To the Graduate Council:

I am submitting herewith a thesis written by Hermon LaFayette Dickerson II entitled "Cost of Producing and Marketing Rooted Cuttings of Three Woody Ornamental Species in Three Middle Tennessee Nurseries, 1980." 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 Ornamental Horticulture and Landscape Design.

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COST OF PRODUCING AND MARKETING ROOTED CUTTINGS OF THREE WOODY ORNAMENTAL SPECIES IN THREE MIDDLE TENNESSEE NURSERIES, 1980

A Thesis

Presented for the

Master of Science

Degree

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To Debra and Laura

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ABSTRACT

The objective of this study was to develop an accurate means of computing total production and marketing cost incurred in propagating a woody ornamental cutting in Tennessee. A form developed by Oregon State University Agricultural Extension Service personnel was modified for production and marketing practices used by propagators in Middle Tennessee. Production and marketing costs were determined for three species of woody ornamental rooted cuttings produced by three commercial propagators.

Production and marketing costs per salable rooted cutting varied between species and among growers. Labor expense was the major cost in the total production and marketing cost per cutting. Both cash and non-cash costs were considered when computing production and marketing cost. Non-cash cost was a significant portion of the total production and marketing cost per salable rooted cutting.

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CHAPTER I

INTRODUCTION

Tennessee's nursery industry continues to grow in size and importance. Sales of woody ornamentals were almost $7 million in 1965 (12) and $20 million in 1972 (31). The plants were grown on approximately 12,000 acres in 1965 (12) and 14,700 in 1972 (31). In 1981, Tennessee growers sold about $100 million worth of woody ornamentals grown on over 20,700 acres. Tennessee ranks ninth in the nation in total woody ornamental sales (11).

In 1965, over 1.2 million rooted cuttings were produced by 62 commercial firms in Tennessee (12). The production of rooted cuttings as a part of the industry has grown rapidly since then but there is no specific data to indicate the rate of growth. The three commercial growers that supplied data for this study produced over two million rooted cuttings in 1980.

Plant propagators have developed improved cultural practices enabling them to produce good quality plants in a minimum length of time and with limited investment. Mist systems have reduced plant mortality and the time required to produce quality rooted cuttings. The use of refrigeration has enabled producers to use labor more efficiently, reduce plant losses in storage and maintain plant quality through the shipping season.

Most propagators have given more attention to reducing propagation expenses than to developing a system of pricing plants adequately to yield a reasonable net profit (8). Net profit for producing rooted cuttings is the money remaining after all production and marketing costs are paid. In other words, total sales revenue minus total production and marketing cost equals net profit.

Total sales revenue for rooted cuttings is determined by the selling price of each plant and the number of plants sold while total production and marketing cost is dependent on the variable and fixed costs incurred during propagation. Variable or direct costs (media, water, chemicals, etc.) vary in relation to the number of plants produced. Fixed costs, known also as indirect or overhead costs (depreciation on buildings and equipment, maintenance, insurance, utilities, etc.) do not vary in relation to the number of plants produced.

The selling price for each plant must cover not only the production and marketing cost but also the desired return on investment (profit). The selling price should be determined only after the plant propagator has considered all costs.

Most producers have limited information on their production and marketing cost. The propagator often assumes cost to be equal to or less than that of competitors. On this assumption, propagators often price plants based on a competitors' selling price. The probability of two propagators having the same production and marketing cost for the same plant species is low. Production and marketing costs vary among growers and between plant species. The variations are the result of

differences in production practices, cost of production materials, size and efficiency of operations, marketing strategies and overhead costs.

A major obstacle to production and marketing cost determination has been the extensive records required. To overcome this obstacle, agricultural economists and ornamental plant specialists of the Oregon State University (OSU) Agricultural Extension Service developed a form for computing plant propagation production and marketing cost using estimates. The form enables growers to determine cost with minimum recordkeeping. The OSU systems takes costs from the beginning to the end of the production cycle and computes a total production and marketing cost for each salable rooted cutting.

The objective of this study was to develop an accurate means of determining total production and marketing cost incurred in propagating a woody ornamental cutting in Middle Tennessee. Production and marketing costs were computed for Juniperus horizontalis 'Plumosa Compacta Youngstown' (Youngstown Andorra juniper), Ilex crenata 'Hetzii' (Hetz Japanese holly) and Euonymus alatus 'Compactus' (dwarf winged euonymus) rooted cuttings (9).

CHAPTER II

REVIEW OF LITERATURE

Published data on the cost of production and marketing for specific species or cultural groups of plants are almost non-existent. However, several researchers have contributed to a better understanding of production and marketing costs and to how these costs are determined.

Surtees (30) developed a series of standardized labor charts based on nursery practices. By using the labor data, growers could reduce the guesswork required for computing the costs of production and for determining a selling price for plant material. The importance of proper recordkeeping was stressed for accurate production cost determination.

Padgett and Frazier (20) collected cost data in 1962 from several small, medium and large woody ornamental container nurseries in Georgia. Average costs of production were computed for liners, 1-gallon and 3-gallon container size plants. No attention was given to individual plant species. Average production costs reported were: liner-size[1] plants--$.125 each; 1-gallon container plants--$.459 each; and 3-gallon container plants--$1.35.[2]

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[1]A well-developed plant in a 2.5 inch (6.4 cm) pot which was capable of becoming a quality 1-gallon container plant.

[2]The study assumed labor cost at $.50 per hour and 85% of plants produced marketable.

