-	-	-	-	-	-
Total for all Tennessee green industry farms	1,002	-	8,535,881	-	23,637	-

"-" indicates that the information was not available

^aFarms reporting \$1,000 or more in sales.

^bFarm numbers and values across categories cannot be used to calculate totals because some farms have sales in more than one category.

Source: 1987 Census of Agriculture

In 1987, a total of 663 Tennessee farms reported the production and sale of nursery plants. This was about two-thirds of all reported green industry farms. The second most commonly reported green industry crop, bedding/garden plants, was grown by 223 farms, or 22.3 percent of all green industry farms. Flowering potted plants and foliage plants were each produced by about 10 percent of farms and only 3 percent of Tennessee farmers reported the production and sale of cut flowers and cut cultivated greens (Table 7).

The largest areas of greenhouse covering or shade were reported for growers of bedding/garden plants and flowering potted plants. Each group reported totals of about 3.5 million square feet under greenhouse covering or shade. Nursery plant farms reported the second largest total amount of covered area, 3.0 million square feet, followed by foliage plant farms, 2.4 million square feet, and cut flowers/cut cultivated greens farms which reported the smallest area under greenhouse covering, 0.4 million square feet.

The largest number of acres of green industry planting in the open was reported by nursery product farms. The area cultivated by these farmers was equal to 94.5 percent of all open acreage green cultivation reported in the state (Table 7). Only small amounts of planting in the open was reported for Tennessee floriculture firms.

**Tennessee Green Industry Farm Income and Expenses
by Product Category**

Gross cash income

Gross cash farm income is defined as the total amount of cash received by a farm operation from the sale of agricultural products during the calendar year and includes cash received for services rendered and/or payment for participation in government commodity programs (Johnson et al.). In 1987, the total gross cash farm income for all Tennessee green industry farms was \$108.8 million (Table 8). Nursery product farms had the highest total gross cash farm income. These farms reported a total of \$70.8 million in gross cash farm income which was the equivalent of 65.5 percent of the gross cash farm income earned from the sale of all Tennessee green industry products. Within the floriculture subsector, bedding plants and flowering potted plants were the most important income earners and contributed about 16 percent, each, to Tennessee's total green industry gross cash farm income. The gross cash farm incomes reported for foliage plant farms (\$10,550 million) and cut flowers/cut cultivated greens farms (\$2,162) were the least among Tennessee green industry growers.

Cash farm expenses

Cash farm expenses are defined as the total amount of funds paid out by farmers during the calendar year. These expenses exclude payments by landlords or other parties under contractual agreement and marketing charges such as commissions, storage, inspection, insurance, drying, check-offs, yardage, and auctioning (Johnson et al.). The distribution of Tennessee's green industry's total cash farm expenses was similar to the distribution of gross farm incomes. The highest total cash farm expense was reported by farmers that marketed nursery products (Table 8). Farmers reporting the production and sale of flowering potted plants reported the second highest total value of cash farm expense, followed by bedding plants, foliage and cut flowers/cut cultivated greens.

Net cash income per farm

The total net cash income of an enterprise is a measure of the amount of net cash earnings that a farm has generated during the year from all sources. Johnson and Johnson define it as gross cash income minus cash expenses, including interest payment but excluding principal payment. When the total annual net cash income is divided by the contributing

Table 8. Income and expense estimates for Tennessee green industry farms by product group, 1987

Subsector	Farms reporting sales ^a		Agricultural income and expenses ^{b,c}					Average value of capital assets per farm ^d
			Total gross cash farm income		Total cash farm expense	Net cash income		
						Total	Average per farm	
	number	percent	(\$1,000)	percent	(\$1,000)	(\$1,000)	dollars	-----dollars-----
Floriculture:								
Bedding plants	223	22.3	18,086	16.6	10,855	7,231	32,426	216,822
Flowering plants	117	11.7	17,313	15.9	12,379	4,934	42,171	286,709
Foliage plants	92	9.2	10,550	9.7	6,876	3,674	39,935	358,547
Cut flowers/greens	30	3.0	2,162	2.0	1,489	673	22,433	442,290
Environmental horticulture:								
Nursery plants	663	66.3	70,765	65.1	47,675	23,090	34,827	228,974
Bulbs	-	-	-	-	-	-	-	-
Flower/veg. seeds	-	-	-	-	-	-	-	-
Sod (turfgrass)	-	-	-	-	-	-	-	-
Other products	-	-	-	-	-	-	-	-
Total for all Tennessee green industry farms ^d	1,002	-	59,923	-	-	-	-	-

^a.- Indicates that the information was not available

^bFarms reporting \$1,000 or more in sales

^cFarms reporting \$100,000 or more in sales

^dIncludes the value of land/building and equipment/machinery

^eThese totals are not achieved through vertical summation due to the double counting of farms reporting sales in more than one product group.

Sources: 1987 Census of Agriculture

Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-91

number of farms, the result is a per farm average net cash income.

Tennessee farms that reported the sale of flowering potted plants had the highest net cash incomes and averaged \$42,171 per farm (Table 8). Foliage plant farms had the second highest net cash income per farm, averaging \$39,935, followed by farms that reported the sale of nursery plants (\$34,827), bedding plants (\$32,426) and cut flowers/cut cultivated greens (\$22,433).

Value of capital assets

In Table 8, the average value of capital assets for Tennessee green industry farms includes both the estimated value of farm land and buildings, and farm machinery and equipment, such as trucks, cars, tractors, tools and implements (Johnson et al.). Cut flower/cut cultivated greens farms reported the highest capital asset value among Tennessee green industry farms. Farms that reported the sale of foliage plants had the second highest capital asset value and farms that reported flowering potted plants were third, followed by bedding plants and, finally, nursery plants. Interestingly, the ordering here is roughly the opposite of that which occurred in previous income and expense measurements. Cut flowers/cut cultivated greens farms, for example, had the lowest levels of gross cash farm income and cash farm expense

in comparison to other product groups, yet had the highest capital asset value. This pattern possibly indicates that the amount of capital investment required to establish production is an important consideration to Tennessee green industry farmers in their selection of crops.

PART 2: INTRODUCTION AND OVERVIEW OF THE GREEN INDUSTRY'S FLORICULTURE SUBSECTOR

Definitions of Terms

A discussion of the entire green industry has been included up to this point in the study in order to demonstrate the importance of this sector of the national and Tennessee agricultural economies. The industry wide perspective has also served to indicate the relative contributions of the floriculture and environmental horticulture subsectors to green industry production and marketing totals. In reality, however, floriculture and environmental products are frequently produced and marketed quite differently. One primary difference between them is that most floriculture crops are grown under greenhouse covering or shade, whereas the majority of environmental horticulture products are grown outdoors in the open. Also, floriculture industry crops are

largely seasonal and marketed as annual crops, while many environmental horticulture crops are perennials or tree crops and can be marketed throughout the year. The remainder of this study will focus on a more detailed examination of production and marketing of floriculture subsector products. As in the previous sections, when possible, data will be presented for national, regional, reduced-south region and Tennessee production and marketing levels.

Floriculture products are commonly divided into five types based primarily on plant physical characteristics, production requirements, and to some extent, the plant's function, or intended use. Bedding plants are marketed primarily as flower or foliage ornamentals for indoor or outdoor patio use, or as seedling vegetables and flowers for garden transplant. Most bedding plants are handled as annuals and marketed in March through June (Marketing Division, Tennessee Department of Agriculture). They are sold in flats, individual pots or hanging baskets. Examples are geraniums, impatiens, begonias, petunias, marigolds, pansies and tomato plants.

Flowering potted plants are grown for their shape, size, color, and their flower characteristics. They are sold year round but with several important seasonal varieties. Examples of flowering potted plants are poinsettias, African violets, Easter lilies, and kalanchoes.

Cut flowers are grown primarily for their blossoms. Examples of cut flowers are cut roses, orchids, chrysanthemums and carnations. Cut cultivated greens are grown primarily for their decorative foliage, and produced and marketed similarly to cut flowers. Examples are cut leatherleaf ferns and chamaedorea.

Foliage plants are produced for their ornamental shape, size, color, and stem and leaf characteristics. They are marketed primarily by the pot or hanging basket for home and business decoration. Examples of foliage plants are ficus, dieffenbachia, schefflera, spathiphyllum and philodendron.

Distribution of Floriculture Farms and Production Area by Product Group

Bedding Plant Farms

The 1987 U.S. Census of Agriculture recorded a total of 11,148 bedding plant production farms (Table 9). The majority of these farms were relatively evenly distributed among northeastern (30.2 percent), north central (29.3 percent) and southern state farmers (28.0 percent), with only 12.5 percent of all U.S. bedding plant farms reported in the western region. The distribution of the floriculture subsector farm

Table 9. Regional distribution of selected floriculture subsector characteristics by product group, 1987

Crop/Region	Total farms ^a		Total area under greenhouse covering or shade ^a		Total area in the open ^a		Total gross sales ^a	
	number	percent	square feet	percent	acres	percent	(\$1000)	percent
Bedding plants:								
Northeast	3,373	30.2	32,691,807	20.8	1,009	7.6	142,240	17.4
North central	3,261	29.3	51,959,012	33.1	2,148	16.1	225,325	27.5
South	3,124	28.0	39,778,294	25.2	6,297	47.3	219,762	26.9
West	1,390	12.5	32,595,926	20.8	3,778	28.4	229,867	28.1
Undisclosed ^b	0	0.0	147,737	0.1	83	0.6	766	0.1
US total	11,148	100.0	157,172,776	100.0	13,315	100.0	817,960	100.0
Cut flowers/cut cul. greens:								
Northeast	864	19.0	8,999,426	6.9	1,778	6.6	63,115	10.6
North central	709	15.6	9,253,811	7.0	2,156	8.0	58,138	9.8
South	885	19.3	11,710,945	8.9	10,724	39.8	97,489	16.4
West	2,098	46.0	98,478,845	75.0	12,195	45.2	365,463	61.5
Undisclosed ^a	0	0.0	2,816,162	2.2	98	0.4	10,263	1.7
All others	5	0.1	0	0.0	4	<0.1	10	0.0
U.S. total	4,561	100.0	131,259,189	100.0	26,955	100.0	594,478	100.0
Foliage plants:								
Northeast	636	12.4	4,757,571	3.1	415	3.6	35,131	5.8
North central	586	11.4	6,068,480	4.0	549	4.7	45,976	7.6
South	2,953	57.2	113,870,687	74.9	7,324	62.8	351,095	58.2
West	975	18.9	27,109,900	17.9	3,327	28.5	166,064	27.5
Undisclosed ^a	0	0.0	151,509	0.1	49	0.4	4,626	0.8
All others	5	0.1	33,800	<0.1	0	0.0	282	0.1
U.S. total	5,155	100.0	151,991,947	100.0	11,664	100.0	603,174	100.0
Flowering potted plants:								
Northeast	1,844	28.8	24,954,540	21.3	871	20.3	137,674	21.3
North central	1,482	23.2	24,371,716	20.7	504	11.7	132,661	20.4
South	2,061	32.2	40,910,545	34.8	1,428	33.2	211,112	32.5
West	1,012	15.7	26,607,007	22.7	1,200	27.9	158,718	24.5
Undisclosed ^a	0	0.0	590,594	0.5	299	6.9	8,017	1.3
All others	6	0.1	16,350	<0.1	0	0.0	58	0.0
U.S. total	6,405	100.0	117,450,752	100.0	4,302	100.0	648,240	100.0

^aFarms reporting \$1,000 or more in sales

^bWithheld to avoid disclosing data for individual firms

Source: 1987 Census of Agriculture

greenhouse space was regionally similar to the distribution of farms. The largest regional proportion of open acreage bedding plant cultivation (47.3 percent) was in the southern region.

The reduced-south region of states (southern states excluding Florida and Texas) contained 77.6 percent of all southern state farms that reported the production and marketing of bedding plants in 1987 (Table 10). These reduced-south region farms cultivated 63.7 percent of the total greenhouse space reported by all southern state bedding plant farms, and 72.6 percent of all reported bedding plant production in the open. Tennessee bedding plant farms accounted for 9.2 percent of the reduced-south region bedding plant farms. These Tennessee farms cultivated 8.3 percent of all reported reduced-south region greenhouse bedding plant area and 3.2 percent of all reduced-south region bedding plant production in the open.

Cut Flowers and Cut Cultivated Greens Farms

The western region reported the largest percentage of all U.S. cut flowers and/or cut cultivated greens farms in 1987 (Table 9). Of the 4,561 farms, nationally, that reported the production and sale of cut flowers and/or cut cultivated greens, 46 percent were located in western region states. The remaining cut flower and cut greens farms were relatively

Table 10. Reduced-south region and Tennessee relative distributions of bedding plant farms and plant production area, 1987

Production characteristic	Southern region ^a	Reduced-south region ^b		Tennessee	
	Total ^c	Total ^c	Percent of south	Total ^c	Percent of reduced-south
Number of farms	3,124	2,424	77.6	223	9.2
Area under cover in square feet	39,778,294	25,333,918	63.7	2,095,746	8.3
Acres in the open	6,297	4,573	72.6	147	3.2

^aSouthern region includes: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma; South Carolina, Tennessee, Texas, Virginia, West Virginia

^bSouthern region excluding Florida and Texas

^cFarms reporting \$1,000 or more in sales

Source: 1987 U.S. Census of Agriculture

evenly distributed among the northeastern, north central and southern regions. Likewise, three-fourths of the total area of greenhouse covering reported by cut flower and cut cultivated green farms was located in western states. Production acreage in the open was primarily divided among western region states (45.2 percent) and southern states (39.8 percent).

The reduced-south region accounted for 43.6 percent of all southern state farms which reported the sale of cut flowers and/or cut cultivated greens (Table 11). The reduced-south region cultivated 23.6 percent of the total amount of greenhouse production space reported by southern state farms and 9.2 percent of the reported acreage in the open. Tennessee farmers accounted for 7.8 percent of all reduced-south region cut flower/cut cultivated greens farms. They contributed 10 percent of the reduced-south region's cut flower/cut cultivated greens production area under cover and 14.1 percent of the reported area cultivated in the open (Table 11).

Foliage Plant Farms

Foliage plants were primarily produced by southern region farms in 1987 and these farms accounted for 57.2 percent of the 5,155 foliage plant production farms reported nationally

Table 11. Reduced-south region and Tennessee relative distributions of cut flower and cut cultivated greens farms and production area, 1987

Production characteristic	Southern region ^a	Reduced-south region ^b		Tennessee	
	Total ^{c,d}	Total ^d	Percent of south	Total ^d	Percent of reduced-south
Number of farms	885	386	43.6	30	7.8
Area under cover in square feet	11,710,945	2,758,841	23.6	276,802	10.0
Acres in the open	10,724	984	9.2	139	14.1

^aSouthern region included: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia

^bSouthern region excluding Florida and Texas

^cInformation for Texas not disclosed

^dFarms reporting sales of \$1,000 or more

Source: 1987 U.S. Census of Agriculture

(Table 9). The remaining farms were fairly evenly distributed among the northeastern, north central and western regions. Southern region farms also reported the largest percentage of all greenhouse space reported by U.S. foliage plant producers (74.9 percent), but most of the remainder was cultivated by western region farmers (17.9 percent) with very little greenhouse cultivation of foliage plant reported by northeastern and north central region farmers. Likewise, southern region foliage plant farms reported 62.8 percent of all open area foliage cultivation and western region farms reported 28.5 percent.

The reduced-south region accounted for 32.3 percent of all southern state foliage plant production farms and contributed 6.7 percent of all southern state foliage plant production under greenhouse covering as well as and 14.4 percent of southern state open area foliage plant cultivation (Table 12). Tennessee farms accounted for 9.6 percent of all foliage plant farms in the reduced-south region, 10.1 percent of all greenhouse space reported by reduced-south region foliage plant farms and 20.5 percent of the open area cultivation (Table 12).

Flowering Potted Plant Farms

The 6,405 U.S. farms reporting the production and sale of flowering potted plants in 1987 were relatively evenly

Table 12. Reduced-south region and Tennessee relative distributions of foliage plant farms and production area, 1987

Production characteristic	Southern region ^a	Reduced-south region ^b		Tennessee	
	Total ^c	Total ^c	Percent of south	Total ^c	Percent of reduced-south
Number of farms	2,953	995	32.3	92	9.6
Area under cover in square feet	113,870,687	7,607,723	6.7	771,543	10.1
Acres in the open	7,324	911	14.4	187	20.5

^aSouthern region included: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia

^bSouthern region excluding Florida and Texas

^cFarms reporting sales of \$1,000 or more

Source: 1987 U.S. Census of Agriculture

distributed across all four regions of states, except that a slightly lesser share was reported for the western region (Table 9). The distribution of all greenhouse covering reported by flowering potted plant farms was also fairly even, except that, interestingly, western states reported the second largest percentage following the south. The distribution of all flowering potted plant cultivation in the open also indicated a larger area, cultivated by fewer farmers, in western states.

The reduced-south region accounted for 65.1 percent of all southern state flowering potted plant producing farms and contributed 51.9 percent of the total area under greenhouse covering and 66.0 percent of all southern state cultivation of flowering potted plants in the open (Table 13). Tennessee farms that produced and marketed flowering potted plants accounted for 8.7 percent of the total for the reduced-south region. These same Tennessee farms contributed 9.3 percent of all reduced-south region flowering potted production under greenhouse covering and 17 percent of all reduced-south region cultivation in the open (Table 13).

Table 13. Reduced-south region and Tennessee relative distributions of flowering potted plant farms and production area, 1987

Production characteristic	Southern region ^a	Reduced-south region ^b		Tennessee	
	Total ^c	Total	Percent of south ^c	Total ^c	Percent of reduced-south
Number of farms	2,061	1,342	65.1	117	8.7
Area under cover in square feet	40,910,545	21,220,853	51.9	1,976,763	9.3
Acres in the open	1,428	943	66.0	160	17.0

^aSouthern region includes: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia

^bSouthern region excluding Florida and Texas

^cFarms reporting sales of \$1,000 or more

Source: 1987 U.S. Census of Agriculture

Distribution of Floriculture Product
Cash Receipts by Product Group

U.S. Regional Distribution

The USDA's 1991 Farm Costs and Returns Survey (FCRS) provided a source of recent floriculture industry financial data. Unlike census statistics that included data for all U.S. farms with cash receipts of \$1,000 or more per year, the FCRS summary included only growers with sales of \$100,000 or more per year resulting in a lack of information on the many smaller sized greenhouse operations.

Among the states for which information was available, floriculture product grower cash receipts totalled \$2.9 million in 1991 (Table 14). The southern and western regions each contributed about one-third of that total and the remainder was relatively evenly divided between growers in the northeastern and north central regions.

A regional distribution of these floriculture receipts by specific crop categories indicated that grower cash receipts for the sale of bedding/garden plants and flowering potted plants were relatively evenly divided among all four U.S. regional divisions. The largest percentages of grower cash receipts for cut greens (85.7 percent) and foliage plants (65.9 percent) were earned by southern state farms, and the

Table 14. Regional distribution of floriculture subsector grower cash receipts by product group, 1991

Region	Floriculture crops ^a											
	Cut flowers		Potted flowering plants		Foliage plants		Bedding and garden plants		Cut greens		Total ^b	
	(\$1,000)	percent	(\$1,000)	percent	(\$1,000)	percent	(\$1,000)	percent	(\$1,000)	percent	(\$1,000)	percent
North central	44,524	9.4	126,407	19.5	29,307	6.5	257,744	27.3	18	>0.1	536,582	18.4
North-east	45,608	3.7	198,823	30.7	16,992	3.8	147,101	15.6	81	0.1	464,056	15.9
South	37,717	8.0	146,890	22.7	294,983	65.9	251,306	26.7	94,240	85.7	936,605	32.2
West	343,707	72.9	175,537	27.1	106,285	23.8	286,298	30.4	15,700	14.3	975,975	33.5
U.S. Total	471,556	100.0	686,944	100.0	447,567	100.0	942,449	100.0	110,039	100.1 ^c	2,913,218	100.0

^aData are for growers with floriculture sales of \$100,000 or more.

^bExpanded wholesale value for all growers.

^cDoes not equal 100.0 percent due to rounding error.

Source: Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-1991

largest share of all grower cash receipt for cut flowers (72.9 percent) was reported by western region farms.

Table 15 provides a more detailed look at the distribution of floriculture sales among southern region farms. Perhaps the most obvious feature, at first glance, is the near complete market domination by Florida growers. Over half (56.4 percent) of all southern region floriculture receipts were contributed by Florida growers. Among other states, only Texas growers accounted for an overall market share of more than 10 percent. Tennessee farmers accounted for only 2.9 percent of all southern region sales and ranked eighth among the nine states for which floriculture statistics were reported (Table 15).

Florida growers accounted for over 80 percent of all grower cash receipts from the sale of cut flowers, foliage plants and cut cultivated greens, and led southern state growers in the sale of crops in four out of five the categories considered. Only receipts for the sale of bedding/garden plants and flowering potted plants were relatively evenly distributed among southern states.