Padgett (21) determined that the average cost of production in 1966 for three-year field grown plants in Georgia was $.855 per plant.[3] Individual plant species were not considered in the study. Padgett classified the types of variable and fixed cost to enable nursery managers to compute production costs.

Seven basic cost categories incurred in woody ornamental production were defined by Alyesworth and Gartner (1). The costs discussed were total variable, average variable, total fixed, average fixed, total, average total and marginal cost. The authors explained how the various costs could affect the nursery operation and influence management decisions. However, a system by which these costs could be computed was not given.

Perkins and Levins (22) described a method of determining cost of production based on the sum of direct (variable) and indirect (fixed) costs. Direct cost depended on the type of plant being grown while indirect cost was based on the overhead expenses allocated to the production area used during the development of a marketable plant.

The importance of using production costs in deciding which plants to produce to maximize profit was stressed by Gunter and Otte (14). They demonstrated how nurserymen could use existing nursery records to compute approximate production cost of a single plant. The authors recommended using the "rent" method. This method summed allocated (direct) costs and the "rent" (indirect costs) due from each plant. The

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[3]The study assumed labor cost at $.50 per hour and 75% of plants produced marketable.

"rent" was expressed in terms of cost per square foot of actual production area.

Florida nurserymen provided data concerning average sales along with costs and returns for several Florida publications (13,15). The studies were designed to supply information for the growers' use in making management decisions. The grower could compare his overall operation costs and efficiency to the data found in the studies. Production costs of specific plant types were not given.

In 1978, Yager (32) computed production cost of $.205 per liner at Cartwright Nurseries in Tennessee. It was assumed that all liner costs were the same regardless of species. Labor cost was the largest production cost item.

Hahn et al. (16) collected data in 1979 from ten wholesale nurseries producing container-grown stock in Ohio. The container production cycle was divided into nine cost factor divisions: liners, canning, fertilizing, weed control, shifting, pruning, spacing, overwintering and overhead. Producers were classified as small (<100,000 ft^2 production area), medium (100,000 to 400,000 ft^2 production area) and large (>400,000 ft^2 production area). Data were aggregated for all plant species. The results showed the cost divisions with the greatest impact on reducing total production costs for large producers were overhead, canning and liners and that the cost increased rapidly as the production cycle was lengthened.

The influence of individual input cost (operator's salary, supervisory labor, land, interest rate and labor wages) changes on total production cost was analyzed by Smith (28). It was assumed that when

one input cost was changed, all other input levels and costs remained unchanged. The results showed labor wages produced the greatest change in production cost per container plant. Other inputs, ranked from high to low in relation to the effect on production cost per plant, were operator's salary, supervisory labor, interest rate and annual cost of land.

Badenhop et al. (2,3,4,5) developed cost of production budgets and cost-price relationships for Pfitzer juniper, Kurume azalea, pin oak and flowering dogwood at nurseries within USDA plant hardiness zones 7, 8 and 9 (Figure 1). Differences in production techniques were found to be a major source of variation between climatic zones and among individual growers. Results indicated that production cost advantages existed for producers in the southern part of the United States.

The Horticultural Research Institute (17,18) has published nationwide analyses of cost data collected from growers. Producers could compare nursery operation costs with industry averages and determine where cost reduction should be undertaken. A major problem with these studies was the required synthesis of different production systems. Little consideration was given to local variables such as temperature and rainfall. Also, the national figures did not always relate to a given nursery situation.

A system for computer analysis of production costs of container-grown nursery stock was developed by Robertson et al. (26,27). The system allowed a grower located anywhere in the nation to enter nursery data into a general production cost model. The producer required access to a computer terminal to use the data bank and to receive the output.