Reduced-south and Tennessee Relative Market Shares

Reduced-south region states contributed 54.8 percent of all southern state receipts for products categorized as flowering potted plants (Table 16). Reduced-south region

Table 15. Southern state distribution of floriculture subsector grower cash receipts by product group, 1991

State	Floriculture crops											
	Cut flowers ^a		Potted flowering plants ^a		Foliage plants ^a		Bedding and garden plants ^a		Cut greens ^a		Total ^b	
	(\$1,000)	percent	(\$1,000)	percent	(\$1,000)	percent	(\$1,000)	percent	(\$1,000)	percent	(\$1,000)	percent
Alabama	342	0.9	19,963	11.3	2,375	0.8	23,185	9.2	N.A.	-	51,160	5.4
Arkansas	50	0.1	1,801	1.0	469	0.2	4,399	1.7	14	>0.1	9,721	1.1
Delaware	-	-	-	-	-	-	-	-	-	-	-	-
Florida	30,986	82.2	62,905	35.6	253,977	86.1	61,303	24.4	93,207	99.0	528,771	56.4
Georgia	263	0.7	-	-	2,830	1.0	18,531	7.4	-	-	36,756	3.9
Kentucky	-	-	-	-	-	-	-	-	-	-	-	-
Louisiana	-	-	-	-	-	-	-	-	-	-	-	-
Maryland	1,173	3.1	6,376	3.6	1,198	0.4	13,981	5.6	2	>0.1	28,850	3.1
Mississippi	-	-	-	-	-	-	-	-	-	-	-	-
North Carolina	1,265	3.3	30,129	17.1	9,163	3.1	29,644	11.8	47	>0.1	74,986	8.1
Oklahoma	-	-	-	-	-	-	-	-	-	-	-	-
South Carolina	-	-	-	-	-	-	-	-	-	-	-	-
Tennessee	675	1.8	10,244	5.8	1,421	0.5	8,486	3.4	-	-	29,646	2.9
Texas	202	0.6	33,419	18.8	21,520	7.3	75,322	30.0	955	1.0	139,351	14.9
Virginia	2,761	7.3	12,053	8.8	2,030	0.7	16,455	6.5	15	>0.1	40,364	4.3
West Virginia	-	-	-	-	-	-	-	-	-	-	-	-
Totals	37,717	100.0	146,890	100.0	294,983	100.0	251,306	100.0	94,240	100.1 ^c	936,605	100.1 ^d

^a- Indicates that the information was not available

^bFarms reporting sales of \$100,000 or more

^cExpanded wholesale value for all growers

^dDoes not equal 100.0 percent due to rounding error

Source: Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-91

Table 16. Reduced-south region and Tennessee relative distribution of floriculture subsector grower cash receipts, 1991

Floriculture crop	Floriculture cash receipts				
	Southern region	Reduced-south region		Tennessee	
	(\$1,000) ^b	(\$1,000) ^b	Percent of south	(\$1,000) ^b	Percent of reduced-south
Cut flowers ^a	37,717	6,529	17.3	675	10.4
Flowering potted plants ^a	146,890	80,566	54.8	10,244	12.7
Foliage plants ^a	294,983	19,486	6.6	1,421	7.3
Bedding plants ^a	251,306	114,681	45.6	8,486	7.4
Cut greens ^a	94,240	78	0.8	-	-

"." indicates that the data was not available

^aFarms reporting sales of \$100,000 or more

^bExpanded wholesale value for all growers

^cData not available

Source: Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-91

farmers also accounted for a relatively high percentage of growers cash receipts for bedding and garden plant sales (45.6 percent). These growers contributed a relatively smaller proportion of the total (southern region) sales among the other product groups considered, however. Reduced-south region sales accounted for only 17.3 percent of all southern state cut flower receipts, 6.6 percent of southern state foliage plant receipts, and 0.8 percent of the receipts for cut cultivated greens. Within this reduced-south region, Tennessee's relative contribution to total grower cash receipts ranged from 7.3 percent of all receipts for foliage plant sales to 12.7 percent of all receipts for the sale of flowering potted plants (Table 16).

Comparison of Average Wholesale Prices for Selected Floriculture Products

The average wholesale prices received by growers of selected floriculture crops in 1991 are shown in Table 17. This information is presented at the national level and for all states within the southern region. The specific products examined in the table were selected from a listing of varieties that were commonly produced and marketed by Tennessee farmers (Tennessee Department of Agriculture), however, and thus, the table does not present examples from

Table 17. Average per unit wholesale prices for selected floriculture crops, 1991

Area	Potted hardy garden mums (large) ^a	Flowering hanging baskets ^a	Vegetable plants (flats) ^a	Foliage hanging baskets ^a	Poinsettias (large) ^a
-----dollars-----					
United States	1.85	5.32	6.46	3.70	3.96
Southern region:					
Alabama	1.59	4.92	7.25	5.38	4.23
Arkansas	-	-	6.59	6.65	4.39
Delaware	-	-	-	-	-
Florida					
Georgia	1.52	4.70	6.09	5.45	3.52
Kentucky	-	-	-	-	-
Louisiana	-	-	-	-	-
Maryland	2.26	5.98	7.28	-	5.17
Mississippi	1.50	4.01	5.91	4.29	3.54
Oklahoma	-	-	-	-	-
South Carolina	-	-	-	-	-
Tennessee	1.56	5.09	6.43	5.85	3.82
Texas					
Virginia	1.78	4.17	6.72	-	3.79
West Virginia	-	-	-	-	-
Reduced-south region ^a	1.70	4.81	6.61	5.53	4.07
Tennessee	1.56	5.09	6.43	5.85	3.82

"-" indicates that the data was not available

^aFarms reporting sales of \$10,000 or more

Source: Floriculture Crops, 1991 Summary (NASS)

each of the five floriculture product categories described earlier. Among the crops considered, U.S. farmers received \$6.46 for vegetable plants sold in flats, \$5.32 for flowering hanging baskets, \$3.96 for large poinsettias, \$3.70 for foliage hanging baskets and \$1.85 for large potted hardy garden chrysanthemums. Among southern region states, Maryland farmers received the highest wholesale prices for all crops examined except foliage hanging baskets. Mississippi farmers received the lowest southern state wholesale price for all crops considered except large poinsettias.

When compared with all other U.S. growers, in 1991 Tennessee farmers received an above average wholesale price only for the sale of foliage hanging baskets. When compared within the reduced-south region, Tennessee farmers received higher than average prices for the sale of both foliage hanging baskets and flowering hanging baskets. For each of the other commonly produced crops, Tennessee growers received less than the average wholesale price when compared at both national and reduced-south region levels.

CHAPTER 2: BACKGROUND AND PROPOSAL

Research Proposal

In 1987, the market value of Tennessee green industry crops totalled \$108.7 million, and green industry products ranked eighth in relative market value among farm commodities (1987 U.S. Census of Agriculture). Cattle and calves was first (\$372.5 million), followed by dairy products (\$248.7 million), cotton (\$167.4 million), hogs (\$142.9 million), soybean (\$138.4 million), poultry and poultry products (\$136.4 million), and tobacco (\$121.3 million).

Between 1982 and 1987, Tennessee's green industry increased in both size and value. The number of green industry farms, including both floriculture and environmental horticulture subsectors, increased by 8.8 percent from 921 (1982) to 1,002 (1987), while at the same time, the amount of greenhouse space increased by 62 percent, from 5.3 to 8.6 million square feet, and number of acres planted in the open increased by 44 percent, from 17 to 24 thousand acres. During the same time period, cash receipts for Tennessee green industry products almost doubled, increasing from \$57 to \$109 million.

Tennessee's central location, within a single day's drive of an estimated 75 percent of the country's population, provides the state an excellent position to compete for a

larger share of the national floriculture product market, but successful expansion may require access to more detailed information about the structure of Tennessee's floriculture industry.

A review of both academic and popular literature revealed little research directed specifically toward an economic analysis of floriculture product marketing but did, on the other hand, point out the general lack of such information and indicated a need for the increased collection of basic industry data (Brooker:1992). Summary statistics, such as those provided by the U.S. Census of Agriculture and the United States Department of Agriculture, are available to provide an initial insight into the structure of the floriculture industry. However, more detailed and state-specific data should provide additional insight to individuals, firms, and agencies concerned with decisions regarding future production and marketing plans.

Beneficial impacts from the information provided by this study are expected to accrue to individuals, firms and agencies connected to all levels of the floriculture crop production industry. Specific impacts of this study could be to:

- 1) Assist extension workers in the allocation of extension information and activities,

- 2) Assist agribusiness firms in identifying potential markets for specific technologies and equipment,
- 3) Provide specific information required by researchers for floriculture firm budget analysis,
- 4) Provide managers with state-wide industry information against which they can evaluate the relative positions of their own firms,
- 5) Provide managers with information useful for decisions regarding future production and marketing, and
- 6) Provide information to those persons considering entering the business.

Research Objectives

The general goal of this study was to provide industry participants with a descriptive report of the floriculture subsector of Tennessee's green industry. The specific objectives were:

- 1) to develop descriptive profiles that characterize Tennessee floriculture industry farms in Tennessee,

- 2) to determine how these profiles differ with respect to operation size, income, and location within Tennessee, and
- 3) to evaluate the relationship between the level of production technology used by Tennessee floriculture industry farms and selected firm characteristics such as size, income, and location.

Literature Review

Greenhouse Feasibility

Researchers have pointed out that economic analysis of alternative enterprises should encompass both production and marketing feasibility. Schermerhorn (1978) outlined and described the major variables of agricultural enterprise feasibility analysis. He identified two primary types of influence which impacts the feasibility of greenhouse operation: direct influences (i.e. market determination, raw product supply and the production process), and environmental influences (i.e. the availability of site, service, labor, transportation, and government structure). Also, in order to balance the effects of the seasonal incomes, feasibility studies of greenhouse enterprises should include cash flow summaries that budget day-to-day operation costs.

Implicit vs. Explicit Costs

Established firms may operate profitably using only explicit cost accounting, i.e. ignoring opportunity costs. However, potential new firms, or firms seeking to expand or replace obsolete facilities, will be required to cover implicit costs. Firms that cannot show a profit based on synthesized costs cannot operate in the long run (Brumfield et al.:1981).

To investigate the importance of implicit cost accounting in greenhouse feasibility studies, Brumfield et al. (1981) compared the overhead costs of production for surveyed greenhouse firms with the overhead costs of replacement generated through synthetic modeling. Consideration of the implicit, or opportunity cost, is critical to feasibility analysis because it represents "true cost" in the long run.

Taylor has suggested that if both implicit and marketing costs were calculated into the total cost of operation, few nursery firms could cover expenses, and the return on investment for establishing new, independently operating container nurseries would be "marginal at best" (Taylor et al.:1983). While his study did not encompass greenhouse operations, the relatively high fixed costs associated with greenhouse production would suggest that his conclusion may be applicable.

Economic Impacts of Greenhouse Size

Among greenhouses with identical production technology and equipment, the total cost per salable plant was lower for large greenhouses because managers can more efficiently utilize existing buildings, equipment and machinery (Brumfield et al.:1981). Brumfield (1981) estimated that the use of production materials and equipment requires a minimum area of about 20,000 square feet of greenhouse space, at which point most firms become a full-time operation. The variable costs of greenhouse plant production, on the other hand, differ according to the specific plant cultural and environmental requirements and remain fairly constant across sizes of greenhouse (Taylor et al., Aldrich et al.:1990). Brumfield (1981) estimated that a that a profitable one-person greenhouse operation requires a minimum of about 2,000 square feet of covered area for retail businesses, or a minimum of 5,000 square feet for a wholesale operation and that many commercial operations expand to about 100,000 square feet and then tend to remain at that size.

Construction Costs and Considerations

The area of land required for greenhouse construction should be large enough to accommodate the currently planned production area, service buildings, roads, and parking/loading

areas, as well as allowing for future expansion. The construction of a 20,000 square foot greenhouse operation requires five acres of land, a 100,000 square foot operation requires about 10 acres, and a 400,00 square foot greenhouse requires about 50 acres (Brumfield et al.:1981).

The location chosen should ensure easy access to main shipping routes to simplify marketing and to minimize transportation costs. Decisions of greenhouse location can also impact the type of fuel used, the water sources available and/or back-up water system requirements (Nelson:1991). The chosen site should be as flat as possible to reduce pre-construction improvement costs, and any trees located on the east, south or west sides of the property should be set back from the greenhouses by a distance of about 2.5 times their height in order to avoid shading the production area.

The size of the service building area required for the operation of a small greenhouse firm (20,000 square feet) is equal to about 13 percent of the total greenhouse area. This proportion diminishes as growing space increases, hence a large greenhouse (400,000 square feet) requires only about 7.5 percent of the total production area for service buildings (Nelson). Overall, the average service building equals about 10 percent of the total area under greenhouse covering (Brumfield et al.:1981).

Technological Considerations

The components of a greenhouse production and environmental control system influence the firm's production capacity, productivity of labor, and variable input requirements. These, in turn, affect the fixed and variable costs of operation, ease of expansion, managerial requirements, and crop mixture options. Greenhouse technologies that do not allow for expansion or which were ill-designed for the proposed crops can severely limit the profitability of an otherwise sound business opportunity. To address this relationship between technological package, crops production and profitability, Giacomelli (1987) recommended the practice of crop dominated decision-making in the selection of greenhouse technological components in order to ensure optimal return on investment and efficiency of resource management. "The crucial thread which links these three major areas [of technological system] is compatibility. Due to their inter-relations, [future] modification within one of the areas can easily influence the [efficient] performance of another." (Giacomelli, p. 184).

Variable Costs of Production

Most greenhouse crop production is highly labor intensive. Among bedding plant producers, for example, labor

costs account for approximately 25 percent of the total cost of production (Aldrich et al.). This production expense can be reduced, however, by the use of more efficient materials handling systems to combine or eliminate some labor tasks (Aldrich). The mechanization of repetitive tasks such as soil mixing, container filling, and seeding can effectively reduce the time requirement and cost of these activities. Likewise, automated watering systems can greatly reduce the labor costs, but frequently, the watering requirements of diverse crops within a single greenhouse make this relatively inflexible technology impractical (Brumfield et al. 1987).

After labor, heating costs are typically the next largest component of greenhouse operating cost (Grimmer:1975) and the high cost of heating energy is often an important determinant of enterprise profitability (Brumfield:1992). The selection of heating equipment depends upon the size and type of greenhouse operation as well as the heating requirements of specific geographic locations. The energy sources available, and their relative prices, can be an important factor in specific site selection as well as influencing the type of heating system chosen.

Environmental Standards

To comply with increasing pervasive and stringent anti-pollution legislation, the future of greenhouse production

feasibility partially depends upon the development of new production technologies that can reduce the fertilizer and pesticide content in greenhouse effluent, yet remain economically sound (Aldrich et al.). Environmentally friendly, closed production systems that greatly reduce leaching of residual chemicals into the sub-soil have been developed to meet this need (Ruijs et al.:1991). For bedding plant production, the most promising solution to environmental hazard problems is the ebb-and-flow, closed irrigation system.

The ebb-and-flow irrigation and fertilization system employs standard potted-soil production techniques, but incorporates individual bench-attached holding tanks that can eliminate nearly all greenhouse effluent (Nelson). With this type of system, the water/nutrient solution is pumped onto the water-tight bench, and, after a brief absorption period, drained back into the holding tank where it can be tested, altered as required, and recycled for months. By using this system, greenhouse managers can reduce the water/fertilizer requirement by about 30-40 percent. This technology is expensive, however, costing about \$4.00 per square foot of bench space, or approximately 10-20 times the cost of other automated watering systems¹.

¹Nelson determines that the cost of materials plus installation for other automated watering systems to be between \$77 and \$162 for a 4 foot by 100 foot bench. This would be between \$0.19 and \$0.41 per square foot.

Cost Models for Business Management and Decisions

"When a greenhouse business fails, it is seldom because the grower is at fault....Poor marketing techniques probably have more to do with business failure than any other factor...unless the businessman has a true handle on the costs of doing business, proper marketing and good growing practices will probably only prolong the inevitable; failure of the business." (Humfield:1986, p. 231). For consistent profits, managers must be able to alter business strategies in response to changing markets. This requires knowledge of production and marketing costs.

In recent years, a number of computer accounting programs have been developed that use greenhouse fixed and variable cost data to estimate per unit plant production and marketing costs. Such programs can assist managers with decisions such as production planning and control, and the development of efficient pricing schemes. Computer programs also allow managers to model various scenarios of production and marketing costs to predict profitability (Tripepi et al.:1988, Kelly et al.:1990, Power et al.:1991, Brumfield:1992). A example of these programs, called Plant Production Cost Accounting/Management (PPCAM) calculates production and marketing costs and allows managers to investigate the profitability of new crops or new product mixes (Power et al.). It assists managers with resource allocation by

monitoring labor, energy and material usage. However, the usefulness of computerized planning and management systems depends upon how closely they match both the specific needs of the user and the management task requirements. In general, user friendliness and adaptability to individual needs are more important factors than are power and flexibility of design (Gollwitzer:1991).

Other Research

Economic studies have used survey data to describe the technological systems used in green industry crop production systems. Brumfield, et al. (1987) applied statistical cluster analysis to greenhouse survey data to identify the technological components that characterize greenhouses of various size in Pennsylvania. A more recent study by Behe and Beckett used mail survey data to statistically describe the sale of U.S. green industry products during 1993.

Floriculture Industry Data Needs

Symposia organized by the American Agricultural Economic Association in 1989 and 1992 were designed to focus the attention of agricultural economists and other researchers on the serious need for new primary data on floriculture industry production and marketing structures. In the published

proceedings, Johnson reported a lack of scientifically rigorous data for use by floriculture industry participants and decision makers and suggested that industry organizations and universities should expand their data collection activities (Johnson:1992). In the same publication, Brooker stressed the need to convince policy makers (and the controllers of research funding) of the actual magnitude and economic importance of the green industry's contribution to the agricultural sector and to the welfare of society as a whole. He indicates that this lack of basic industry production and marketing data has resulted, at least partially, from the failure of researchers to convince policy makers of the true economic and social importance of green industry products.

CHAPTER 3: METHODOLOGY AND PROCEDURE

Survey Sample Selection

A complete listing of Tennessee greenhouses that were certified for inter-state commerce by the Tennessee Department of Agriculture in 1993-1994 was used as the floriculture industry population. This list, issued by the Division of Plant Industries, contained the names and addresses of 564 certified greenhouses as well the area of each in square feet. Due to the limited resources available and the intentions of this study, the decision was made that a survey sample of 250 firms would be chosen.

Prior to sample selection, the listing of firms was arranged in ascending order according to greenhouse size in square feet. Organized in this manner, the certified greenhouses ranged in size from zero square feet (there were eight of these) to 566,280 square feet, the largest size recorded. An examination of Figure 10 reveals the skewed or asymmetrical distribution of the sample population due to the relatively large number of small greenhouses, and relatively small number of large greenhouses.

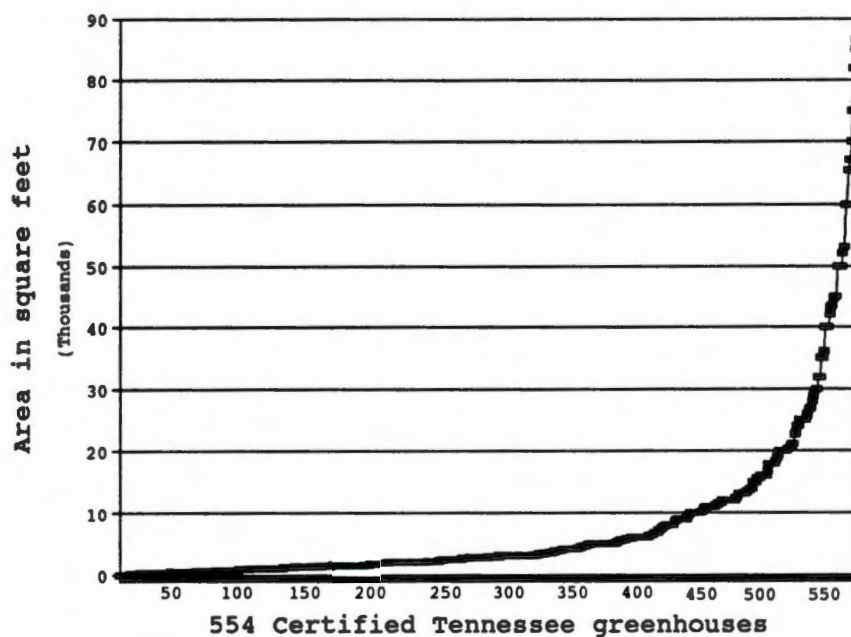


Figure 10. Distribution of 554 Tennessee greenhouses by size in square feet

Note: The ten largest greenhouse operations ranging in size from 101,180 square feet to 566,280 square feet were dropped from the distribution in order to clearly demonstrate the skewed nature of the population.