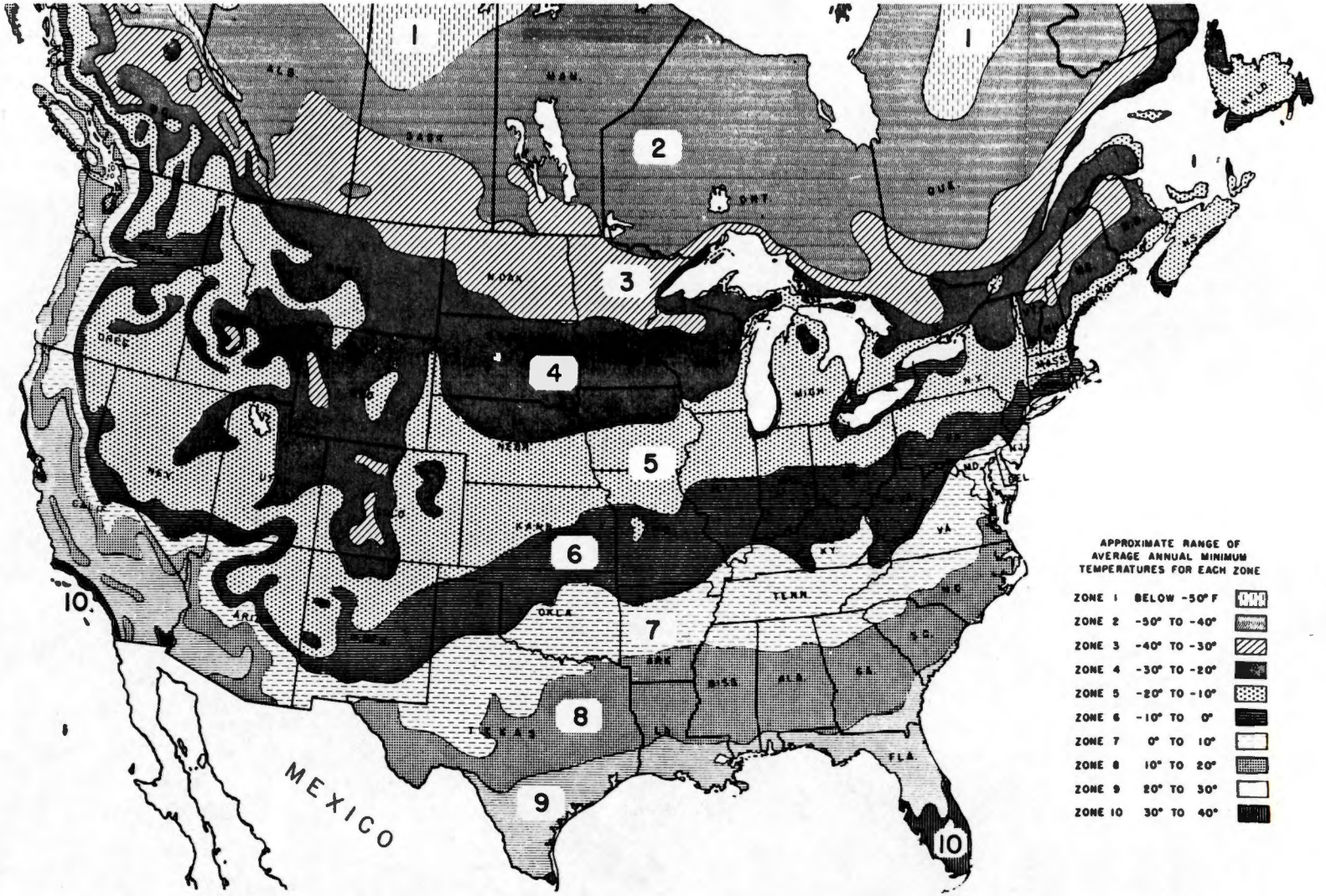


FIGURE 1. Zones of plant hardiness in the United States (from Plant Hardiness Zone Map, U.S. Dept. of Ag. Misc. Pub. 814, 1960).

The computer compared the nurseryman's input with industry-wide data taken during 1977 in Ohio. However, the changing economic climate made the accuracy of the comparison data questionable. If the nursery was not located in Ohio, the industry data were not always adequate for comparative purposes.

Phillips (23,24) developed a method to estimate the cost of producing woody ornamental landscape plants. Records required for completing the Internal Revenue Schedule F, Form 1040, were used in conjunction with cost of production budgets.

Lauderdale (19), using 1981 production data, determined a total production cost of $.28 per liner for Monrovia Nursery Company in California. The cost of production was computed without regard to plant species. Approximately $.14 of the total were variable (direct) growing costs. The remaining $.14 included costs such as equipment depreciation, management salaries, packing and delivery.

CHAPTER III

METHODOLOGY

The primary objective of this study was to develop a practical and accurate method for computing the production and marketing cost of propagating a woody ornamental cutting (Figure 2) in Middle Tennessee. Production and marketing costs per salable cutting were determined for three woody ornamental species propagated by three commercial growers.

A modified version of the OSU form (Appendix A) was developed to record expenditures made by Tennessee propagators. Several standard cost inputs on the original form were changed to reflect expenses found among growers in the Middle Tennessee production area.

Skilled labor (operator, supervisor, foreman) cost in this study was figured at $4.50 per hour. The unskilled labor (laborers) wage rate was $4.00 per hour. The total wage rate included the basic wage, social security tax (FICA), worker's compensation and unemployment compensation.

The mileage rate used for calculating travel costs was $.25 per mile. The mileage rate was adopted from AAA Auto Club estimates for 1980. The figure covered gasoline/oil, maintenance and repair, insurance, depreciation and other miscellaneous costs.

Middle Tennessee propagators sometimes use other growers' stock blocks as a source for unrooted cutting material.[4] This arrangement allows the producer to benefit from a stock block without having the

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[4]Stock blocks are used only as a source of cutting material.

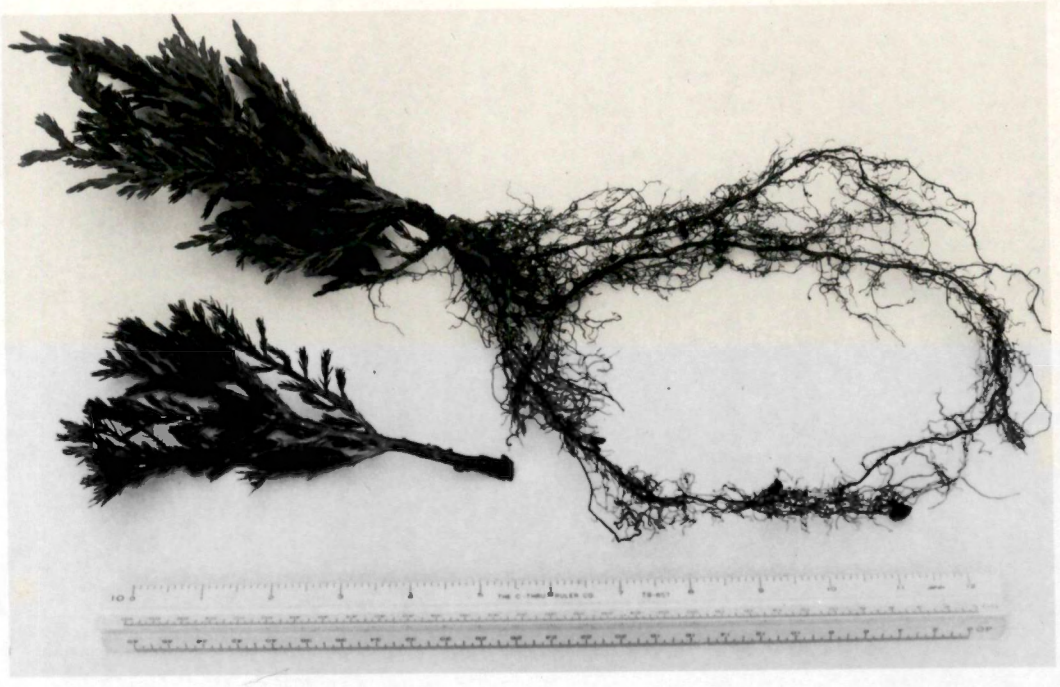


FIGURE 2. Unrooted and rooted Youngstown Andorra juniper cuttings.

responsibility for maintenance costs such as fertilization and weeding. As compensation, the original supplier of the unrooted material receives a percentage of the rooted crop (trade-back) or a discount from the propagator on a later purchase of nursery stock. The normal trade-back practice is for the original supplier to receive up to 10% of the rooted cuttings for the use of the stock block for cuttings.

The form was modified to include the trade-back cost. Producers normally did not consider trade-back plants a cost item when computing production cost. Because the propagator invested capital into the trade-back cuttings during their development, the investment should be recovered. In order to do so, growers should increase their production cost on the remaining (after trade-back) marketable crop to include the trade-back expense.

A 12% per annum interest rate was used to compute the opportunity cost for capital expenditures. Opportunity cost is the return a resource (capital) can earn when put to its best alternative use (10). By investing the capital into the nursery business, the owner has elected to forego the opportunity to use his money in other enterprises.

Depreciation cost was figured using the straight-line method.[5] As a piece of equipment or a building is used, its economic value is gradually transformed into a product (10) such as rooted cuttings. Depreciation cost sets aside the expended economic worth so it may be used to replace the resource at the end of its useful life.

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[5](Original cost - salvage value) ÷ useful life in years.

Both cash and non-cash costs were used in computing the propagation production and marketing cost. Cash costs were those costs which required the grower to spend money, often described by the trade as out-of-pocket expenses. Wage, material and equipment expenditures are examples of cash costs. Non-cash costs do not involve the actual transfer of funds. These costs were difficult for most producers to determine since money was not physically spent. Examples of non-cash costs are depreciation and interest. Many growers fail to consider non-cash costs when computing production and marketing costs. When this occurs, the propagator will generally underestimate the capital required to produce plants.

Production and marketing costs were developed for three plant species. The species were selected because they are grown by many Southeastern propagators and the propagation systems used are representative of those used for many other plant species. Data were collected from three Middle Tennessee commercial propagators. Two growers propagated over one-half million rooted cuttings each in 1980 while the third grower produced about one million. Each producer was interviewed on several occasions. The propagators supplied the input data to compute each separate cost.

CHAPTER IV

PROPAGATION FACILITIES AND PRODUCTION PROCEDURE

Two basic types of propagation facilities were used: (1) individual outdoor beds and (2) plastic covered quonset houses each containing two growing beds (Figures 3, 4 and 5).

Grower 1 used 4 ft x 50 ft (1.2 m x 15.2 m) outdoor propagation beds for all production. Concrete reinforcement wire was used to support the plastic covering. The structure remained closed on both ends until rooting began. The mist system was placed in the covered bed and remained in operation 6 to 8 weeks or until rooting was well underway. Beds were hand-watered after the mist system was removed. After the cuttings were well established and as weather permitted, the plastic covering was removed. The cuttings were maintained until harvest.

Grower 2 used 12 ft x 98 ft (3.7 m x 29.9 m) plastic covered quonset houses which contained two 5 ft x 96 ft (1.5 m and 29.3 m) propagating beds. The mist system was placed in each rooting bed. The beds were misted for 6 to 8 weeks or until the cuttings were rooted. During spring and summer months, the houses were sprayed with white wash or covered with shade cloth to protect cuttings from excessive solar radiation. Maintenance practices were continued until harvest.

Grower 3 used both the 12 ft x 98 ft (3.7 m x 29.9 m) plastic covered quonset houses which contained two 4 ft x 96 ft (1.2 m x 29.3 m) growing beds and 4 ft x 48 ft (1.2 m x 14.6 m) outdoor



FIGURE 3. Types of propagation structures used by growers; outdoor beds and quonset houses.



FIGURE 4. Outdoor beds covered for winter protection.



FIGURE 5. Quonset house containing two beds.

propagation beds. Cultural techniques were similar to those used by growers 1 and 2.

The production cycles used in the propagation of each species are standardized and given in Appendix B. Only minor differences were found in the propagation practices used by the three growers.

CHAPTER V

RESULTS AND DISCUSSION

Production Cycle Characteristics

Data for the 1980 rooted cutting crop were used in this study. The length of production cycle, number of cuttings stuck and survival rate of cuttings for each grower are given in Table 1.

TABLE 1. Production cycle characteristics of three species of woody ornamental rooted cuttings for three growers, Middle Tennessee, 1980.