Source: Tennessee Nurseries, Collectors and Plant Dealers
Certified 1992-1993

Based on this asymmetrical nature of the population, the decision was made to use a stratified sampling technique, as opposed to ordinary random sampling without stratification.

For stratified random sampling techniques, the survey population is first divided into subgroups based on some specific characteristic of interest, and then a random sample is drawn from each subgroup. This sampling technique is especially useful for the measurement of highly skewed populations because it ensures an adequate sample representation from each subgroup formed, and because it allows investigation of specific characteristics of interest within particular subgroups of the population. Furthermore, because the partitioning of the data into subgroups resulted in greater homogeneity for those subgroups than had existed for the population as a whole, the within strata variability is less than had been the variability for the population, and the sample statistics produced are more accurate, having smaller sampling error than those generated through non-stratified ordinary random sampling techniques. Ultimately, however, this creation of ever smaller, ever more homogeneous strata for statistical analysis becomes a trade-off between the benefits obtained from the increased partitioning of data and the cost, in terms of sample design, data collection, and analysis, of creating additional strata (Churchill:1976).

For the purpose of this research, the survey population of 564 firms was stratified into five subgroups based on

greenhouse area in square feet. The first subgroup, the smallest sized greenhouses, included firms that had less than 2,500 square feet of greenhouse space. There were 252 greenhouse firms in this stratum of the population (Table 18). The second subgroup included firms that had from 2,500 to 9,999 square feet of greenhouse space and contained 177 firms. The third subgroup included firms that had from 10,000 to 24,999 square feet of greenhouse space and contained 82 firms. The fourth subgroup included firms that had from 25,000 to 49,999 square feet and contained 28 firms. The fifth subgroup, the stratum of largest sized greenhouses, had 50,000 square feet or more of greenhouse area. There were 25 firms in this subgroup of the population.

Having determined the total sample size of 250 firms and stratified the population into five subgroups, only the allocation of the sampling units among the five subgroups remained. The percentage of sampling units that should be allocated to each stratum can be determined by either of two methods: proportional stratified sampling or disproportional (optimal) stratified sampling.

The first, proportional stratified sampling requires that the sampling units be allocated among the strata according to the same relative proportions with which they were distributed in the actual population. This selection technique preserves the relative importance of the strata in the true population but also, and importantly, assumes that the within stratum

Table 18. Calculations required to determine sampling unit distribution among five strata based on greenhouse area

Greenhouse strata	Number of firms N_h	Total Square feet for the stratum	Mean per firm Y_h	Standard deviation S_h
	number	square feet	square feet	square feet
Less than 2,500 square feet	252	279,947	1,111	691
2,500-9,999 square feet	177	824,488	4,606	1,901
10,000-24,999 square feet	82	1,200,621	14,642	3,956
25,000-49,999 square feet	28	930,129	33,219	7,205
50,000 or more square feet	<u>25</u>	<u>3,243,200</u>	129,728	127,039
Total	564	6,478,385		

Greenhouse area	Number of firms N_h	$N_h S_h$	Relative sample size $N_h S_h / \sum N_h S_h$	Actual sample size	Sampling rate
	number			number	percent
Less than 2,500 square feet	252	174,239	0.041	39	15.5
2,500-9,999 square feet	177	340,223	0.081	76	42.9
10,000-24,999 square feet	82	324,407	0.077	82	100.0
25,000-49,999 square feet	28	201,734	0.048	28	100.0
50,000 or more square feet	<u>25</u>	<u>3,175,968</u>	<u>0.753</u>	<u>25</u>	100.0
Total	564	4,216,571	1.000	250	

variation is constant across all strata. Examination of the standard deviations shown in Table 18 indicates that the within strata variation, ranging from 691 to 7,205 is far from constant, however.

The alternative technique, disproportionate, or optimal stratified sampling, addresses the problem of within strata variation that results from the stratification of highly skewed populations by incorporating information on both strata size and within strata variability into the distribution of sampling units among the strata of the population. According to Snedecor, for populations having a highly skewed or asymmetrical distribution of the principal variable, disproportionate sampling is more efficient than proportional sampling. The principal, here, is that those strata that exhibit more variability are sampled more than proportionately to their relative size. Conversely, those strata that are very homogeneous (containing little within strata variation) are sampled less than proportionately to their relative size. Furthermore, Snedecor recommends that the use of disproportionate sampling from a population stratified by size of institution is an especially efficient method for sample selection in industries that are characterized by having a large number of small firms and a small number of large firms.

The number of firms in each strata (N_h) was multiplied by the standard deviation of square footage in each strata (S_h). These values ($N_h S_h$) were summed over all strata and sizes for

each strata computed. These ratios, when multiplied by the intended sample size of 250 should indicate the distribution of the sample by strata. However, because of the large standard deviation for the stratum containing the largest sized firms, the rule requires that 75.3 percent of the sample be taken from this stratum. Given a selected sample size of 250, then $(0.753)(250)$ or 188 firms need to be selected from this stratum; however there are only 25 firms. So 100 percent of the firms in this stratum will be used and the remaining 225 sampling units are allocated to the other four strata. This procedure results in selection of 100 percent of the firms in the three stratum containing the larger sized greenhouses. The final remaining 115 sampling units were distributed among the two subgroups containing the smaller sized greenhouse firms. The stratum containing greenhouse operations with 2,500 to 9,999 square feet of area received 76 of the remaining 115, as shown below.

$$115[0.081/(0.081 + 0.039)] = 76$$

Finally, the sample size in the stratum containing the smallest sized firms, less than 2,500 square feet, was set at 39, which results from subtracting 76 from 115. For the actual sample drawing, each greenhouse was assigned a four digit number and a table of random numbers was used to select which greenhouse firms were included in the sample for each stratum.

The Survey Questionnaire

A mail-back survey questionnaire was developed to elicit information from greenhouse managers on floriculture crop production and sales. The questionnaire, developed through collaboration with horticulture specialists, was divided into four major topics of inquiry: 1) general firm information, 2) production area and space allocation, 3) production technologies employed and 4) greenhouse business activity (see Appendix). Prior to the actual survey sampling, the questionnaire was pre-tested via personal interviews with managers at two greenhouse firms. Survey questions were examined for areas of potential misunderstanding, or ambiguity, with appropriate corrections made in the wording of several questions. The full survey was administered and returns collected during the months of March and April, 1994. Approximately two weeks after the first mailing, nonrespondents were sent a second questionnaire with another letter requesting their participation.

Statistical Analysis

The data from the responding managers were coded and firms were stratified for analysis with frequency distributions and other descriptive statistics. Various cross

tabulations were examined to identify significant differences between various strata of greenhouse firms in relation to selected criterion variables. Although a spreadsheet program was used to perform all the necessary calculations to determine the level of significance, the theory behind the chi-square test is demonstrated by the hypothetical example in Table 19.

The marginal frequencies are the row and column sums. The expected frequencies are calculated from the marginal frequencies and the sample total. The degrees of freedom (d.f.) are determined by the formula $(r-1)(c-1)$ where:

r = the number of rows

c = the number of columns

The chi-square statistic is calculated as follows:

$$\chi^2 = \sum \sum (O_{ij} - E_{ij})^2 / E_{ij}$$

where:

χ^2 = the Chi-square statistic

O_{ij} = the actual observed frequencies in each cell

The calculated statistic is compared to a Chi-square table value. If the calculated Chi-square statistic is greater than the Chi-square table value, then the findings are considered significant and the chi-square test's null hypothesis of independence is rejected. The table value is

Table 19. Two-way classification of hypothetical data

Technology variable	Firm Size Variable					Total
	Size 1	Size 2	Size 3	Size 4	Size 5	
Technology A	8 ^a 8.22 ^b	10 ^a 11.08 ^b	20 ^a 16.09 ^b	16 ^a 17.52 ^b	10 ^a 11.08 ^b	64 ^c
Technology B	9 ^a 8.87 ^b	12 ^a 11.95 ^b	16 ^a 17.35 ^b	21 ^a 18.89 ^b	11 ^a 11.95 ^b	69 ^c
Technology C	6 ^a 5.91 ^b	9 ^a 7.79 ^b	9 ^a 11.56 ^b	12 ^a 12.59 ^b	10 ^a 7.97 ^b	46 ^c
Total	23 ^c	31 ^c	45 ^c	49 ^c	31 ^c	179 ^d

Observed frequency
^aExpected frequency (E_{ij})
^bMarginal frequencies (R_i and C_j)
^cSum of marginal frequencies

$$E_{ij} = R_i C_j / N$$

where: E_{ij} = the expected frequency for the cell in row i , column j

R_i = the sum of the frequencies in row i

C_j = the sum of the frequencies in column j

N = the sum of the frequencies for all cells

determined by using a Chi-square table in which the degrees of freedom are matched with the predetermined level of significance. Thus, for the hypothetical research hypothesis:

H_0 : The variables are independent. There is no significant relationship between the technology used and the size of the firm's greenhouse.

H_r : The variables are not independent. There is a significant relationship between the technology used and the size of the firm's greenhouse.

Using the above general formula to calculate the Chi-square statistic for the above example yields:

$$\chi^2 = [(8-8.22)^2/8.22] + [(10-11.08)^2/11.08] \\ + \dots + (10-7.97)^2/7.97 \quad \chi^2 = 2.991$$

The calculated hypothetical Chi-square statistic is 2.911 which is less than the table value of 13.65 at the 90 percent confidence level with 8 degrees of freedom for a 3 by 5 table $[(3-1)(5-1)]$. The critical value rule requires that the null hypothesis be rejected only when the calculated Chi-square value is greater than the table value. Therefore, in the hypothetical example, 2.911 is less than 13.65 so the null hypothesis cannot be rejected (Churchill).

CHAPTER 4: RESULTS OF TENNESSEE'S GREENHOUSE SURVEY

Introduction

A mail survey conducted among 250 Tennessee greenhouse managers resulted in a total of 83 responses, or 33.2 percent of the survey sample (Table 20). These response data were computer coded and partitioned into five strata based on greenhouse size. Table 20 lists the areas in square feet that were encompassed by each stratum and gives the response rate for each stratum relative to the sample total and the total population. For simplicity, the strata shall be referred to as greenhouse size categories 1 through 5 in the text.

In general, the responding firms were distributed among these five strata in the same disproportionate manner with which the sample had been selected. In other words, the strata having the highest expected variation within the population (i.e. the strata of larger sized firms) were more heavily represented in the sample return than were the strata with lower expected variations (i.e. the strata of smaller sized firms). This relationship is even more strikingly exhibited by the presentation of survey responses as percentages of the total population in each strata (Table 20).

Table 20. Distribution of survey sample and response by size of greenhouse operation

Greenhouse size category	Total in sample	Survey response		
		Number of responses	Percent of sample	Percent of total pop.
	number	number	percent	percent
Size 1: Less than 2,500 square feet	39	11	28.2	4.4
Size 2: 2,500-9,999 square feet	76	27	35.5	15.1
Size 3: 10,000-24,999 square feet	82	22	26.8	26.8
Size 4: 25,000-49,999 square feet	28	12	42.9	42.9
Size 5: 50,000 square feet or more	25	10	40.0	40.0
Undisclosed		1	0.4	
Overall	250	83	33.2	14.5

Data Classification

Consistent with the study objectives, the computerized data were variously partitioned into strata in order to examine specific characteristics of crop production and marketing from the prospective of greenhouse size, economic class and regional location within Tennessee. These three criterion for data stratification along with their corresponding distributions of response percentages are shown in Table 21. For most characteristics considered by this study, there was little difference between the distributions of data by size of operation or by economic class and thus, only one of the two generally required discussion in the text. For simplicity, size categorization was selected. Important differences between these two distributions have been identified as they occurred, however. The distributions of data arranged by regional division have been reported consistently.

General Information

Period of Establishment

The dates of greenhouse enterprise establishment were categorized in ten year intervals from 1960 through 1989. Of

Table 21. Distribution of responding firms by greenhouse size, gross annual sales and location within Tennessee

Categories of greenhouse size	number	percent
Size 1 (less than 2,500 square feet)	11	13.2
Size 2 (2,500-9,999 square feet)	27	32.5
Size 3 (10,000-24,999 square feet)	22	26.5
Size 4 (25,000-49,999 square feet)	12	14.5
Size 5 (50,000 square feet or more)	10	12.1
Undisclosed ^a	1	1.2
Total	83	100.0

Economic classification of firms ^b	number	percent
Class 1 (less than \$10,000)	15	18.1
Class 2 (\$10,000-\$24,999)	13	15.7
Class 3 (\$25,000-\$49,999)	12	12.1
Class 4 (\$50,000-\$99,999)	10	14.5
Class 5 (\$100,000-\$499,999)	20	24.1
Class 6 (\$500,000 or more)	13	15.7
Total	83	100.0

Region of Tennessee	number	percent
East ^c	50	60.2
Middle ^d	16	19.3
West ^e	17	20.2
Total	83	100.0

^aOne firm did not respond to this question

^bBased on total annual sales

^cEast Tennessee includes the following counties:

Anderson, Bledsoe, Blount, Bradley, Campbell, Carter, Claiborne, Cocke, Cumberland, Grainger, Greene, Hamblin, Hamilton, Hancock, Hawkins, Jefferson, Johnson, Knox, Loudon, McMinn, Marion, Meigs, Monroe, Morgan, Polk, Rhea, Roane, Scott, Sevier, Sullivan, Unicoi, Union, Washington

^dMiddle Tennessee includes the following counties:

Bedford, Cannon, Cheatham, Clay, Coffee, Davidson, DeKalb, Dickson, Fentress, Franklin, Giles, Grundy, Hickman, Houston, Humphreys, Jackson, Lawrence, Lewis, Lincoln, Macon, Marshall, Maury, Montgomery, Moore, Overton, Perry, Pickett, Putnam, Robertson, Rutherford, Sequatchie, Smith, Stewart, Sumner, Trousdale, Van Buren, Warren, Wayne, White, Williamson, Wilson

^eWest Tennessee includes the following counties:

Benton, Carroll, Chester, Crockett, Decatur, Dyer, Fayette, Gibson, Hardeman, Hardin, Haywood, Henderson, Henry, Lake, Lauderdale, McNairy, Madison, Obion, Shelby, Tipton, Weakley

the 83 greenhouses that responded to the survey, about one-fourth (26.5 percent) were established during the 1970s and almost one-half (43.4 percent) were established during the 1980s (Table 22). Greenhouses established during the 1960s were the least represented by survey data. Only 3.6 percent of all responding firms indicated that the greenhouse operation had been established during the 1960s. Greenhouses established before 1960, and greenhouses established during the 1990s were each represented by 12 percent of the sample response.

Employment Structure

Greenhouse managers were asked to enumerate their employees under categories of paid or unpaid family members, full or part-time (non-family) permanent employees, and seasonal workers. The response indicated that on average, Tennessee greenhouse firms employed 2.4 paid or unpaid family members, and that the average number of family members employed by these firms increased as the sizes of greenhouses increased (Table 23). Regionally, on average, middle Tennessee greenhouses employed the most paid or unpaid family member (3.0) and east Tennessee employed the fewest (2.1).

Table 22. Time period when greenhouse operations were established

Greenhouse characteristic	Time period					Undisclosed	Total
	Prior to 1960	1960- 1969	1970- 1979	1980- 1989	1990 or after		
Greenhouse area	-----percent-----						
Size 1	1.2	0	3.6	6.0	3.6	0	14.5
Size 2	1.2	1.2	9.7	16.9	4.8	1.2	35.0
Size 3	2.4	1.2	7.2	10.9	2.4	0	24.1
Size 4	3.6	1.2	3.6	3.6	1.2	1.2	14.5
Size 5	3.6	0	2.4	6.0	0	0	12.0
Overall	12.0	3.6	26.5	43.4	12.0	2.4	100.1*

Economic class							
Class 1	1.2	0.0	2.4	7.2	6.0	1.2	18.1
Class 2	1.2	1.2	4.8	6.0	2.4	0.0	15.7
Class 3	0.0	0.0	4.8	8.4	1.2	0.0	14.5
Class 4	1.2	0.0	4.8	4.8	1.2	0.0	12.0
Class 5	3.6	2.4	7.2	8.4	1.2	1.2	24.1
Class 6	4.8	0.0	2.4	8.4	0.0	0.0	15.7
Overall	12.0	3.6	26.5	43.4	12.0	2.4	99.9*

Tennessee region							
East	8.4	1.2	13.2	28.9	7.2	1.2	60.3
Middle	1.2	1.2	7.2	8.4	1.2	0.0	19.3
West	2.4	1.2	6.0	6.0	3.6	1.2	20.5
Total	12.0	3.6	26.5	43.4	12.0	2.4	100.1*

*Does not sum to 100.0 due to rounding error

Table 23. Employee Structure

Criterion of stratification	Paid/unpaid family	Full or part-time permanent	Seasonal	Type of employee	
				average	range
Greenhouse area				average	range
Size 1	1.4	0-5	0.1	0-5	0.2
Size 2	2.3	0-10	1.4	0-10	1.2
Size 3	2.5	0-5	1.9	0-6	3.5
Size 4	2.8	0-7	4.2	0-15	2.4
Size 5	3.5	0-9	23.6	5-120	15.6
Overall	2.4	0-10	4.5	0-120	3.5
Economic class				average	range
Class 1	1.7	0-5	0.2	0-1	0.8
Class 2	2.7	0-10	1.1	0-10	0.5
Class 3	2.5	0-5	1.0	0-5	1.4
Class 4	2.7	0-4	2.3	0-4	3.5
Class 5	2.4	0-7	3.6	0-15	3.4
Class 6	3.6	0-9	19.2	5-120	12.3
Overall	2.4	0-10	4.5	5-120	3.5
Region				average	range
East	2.1	0-10	3.0	0-10	3.9
Middle	3.0	0-7	10.5	0-6	4.2
West	2.7	0-9	3.3	5-120	2.0
Overall	2.4	0-10	4.5	5-120	3.5

Overall, greenhouse managers reported an average of 4.5 full or part-time (non-family) permanent employees (Table 23). The average number of non-family permanent employees also increased as the size of the greenhouse operation increased. Only 0.1 percent of the greenhouses categorized as size 1 greenhouses reported the employment of non-family persons on a permanent basis (range 0-1). Size 2 and size 3 greenhouses each average more than one permanent employee but less than two, and size 4 greenhouses averaged 4.2 full or part-time permanent (non-family) employees. The result of the survey indicated that on average 23.6 persons were permanently employed by size 5 greenhouses. This calculation is misleading, however, since this average decreases to 7.7 persons with the removal of a single outlier.

A similar pattern described the employment of seasonal workers. Overall, greenhouse managers reported an average of 3.5 seasonal employees (range 0-70). The smallest sized greenhouses employed very few seasonal workers, averaging only 0.2 per firm (range 0-2), and in general, the number of seasonal workers employed increased as the size of operation increased. In this case, however, managers of size 3 greenhouses reported a greater number of seasonal workers on average than did size 4 greenhouse managers. The largest employer of seasonal workers, size 5 greenhouses, reported an average of 15.6 per firm (range 0-70).

Regionally, middle Tennessee counties employed the largest number of workers in each category. East Tennessee region greenhouses employed the least number of family members and permanent workers, on average, and west Tennessee counties reported the least average number of seasonal employees.

Greenhouse Area and Covering Types

Area under cover

The 83 responding firms reported a total of 2.7 million square feet of greenhouse covered area. Size 5 greenhouses accounted for 63.6 percent of this total area and size 4 greenhouses accounted for 16.5 percent (Table 24). Together, these two strata included only about one-fourth of all responding firms yet accounted for 80.1 percent of the total area of reported greenhouse covering.