Plant species	Unit	Grower 1	Grower 2	Grower 3
Youngstown Andorra Juniper				
Survival percentage	percent	70	80	85
Cuttings stuck	number	33,000	82,000	13,700
Length of production cycle	months	18	18	18
Hetz Japanese Holly				
Survival percentage	percent	65	90	85
Cuttings stuck	number	23,100	24,000	15,800
Length of production cycle	months	18	18	20
Dwarf Winged Euonymus				
Survival percentage	percent	60	90	85
Cuttings stuck	number	69,000	36,000	59,800
Length of production cycle	months	7	7	24

The survival percentage of cuttings was dependent on mortality and culling losses which were estimated by each grower using records of previous crops. Grower 1 had the lowest survival percentages on all species. Growers 2 and 3 had survival percentages ranging from

80 to 90% for the three species. The survival percentage depended on several factors: (1) the species rooted, (2) adequate misting of cuttings during root development, (3) maintenance (weeding, watering, pruning, fertilizing) of rooted cuttings through development into a marketable plant and (4) grading standards used in selecting salable cuttings.

The size of each cutting crop stuck was obtained from production records kept by each grower. The growers considered past sales records and the availability of the species in the marketplace to decide which species to grow and how many cuttings of a species to produce.

All three growers used similar production cycles for Youngstown Andorra juniper and Hetz Japanese holly. However, for dwarf winged euonymus, growers 1 and 2 used a 7-month production cycle while grower 3 used a 24-month production cycle.

Production data used in determining the production and marketing costs for each grower are given in Table 2. The primary difference in production cost data between growers was overhead expense, in particular initial investment in buildings and equipment.

Computed Production and Marketing Cost

The computed production and marketing cost per marketable cutting for each species and grower is given in Table 3. Grower 2 had the lowest production and marketing cost for all three species while grower 3 had the highest. A comparison of production and marketing cost per rooted cutting with the wholesale selling price (Table 2) demonstrates the importance of knowing all costs.

TABLE 2. Production data used for computation of production and marketing cost for three species of woody ornamental rooted cuttings for three growers, Middle Tennessee, 1980.

Item	Unit	Grower 1	Grower 2	Grower 3
Factor costs				
Land per acre	dollars	3,000	1,500	1,500
Taxes per acre	dollars	15	2	5
Labor per hour				
Skilled	dollars	4.5	4.5	4.5
Unskilled	dollars	4	4	4
Management				
Labor, percent of total labor cost	percent	20	20	20
Operation, percent of total cash costs	percent	15	15	15
Capital interest rate (annual)	percent	12	12	12
Overhead (annual)	dollars	15,300	25,000	24,000
Total cuttings produced	million	.5	1	.5
Initial investment				
Buildings	dollars	30,000	80,000	80,000
Propagation structure				
Bed	dollars	209		150
Greenhouse	dollars		500	400
Irrigation system				
Bed	dollars	125		117
Greenhouse	dollars		294	303
Equipment	dollars	3,500	22,600	59,500
Wholesale price per plant/size of plant at harvest				
Youngstown Andorra Juniper	dollars/inches	.32/6	.32/6	.30/6
Hetz Japanese Holly	dollars/inches	.30/6	.30/6	.30/6
Dwarf Winged Euonymus	dollars/inches	.30/6	.30/6	.55/6-9 .80/9-12

TABLE 3. Production and marketing cost per marketable cutting for three species of woody ornamental plants for three growers, Middle Tennessee, 1980.

Plant species	Grower 1	Grower 2[a]	Grower 3	Average for species
	----cents per rooted cutting-----			
Youngstown Andorra Juniper	27	18	34	26
Hetz Japanese Holly	30	20	43	31
Dwarf Winged Euonymus	20	10	40	23
Average for grower	26	16	39	

[a]Actual production cost may be slightly higher for Youngstown Andorra juniper and Hetz Japanese holly due to discounts on other types of plant material in place of trade-back arrangement.

Cash and Non-cash Costs

Cash and non-cash costs are given in Table 4. Cash cost ranged from 7.6 to 26.2 cents per salable cutting or 61 to 79% of the total production and marketing cost. Non-cash cost ranged from 3.4 to 16.8 cents per salable cutting or 21 to 39% of the total production and marketing cost. Non-cash costs were a significant component of the total production and marketing cost. If a producer does not take non-cash costs into account, an underestimation of investment may occur.

Labor Cost

Labor expense was a large portion of the total production and marketing cost. Labor cost as a percentage of total cost is shown in Table 5. Labor cost percentage ranged from 30 to 53% of the total

TABLE 4. Cash and non-cash amount and percentage of total production and marketing cost for three species of woody ornamental rooted cuttings for three growers, Middle Tennessee, 1980.

Plant species	Grower 1		Grower 2		Grower 3	
	Cents per plant	Percent of total cost	Cents per plant	Percent of total cost	Cents per plant	Percent of total cost
Youngstown Andorra Juniper						
Cash	17.8	66	12.2	68	22.1	65
Non-cash	9.2	34	5.8	32	11.9	35
Total	27.0	100	18.0	100	34.0	100
Hetz Japanese Holly						
Cash	19.2	64	14.0	70	26.2	61
Non-cash	10.8	36	6.0	30	16.8	39
Total	30.0	100	20.0	100	43.0	100
Dwarf Winged Euonymus						
Cash	15.8	79	6.7	67	24.8	62
Non-cash	4.2	21	3.3	33	15.2	38
Total	20.0	100	10.0	100	40.0	100

TABLE 5. Labor cost as a percentage of total production and marketing cost for three species of woody ornamental rooted cuttings for three growers, Middle Tennessee, 1980.