Regionally, middle Tennessee greenhouses contributed the largest proportion of all reported greenhouse space (44.7 percent), followed by east Tennessee greenhouses (44.5 percent) and those in the western region (10.8 percent). A comparison of this distribution of space with the regional distribution of responding firms (Table 25) indicated that the middle Tennessee region contained a relatively small number of

Table 24. Distribution of area under greenhouse covering and greenhouse covering types by size, economic classification and location within Tennessee

Criterion of stratification	Total covered area square feet	Average square feet	Percent of total percent	Type of covering						Total
				Double layer poly	Glass	Single layer poly	Fiber-glass	Shade	Acrylic/poly	
Greenhouse size										
Size 1	14,255	1,296	0.5	66.9	13.7	1.4	18.0	0.0	0.0	100.0
Size 2	157,993	5,852	5.9	71.3	6.4	13.4	7.6	1.3	0.0	100.0
Size 3	367,029	16,686	13.6	77.7	4.1	15.5	0.6	2.1	0.0	100.0
Size 4	442,900	39,903	16.5	78.5	16.1	2.3	1.1	0.7	1.3	100.0
Size 5	1,712,000	171,200	63.6	50.9	36.7	6.5	4.7	1.3	0.0	100.0
Overall ^a	2,694,240	32,857	100.1 ^b	60.3	27.0	7.4	3.8	1.3	0.2	100.0
Firm economic classification										
Class 1	27,311	1,951	1.1	68.5	7.1	8.8	9.8	5.9	0.0	100.0
Class 2	87,573	6,734	3.2	60.1	17.0	10.6	11.5	0.7	0.0	100.0
Class 3	129,143	10,762	4.8	92.9	0.0	5.3	1.8	0.0	0.0	100.1 ^b
Class 4	136,048	13,605	5.1	71.8	6.2	22.2	0.7	0.0	0.0	100.1 ^b
Class 5	572,570	28,678	21.2	69.3	10.8	14.8	1.3	3.0	0.9	100.1 ^b
Class 6	1,740,632	133,895	64.6	54.0	36.8	3.7	4.6	0.8	0.0	100.0 ^b
Overall	2,694,240	32,857	100.0	60.3	27.0	7.4	3.8	1.3	0.2	100.0
Region										
East	1,268,002	25,360	44.5	77.7	11.6	7.6	2.6	0.5	0.0	100.0
Middle	1,132,062	75,471	44.7	43.3	48.1	6.7	0.2	1.7	0.0	100.0
West	294,176	17,304	10.8	50.9	11.9	8.9	23.1	3.2	1.9	100.0
Overall	2,694,240	32,857	100.0	60.3	27.0	7.4	3.8	1.3	0.2	100.0

^aData not available for one firm, N = 82

^bDoes not equal 100.0 percent due to rounding error

**Table 25. Regional distribution of total area under cover
by greenhouse size**

Greenhouse area	Region			Total
	East	Middle	West	
	-----percent-----			
Size 1	9.8	0.0	3.6	13.4
Size 2	17.0	6.1	9.8	32.9
Size 3	19.5	4.9	2.5	26.9
Size 4	9.7	1.2	3.7	14.6
Size 5	4.9	6.1	1.2	12.2
Overall ^a	60.9	18.3	20.8	100.0

^aN=82

large greenhouses, and the eastern region contained a relative large number of small greenhouses.

East Tennessee greenhouses reported the largest proportion of greenhouses in size categories 1 through 4, and middle Tennessee firms reported the largest relative proportion of size 5 greenhouses (Table 25). Interestingly, no size 1 firms were reported by middle Tennessee managers. Western Tennessee greenhouses were primarily smaller sized with only 1.2 percent of size 5 greenhouses reported from this region.

Double layer poly covering

Double layer poly covering was reported to be the most extensively used greenhouse covering material. Of all greenhouse area reported under cover, 60.3 percent was covered with double layer poly (Table 24). This type of covering was reported to cover the largest relative percentage of greenhouse area for firms in all sizes categories. In general, the percentage of total greenhouse space that was reported by managers to be covered with double layer poly film increased as the size of greenhouses increased, but interestingly, the largest sized greenhouses reported the least usage of double layer poly relative to other sizes of firms.

East Tennessee greenhouse managers reported the largest percentage of double layer poly film covering relative to other regions (77.7 percent). Managers of west Tennessee greenhouses indicated that approximately half of their greenhouse space was under double layer poly film covering (50.9 percent) and 43.3 percent of the all greenhouse space reported for middle Tennessee counties was double poly film covered (Table 24).

Glass covering

Next in importance among the selected covering types was glass. Overall, 27 percent of the total reported greenhouse area was covered with glass (Table 24). The two categories of largest sized firms reported relatively large percentages of greenhouse area to be covered with glass. Among size 4 greenhouses, 16.1 percent of all covered area was covered by glass, and among size 5 greenhouses, 36.7 percent of all covered area was reported to be under glass. Interestingly, glass covering is also relative important among size 1 greenhouses, the category of smallest covered area.

Regionally, 48.1 percent of all middle Tennessee greenhouse space was covered with glass. West Tennessee greenhouses reported that on average, 11.9 percent of all greenhouse area was under glass covering, and eastern region

counties reported that 11.6 percent of their greenhouse space was covered with glass (Table 24).

Other types of covering

Single layer poly film, fiberglass, shade and acrylic/polycarbonate greenhouse coverings each accounted for less than 10 percent of total reported area under cover (Table 24). Relative to other types of covering, single layer poly film was most important among mid-sized greenhouses (size categories 2 and 3), with its usage fairly evenly distributed across regional divisions. Fiberglass covering was relatively important among smaller sized greenhouses and was reported primarily by west Tennessee firms. Shade covering and acrylic/polycarbonate were relatively important among all greenhouse operations in middle and west Tennessee.

Planned Expansion of Greenhouse Area

Overall, 28.9 percent of the respondents indicated a plan to expand their greenhouse area within the next two years (Table 26). Stratified by size of operation, about half of the managers of size 3 and size 5 greenhouses indicated a plan to expand. About one-fourth responding managers from size 2

Table 26. Planned greenhouse expansion within the next two years as a percentage of the current area under cover

Criterion of stratification	Number of firms	Percentage of firms planning to expand	Planned expansion as percentage of current area
Greenhouse size			
Size 1	11	0.0	0.0
Size 2	27	22.2	42.8
Size 3	22	45.5	41.3
Size 4	12	25.0	25.3
Size 5	10	50.0	22.0
Overall	82 ^a	29.3 ^a	35.7

Firm economic classification			
Class 1	15	6.7	7.0
Class 2	13	15.4	28.1
Class 3	12	25.0	34.7
Class 4	10	30.0	45.7
Class 5	20	45.0	41.9
Class 6	13	46.2	29.0
Overall	83	28.9	35.7

Region			
East	50	28.0	39.2
Middle	16	50.0	29.7
West	17	11.8	34.9
Overall	83	28.9	35.7

^aData not available for one firm, N = 82

and size 4 greenhouses indicated a plan to expand their size of their operations. Interestingly, no managers of size 1 greenhouses indicated a plan to expand the size of their covered area within the next two years.

From the perspective of economic size, however, managers of greenhouses in all strata of economic classification indicated a plan to expand the size of their greenhouse area within the next two years (Table 26), and the percentages of managers that indicated a plan to expand the size of their greenhouses increased as the reported value of gross annual sales increased. Regionally, 50 percent of middle Tennessee greenhouses indicated a plan to expand the size of their operation within the next two years; 28 percent of east Tennessee greenhouses indicated planned expansion; and only 11.8 percent of west Tennessee greenhouse managers plan to expand the size of their greenhouse area within the next two years.

To examine the relative size increase that would result from this planned expansion, the square footage of each planned expansion was mathematically converted to a percentage of that firm's current size. Overall, managers indicated a plan to increase the area of their greenhouses by an average of 35.7 percent of their current sizes (Table 26). Interestingly, managers of size 2 and 3 greenhouses and those greenhouses in the class 4 and 5 income strata indicated the largest planned expansion in greenhouse area relative to

current size. Managers of class 4 greenhouses planned the largest relative size increase. Managers of these greenhouses reported a plan to increase their total covered area by 45.7 percent of the current size within the next two years (Table 26). Managers of class 5 indicated a plan to increase the size of their operation's greenhouse area by 41.9 percent of the current area.

Regionally, east Tennessee managers plan the largest expansion relative to current size. On average, managers of east Tennessee greenhouses plan to increase the size of their operations by 39.2 percent. Among those west Tennessee managers that planned to expand the size of their greenhouses, the expansion was expected to average 34.9 percent of current area. Middle Tennessee greenhouse managers planned the least relative expansion and indicated that they planned to increase the sizes of their greenhouse by an average of 29.7 percent of the size of their current holding.

Constraints to Expansion

Greenhouse managers were presented with a list of factors in order to determine the impact of each on decisions of greenhouse area expansion. They were asked to indicate which factors were considered to be constraints to current expansion by rating each factor from 1 (not important as a constraint to

expansion) to 5 (very important as a constraint to expansion). For analysis, values of 3 or more were classified as "important" and rankings of less than 3 were classified as "unimportant".

Overall, market demand, labor, and non-environmental government regulations were rated as the important constraints to expansion of greenhouse area. Market demand was ranked as the most important constraint to greenhouse area expansion by managers of all greenhouse size classifications other than size 5 (Table 27). Labor was considered to be a constraint to expansion among all firms except those classified as size 4. Although non-environmental government regulations were also rated overall as an important constraint to greenhouse expansion, it was indicated as not important by greenhouses categorized as size 1 and size 4.

Competition, land, own management capacity, environmental regulation and the ability to hire competent management were not rated overall as constraints to greenhouse expansion, although they were considered as important constraints to expansion by managers within some strata of firms. Land was not considered to be a constraint to expansion by managers of firms in any greenhouse size grouping.

Table 27. Factors influencing decisions regarding greenhouse expansion

	Expansion constraint								
Criterion of stratification	Market demand	Competition	Land	Labor	Own management capacity	Environmental regulations	Other govt regulations	Ability to hire competent management	Other
Greenhouse size	average indexed rankings.....								
Size 1	3.9	3.1	2.0	3.0	2.8	1.8	2.1	1.9	5.0
Size 2	3.6	3.1	2.2	3.0	2.8	3.1	3.2	2.2	4.2
Size 3	3.8	2.8	2.0	3.5	3.5	3.5	3.5	3.3	0.0
Size 4	3.7	2.3	2.9	2.0	2.3	3.1	2.7	3.2	5.0
Size 5	3.3	2.7	2.5	3.0	3.0	3.0	3.7	3.3	5.0
Overall	3.7	2.9	2.3	3.0	2.9	2.9	3.1	2.7	4.4
.....									
Economic class									
Class 1	4.3	3.3	1.9	3.2	3.6	2.4	2.8	2.1	4.7
Class 2	3.7	3.0	2.8	3.6	2.3	2.4	2.0	2.0	3.7
Class 3	3.0	2.3	1.7	2.6	3.0	2.7	3.0	2.9	5.0
Class 4	4.5	3.5	1.9	3.5	3.4	4.1	4.1	2.8	5.0
Class 5	4.0	2.9	2.7	2.8	2.8	3.1	2.8	3.4	4.0
Class 6	2.7	2.3	2.6	2.4	2.7	2.9	3.5	3.0	4.5
Overall	3.7	2.9	2.3	3.0	2.9	2.9	3.1	2.7	4.4
.....									
Region									
East	3.6	2.9	2.1	3.0	2.9	3.0	3.2	2.8	4.6
Middle	3.7	2.3	2.3	2.5	2.9	2.5	2.5	3.0	3.0
West	4.1	3.3	2.8	3.2	3.0	3.0	3.0	2.2	4.8
Overall	3.7	2.9	2.3	3.3	2.9	2.9	3.1	2.7	4.4

Seasonal Allocation of Greenhouse Space

Spring

Among all size classifications of greenhouses, bedding and garden plants were allocated the greatest percentage of growing space relative to other crops during the spring production season. On average, managers allocated 46.6 percent of all reported area under greenhouse covering or shade to bedding and garden plants during the spring production period (Table 28). Greenhouses classified as size 1 reported the largest relative percentage of space allocated to bedding and garden plants, 55.2 percent, and size 5 greenhouses allocated the smallest relative percentage of total space to these crops, 42.4 percent. In general, the relative proportion of growing space allocated to bedding and garden plants during the spring production period decreased as the sizes of greenhouses increased. Other relatively important crops in the spring rotation included flowering potted plants, allocated 15.3 percent of all growing space, and foliage plants which, on average, occupied 12.5 percent of all greenhouses growing space. Overall, cut flower production occupied 8.5 percent of all spring production area and cut cultivated greens 8.4 percent (Table 28).

Table 28. Seasonal allocation of growing space to specific crops by size of greenhouse, economic class and region within Tennessee

Season and crop		Greenhouse size categories					Overall
		Size 1	Size 2	Size 3	Size 4	Size 5	
		-----percent-----					
Spring:	Bedding and garden plants	55.2	43.9	49.0	45.5	42.5	46.6
	Foliage plants	7.5	16.0	13.1	11.7	7.0	12.5
	Cut flowers	2.7	8.5	7.1	17.1	8.5	8.6
	Flowering potted plants	14.3	13.4	15.0	13.3	24.2	15.3
	Cut cultivated greens	6.8	9.4	8.5	6.3	9.3	8.5
	Vacant	13.6	8.8	7.3	6.1	8.5	8.5
	Total	100.1	100.0	100.0	100.0	100.0	100.0
Summer:	Bedding and garden plants	11.2	11.4	13.9	15.6	6.8	12.0
	Foliage plants	0.4	14.1	19.9	23.8	4.7	13.9
	Cut flowers	0.0	6.8	5.7	13.9	0.0	5.9
	Flowering potted plants	35.0	21.5	17.8	12.2	35.9	23.1
	Cut cultivated greens	20.4	10.1	11.6	14.0	23.9	14.9
	Vacant	33.0	36.1	31.1	20.5	28.7	30.2
	Total	100.0	100.0	100.0	100.0	100.0	100.0
Fall:	Bedding and garden plants	7.9	8.8	8.8	12.5	10.3	9.3
	Foliage plants	0.4	16.7	15.2	16.1	5.5	12.5
	Cut flowers	3.6	3.9	3.0	17.4	0.0	4.7
	Flowering potted plants	41.9	19.8	25.3	27.7	50.6	29.8
	Cut cultivated greens	21.3	22.2	21.6	8.5	20.2	19.9
	Vacant	24.9	28.6	26.1	17.8	13.4	23.8
	Total	100.0	100.0	100.0	100.0	100.0	100.0

Table 28. (Cont.)

Season and crop	Region of Tennessee			Overall
	East	Middle	West	
	-----percent-----			
Spring: Bedding and garden plants	46.7	45.5	47.0	46.6
Foliage plants	12.5	12.0	13.0	12.5
Cut flowers	10.6	6.3	4.4	8.5
Flowering potted plants	14.5	21.9	11.0	15.3
Cut cultivated greens	8.1	7.8	10.4	8.4
Vacant	<u>7.6</u>	<u>6.5</u>	<u>14.2</u>	<u>8.7</u>
Total	100.0	100.0	100.0	100.0
Summer: Bedding and garden plants	12.6	12.3	9.3	12.0
Foliage plants	15.9	7.0	16.8	13.9
Cut flowers	9.6	0.0	0.0	5.9
Flowering potted plants	21.9	26.3	22.6	23.1
Cut cultivated greens	14.6	14.9	15.9	14.9
Vacant	<u>25.4</u>	<u>39.5</u>	<u>35.4</u>	<u>30.3</u>
Total	100.0	100.0	100.0	100.1 ^a
Fall: Bedding and garden plants	9.3	9.5	9.0	9.3
Foliage plants	12.2	6.9	23.1	12.5
Cut flowers	7.8	0.0	0.0	4.7
Flowering potted plants	29.7	32.7	25.5	29.8
Cut cultivated greens	17.0	24.4	23.9	19.9
Vacant	<u>24.0</u>	<u>26.5</u>	<u>18.4</u>	<u>23.8</u>
Total	100.0	100.0	99.9 ^a	100.0

^aDoes not equal 100.0 percent due to rounding error

Overall, 8.7 percent of the total area under greenhouse covering or shade was reported as vacant, or unplanted during spring production. Size 1 greenhouses reported the largest relative percentage of vacant space (13.6 percent) and size 4 greenhouses the least (6.1 percent).

Managers in all regional divisions indicated that bedding and garden plants were the most important when allocating spring production space among selected crops. Flowering potted plants and foliage plants were also relatively important in the spring crop rotation for managers in all regions. Western Tennessee counties reported the highest percentage of vacant space in the spring (14.2 percent) and middle Tennessee counties reported the least (6.5 percent).

Summer

The most striking changes to occur between the spring and summer production seasons were an overall decrease in the average amount of space allocated to bedding and garden plants, and a sharp increase in the total percentage of space allocated as vacant, or unplanted. On average, the space allocation to bedding and garden plants decreased from 46.6 percent of all covered area in the spring to 12 percent of all covered area in the summer (Table 28).

Flowering potted plants were allocated the largest percentage of all covered area relative to other crops during

the summer production season (23.1 percent). The increased allocation of space to flowering potted plants was especially pronounced among size 1 and size 2 greenhouses. Among the smallest sized greenhouses the space allocation to flowering potted plants more than doubled and among size 2 greenhouse, the relative space allocation to flowering potted plants rose from 13.4 percent of available cropping space (spring) to 21.5 percent (summer). Only among size 4 greenhouses did the relative proportion of space allocated to flowering plants decrease over the spring season allocation. Among size 4 greenhouses, this allocation of space fell from an average of 13.3 percent to an average of 12.2 percent. This was only a small decline, obviously, but since there was a definite and frequently substantial increase in the space allocation to flowering potted plants among other sized greenhouses during the summer production season, this may indicate the general presence of an alternative business strategy among size 4 greenhouses.

Other evidence of a size 4 greenhouse summer production schedule that differs from other sized greenhouses is a relatively large average increase in the amount of space allocated to foliage plants for these greenhouses. Size 3 greenhouses also increased the average relative allocation to these foliage plants in the summer season but the increase was small in comparison. Among all other size categories of

greenhouse, the allocation of space to foliage plants decreased in the summer months (Table 28).

There was an overall average decrease in the amount of space allocated to cut flowers during the summer production period among all sizes of greenhouse. No space allocation to cut flowers during the summer production period was reported by the smallest greenhouses (size 1) and the largest (size 5).

Although the percentages of total space allocated to flowering potted plants, foliage plants, and cut cultivated greens were each expanded during the summer production season, a large proportion of the area which had previously been occupied during the spring remained vacant during the summer growing period. Overall, the percentage of total covered area reported by managers as vacant, or unplanted, increased from 8.5 percent on average in spring to 30.2 percent during the summer. Managers of greenhouses in size category 2 reported the largest percentage of vacant production space during the summer season (36.1 percent) and managers of size 4 greenhouses reported the least percentage of vacant, or unplanted area (20.5 percent). In general, the larger sized greenhouses indicated smaller percentages of unused production space during the summer season and the relative proportion of space that remained vacant, or unplanted during the summer growing season decreased as the sizes of greenhouses increased (Table 28).

Fall

The overall percentage of the total covered area that was allocated to the production of flowering potted plants and cultivated greens continued to increase during the fall production season and the space allocated to bedding plants and cut flowers continued to decrease. The percentage of vacant, or unused production space also decreased slightly from 30.2 percent in the summer to 23.8 in the fall (Table 28).

Monthly Allocation of Greenhouse Space

A monthly accounting of the relative percentages of occupied and vacant (unplanted) greenhouse space indicated that during the months of March, April and May, greenhouses in all size categories were operating at their highest levels of space utilization (Figure 11). All strata of greenhouses reached their maximum percentages of crop space utilization during April. During this month, an average of 94.6 percent of all recorded greenhouse area was allocated to crop production with only 5.4 percent remaining vacant or unplanted. On average, greenhouses in size categories 4 and 5 indicated that 100 percent of their available production space was allocated to crop production in April, and managers of size 3 firms indicated that 92.6 percent of their total area had been planted. Greenhouses on size categories 1 and

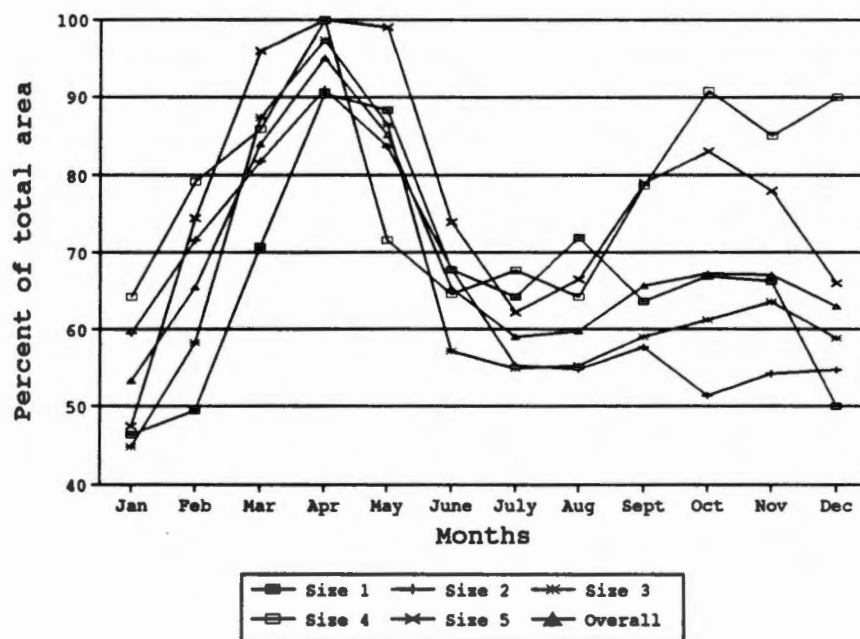


Figure 11. Monthly allocation of greenhouse space by size of greenhouse

Source: Tennessee's Greenhouse Survey

2 indicated that production levels reached only 90 percent of the total capacity during this period.

Distribution of Specific Greenhouse Crop Production and Marketing Technologies

Heating System

Unit heaters were the most commonly reported type of greenhouse heat source. Overall, 78.7 percent of responding greenhouse managers indicated the use of unit heaters (Table 29). Relative to other size categories, greenhouses classified as size 1 indicated the least usage of unit heaters. Only 58.3 percent of size 1 greenhouse managers reported the use of unit heaters. Unit heaters were indicated for from 80 percent to 90 percent of all other strata of greenhouses. Horizontal fans and poly tube vents were also important types of greenhouse heating systems and were reported among all economic classifications of firms. The data indicated that the usage of horizontal air fans increased in frequency as the sizes of greenhouses increased. The relative percentage of managers reporting the usage of poly tube ventilation also generally increased as the size of greenhouse increased with the exception of the largest greenhouses, size 5.

Table 29. Distribution of specific greenhouse heating technologies by size of covered area, location within Tennessee and economic class

Technological component	Greenhouse size					Overall	Region			
	Size 1	Size 2	Size 3	Size 4	Size 5		East	Middle	West	Overall
.....percent.....										
Heating System										
Unit heaters	58.3	82.2	80.0	90.0	80.0	78.7	73.5	86.7	87.5	78.7
Horizontal air fans	25.0	32.2	50.0	50.0	80.0	43.7	40.8	40.0	56.2	43.7
Poly tube ventilation	33.3	35.7	45.0	70.0	50.0	43.7	47.0	26.7	50.0	43.7
Central heating system (water or steam)	8.3	10.7	15.0	50.0	60.0	22.5	20.5	20.0	31.2	22.5
Other	25.0	7.2	5.0	10.0	0.0	8.7	10.2	6.7	6.2	8.7
Convection heaters	0.0	7.2	5.0	10.0	20.0	7.5	6.1	20.0	0.0	7.5
N =	12	28	20	10	10	80	49	15	16	80
Heat Delivery										
Horizontal air flow fans	66.7	52.0	71.6	50.0	90.0	63.4	65.1	64.3	57.2	63.4
Poly tube ventilation	44.4	48.0	41.2	70.0	50.0	49.3	51.2	28.6	64.3	49.3
Bottom heating under benches	0.0	20.0	17.6	50.0	70.0	28.2	20.9	28.6	50.0	28.2
Root zone heating	11.1	16.0	23.5	50.0	40.0	25.3	23.3	21.4	35.7	25.3
Perimeter lines	0.0	4.0	5.9	20.0	20.0	8.4	7.0	7.2	14.3	8.4
Radiant heat in floor/beds	0.0	4.0	5.9	10.0	10.0	5.6	4.7	7.2	7.2	5.6
Other	11.1	4.0	5.9	10.0	0.0	5.6	4.6	0.0	14.3	5.6
N =	9	25	17	10	10	71	43	14	14	71

Table 29. (Cont.)

Technological component	Economic class						Overall
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	
	-----percent-----						
Heating System							
Unit heaters	66.7	75.0	84.6	80.0	83.3	83.3	78.7
Horizontal air fans	13.3	25.0	38.5	60.0	66.7	58.3	43.7
Poly tube vent	26.7	41.7	38.5	50.0	50.0	58.3	43.7
Central heating							
(water or steam)	3.3	25.0	0.0	0.0	33.3	58.3	22.5
Other	20.0	8.3	7.7	10.0	5.6	0.0	8.7
Convection heaters	0.0	25.0	0.0	0.0	11.1	8.3	7.5
N =	15	12	13	10	18	12	80
Heat Delivery							
Horizontal							
air flow fans	53.8	37.5	45.4	80.0	70.6	83.3	63.4
Poly tube vent	30.8	75.0	54.5	50.0	41.2	58.3	49.3
Bottom heating							
under benches	23.1	12.5	18.2	0.0	41.2	58.3	28.2
Root zone heating	23.1	0.0	18.2	20.0	41.2	3.3	25.3
Perimeter lines	0.0	0.0	0.0	0.0	23.5	16.7	8.4
Radiant heat in							
floor/beds	0.0	12.5	0.0	0.0	11.8	8.3	5.6
Other	7.7	12.5	0.0	10.0	5.9	0.0	5.6
N =	13	8	11	10	17	12	71

Central heating was primarily used by the two categories of largest sized greenhouses. The usage of central heating (water or steam) was reported by 50 percent of size 4 firms and 60 percent of size 5 firms. Convection heaters were the least common heating system among responding greenhouses and was reported by only 7.5 percent of firms, overall, with the majority being reported from larger sized greenhouses. Other heating options not listed in the survey were recorded for 8.7 percent of greenhouses. Wood stove heating was the most commonly listed heating alternative.

Heat Delivery System

Horizontal air flow fans were the most frequently reported heat delivery systems (Table 29). Over half of the greenhouses in each size category reported the use of horizontal air flow fans for greenhouse heat delivery. Overall, 63.4 percent of greenhouse managers reported the usage of horizontal air flow fans for heat delivery. They were most common among size 5 greenhouses (90 percent) and least common among size 4 greenhouses (50 percent).

Poly tube ventilation was the second most commonly reported heat delivery system. Among all responding greenhouses, 49.3 percent indicated the use of poly tube ventilation. This heat delivery system was most commonly reported among size 4 greenhouse managers (70 percent) and was

reported by from 40 to 50 percent of managers in other greenhouse size categories. Bottom heating under the beds or benches and root zone heat delivery systems were employed by about one-fourth of all responding managers. In general, these were more common among larger sized greenhouses, with no size one greenhouses indicating the use of bottom heating under the benches.

Perimeter lines and radiant heat in the floor or beds were each recorded for 10 percent or fewer of the greenhouses in each size category (Table 29). Other heat delivery systems were indicated but no examples were given by managers.

Greenhouse Cooling Systems

When asked to indicated the types of greenhouse cooling systems that were used, the most commonly reported was side exhaust fans (Table 30). Overall, 75.0 percent of greenhouse managers indicated the use of side exhaust fans for greenhouse cooling. From 60.0 percent to 90.0 percent of the greenhouses in each size category reported the usage of side exhaust fans.

Poly tube ventilation and opening the doors in the summer were the second most commonly reported methods for greenhouse cooling. In general, poly tube ventilation cooling was most

Table 30. Distribution of specific greenhouse cooling and environmental control systems by size of covered area, location within Tennessee and economic class

Technological component	Greenhouse size					Overall	Region			
	Size 1	Size 2	Size 3	Size 4	Size 5		East	Middle	West	Overall
	-----percent-----									
Cooling										
Side exhaust fan	66.7	78.6	75.0	60.0	90.0	75.0	75.5	75.5	73.3	75.0
Poly tube ventilation	33.3	39.3	35.0	70.0	50.0	42.5	49.0	31.2	33.3	42.5
Open doors in summer	33.3	50.0	50.0	30.0	30.0	42.5	37.8	25.0	73.3	42.5
Fan and pad cooling (evaporative)	33.3	21.4	5.0	50.0	30.0	23.7	18.4	31.2	33.3	23.7
Ceiling fan	8.3	17.9	10.0	10.0	10.0	12.5	4.1	18.7	33.3	12.5
Other	0.0	3.6	15.0	0.0	0.0	5.0	6.1	0.0	6.7	5.0
High pressure fog	0.0	0.0	0.0	0.0	20.0	2.5	4.1	0.0	0.0	2.5
Ridge vents	8.3	17.9	15.0	60.0	30.0	22.5	18.4	18.7	40.0	22.5
N =	12	28	20	10	10	80	49	16	15	80
Environmental Control										
Thermostat	91.7	96.3	95.0	90.0	70.0	91.2	93.9	93.7	78.6	91.2
Manual adjustment	16.7	14.8	35.0	60.0	40.0	29.1	26.5	37.5	28.6	29.1
Thermister (sensor/voltage regulator)	0.0	0.0	5.0	20.0	30.0	7.6	4.1	18.7	7.2	7.6
Environmental sensor with microprocessor chip (computer control)	0.0	0.0	0.0	10.0	40.0	6.3	4.1	12.5	7.2	6.3
Other	0.0	0.0	0.0	10.0	0.0	1.3	2.1	0.0	0.0	1.3
N =	12	27	20	10	10	79	49	16	14	79

Table 30. (Cont.)

Technological component	Economic class						Overall
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	
	percent						
Cooling							
Side exhaust fan	66.7	72.7	84.6	70.0	73.7	83.3	75.0
Poly tube ventilation	26.7	45.4	30.8	60.0	42.1	58.3	42.5
Open doors in summer	46.7	36.4	38.5	70.0	42.1	25.0	42.5
Fan and pad cooling (evaporative)	33.3	18.2	15.4	20.0	15.8	41.7	23.7
Ceiling fan	6.7	18.2	23.1	0.0	10.5	16.7	12.5
Other	6.7	0.0	0.0	10.0	10.5	0.0	5.0
High pressure fog	0.0	0.0	0.0	0.0	0.0	16.7	2.5
Ridge vents	13.3	18.2	15.4	20.0	26.3	41.7	22.5
N -	15	11	13	10	19	12	80
Environmental Control							
Thermostat	100.0	100.0	84.6	90.0	94.7	75.0	91.2
Manual adjustment	16.7	23.1	15.4	40.0	36.9	41.7	29.1
Thermister (sensor/voltage regulator)	0.0	0.0	7.7	0.0	5.3	25.0	7.6
Environmental sensor with microprocessor chip (computer control)	0.0	0.0	0.0	0.0	5.3	25.0	6.3
Other	0.0	0.0	0.0	0.0	5.3	0.0	1.3
N -	12	13	13	10	19	12	79

frequently reported among managers of the larger sized greenhouses, and opening the doors to cool the greenhouse in the summer was most commonly reported among the smaller sized greenhouses.

Fan and pad (evaporative) cooling and ridge vent cooling were each reported by about one-fourth of the greenhouses, overall, and were listed by managers of greenhouse in all size categories (Table 30). Each, however, was most frequently reported among managers of size 4 greenhouses. Ceiling fans, reported by 12.5 percent of managers overall, were indicated to be in use by small numbers of greenhouses in each size category. High pressure fog, reported as 2.5 percent overall, was only found among the largest sized greenhouses. Other cooling systems were indicated by managers but no examples were given.

Environmental Control Systems

Thermostat control of the greenhouse environment was reported by 91.2 percent of managers, overall, and was the predominant type of system for environmental control in each size category (Table 30). Among other systems listed, 29.1 percent of managers, overall, indicated the use of manual adjustment to control the greenhouse environment, with this method also reported from greenhouses in each size category. Thermister (sensor/voltage regulator) systems for greenhouse

environment control, and control of the environment through sensors with microprocessor chips (computer control) were reported only among the three larger size greenhouse categories and the reported frequencies increased with increased size of greenhouse operation.

Types of Beds and/or Benches

Among managers which indicated the use of raised fixed benches, snow fencing was the primary construction material, overall, and was the most commonly reported material for all size categories except size 5 (Table 31). Among size 5 greenhouses, the most commonly reported bench construction material was expanded metal. Beds for growing plants on the floor were most commonly constructed of dirt and/or gravel. Overall, 51.2 percent of responding managers indicated the use of dirt and/or gravel in the construction of ground levels beds. Dirt and/or gravel was the most commonly reported ground bed construction material among all sizes of greenhouses. Rolling bench systems, moveable bench/rail systems and ebb and flow benches were each reported by only 5.0 percent or less of managers, overall, and although there is not a clear trend, these were each most frequently reported among size 5 greenhouses. Other bench materials listed

Table 31. Distribution of specific bench types and bench construction materials by size of covered area, location within Tennessee and economic class

Technological component	Greenhouse size					Overall	Region				Overall
	Size 1	Size 2	Size 3	Size 4	Size 5		East	Middle	West		
	percent										
Type of Beds/Benches											
Raised fixed benches											
snow fencing	36.4	28.6	42.1	66.6	30.0	38.7	41.7	20.0	47.1	38.7	
expanded metal	18.2	17.9	10.5	16.7	40.0	18.7	20.8	13.3	17.6	18.7	
hardware cloth	18.2	21.4	10.5	8.3	10.0	15.0	14.6	13.3	17.6	15.0	
black poly	0.0	7.2	5.3	16.7	20.0	8.7	6.2	6.7	17.6	8.7	
Growing on the floor											
dirt/gravel	45.4	46.4	57.9	58.3	50.0	51.2	50.0	46.7	58.2	51.2	
porus concrete	27.3	7.2	15.8	8.3	30.0	15.0	16.7	20.0	5.9	15.0	
fresh-cut flower beds	0.0	3.6	15.8	16.7	0.0	7.5	12.5	0.0	0.0	7.5	
Other	9.1	14.3	10.5	8.3	10.0	11.2	10.4	20.0	5.8	11.2	
Rolling bench system											
expanded metal	0.0	7.2	0.0	0.0	20.0	5.0	4.2	6.7	5.8	5.0	
other	9.1	7.2	0.0	0.0	10.0	5.0	4.2	13.3	0.0	5.0	
Moveable bench/rail (system)	0.0	3.6	0.0	0.0	20.0	3.7	3.7	4.2	0.0	3.7	
Ebb and flow benches	0.0	0.0	0.0	0.0	20.0	2.5	0.0	13.3	0.0	2.5	
N =	11	28	19	12	10	80	48	15	17	80	

Table 31. (Cont.)

Technological component	Economic class						Overall
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	
	-----percent-----						
Type of Beds/Benches							
Raised fixed benches							
snow fencing	28.6	27.3	38.5	33.3	60.0	30.8	38.7
expanded metal	21.4	18.2	7.7	33.3	10.0	30.8	18.7
hardware cloth	14.3	27.3	15.4	11.1	15.0	7.7	15.0
black poly	7.2	9.1	7.7	0.0	15.0	7.7	8.7
Growing on the floor							
dirt/gravel	50.0	54.5	53.8	44.4	60.0	38.5	51.2
porus concrete	21.4	0.0	15.4	22.2	5.0	30.8	15.0
cut flower beds	0.0	9.1	0.0	11.1	20.0	0.0	7.5
Other	14.3	9.1	23.1	0.0	10.0	7.7	11.2
Rolling bench system							
expanded metal	0.0	0.0	7.7	11.1	0.0	15.4	5.0
other	7.2	9.1	0.0	11.1	0.0	7.7	5.0
Moveable bench/rail (system)	7.2	0.0	0.0	0.0	0.0	15.4	3.7
Ebb and flow benches	0.0	0.0	0.0	0.0	0.0	15.4	2.5
N =	14	11	13	9	20	13	80

included wood construction and the use of wooden pallets to elevate plants off the floor.

Irrigation and Fertilization Systems

Managers were asked to indicate which types of irrigation and fertilizer systems were currently used in their greenhouse operation and information was collected for both fresh-cut flower and potted plant production. Hand watering was the predominant irrigation and fertilization technique for both types of product (Table 32).

Several other types of fresh-cut flower irrigation and fertilization technologies such as dew hose watering, turbulent twin wall irrigation, and perimeter watering were each indicated by small number of firms. Interestingly, greenhouses classified as size 2 and size 4 exhibited the widest relative distributions of these systems. Although "other" types were indicated by respondents, no examples were listed.

Miscellaneous Equipment

The most frequently reported miscellaneous equipment were shade curtains and horizontal air flow fans. Overall, each was reported by about half of the responding greenhouse (Table 33). Less than half of the responding managers indicated the

Table 32. Distribution of specific greenhouse irrigation and fertilization technologies by size of covered area, location within Tennessee and economic class

Technological component	Greenhouse size					Overall	Region			
	Size 1	Size 2	Size 3	Size 4	Size 5		East	Middle	West	Overall
-----percent-----										
Irrigation and Fertilization system										
Fresh-cut flowers										
hand watering	41.7	41.7	45.0	81.8	20.0	40.3	38.0	31.2	56.2	40.3
dew hose	0.0	3.5	5.0	36.4	0.0	7.3	10.0	0.0	6.2	7.3
turbulent twin wall	0.0	3.5	0.0	9.1	0.0	2.5	2.0	0.0	6.2	2.5
other	0.0	3.5	5.0	0.0	0.0	2.5	2.0	0.0	6.2	2.5
perimeter watering	0.0	0.0	0.0	18.1	0.0	2.5	4.0	0.0	0.0	2.5
ooze header	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
growing in rock wool	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Potted plants										
hand watering	100.0	89.6	90.0	90.9	100.0	92.7	92.0	87.5	100.0	92.7
spaghetti tubes	8.3	20.7	40.0	54.6	60.0	32.9	30.0	50.0	18.7	32.9
overhead spray	25.0	20.7	15.0	18.1	60.0	24.4	20.0	37.5	25.0	24.4
ebb and flow	0.0	0.0	0.0	0.0	20.0	2.5	0.0	12.5	0.0	2.5
other	8.3	0.0	0.0	0.0	10.0	2.5	2.0	6.2	0.0	2.5
matt watering	0.0	0.0	0.0	0.0	10.0	1.2	0.0	6.2	0.0	1.2
N =	12	29	20	11	10	82	50	16	16	82

Table 32. (Cont.)

Technological component	Economic class						Overall
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	
	-----percent-----						
Irrigation and Fertilization system							
Fresh-cut flowers							
hand watering	40.0	61.6	16.7	40.0	55.5	16.7	40.3
dew hose	0.0	0.0	0.0	0.0	30.0	0.0	7.3
turbulent twin wall	0.0	0.0	0.0	0.0	10.0	0.0	2.5
other	0.0	7.7	0.0	10.0	0.0	0.0	2.5
perimeter watering	0.0	0.0	0.0	0.0	10.0	0.0	2.5
ooze header	0.0	0.0	0.0	0.0	0.0	0.0	0.0
growing in rock wool	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Potted plants							
hand watering	86.7	100.0	91.7	90.0	90.0	100.0	92.7
spaghetti tubes	13.3	23.1	25.0	20.0	40.0	75.0	32.9
overhead spray	40.0	7.7	16.7	20.0	15.0	50.0	24.4
ebb and flow	0.0	0.0	0.0	0.0	0.0	16.7	2.5
other	6.7	0.0	0.0	0.0	0.0	8.3	2.5
matt watering	0.0	0.0	0.0	0.0	0.0	8.3	1.2
N =	15	13	12	10	20	12	82

Table 33. Distribution of specific miscellaneous greenhouse equipment by size of covered area, location within Tennessee and economic class

Technological component	Greenhouse size					Overall	Region			
	Size 1	Size 2	Size 3	Size 4	Size 5		East	Middle	West	Overall
-----percent-----										
Miscellaneous Equipment										
Shade curtain	71.4	45.8	33.3	63.7	70.0	51.4	48.9	50.0	61.6	51.4
Horizontal air flow fan	42.9	45.8	50.0	45.4	80.0	51.4	58.2	35.7	46.1	51.4
Black cloth	28.6	54.2	38.9	63.7	20.0	44.3	44.2	21.4	69.2	44.3
Supplemental lighting	28.6	16.7	27.8	54.5	50.0	31.4	34.9	14.3	38.5	31.4
Mist/fog system for propagation	14.3	8.3	16.7	63.7	70.0	28.6	27.9	21.4	38.5	28.6
Plug seeder	0.0	4.2	27.8	45.4	70.0	25.7	25.6	28.6	23.1	25.7
Refrigerated storage	0.0	12.5	5.6	54.5	20.0	17.2	18.6	7.2	23.1	17.2
Automatic potting machine	0.0	0.0	5.6	9.1	70.0	12.9	11.6	14.3	15.4	12.9
High frequency lighting	14.3	0.0	5.6	18.2	40.5	11.4	13.9	7.2	7.7	11.4
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ridge mounted vertical fan to direct air down	0.0	0.0	11.1	0.0	0.0	4.3	4.6	7.2	0.0	4.3
Thermal screen	0.0	0.0	0.0	0.0	30.0	4.3	2.3	7.2	7.7	4.3
CO2 enrichment	0.0	0.0	0.0	0.0	10.0	1.4	2.3	0.0	0.0	1.4
Automatic transplanter	0.0	0.0	0.0	0.0	10.0	1.4	0.0	7.2	0.0	1.4
N =	7	24	18	11	10	70	43	14	13	70

Table 33. (Cont.)

Technological component	Economic class						Overall
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	
	-----percent-----						
Miscellaneous Equipment							
Shade curtain	40.0	71.4	54.1	30.0	47.4	69.2	51.4
Horizontal air flow fan	3.0	14.3	36.4	70.0	68.4	61.1	51.4
Black cloth	7.0	42.9	36.4	30.0	47.4	38.5	44.3
Supplemental lighting	3.0	14.3	18.2	20.0	42.1	46.1	31.4
Mist/fog system for propagation	2.0	0.0	18.2	20.0	31.6	61.6	28.6
Plug seeder	0.0	14.3	27.3	20.0	26.3	53.8	25.7
Refrigerated storage	20.0	0.0	0.0	10.0	26.3	30.8	17.2
Automatic potting machine	0.0	0.0	0.0	10.0	0.0	61.6	12.9
High frequency lighting	10.0	0.0	0.0	10.0	10.5	30.8	11.4
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ridge mounted vertical fan to direct air down	0.0	0.0	9.1	0.0	5.3	7.7	4.3
Thermal screen	0.0	0.0	0.0	0.0	0.0	23.1	4.3
CO2 enrichment	0.0	0.0	0.0	0.0	0.0	7.7	1.4
Automatic transplanter	0.0	0.0	0.0	0.0	0.0	7.7	1.4
N =	10	7	11	10	19	13	70

usage of other types of miscellaneous equipment although a wide variety of these equipment were indicated by smaller percentages across all size categories. In general, the specific miscellaneous technologies listed were most frequently reported among the larger sized greenhouses and managers of size 5 greenhouses indicated some use of each type of equipment listed (Table 33).