Plant species	Grower 1	Grower 2	Grower 3
	------percent-----		
Youngstown Andorra Juniper	36	39	32
Hetz Japanese Holly	33	46	31
Dwarf Winged Euonymus	53	47	30

production and marketing cost for the three species. The computed values support the findings of other researchers (16,25). Grower 3 had the least variation in labor cost percentage, ranging from 30 to 32% of total cost. Grower 1 had the highest labor cost percentage (53%) for winged euonymus. Labor time requirements for the three growers are given in Table 6. Grower 1 used 11.5 man-hours of labor per thousand rooted winged euonymus cuttings (7-month production cycle) as compared to 9.4 and 8.6 man-hours for the Andorra juniper and Hetz holly (18-month production cycles). Plant propagation practices used by the three growers in Middle Tennessee require much hand labor. Maintenance practices (weeding, watering, pruning, fertilizing) are done primarily by hand. Little mechanization was involved in production of the three species studied. The labor time used for each crop was influenced by: (1) cultural requirements of the species, (2) efficiency of workers and/or supervisors and (3) length of the production cycle.

TABLE 6. Man-hours required to produce one thousand woody ornamental rooted cuttings of three species for three growers, Middle Tennessee, 1980.

Plant species	Grower 1	Grower 2	Grower 3
	man-hours per thousand rooted cuttings		
Youngstown Andorra Juniper	9.4	7.1	10.0
Hetz Japanese Holly	8.6	11.7	11.8
Dwarf Winged Euonymus	11.5	7.2	12.7

All three growers pruned Andorra juniper and Hetz holly at least one time during the 18-month production cycle (Schedules B-1 and B-2, Appendix B). However, winged euonymus was not pruned since it produces only one flush of growth during each growing season. Thus, labor requirement for winged euonymus was reduced.

For Andorra juniper, grower 2 used only 7.1 man-hours per thousand rooted cuttings compared to 9.4 man-hours and 10.0 man-hours for growers 1 and 3. These data show the comparative labor efficiency of grower 2, especially when the size of the crop is considered. Grower 2 propagated 82,000 Andorra juniper cuttings while growers 1 and 3 propagated 33,000 and 13,700, respectively.

Grower 2 used 11.7 man-hours per thousand Hetz holly cuttings versus 7.2 man-hours per thousand winged euonymus cuttings. The difference in man-hour requirement between the two species was due partially to the length of the production cycle (18-month for Hetz

holly and 7-month for winged euonymus). Because winged euonymus had a seven-month production cycle, grower 2 reduced the number of man-hours required to maintain the crop during production.

Grower 1 used 1.9 beds to propagate Hetz holly cuttings while 9.6 beds were used to produce the winged euonymus crop. The greater number of propagation beds for winged euonymus required more labor time to monitor the growth and development of the cuttings. For grower 1, more man-hours were necessary to prepare, stick and harvest the winged euonymus cuttings. Data (Table 6) show that .0115 man-hours of labor were used per winged euonymus cutting while .0086 man-hours of labor were required to produce a Hetz holly cutting.

Analysis of Computed Production and Marketing Cost

An analysis of the cost categories used in determining the total production and marketing cost of each species for each grower is given in Table 7. A more detailed itemization of the cost categories shown in Table 7 is given in Tables 8, 9 and 10.

Cost of cutting (before sticking). The cutting (before sticking) cost category was subdivided into: (1) cuttings taken from plants other than stock plants, (2) cuttings taken from stock plants and (3) cuttings purchased. None of the growers purchased cuttings from a commercial supplier for any of the species studied. Grower 1 used other producers' stock plants as a source of cuttings for the three species. Grower 2 used other growers' stock plants to supply cuttings, except for the winged euonymus. A stock block of winged euonymus was maintained as

TABLE 7. Amount and percentage of production and marketing cost by cost categories for three species of woody ornamental rooted cuttings for three growers, Middle Tennessee, 1980.

Cost categories	Grower 1		Grower 2		Grower 3	
	Cents per plant	Percent of total cost	Cents per plant	Percent of total cost	Cents per plant	Percent of total cost
Youngstown Andorra Juniper						
Cutting (before sticking)	1.5	5.6	1.1	6.3	3.7	10.9
Rooting and growing cuttings	13.2	48.9	10.0	55.6	17.8	52.2
Overhead	6.6	24.6	4.7	25.9	8.5	25.1
Operating capital interest	3.2	11.8	2.2	12.2	4.0	11.8
Trade-back[a]	2.5	9.1	--	--	--	--
Total	27.0	100.0	18.0	100.0	34.0	100.0
Hetz Japanese Holly						
Cutting (before sticking)	1.2	4.1	4.0	20.0	2.3	5.4
Rooting and growing cuttings	15.4	51.3	9.3	46.6	25.7	59.7
Overhead	7.2	24.1	4.2	20.8	9.7	22.6
Operating capital interest	3.5	11.5	2.5	12.6	5.3	12.3
Trade-back[a]	2.7	9.0	--	--	--	--
Total	30.0	100.0	20.0	100.0	43.0	100.0
Dwarf Winged Euonymus						
Cutting (before sticking)	2.9	14.5	2.8	28.3	0.7	1.8
Rooting and growing cuttings	12.1	60.5	5.1	50.5	23.8	59.4
Overhead	2.9	14.7	1.6	16.5	9.6	24.0
Operating capital interest	1.1	5.5	0.5	4.7	5.9	14.8
Trade-back[a]	1.0	4.8	--	--	--	--
Total	20.0	100.0	10.0	100.0	40.0	100.0

[a]Compensation, usually 5 to 10% of the rooted salable cuttings of the same species, given by the grower to another producer who furnishes stock plants as a source of unrooted plant material.