Greenhouse Computer Technologies

Managers among all size categories of greenhouse reported the use of computers in their greenhouse operation. Approximately three-fourths of the responding managers that reported the use of computers indicated that they were used as word processors (Table 34). The second most frequently reported use for computers by greenhouse managers was for accounting. Although computerized accounting was reported among all size classifications of greenhouses, the use of computers for accounting was relatively more common among the larger sized greenhouses. Computerized production scheduling, marketing and inventory functions were each reported by 28.6 percent of responding firms, overall, although they were primarily distributed among greenhouses of size 2 and above. Other computer functions were reported variously by small numbers of greenhouses which were distributed across all size classifications, except size 1.

Table 34. Distribution of specific computer technologies and product handling equipment by size of covered area, location within Tennessee and economic class

Technological component	Greenhouse size					Overall	Region			
	Size 1	Size 2	Size 3	Size 4	Size 5		East	Middle	West	Overall
-----percent-----										
Computerization										
Word processing	100.0	53.8	71.4	83.3	100.0	74.3	70.0	71.4	87.5	74.3
Accounting	50.0	30.8	85.7	83.3	85.7	62.9	60.0	85.7	50.0	62.9
Production scheduling	0.0	30.8	42.9	0.0	42.9	28.6	30.0	14.3	37.5	28.6
Marketing	0.0	30.8	28.6	16.7	42.9	28.6	35.0	42.9	0.0	28.6
Inventory	50.0	23.1	28.6	16.7	42.9	28.6	15.0	14.3	75.0	28.6
Communication	0.0	7.7	14.3	33.3	28.6	17.2	20.0	28.6	0.0	17.2
Environmental control	0.0	7.7	0.0	0.0	42.9	11.4	5.0	11.4	25.0	11.4
Other	0.0	15.4	14.3	0.0	14.3	11.4	10.0	28.6	0.0	11.4
Financial investment	0.0	0.0	14.3	0.0	14.3	5.7	0.0	14.3	12.5	5.7
Crop rotation	0.0	0.0	14.3	0.0	14.3	5.7	5.0	14.3	0.0	5.7
N =	2	13	7	6	7	35	20	7	8	35
Handling Equipment										
Carts (hand)	100.0	94.8	100.0	100.0	100.0	98.2	96.9	100.0	100.0	98.2
Carts (motorized)	0.0	5.3	7.2	20.0	40.0	14.5	12.5	15.4	20.0	14.5
Conveyors	0.0	0.0	7.2	10.0	30.0	9.1	9.4	7.7	10.0	9.1
Other	0.0	5.3	7.2	0.0	10.0	5.4	6.2	7.7	0.0	5.4
Movable bench system	0.0	0.0	0.0	0.0	20.0	3.7	3.1	7.7	0.0	3.7
Monorail	0.0	0.0	0.0	0.0	10.0	1.8	3.1	0.0	0.0	1.8
N =	2	19	14	10	10	55	32	13	10	55

Table 34. (Cont.)

Technological component	Economic class						Overall
	Class 6	Class 5	Class 4	Class 3	Class 2	Class 1	
	-----percent-----						
Computerization							
Word processing	100.0	25.0	66.7	80.0	63.7	100.0	74.3
Accounting	0.0	25.0	66.7	80.0	81.8	75.0	62.9
Production scheduling	25.0	50.0	33.3	20.0	27.3	25.0	28.6
Marketing	25.0	0.0	33.3	20.0	36.4	37.5	28.6
Inventory	0.0	75.0	0.0	20.0	18.2	50.0	28.6
Communication	0.0	0.0	33.3	20.0	18.2	25.0	17.2
Environmental control	0.0	25.0	0.0	0.0	0.0	37.5	11.4
Other	0.0	0.0	33.3	40.0	0.0	12.5	11.4
Financial investment	0.0	0.0	0.0	20.0	0.0	12.5	5.7
Crop rotation	0.0	0.0	0.0	20.0	0.0	12.5	5.7
N =	4	4	3	5	11	8	35
Handling Equipment							
Carts (hand)	100.0	100.0	90.0	100.0	100.0	100.0	98.2
Carts (motorized)	0.0	0.0	10.0	12.5	13.3	30.8	14.5
Conveyors	0.0	0.0	0.0	0.0	13.1	23.1	9.1
Other	0.0	25.0	0.0	12.5	0.0	7.7	5.4
Movable bench system	0.0	0.0	0.0	0.0	0.0	15.4	3.7
Monorail	0.0	0.0	0.0	0.0	0.0	7.7	1.8
N =	5	4	10	8	15	13	55

Handling Equipment

Among specific items of handling equipment listed in the questionnaire, only hand carts were commonly employed across all classifications of greenhouses. Among respondents that indicated the use of handling equipment, 98.2 percent, overall, recorded the use of hand carts in their greenhouse operation (Table 34). Next in importance were motorized carts which were reported by 14.5 percent of responding managers; however, 40 percent of responding size 5 greenhouses used motorized carts. Other listed items of handling equipment were each employed by less than 10 percent of greenhouses, overall. Managers of size 5 greenhouses indicated the widest range of handling equipment use.

Planned technological changes

Computerization was the most common technology change planned by greenhouse managers during the the next two years (Table 35). Due to the small numbers of managers that responded to this section of the survey questionnaire, it was necessary to combine the five greenhouse size categories into only two. Among greenhouse sizes 1 through 3 (less than 25,000 square feet), 32 percent of responding managers

Table 35. New technologies planned for adoption within the next two years by greenhouse managers

Technological component	Greenhouse size						Region							
	Sizes 1-3		Sizes 4-5		Overall		East		Middle		West		Overall	
	number	percent	number	percent	number	percent	number	percent	number	percent	number	percent	number	percent
Computerization	23	32.0	44	41.5	67	37.7	32	36.0	16	48.5	19	33.3	67	37.6
Miscellaneous equipment	14	19.5	23	21.7	37	20.8	18	20.2	6	18.2	13	22.8	37	20.8
Types of beds/benches	5	7.0	14	13.2	19	10.7	9	10.1	2	6.1	8	14.0	19	10.7
Irrigation and fertilization system (potted plants)	9	12.5	6	5.7	15	8.4	3	6.7	6	9.1	7	12.3	15	8.4
Heat Delivery	8	11.1	3	2.8	11	6.2	9	10.1	1	3.0	1	1.8	11	6.2
Handling equipment	2	2.8	9	8.5	11	6.2	6	6.7	2	6.1	3	5.3	11	6.2
Heating System	6	8.3	4	3.8	10	5.6	6	6.7	2	6.1	2	3.5	10	5.6
Cooling	5	7.0	1	1.0	6	3.4	2	2.2	1	3.0	3	5.3	6	3.4
Environmental control	0	0.0	2	1.9	2	1.1	1	1.1	0	0.0	1	1.8	2	1.1

Table 35. (Cont.)

Technological component	Economic classification							
	Classes 1-2		Classes 3-4		Classes 5-6		Overall	
	number	percent	number	percent	number	percent	number	percent
Heating System	0	0	2	5.9	8	7.2	10	5.6
Heat Delivery	1	3.0	5	14.7	5	4.5	11	6.2
Cooling	4	12.1	0	0.0	2	1.8	6	3.4
Environmental control	0	0.0	0	0.0	2	1.8	2	1.1
Types of beds/benches	3	9.1	1	3.0	15	13.5	19	10.7
Irrigation and fertilization system (potted plants)	5	15.1	2	5.9	8	7.2	15	8.4
Miscellaneous equipment	4	12.1	11	32.3	22	19.8	37	20.8
Computerization	14	42.4	9	26.8	44	39.7	67	37.7
Handling equipment	2	6.1	4	11.8	5	4.5	11	6.2

indicated a plan to adopt new computer technology or to expand the use of current computer technology for more greenhouse management functions within the next two years. Among responding managers of size 4 and size 5 greenhouses (25,000 square feet or more), 37.5 percent indicated a plan to adopt computer technology. The most commonly listed computer functions for planned adoption were word processing and accounting.

Items listed in the survey questionnaire under a general heading of "miscellaneous equipment" were the second most frequently reported technologies planned for adoption. Overall, 20.8 percent of the responding managers indicated a plan to adopt one or more of the miscellaneous equipment items listed. The most common examples included shade cloth, horizontal air flow fans and black cloth.

Otherwise, the larger sized firms generally indicated a greater emphasis on the planned adoption of new types of benches, handling equipment and environmental control technologies, while the smaller sized greenhouses placed a greater emphasis on the adoption of new irrigation, heating and cooling systems.

Tennessee Floriculture Product Sales

Customer Profile

Managers indicated that greenhouses from each size category marketed their products to a variety of customers. Overall, customer retail sales accounted for over half of total sales, however, importance of the retail outlet decreased as the size of greenhouse increased (Table 36). Figure 12 shows the inverse relationships between greenhouse size and the percentage of total sales contributed by selected retail and wholesale outlets.

Wholesale sales to garden centers was indicated to be the second most important market for greenhouse floriculture products. These sales accounted for only 14.2 percent of total sales, overall, but managers of size 3 and size 5 greenhouses reported that nearly one-fourth of their product was marketed wholesale to garden centers. Other marketing channels, such as wholesale to florists, wholesale to mass merchandisers and mail order were less frequently reported, overall, but generally increased in importance and the size of greenhouse increased.

Table 36. Customer profile of sales by greenhouse size, economic class and location within Tennessee

Criterion of Stratification	Market channel						Total
	Retail to customers	Wholesale to garden centers	Wholesale to florists	Wholesale to mass merchandisers	Mail order	Other	
Greenhouse area							
Size 1	86.3	8.3	2.5	2.1	0.8	0.0	100.0
Size 2	76.0	8.1	6.3	1.1	1.8	6.6	100.0
Size 3	51.3	22.4	13.7	9.4	0.0	3.3	100.0
Size 4	30.1	11.5	36.8	17.2	2.7	1.7	100.0
Size 5	15.0	24.8	6.2	41.5	10.0	7.5	100.0
Overall*	57.7	14.2	11.7	10.5	2.4	3.6	100.f

Economic class							
Class 1	86.5	2.7	0.7	1.5	0.0	8.7	100.f
Class 2	72.7	7.5	5.8	8.6	0.8	4.6	100.0
Class 3	55.4	35.4	4.2	5.0	0.0	0.0	100.0
Class 4	69.6	17.8	5.1	2.5	5.0	0.0	100.0
Class 5	45.8	7.0	32.0	9.9	1.6	3.7	100.0
Class 6	20.8	21.8	12.1	34.6	7.7	3.1	100.f
Overall	57.7	14.2	11.7	10.5	2.4	3.6	100.f

Region							
East	55.5	14.6	14.2	9.9	3.6	2.1	100.0
Middle	56.8	16.4	9.6	17.2	0.0	0.0	100.0
West	65.1	10.6	6.2	5.3	1.0	11.8	100.0
Overall	57.7	14.2	11.7	10.5	2.4	3.6	100.f

^aData not available for one firm, N=82

^bDoes not equal 100.0 percent due to rounding error

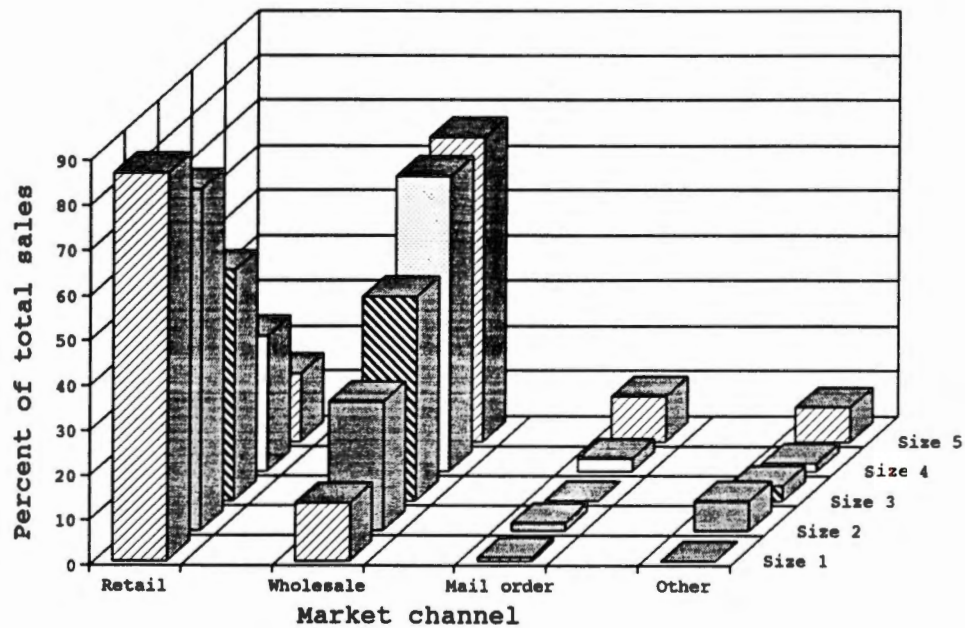


Figure 12. Relationship between greenhouse size and the distribution of sales between retail and wholesale markets

Note: Wholesale includes sales to garden centers, florists and mass merchandisers

Source: Tennessee's Greenhouse Survey

Greenhouse Product Advertisement

Greenhouse managers were asked to report their annual advertising budgets as a percentage of total annual sales. Overall, 4.5 percent of annual sales were reported to have been allocated for product advertisement (Table 37). The highest allocation of sales dollars to advertising was reported by size 2 greenhouses. These managers indicated that on average, 7.8 percent of the value of their annual sales was utilized for advertisement purchasing. The percentage of total sales allocated to advertising expenditure generally decreased as the size of greenhouse increased.

Overall, newspaper advertising was allocated the largest proportion of advertising dollars and on average received 36.6 percent of all advertising dollars. Managers of size 1 greenhouses reported the largest percentage allocated to newspaper advertising (50.0 percent) and size 6 greenhouses reported the least (16.7 percent). Television advertising, listed by managers as "other", received the second largest proportion of greenhouse advertising budgets, 16.0 percent, overall. Although no greenhouses listed as size 1 reported television advertisement, it was reported by firms from all economic classifications (Table 37). Television advertisement received relatively larger allocations of advertisement dollars among the larger sized greenhouses. Managers of size 5 greenhouses reported that 40.6 percent of their advertising

Table 37. Allocation of advertisement expenditure to specific media

Criterion of stratification	Advertising media										Total	Advertising expenditure as percent of annual sales
	Yellow pages	Bill-boards	Trade journal	Trade shows	Direct mail	Radio	Catalog	News-paper	News-letter	Other		
	percent											
Greenhouse size												
Size 1	0.0	20.0	16.0	0.0	4.0	10.0	0.0	50.0	0.0	0.0	100.0	4.4
Size 2	10.2	0.0	16.1	7.2	12.5	17.5	0.0	18.8	4.3	13.4	100.0	7.8
Size 3	24.4	5.5	6.5	2.7	7.5	4.7	1.2	36.2	2.0	9.3	100.0	3.1
Size 4	8.3	0.0	0.0	0.6	20.0	2.0	0.0	48.6	0.1	20.4	100.0	3.4
Size 5	8.3	1.1	5.6	12.2	3.3	8.9	1.1	16.7	2.2	40.6	100.0	1.8
Overall	13.9	3.4	5.8	3.3	7.5	11.0	0.4	36.5	2.3	16.0	100.1*	4.5
Economic class												
Class 1	6.7	16.7	0.0	0.0	6.7	6.7	0.0	51.7	10.0	1.7	100.0	13.7
Class 2	2.0	0.0	16.0	0.0	10.0	24.0	0.0	35.0	0.0	12.0	100.0	5.4
Class 3	37.2	5.6	2.2	2.2	1.1	10.6	0.0	36.7	0.0	4.5	100.1*	4.8
Class 4	19.5	0.0	11.7	3.7	5.8	12.0	2.0	37.0	0.0	8.3	100.0	2.1
Class 5	4.7	0.4	5.4	0.1	15.9	11.7	0.0	37.8	1.7	21.3	100.0	2.5
Class 6	10.8	0.9	4.5	10.0	3.7	5.8	0.9	27.3	2.9	33.1	99.9*	3.0
Overall	13.9	3.4	5.8	3.3	7.5	11.0	0.4	36.5	2.3	16.0	100.1*	4.5
Region												
East	15.7	3.5	5.8	1.7	7.8	9.2	0.4	39.4	1.1	15.3	99.9*	3.2
Middle	13.5	6.0	3.0	3.0	3.0	20.5	1.0	30.0	2.0	18.0	100.0	2.2
West	7.8	0.0	8.9	8.9	11.2	6.1	0.0	34.5	6.8	15.9	100.1*	11.7
Overall	13.9	3.4	5.8	3.3	7.5	11.0	0.4	36.5	2.3	16.0	100.1*	4.5

*Does not equal 100.0 percent due to rounding error

expenditure had been allocated to television. Yellow pages and radio were the only other advertisement media that were allocated more than 10 percent of the advertising budget, on average (Table 37). Interestingly, managers of size 1, the smallest sized greenhouses allocated the highest relative percentages of their advertising budgets to billboards, trade journals and radio.

Product Price Determination

Greenhouse managers were presented with a list of nine factors and asked to rate the importance of each with relation to decisions of product pricing. Respondents were instructed to rate each factor as from 1 (not important) to 5 (very important) and ratings were adjusted to allow relative comparison across size categories. Adjusted ratings of 3.0 or above were considered to indicate that the factor was important and adjusted rating of less than 3 were considered to indicate that the factor was not important in price determination.

There was a general consistency in the ratings given to the various factors by managers of different sized greenhouses. Relative to other factors, the cost of production and quality of plants, each with adjusted ratings

of 4.2, were considered by managers overall to be the most important factors in price determination (Table 38). Other factors of importance to managers were last year's price (rated 3.7), market demand (rated 3.7), comparison with other growers (rated 3.5), time of year (rated 3.3) and traditional price (rated 3.1). Managers indicated that neither current inventory nor inflation were important factors in product price determination. Interestingly, managers of size 4 greenhouses disagreed with other managers on the importance of several factors. Managers of size 4 greenhouses indicated that comparison with other growers and traditional price were not factors in price determination and that inflation was an important consideration.

Distribution of Gross Annual Income

Managers were asked to indicate the value of gross annual sales for greenhouse products during 1993. In general, the gross annual incomes for greenhouse operations increased with increasing sizes of greenhouses, but this was not always a clear-cut distribution. The majority (75 percent) of size 1 greenhouses were reported as economic class 1 (less than \$10,000), for example, but some of these smallest greenhouses

Table 38. Factors impacting product pricing decisions by greenhouse size, economic class and location within Tennessee

Criterion of stratification	Factors of price determination									
	Last year's price	Based on inventory	Inflation	Cost of production	Comparison to other growers	Quality of plants	Market demand	Time of year	Traditional price	Other
	Indexed rating.....									
Greenhouse size										
Size 1	3.6	2.2	2.5	3.9	3.9	4.0	4.0	3.4	3.7	5.0
Size 2	3.5	2.8	2.7	4.2	3.3	4.4	3.5	3.2	2.9	5.0
Size 3	3.8	2.4	2.5	4.1	3.5	4.1	3.6	3.2	3.0	0.0
Size 4	3.4	2.2	3.4	4.8	2.8	4.3	3.6	3.2	2.5	0.0
Size 5	4.3	2.8	2.0	4.3	4.3	4.3	4.1	4.0	3.6	0.0
Overall	3.7	2.5	2.6	4.2	3.5	4.2	3.7	3.3	3.1	5.0
Economic class										
Class 1	3.6	2.2	2.5	3.7	3.7	4.1	3.9	3.5	3.1	0.0
Class 2	3.5	2.9	2.8	4.2	3.4	4.0	3.5	3.1	3.1	5.0
Class 3	3.9	2.5	2.5	4.3	3.3	4.5	3.5	3.3	3.2	5.0
Class 4	3.8	2.5	2.7	4.5	3.9	4.3	3.6	3.4	3.3	0.0
Class 5	3.5	2.3	2.9	4.2	3.2	4.0	3.7	2.8	2.7	0.0
Class 6	3.8	2.9	2.3	4.5	3.8	4.5	4.1	4.3	3.4	0.0
Overall	3.7	2.5	2.6	4.2	3.5	4.2	3.7	3.3	3.1	5.0
Region										
East	3.7	2.5	2.7	4.2	3.6	4.1	3.7	3.5	3.1	0.0
Middle	3.9	2.8	2.4	4.3	3.5	4.3	3.9	3.4	2.7	5.0
West	3.5	2.3	2.5	4.2	3.3	4.4	3.6	2.9	3.2	5.0
Overall	3.7	2.5	2.6	4.2	3.5	4.2	3.7	3.3	3.1	5.0

also reported incomes in the class 2 (\$10,000-\$24,999) and class 3 (\$25,000-\$49,999) ranges (Table 39). Likewise, the distributions of size 2 and size 3 greenhouses also encompassed a wide range of gross annual income classifications. The widest dispersion of gross annual sales value was reported by managers of size 2 greenhouses. The sales from these farms ranged in value from less than \$10,000 (class 1) to \$499,999 (class 5). All size 4 and size 5 greenhouses reported gross annual sales of at least \$100,000 with the majority (75 percent) of size 5 greenhouses reporting sales of from \$100,000 to \$499,999, and the majority (90 percent) of size 5 greenhouse managers reporting gross sales of more than \$500,000.

Gross Annual Sales Distributed by Crop

Among greenhouses from all size categories, managers indicated that bedding plants were the most important contributor to gross annual sales. Overall, bedding plant accounted for 52.5 percent of annual sales on average (Table 40). Flowering potted plants, contributing 21.5 percent of total sales, were reported by managers to be the second most important contributor to total sales, overall. Foliage plants were of lesser importance in terms of total sales, contributing only 9.5 percent, overall, but small numbers of greenhouses in each size category reported foliage plant

Table 39. Distribution of gross annual income into economic class, by greenhouse size and region within Tennessee

	Economic classification												Overall	
	Class 1		Class 2		Class 3		Class 4		Class 5		Class 6			
	number	percent	number	percent	number	percent	number	percent	number	percent	number	percent	number	percent
Size:														
Size 1	9	75.0	2	16.7	1	8.3	0	0.0	0	0.0	0	0.0	12	100.0
Size 2	6	23.1	9	34.6	5	19.2	4	15.4	2	7.7	0	0.0	26	100.0
Size 3	0	0.0	2	9.1	6	27.3	6	27.3	8	36.4	0	0.0	22	100.1 ^a
Size 4	0	0.0	0	0.0	0	0.0	0	0.0	9	75.0	3	25.0	12	100.0
Size 5	0	0.0	0	0.0	0	0.0	0	0.0	1	10.0	9	90.0	10	100.0
Region:														
East	9	18.0	5	10.0	8	16.0	8	16.0	14	28.0	6	12.0	50	100.0
Middle	1	6.2	3	18.8	4	25.0	0	0.0	4	25.0	4	25.0	16	100.0
West	5	29.4	5	29.4	0	0.0	2	11.8	2	11.8	3	17.6	17	100.0

^aDoes not equal 100.0 percent due to rounding error

Table 40. Distribution of gross annual sales to selected crop categories by greenhouse size, economic class and location within Tennessee

Criterion of stratification	Product						Overall
	Bedding plants	Foliage plants	Cut flowers	Flowering potted plants	Cut cultivated greens	Other	
	-----percent-----						
Greenhouse size							
Size 1	59.7	10.9	0.0	16.8	0.0	12.5	14.8
Size 2	53.2	7.7	8.8	19.1	0.0	11.1	34.6
Size 3	45.0	10.7	3.0	26.4	0.0	14.7	24.7
Size 4	59.5	2.1	0.0	34.7	0.0	3.7	13.6
Size 5	49.0	18.5	6.0	9.5	0.0	17.0	12.3
Overall	52.5	9.5	4.5	21.5	0.0	8.6	100.0
Economic class							
Class 1	67.1	9.6	0.0	19.9	0.0	3.3	18.5
Class 2	52.3	6.1	5.8	20.1	0.0	15.6	16.0
Class 3	43.0	10.0	16.2	21.2	0.0	9.6	14.8
Class 4	56.8	7.3	0.0	9.1	0.0	26.8	11.1
Class 5	42.6	7.9	0.8	37.9	0.0	10.8	23.5
Class 6	56.1	16.0	6.1	9.8	0.0	11.9	16.0
Total	52.5	9.5	4.5	21.5	0.0	12.0	99.9 ^a
Region							
East	46.6	8.9	7.0	22.2	0.0	15.3	59.3
Middle	53.3	10.7	1.9	25.6	0.0	8.5	19.7
West	68.5	10.0	0.0	15.8	0.0	5.8	21.0
Total	52.5	9.5	4.5	21.5	0.0	12.0	100.0

^aDoes not equal 100.0 percent due to rounding error

sales. Cut flower sales were reported only by small numbers of greenhouses and no size 1 or size 4 greenhouses indicated cut flower sales. No sale of cut cultivated greens was reported. Other important sales crop listed by managers were perennials, cacti and tobacco seedlings.

Monthly Distribution of Gross Annual Sales

Figure 13 illustrates the seasonality of floriculture product sales. This distribution, calculated as averages for respondents in each size category, indicates that the smaller sized greenhouses received a larger proportion of annual sales during the peak sales period of April/May than did larger sized greenhouses. This chronological percentage distribution is similar to the monthly allocation of production space that was shown in Figure 11.

Chi-square Analysis

To examine the statistical significance of some of the research findings, Chi-square contingency tests were conducted with the data stratified by greenhouse size and by regional location within Tennessee. Due to the test reliability requirement that contingency table cells must each contain five or more observations, data for the five greenhouse size categories were collapsed into only two groups: small

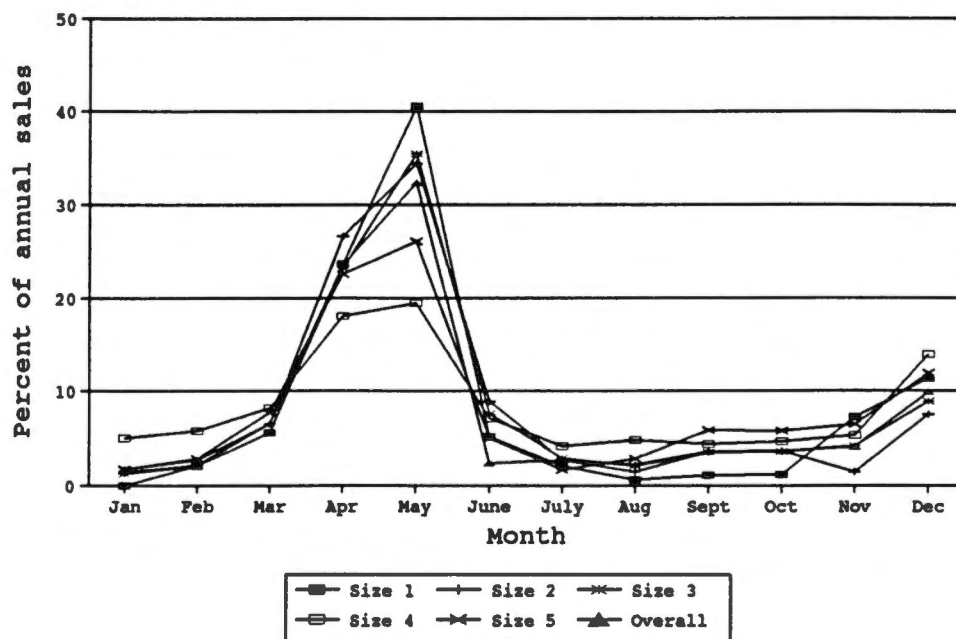


Figure 13. Monthly distribution of gross annual income by size of greenhouse

Source: Tennessee's Greenhouse Survey

groups: small greenhouses, less than 25,000 square feet, and large greenhouses, 25,000 square feet or more. The regional stratification of greenhouses was not modified for chi-square calculations although, as will be shown, the small numbers of responses from middle and west Tennessee growers often lead to inconclusive statistical results.

The specific null and research hypotheses of the chi-square tests were that:

H_0^1 : There is no relationship between the production technology used and the size of greenhouse in square feet.

H_r^1 : There is a relationship between the production technology used and the size of greenhouse in square feet.

H_0^2 : There is no relationship between the production technology used and greenhouse regional location within Tennessee.

H_r^2 : There is a relationship between the production technology used and greenhouse regional location within Tennessee.

Table 41 presents the results of hypothesis testing with reference to size. With reference to greenhouse size, significant differences in technology were identified at the 0.10 and 0.05 percent levels under each major technological heading. An important point to remember, however, is that the chi-square method tests only for a significant difference between two proportions and does not indicate the direction of that difference (Berenson and Levine:1990). For the purpose

Table 41. Relationship between greenhouse size and the current use of selected production practices

Greenhouse production technology	Greenhouse size				Chi-square statistic
	Small		Large		
	yes	no	yes	no	
	-----number-----				
<u>Heating System</u>					
Central heating system (water or steam)	7	53	11	11	13.81**
Unit heaters	45	15	17	5	0.04
Convection heat	3	57	3	19	1.77
Horizontal air fans	22	38	13	9	3.31*
Poly tube ventilation	23	37	12	10	1.73
Other	6	54	1	21	0.62
<u>Heat Delivery</u>					
Bottom heating under benches	8	52	12	10	14.82**
Perimeter lines	2	58	4	18	5.24** *
Radiant heat in floor/beds	2	58	2	20	1.15
Root zone heating	9	51	9	13	6.31**
Poly tube ventilation	23	37	12	10	1.73
Horizontal air flow fans	30	30	14	8	1.21
Other	3	57	1	21	0.01
<u>Cooling</u>					
Poly tube ventilation	22	38	12	10	2.12
Side exhaust fans	45	15	15	7	0.38
Ceiling fans	8	52	2	20	0.27
Ridge vents	9	51	9	13	6.31**
Open doors in summer	28	32	6	16	2.50
Fan and pad cooling (evaporative)	10	50	8	14	3.65*
High pressure fog	0	60	2	20	5.60** *
Other	4	56	0	22	
<u>Environmental Control</u>					
Manual adjustment	13	47	10	12	4.52**
Thermostat	55	5	16	6	4.97**
Thermister (sensor/voltage regulator)	1	59	5	17	10.53** *
Environmental sensor					
with microprocessor chip (computer control)	0	60	5	17	14.52** *
Other	4	56	0	22	1.54
<u>Type of Beds/Benches</u>					
Growing on the Floor					
a. dirt/gravel	28	32	12	10	0.40
b. porous concrete	7	53	4	18	0.59
c. fresh-cut flower beds	4	56	2	20	0.14
Raised fixed benches					
a. snow fencing	20	40	11	11	1.90
b. black poly	3	57	4	18	3.58* *
c. hardware cloth	10	50	2	20	0.74
d. expanded metal	9	51	6	16	1.62
Rolling Bench System					
a. expanded metal	2	58	2	20	1.15
b. other	3	57	1	21	0.01
Moveable bench/rail (system)	1	59	2	20	2.52
Ebb and flow benches	0	60	2	20	5.59** *

*Significant at 0.10 percent level

**Significant at 0.05 percent level

*One or more cells contain less than 5 observations

*No greenhouses indicated the use of this technology

Table 41. (Cont.)

Greenhouse production technology	Greenhouse size				Chi-square statistic
	Small		Large		
	yes	no	yes	no	
-----number-----					
<u>Irrigation and Fertilization</u>					
Fresh-cut flowers					
a. hand watering	26	34	7	12	0.89
b. perimeter watering	0	60	2	20	5.59** a
c. dew hose	2	58	4	18	5.24** a
d. ooze header	0	60	0	22	--b
e. turbulent twin wall	1	59	1	21	0.56
f. growing in rock wool	0	60	0	22	--b
g. other	2	58	0	22	0.75
Potted Plants					
a. hand watering	55	5	20	2	0.01
b. spaghetti tubes	15	45	12	10	6.36**
c. matt watering	15	45	1	21	4.29** a
d. overhead spray	11	49	8	14	2.94*
e. ebb and flow	0	60	2	20	5.59** a
f. other	1	59	1	21	0.56
<u>Miscellaneous Equipment</u>					
Shade curtain	22	38	14	8	4.76**
Thermal screen	0	60	3	19	8.50** a
Black cloth	22	38	9	13	0.12
CO2 enrichment	0	60	1	21	2.76* a
Ridge mounted vertical fan to direct air down	2	58	1	21	0.07
Mist/fog system	6	54	14	8	25.11**
Supplemental lighting	11	49	11	11	8.22**
Horizontal air flow fans	23	37	13	9	2.82*
Plug seeder	6	54	12	10	18.65**
Automatic potting machine	1	59	8	14	19.84** a
Automatic transplanter	0	60	1	21	2.76* a
High intensity lighting	2	58	6	16	10.48** a
Refrigerated storage	4	56	8	14	10.34** a
Other	0	60	0	22	--b
<u>Computerization</u>					
Word processing	14	46	12	10	7.24**
Accounting	11	49	11	11	8.22**
Inventory	6	54	4	18	1.01
Financial investment	1	59	1	21	0.56
Marketing	6	54	4	18	1.01
Communications	2	58	4	18	5.24** a
Crop rotation	1	59	1	21	0.56
Production scheduling	7	53	3	19	0.06
Environmental control	1	59	3	19	4.97** a
Other	3	57	1	21	0.01
<u>Handling Equipment</u>					
Carts (hand)	34	26	20	2	8.39** a
Carts (motorized)	2	58	6	16	10.48**
Monorail	0	60	1	21	2.76* a
Conveyors	1	59	4	18	7.67** a
Movable bench system	0	60	2	20	5.59** a
Other	2	58	1	21	0.07

*Significant at 0.10 percent level

**Significant at 0.05 percent level

*One or more cells contain less than 5 observations

*No greenhouses indicated the use of this technology

of this study, then, the rejection of a null hypothesis indicated only that there was a significant difference in greenhouse technology related to greenhouse size, but the chi-square test does not identify the group in which the usage is significantly higher or lower.

Significant differences related to greenhouse size were found in the usage of specific heating and cooling technologies. The chi-square tests identified differences in the usage of water or steam central heating systems and horizontal air fan heating. Methods of heat delivery were also significantly different between the two populations and included bottom heating under benches, and root zone heating. With reference to cooling technologies, only the usage of ridge vent cooling was significantly different.

Further significant technological differences were identified in components of greenhouse environmental control, irrigation and fertilization systems, miscellaneous equipment, computerization, and handling equipment. Although a relatively large number of these technologies were identified as significantly different, the results were inconclusive in some cases due to the small sample size. Production equipment for which the difference was particularly significant included the usage of mist/fog systems, plug seeders, motorized carts and spaghetti tube watering. There was a significant difference in the useage of manual and thermostat environmental control. The computerization of greenhouse

business activities was significantly different with reference to word processing and accounting functions.

Because of the small sample representation by middle and west Tennessee greenhouses, the survey results were inconclusive with respect to regionally related technological differences. Only the usage of convection heaters, thermostat environmental control, matt watering for potted plants, automatic transplanters and computerized inventory was significantly related to regional location of the greenhouse at the 0.01 percent level and in each contingency table one or more cells contained fewer than the required five observations.

A similar small sample problem arose in the chi-square significance testing of the relationship between the size of greenhouse and the production technologies planned for future adoption (data not shown). In this case the data were adjusted by collapsing the list of technologies under each general component heading into single groups. These tests identified that there were significantly different proportions of small and large greenhouses that planned to adopt new environmental control, new types of beds or benches, new computer technologies or applications, and new product handling equipment within the next five years.

Greenhouse data related to product market channels was also tested for significant differences between small and large greenhouses. These statistics indicated that with a

significance level of 0.01, there was difference between the proportions of small and large greenhouses that marketed products only through retail channels; however, these results are inconclusive due to the small numbers of observations in some cells (Table 42). Testing of a similar wholesale market hypothesis indicated that there was not a significant difference in the proportions of small and large greenhouses that marketed only through wholesale channels.

A basic technological profile for Tennessee greenhouses is given in Table 43. In the table, the specific technologies that were employed by 50 percent or more of the responding managers in each size category are listed. In general, the smaller greenhouses relied on only one, or at least a relatively small number of technologies to accomplish any given task. Among the larger sized greenhouses, on the other hand, a wider variety of the technological options were used within the same greenhouse to accomplish specific tasks. Since there was no indication that the larger greenhouses specialized in crops that were not produced by the smaller greenhouses, this greater diversity of technology was probably related to greenhouse size and income rather than to crop specialization.

**Table 42. Relationship between greenhouse size
and market channel**

	Market channel			
	Retail		Wholesale	
	yes	no	yes	no
	-----number-----			
Size 1	11	0	4	7
Size 2	25	2	16	11
Size 3	15	7	17	5
Size 4	9	3	11	1
Size 5	5	5	10	0
Chi-square statistic	8.51*		5.78	

*Significant at 0.10 percent level.

Table 43. Summary of greenhouse technologies used by 83 Tennessee greenhouses

Technology	Greenhouse size				
	Size 1	Size 2	Size 3	Size 4	Size 5
	-----specific technology-----				
Heating system:	unit heaters	unit heaters	unit heaters horizontal air flow fans	unit heaters horizontal air flow fans poly tube ventilation	unit heaters horizontal air flow fans poly tube ventilation
Heat delivery system:	horizontal air flow fans	horizontal air flow fans	horizontal air flow fans poly tube ventilation	horizontal air flow fans poly tube ventilation bottom heating under benches	horizontal air flow fans poly tube ventilation bottom heating under benches
Cooling system:	side exhaust fans	side exhaust fans open doors in summer	side exhaust fans open doors in summer	side exhaust fans poly tube ventilation fan and pad cooling ridge vents	side exhaust fans poly tube ventilation open doors in summer
Environmental control:	thermostat	thermostat	thermostat manual adjustment	thermostat	thermostat
Bed/bench material:	snow fencing dirt/gravel	snow fencing dirt/gravel	snow fencing dirt/gravel	dirt/gravel	snow fencing expanded metal dirt/gravel

Table 43. (Cont.)

Technology	Greenhouse size				
	Size 1	Size 2	Size 3	Size 4	Size 5
	-----specific technology-----				
Irrigation and fertilization system:					
Fresh cut flowers:	hand watering	hand watering	hand watering	hand watering	hand watering
Potted plants:	hand watering	hand watering	hand watering	hand watering spaghetti tubes overhead spray	hand watering spaghetti tubes
Miscellaneous equipment:	shade curtain		horizontal air flow fans	shade curtain	shade curtain
		black cloth		black cloth supplemental lighting mist/fog system for propagation refrigerated storage	horizontal air flow fans supplemental lighting mist/fog system for propagation plug seeder automatic potting machine
Computerization:	word processing accounting inventory	word processing	word processing accounting	word processing accounting	word processing accounting
Handling equipment:	hand carts	hand carts	hand carts	hand carts	hand carts

Managers indicated a plan to incorporate more computer functions into their greenhouse operation and management within the next two years. Managers were most interested in word processing and accounting computer functions.

Overall, the planned adoption of specific types of production technologies appeared to be related to the size of greenhouse. In general, managers of larger sized greenhouses expressed the most interest in adopting new types of benches, new types of product handling equipment and new techniques of environmental control, whereas managers of the smaller sized firms were primarily interested in new irrigation, heating, and cooling systems.

Specific technological differences between small and large greenhouses were identified using the chi-square contingency test. Statistically significant difference were shown under each major component of greenhouse technology to include heating, heat delivery and cooling systems, greenhouse environmental control, beds and benches, irrigation and fertilization technology, miscellaneous equipment, computerization and product handling equipment. Due to small sample sizes, results of test for significant differences in greenhouse technology related to regional location within Tennessee were inclusive.

**CHAPTER 5: SUMMARIES, CONCLUDING REMARKS,
AND FURTHER RESEARCH NEEDS**

In 1991, the U.S. green industry was valued at \$8.7 billion and ranked sixth in value of grower cash receipts among U.S. agricultural commodities. Included in the green industry total were the sale of both floriculture and environmental horticulture products. During each year from 1987 to 1991, southern region states earned the largest relative percentage of all U.S. green industry receipts, although the market share for these farmers decreased in each of those years except 1990. Western region states earned the second largest percentage of grower cash receipts during each year considered and the relative market share of these states increased during each year. North Central and Northeastern states accounted for only about 15 percent of the U.S. total each during each year of the period examined.

The reduced-south region (southern states excluding Florida and Texas) accounted for about 19 percent of all U.S. green industry grower cash receipts during each of the years from 1987 through 1991, and there was a small increase in the

market share by this reduced-south region. Tennessee's contribution to the reduced-south region total grower cash receipts fell from 10 percent in 1987 to 7.6 percent in 1991.

Among green industry farms in 1987 nursery plants were the most commonly grown crops and accounted for the largest proportion of all U.S. green industry grower cash receipts. Bedding plants, the second most commonly reported crop, earned the second largest proportion of U.S. green industry grower cash receipts followed, in order, by flowering potted plants, foliage plants and cut flowers/cut cultivated greens.