TABLE 8. Analysis of the production and marketing costs of rooted cuttings by cost categories, Youngstown Andorra juniper, Middle Tennessee, 1980.

Cost categories	Grower 1	Grower 2	Grower 3
	--------percent--------		
Cutting (before sticking)			
Cuttings taken from plants other than stock plants	74.9	76.6	--
Cuttings from stock plants	--	--	94.6
Overhead	25.1	23.4	5.4
Total	100.0	100.0	100.0
Rooting and growing cuttings			
Facilities, equipment and supplies	37.5	48.0	64.6
Media	5.5	9.4	7.0
Preparing and sticking	13.6	10.2	9.7
Culture	13.6	10.1	1.9
Harvesting	17.8	10.5	11.5
Waste disposal and cleanup	1.2	0.5	0.2
Utilities	10.8	11.3	5.1
Total	100.0	100.0	100.0
Overhead			
Advertising and promotion	14.9	20.1	6.8
Dues, licenses, fees	11.7	4.8	6.7
Accounting, bookkeeping and secretarial services	29.5	43.6	48.2
Miscellaneous travel expense	25.8	10.9	16.9
Labor management	5.8	8.7	9.6
Operation management	12.3	11.9	11.8
Total	100.0	100.0	100.0

TABLE 9. Analysis of the production and marketing costs of rooted cuttings by cost categories, Hetz Japanese holly, Middle Tennessee, 1980.

Cost categories	Grower 1	Grower 2	Grower 3
	--------percent--------		
Cutting (before sticking)			
Cutting taken from plants other than stock plants	75.7	78.2	--
Cuttings from stock plants	--	--	88.2
Overhead	24.3	21.8	11.8
Total	100.0	100.0	100.0
Rooting and growing cuttings			
Facilities, equipment and supplies	40.6	50.9	69.0
Media	5.3	10.0	6.2
Preparing and sticking	10.6	7.1	6.6
Culture	9.6	11.3	4.4
Harvesting	22.6	9.3	9.5
Waste disposal and cleanup	1.2	0.5	0.3
Utilities	10.1	10.9	4.0
Total	100.0	100.0	100.0
Overhead			
Advertising and promotion	14.9	20.1	6.8
Dues, licenses, fees	11.7	4.8	6.7
Accounting, bookkeeping and secretarial services	29.5	43.6	48.2
Miscellaneous travel expense	25.8	10.9	16.9
Labor management	5.8	8.7	9.6
Operation management	12.3	11.9	11.8
Total	100.0	100.0	100.0

TABLE 10. Analysis of the production and marketing costs of rooted cuttings by cost categories, dwarf winged euonymus, Middle Tennessee, 1980.

Cost categories	Grower 1	Grower 2	Grower 3
	--------percent--------		
Cutting (before sticking)			
Cuttings taken from plants other than stock plants	76.4	--	--
Cuttings from stock plants	--	91.4	84.6
Overhead	23.6	8.6	15.4
Total	100.0	100.0	100.0
Rooting and growing cuttings			
Facilities, equipment and supplies	24.3	31.1	69.5
Media	12.2	15.1	5.7
Preparing and sticking	19.3	13.4	6.1
Culture	5.5	15.0	5.4
Harvesting	30.8	16.8	8.8
Waste disposal and cleanup	2.7	0.7	0.2
Utilities	5.2	7.9	4.3
Total	100.0	100.0	100.0
Overhead			
Advertising and promotion	14.9	20.1	6.8
Dues, licenses, fees	11.7	4.8	6.7
Accounting, bookkeeping and secretarial services	29.5	43.6	48.2
Miscellaneous travel expense	25.8	10.9	16.9
Labor management	5.8	8.7	9.6
Operation management	12.3	11.9	11.8
Total	100.0	100.0	100.0

a cutting source by grower 2. Grower 3 maintained stock blocks as a supply source for all three species.

By maintaining stock blocks, grower 3 reduced travel time for laborers and wear on vehicles. Because stock blocks were owned by grower 3, a supply of unrooted cutting material was guaranteed. However, stock block ownership was accompanied by installation and maintenance costs. Growers 1 and 2 avoided stock block expenses by using other growers' stock plants.

The data given in Table 7 shows that the number of cuttings taken by grower 3 from stock plants influenced the cost of cutting (before sticking) percentage and actual cost. Grower 3 reduced the cost of cutting (before sticking) from 3.7 to .7 cents by increasing the number of cuttings taken from the stock block from 13,700 to 59,800. In order to justify the ownership of stock blocks, the data suggests it may be necessary to have a minimum number of cuttings taken each production period. The minimum number would depend on the direct (variable) and indirect (fixed) expenses incurred while installing and maintaining the stock block. Because expenses differ between plant species and among growers, the minimum number of cuttings would not be the same for each grower or stock block.