Although the green industry is an important sub-sector of the U.S. agricultural economy, little economic data is available for use by researchers. This lack of basic industry data has been noted in both the academic literature and trade journals related to floriculture and environmental horticulture crop production and marketing. The purpose of this study, therefore, was to provide industry data for use by individuals, firms and agencies concerned with the production and marketing of greenhouse products. The primary objectives were: 1) to develop descriptive profiles that characterize floriculture industry farms in Tennessee, 2) to determine how these profiles differ with respect to size, income and location within Tennessee, and 3) to evaluate the relationship between the level of production technology used by floriculture industry farms and selected firm characteristics such as size, income and location within Tennessee. To

achieve these objectives, postage paid return-mail survey questionnaires were used to solicit information on the size, production, and business activity of Tennessee greenhouse firms.

The 564 commercial greenhouses that were certified by the Tennessee Department of Agriculture for 1992-1993 were selected as a population for the survey. This population was partitioned into five strata based on greenhouse size in square feet and the disproportionate (optimal) stratified sampling technique was used to randomly select 250 firms for participation in the survey. A total of 83 questionnaires were received in response to the survey mailing.

Summary of the Results

Product activities

The Tennessee floriculture production industry began a rapid expansion in the number of firms during the 1970s that has continued up to the present. Of all responding greenhouses, eight out of ten firms were established during 1970 or later, with the decade of the eighties exhibiting the largest sustained growth within recent industry history. Positive, strong growth in Tennessee's green industry floriculture subsector has continued into the 1990s.

In 1993, Tennessee greenhouses employed an overall average of 6.9 permanent employees (to include both family and non-family permanent workers) and an average of 3.5 seasonal workers. Examined with respect to greenhouse size, in general, the average number of employees of all types increased as the size of greenhouse increased. The survey results further indicated that Tennessee greenhouses of all sizes were predominantly family operated. Especially among the smallest sized greenhouses, positions of permanent employment were almost exclusively held by family members. While larger sized firms employed progressively larger numbers of family members, on average, these farms also employed larger numbers of non-family and seasonal workers.

The respondent managers reported a total of 2.7 million square feet of area under greenhouse covering or shade. Multiplying the average area reported for each stratum by the number of farms within that stratum of the population indicated, by extrapolation, that in 1993, Tennessee floriculture industry farms cultivated approximately 8.1 million square feet of area under greenhouse covering or shade. As might be expected, the extrapolated total area reported for each population stratum increased with increased sizes of greenhouse, but the survey results indicated that after the largest sized greenhouses (50,000 square feet or more), mid-sized greenhouses (10,000-24,999 square feet) cultivated the second largest total area.

The most extensively used types of greenhouse covering among Tennessee greenhouse farms was double-layer polyethylene followed by glass, single-layer polyethylene, and fiberglass. Nearly two-thirds (60.3 percent) of Tennessee greenhouses are constructed with a covering of double-layer of polyethylene film and it was reported as the most extensively used greenhouse covering among all sizes of greenhouse. Glass covering was reported primarily among the smallest and largest sized greenhouses, single-layer poly covering was restricted mainly to mid-sized operations, and only small farms exhibited the relatively frequent use of fiberglass.

A large proportion of greenhouses managers indicated a plan to expand the size of their greenhouse operation within the next two years. Only managers of the smallest greenhouses (less than 2,500 square feet) did not report a plan to expand their greenhouse area. Otherwise, managers of other greenhouses indicated plans to increase the size of their operation by about one-third (35.7 percent) of the current size. Managers of the largest and mid-sized greenhouses indicated the greatest amount of relative planned expansion, on average. Managers of greenhouses in all regions of Tennessee reported plans to expand the size of their operations. On average across all size categories, eastern region farmers reported the largest relative planned expansion (39.2 percent) and middle Tennessee farmers reported the least

planned increase in greenhouse size relative to current holdings (29.7 percent).

Among farmers that did not indicate a plan to expand the size of their greenhouse operations within the next two years, market demand, labor and non-environmental government regulations were rated as important constraints to growth. Competition and own management capacity were also important constraints to expansion for some firms. Regionally, market demand was considered to be the most important constraint to expansion in areas of Tennessee.

The monthly patterns of greenhouse space utilization and the seasonal patterns of the allocation of greenhouse space to specific crops indicated that April was the month of the most intensive production activity, and that bedding plants occupied the largest relative percentage of all growing space during the spring production period. On average, managers reported that during April, 91.5 percent of their total covered area was occupied by crops and only 8.5 percent was vacant (unplanted). The largest relative proportion of vacant production space during the spring was reported by the smallest sized greenhouses and mid-sized reported the least.

During the summer production period, the relative proportions of greenhouse space allocated to flowering potted plants, foliage plants, and cut cultivated greens increased among greenhouses overall. Flowering potted plants were reported to occupy the greatest percentage of occupied

production space during the summer production season. Only among mid-sized greenhouses was the space allocation to flowering potted plants decreased during the summer months, possibly indicating an alternative production and marketing strategy by these operations. During the summer, there was an overall decline in greenhouse production activity and the percentage of vacant space rose from 8.5 percent on average in spring to 30.2 percent on average during the summer.

A second, although smaller production peak was observed during the month of October. During the fall production period, the relative proportion of greenhouse space allocated to flowering potted plants and cut cultivated greens continued to increase on average over spring and summer levels, and the relative proportion of vacant space decreased, on average, from 30.2 percent in the summer to 23.8 percent in the fall. In general, there were smaller amounts of vacant space among the larger sized greenhouses indicating a comparative advantage achieved through size.

In general, the smaller greenhouse relied on only one, or at least a relatively small number of technologies to accomplish any given task. Among the larger sized greenhouses, on the other hand, a wider variety of the technological options were used within the same greenhouse to accomplish specific tasks. Since there was no indication that the larger greenhouses specialized in crops that were not produced by the smaller greenhouses, this greater diversity of

technology was probably related to greenhouse size and income rather than to crop specialization.

Managers indicated a plan to incorporate more computer functions into their greenhouse operation and management within the next two years. Managers were most interested in word processing and accounting computer functions.

Overall, the planned adoption of specific types of production technologies appeared to be related to the size of greenhouse. In general, managers of larger sized greenhouses expressed the most interest in adopting new types of benches, new types of product handling equipment and new techniques of environmental control, whereas managers of the smaller sized firms were primarily interested in new irrigation, heating, and cooling systems.

Specific technological differences between small and large greenhouses were identified using the chi-square contingency test. Statistically significant difference were shown under each major component of greenhouse technology to include heating, heat delivery and cooling systems, greenhouse environmental control, beds and benches, irrigation and fertilization technology, miscellaneous equipment, computerization and product handling equipment. Due to small sample sizes, results of test for significant differences in greenhouse technology related to regional location within Tennessee were inclusive.

Marketing activity

Retail sales to customers represented the largest market outlet overall (57.7 percent) in the survey. Wholesale sales to garden centers were the second largest outlet (14.2 percent) followed by wholesale sales to florists (11.7 percent) and wholesale sales to mass merchandisers (10.5 percent). The relative percentage of total sales to wholesale and retail outlets varied with the size of greenhouse. In general, larger sized greenhouses reported a larger proportion of sales through wholesale markets and the smaller sized greenhouses reported a larger relative proportion of sales through retail market outlets. A chi-square test of retail marketing data for the 83 greenhouses identified a significant relationship between greenhouse size the sale of products exclusively in retail markets. A similar test of wholesale market information indicated that there was not a significant relationship between greenhouse size and exclusive participation in wholesale markets.

Greenhouse managers indicated that on average, 4.5 percent of their gross annual sales was allocated toward advertisement in 1993. Overall, the largest percentages of this advertising budget were spent on newspaper, yellow pages and radio advertising. Television advertisement was reported by all categories of greenhouse except those in the smallest size stratum. Television was especially important among the

largest greenhouses, and received the largest relative percentage of the total advertizing budget for these operations. The relative allocation of the total advertising expenditure among eastern, middle and western Tennessee greenhouse indicated that advertising dollars were spent roughly the same in each region. Among all regions, newspaper advertisement was indicated to have received the largest relative proportion of advertising dollars in 1993. Among East Tennessee greenhouses, advertisement in the yellow pages was reported as second in relative cost, in Middle Tennessee radio was ranked second, and in West Tennessee, "other" media, primarily television, was listed as second in relative advertising expense.

The managers of greenhouses in all size categories indicated that a large number of factors were considered in decisions of product pricing. Pricing decision factors listed as important to growers included, in descending order, the cost of production, the quality of plants, market demand, last years price, comparison to other growers, time of year, and traditional price. Pricing factors considered overall to be not important were current inventory and inflation.

Bedding plants were reported to contribute the largest relative proportion of greenhouse gross annual sales by managers of greenhouses of all sizes. Next in importance were flowering potted plants, followed by foliage plants, and cut flowers. Greenhouse products listed as "other" were also

important to the sales of some greenhouses and included plants such as cacti and tobacco seedlings.

The greenhouse survey results indicated that two peak sales periods accounted for almost three-fourths (71.9 percent) of the total annual sales of greenhouse products. The largest relative percentages of sales, overall, was reported to occur in April (57.9 percent) and December (14 percent). In general, the incomes of larger sized greenhouse operations were relatively more evenly distributed throughout the year than were the incomes generated by smaller farms indicating a comparative advantage of the larger sized greenhouse operations.

Concluding Remarks

The relatively lengthy introduction to this study was proposed in order to draw specific attention to the overall size of the green industry, and to point out the economic importance of national, regional and Tennessee green industry product sales. A second purpose of the introduction was to examine the relative contributions of both the floriculture and environmental horticultural subsectors to overall green industry totals. This portion of the overall study drew on secondary data to disaggregate industry production and marketing totals into U.S., southern region, reduced-south

(excluding Florida and Texas) region and Tennessee statistics. Examination of these statistics provided a background for the green industry economic environment; assisted with the identification of specific floriculture industry data needs; and provided a foundation for survey questionnaire development.

This economic survey and resulting study have served to assist economists and agriculturalists alike through the collection and summarization of primary floriculture industry production and marketing data for Tennessee. The dearth of such information in general, and the need to increase the role of university researchers in primary floriculture industry data collection has been cited by researchers at the state and federal levels. In addition to providing a set of primary data, the study has also provided a survey instrument that could be used to measure the population at repeated intervals in order to examine structural changes in the production and marketing of Tennessee greenhouse products over time.

This study should be of value to Tennessee greenhouse managers, agribusiness firms and agricultural extensionists because it has provided a detailed description of state-wide production and marketing characteristics with reference to greenhouse size, gross annual income and region. Additionally, the distribution of floriculture product sales by market channel has been examined, along with the pricing strategies employed by greenhouse managers. The information

provided through the survey about manager-planned increases in the total area under greenhouse covering and the planned adoption of new greenhouse production technologies should be of use to concerned individuals or agencies with respect to long-run planning decisions.

Further Research Needs

A particular weakness of this survey was the insufficient detail of information provided by the questionnaire for greenhouses in the higher range of gross annual sales. Evidence of this problem was revealed in an initial attempt to use economic class mid-point dollar values to derive estimates of the average gross annual sales per square foot of space for greenhouse operations of various sizes. The extremely low average sales value per square foot for class 6 greenhouse operations indicated that these farms must have sold products valued well in excess of \$500,000 which was the highest dollar value specifically categorized for response in the survey questionnaire. An appropriate adjustment to the questionnaire would be to expand some of the lower sales categories to include a wider range of values while at the same time adding new, more detailed strata for the classification of firms with relatively high incomes. This adjustment would allow the recovery of detailed data for these more economically

important greenhouses without increasing the overall number of strata to be manipulated during analysis.

A data problem also resulted in the attempt to use data collected according to greenhouse size for an analysis of greenhouse characteristics related to region within Tennessee. While some significant findings were identified, the results of statistics based on a regional stratification of the data were inconclusive. Further investigation of this would require larger samples from middle and west Tennessee farmers.

Although a relatively large amount of descriptive data has been collected, further surveys will be required to obtain the detailed financial and crop specific production information needed by researchers to create representative production and marketing budgets for specific Tennessee floriculture products, and to determine the economic efficiency of various combinations of greenhouse crop production technologies currently in use by Tennessee farmers.

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APPENDIX

GENERAL INFORMATION

1. In what year was your greenhouse

business established? _____

2. How many people does your business
employ at this location?

Paid or unpaid family members _____

Other full or part time
permanent employees _____

Seasonal employees _____

PRODUCTION AREA

3. What is the total area you have under
greenhouse covering?

_____ sq.ft.

4. How much of your greenhouse area is
under each of the following types of
covering?

<u>Type of Covering</u>	<u>Area</u>
Single layer poly	_____ sq.ft.
Double layer poly	_____ sq.ft.
Acrylic/polycarbonate	_____ sq.ft.
Fiberglass	_____ sq.ft.
Glass	_____ sq.ft.
Shade	_____ sq.ft.

5. Do you plan to expand your growing area within the next 2 years? If so, by about how many square feet?

_____ sq. ft.

6. If you do not plan to expand, what factors currently limit the size of your production capacity? Please indicate the relative importance of each of the following.

	<u>not</u> <u>important</u>		<u>very</u> <u>important</u>		
Market demand	1	2	3	4	5
Competition	1	2	3	4	5
Land	1	2	3	4	5
Labor	1	2	3	4	5
Own management capacity	1	2	3	4	5
Environmental regulation	1	2	3	4	5
Other government regulations	1	2	3	4	5
Ability to hire competent management	1	2	3	4	5
Other_____	1	2	3	4	5

7. For each season in 1993, please estimate the percentage of your total greenhouse space which was allocated to each of the following crops.

	Spring	Summer	Fall
Bedding/garden plants	_____ %	_____ %	_____ %
Foliage	_____ %	_____ %	_____ %
Cut flowers	_____ %	_____ %	_____ %
Flowering potted	_____ %	_____ %	_____ %
Cut cultivated greens	_____ %	_____ %	_____ %
Vacant (not planted)	_____ %	_____ %	_____ %
	100%	100%	100%

8. Between 0% and 100%, approximately what percentage of your total production space was occupied during each month in 1993?

JAN _____ %	MAY _____ %	SEPT _____ %
FEB _____ %	JUN _____ %	OCT _____ %
MAR _____ %	JUL _____ %	NOV _____ %
APR _____ %	AUG _____ %	DEC _____ %

GROWING PRACTICES AND EQUIPMENT

9. Which of the following production methods, or greenhouse equipment, do you currently use, or plan to adopt within the next five years? Please check the appropriate column. If you do not use a specific item, or do not plan to adopt it, leave the spaces for that entry blank.

	<u>currently</u> <u>using</u>	<u>planned</u> <u>within</u> <u>next</u> <u>5 years</u>
Heating System		
Central heating system (water or steam)	_____	_____
Unit heaters	_____	_____
Convection heat	_____	_____
Horizontal air fans	_____	_____
Poly tube ventilation	_____	_____
Other _____	_____	_____
Heat Delivery		
Bottom heating under benches	_____	_____
Perimeter lines	_____	_____
Radiant heat in floor/beds	_____	_____
Root zone heating	_____	_____
Poly tube ventilation	_____	_____
Horizontal air flow fans _____	_____	_____
Other _____	_____	_____

	<u>currently</u> <u>using</u>	<u>planned</u> <u>within</u> <u>next</u> <u>5 years</u>
Cooling		
Poly tube ventilation	_____	_____
Side exhaust fans	_____	_____
Ceiling fans	_____	_____
Ridge vents	_____	_____
Open doors in summer	_____	_____
Fan and pad cooling (evaporative)	_____	_____
High pressure fog	_____	_____
Other _____	_____	_____
Environmental Control		
Manual adjustment	_____	_____
Thermostat	_____	_____
Thermister (sensor/ voltage regulator)	_____	_____
Environmental sensor with microprocessor chip (computer control) _____	_____	_____
Other _____	_____	_____

	<u>currently</u> <u>using</u>	<u>planned</u> <u>within</u> <u>next</u> <u>5 years</u>
Type of Beds/Benches		
Growing on the Floor		
a. dirt/gravel	_____	_____
b. porous concrete	_____	_____
c. fresh-cut flower beds	_____	_____
Raised fixed benches		
a. snow fencing	_____	_____
b. black poly	_____	_____
c. hardware cloth	_____	_____
d. expanded metal	_____	_____
Rolling Bench System		
a. expanded metal	_____	_____
b. other	_____	_____
Moveable bench/rail (system)	_____	_____
Ebb and flow benches	_____	_____
Other _____	_____	_____

	<u>currently</u> <u>using</u>	<u>planned</u> <u>within</u> <u>next</u> <u>5 years</u>
--	----------------------------------	--

Irrigation and Fertilization System

Fresh-cut flowers

a. hand watering	_____	_____
b. perimeter watering	_____	_____
c. dew hose	_____	_____
d. ooze header	_____	_____
e. turbulent twin wall	_____	_____
f. growing in rock wool	_____	_____
g. other	_____	_____

Potted Plants

a. hand watering	_____	_____
b. spaghetti tubes	_____	_____
c. matt watering	_____	_____
d. overhead spray	_____	_____
e. ebb and flow	_____	_____
f. other	_____	_____

	<u>currently</u> <u>using</u>	<u>planned</u> <u>within</u> <u>next</u> <u>5 years</u>
Miscellaneous Equipment		
Shade curtain	_____	_____
Thermal screen	_____	_____
Black cloth	_____	_____
CO2 enrichment	_____	_____
Ridge mounted vertical fan to direct air down	_____	_____
Mist/fog system for propagation	_____	_____
Supplemental lighting	_____	_____
Horizontal air flow fans	_____	_____
Plug seeder	_____	_____
Automatic potting machine	_____	_____
Automatic transplanter	_____	_____
High intensity lighting	_____	_____
Refrigerated storage	_____	_____
Other_____	_____	_____

	<u>currently</u> <u>using</u>	<u>planned</u> <u>within</u> <u>next</u> <u>5 years</u>
Computerization		
Word processing	_____	_____
Accounting	_____	_____
Inventory	_____	_____
Financial Investment	_____	_____
Marketing	_____	_____
Communications	_____	_____
Crop rotation	_____	_____
Production scheduling	_____	_____
Environmental Control	_____	_____
Other_____	_____	_____
Handling Equipment		
Carts (hand)	_____	_____
Carts (motorized)	_____	_____
Monorail	_____	_____
Conveyors	_____	_____
Movable bench system	_____	_____
Other_____	_____	_____

BUSINESS ACTIVITY**CUSTOMER PROFILE**

10. Approximately what percentage of your total sales was to each of the following types of customer in 1993?

- a. Retail to customers _____ %
 - b. Wholesale to mass merchandisers
(grocery, discount center, etc.) _____ %
 - c. Wholesale to florists _____ %
 - d. Wholesale to garden centers _____ %
 - e. Mail order _____ %
 - f. Other _____ %
- 100%**

ADVERTISING

11. What percentage of annual sales do you allocate to advertising? _____ %

12. How do you allocate these advertising dollars?

- | | |
|------------------------|--------------------|
| Yellow pages _____ % | Radio _____ % |
| Billboards _____ % | Catalogs _____ % |
| Trade journals _____ % | Newspaper _____ % |
| Trade shows _____ % | Newsletter _____ % |
| Direct mail _____ % | Other _____ % |
| | 100% |

PRICE DETERMINATION

13. How do you determine the sales price for greenhouse products? Please indicate the relative importance of each of the following.

	<u>not</u> <u>important</u>			<u>very</u> <u>important</u>	
Last year's price	1	2	3	4	5
Based on inventory	1	2	3	4	5
Inflation	1	2	3	4	5
Cost of production	1	2	3	4	5
Comparison to other growers	1	2	3	4	5
Quality of plants	1	2	3	4	5
Market demand	1	2	3	4	5
Time of year	1	2	3	4	5
Traditional price	1	2	3	4	5
Other _____	1	2	3	4	5

SALES DISTRIBUTION

14. Please estimate the percentage of your total annual sales which occurred during each month in 1993? These should add up to 100% for the entire year.

JAN _____%	MAY _____%	SEP _____%
FEB _____%	JUN _____%	OCT _____%
MAR _____%	JUL _____%	NOV _____%
APR _____%	AUG _____%	DEC _____%
		100%

15. Please rank each of the following in order of relative importance to total sales during your last fiscal year.

Bedding/garden plants	_____%
Foliage	_____%
Fresh-cut flowers	_____%
Flowering potted plants	_____%
Cut cultivated greens	_____%
Other _____	_____%
Other _____	_____%
Other _____	_____%
	100%

GROSS SALES

16. What was the gross value of product sales from your greenhouse in 1993, or your most recently completed fiscal year? Please check the appropriate category.

- _____ Less than \$10,000
- _____ \$10,000 - \$24,999
- _____ \$25,000 - \$49,999
- _____ \$50,000 - \$99,999
- _____ \$100,000 - \$499,999
- _____ \$500,000 or more

VITA

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