Cost of rooting and growing cuttings. The cost of rooting and growing cuttings was the major expense in the total cost of a rooted cutting. The rooting and growing cost category accounted for 46.6 to 60.5% of the cost of production and marketing or 9.3 to 12.1 cents per rooted cutting. The rooting and growing cost category included

expenses for nursery structures, equipment, materials and utilities. Also included were labor costs incurred in the preparation, sticking, culture and harvesting of cuttings and cleanup of propagation beds after harvest. Shipping cost was not considered as a part of the production and marketing costs in this study. The growers who contributed data to this study transferred the expense of shipping to the consumer in the form of a handling charge or direct charge for shipping expense. Information on the shipping destinations for the crops studied is given in Appendix C. The data on shipping destinations were taken from shipping records of each grower.

Spacing intervals for the cuttings influenced the total cost per rooted cutting. Spacing intervals for each species are given in Table 11. Grower 2 used a closer spacing (1.5 in or 3.8 cm) than grower 3 and thus placed more cuttings in a given production area than grower 3. For example, using 1.5 in (3.8 cm) spacing, grower 2 placed nearly 24,600 juniper cuttings in a 4 ft x 96 ft (1.2 m x 29.3 m) area. Grower 3, using 1.75 in (4.4 cm) spacing, could put only 18,100 juniper cuttings in the same area. The additional 6,500 cuttings stuck by grower 2 would be allocated a portion of the direct (variable) and indirect (fixed) costs of the propagation bed, thereby reducing the amount allocated to each rooted cutting in each bed. An optimum spacing would maximize the number of cuttings in a given growing area and minimize cutting loss due to overcrowding, insects and disease.

TABLE 11. Spacing interval, rooting bed dimensions and approximate cutting capacity of beds used by three growers for three species of woody ornamental cuttings, Middle Tennessee, 1980.

Plant species	Unit	Grower 1	Grower 2	Grower 3
Youngstown Andorra Juniper				
Spacing interval	inches(centimeters)	1.5(3.8)	1.5(3.8)	1.75(4.4)
Rooting bed dimensions	feet(meters)	4 x 50(1.2 x 15.2)	5 x 96(1.5 x 29.3)	4 x 96(1.2 x 29.3)
Cutting capacity	number	12,800	30,700	18,100
Hetz Japanese Holly				
Spacing interval	inches(centimeters)	1.5(3.8)	1.5(3.8)	2.0(5.1)
Rooting bed dimensions	feet(meters)	4 x 50(1.2 x 15.2)	5 x 96(1.5 x 29.3)	4 x 48(1.2 x 14.6)
Cutting capacity	number	12,800	30,700	6,900
Dwarf Winged Euonymus				
Spacing interval	inches(centimeters)	2.0(5.1)	1.5(3.8)	2.0(5.1)
Rooting bed dimensions	feet(meters)	4 x 50(1.2 x 15.2)	5 x 96(1.5 x 29.3)	4 x 48(1.2 x 14.6)
Cutting capacity	number	7,200	30,700	6,900

Overhead. Overhead costs reflected the management decisions of each propagator. The data show that increasing production decreased cost per cutting. Grower 2 produced one million rooted cuttings while growers 1 and 3 each produced about one-half million. Therefore, overhead (fixed) costs were distributed over more cuttings for grower 2 which reduced the total cost for each rooted cutting. Grower 3 had the highest cost per salable cutting for each of the selected species. The total annual overhead costs for grower 3 ($24,000) were almost the same as those of grower 2 ($25,000). Because grower 3 produced only one-half as many cuttings as grower 2, the overhead cost distributed to each marketable cutting was increased.

Overhead costs charged to the individual plant increased as the production cycle lengthened. Grower 3 used a 24-month production cycle for winged euonymus and overhead costs were $5,700. If a 7-month production cycle had been used, overhead costs would have decreased to approximately $1,700. The additional 17 months increased overhead costs by $4,000 or over $235 per month. The data suggests that the production cycle be shortened as much as possible. However, the propagator must consider the size and quality of the finished plant.

Operating capital interest. Operating capital interest was directly affected by the cash costs incurred in the cutting (before sticking), rooting and growing cuttings and overhead cost categories. Decreased cash expenditures would result in a lower operating capital interest charge for each grower. For example, grower 1 had total cash costs of $3,700 for the production of Andorra juniper which produced

an operating capital expense of over $650. By reducing total cash expenses 20%, operating capital interest would have been lowered to about $530.

Operating capital interest expense could have been reduced if the production cycle was shortened. For example, if grower 3 had used a 7-month production cycle for winged euonymus instead of a 24-month production cycle, interest charges would have lowered from over $3,500 to about $1,000.

Trade-back cost. Only grower 1 used a trade-back arrangement to procure a supply of unrooted cuttings. The data in Table 7 shows the effect of trade-back on the final production and marketing costs. Ten percent of both the rooted Andorra juniper and Hetz holly crop were traded-back while 5% of the rooted winged euonymus crop was traded-back to the original supplier of the unrooted cutting materials. This added 1 to 2.7 cents to the production and marketing cost per rooted salable cutting for grower 1.

Grower 2 gave a 10% discount on any nursery stock to the supplier of unrooted Andorra juniper and Hetz holly material. The effect of the discount on the total production and marketing cost per plant is unknown but would depend on the discounted price of the nursery material purchased by the supplier of the unrooted material. The grower should consider the effects of discounts on the production and marketing cost and make the required adjustments in total cost.

Limitations

The computed costs in this thesis are valid only for the data used herein and should not be used for other nursery production systems or plant species. Each grower must evaluate production practices, cost of production materials, size of operation, marketing strategies and overhead costs during a specific production period. Adjustments in the various costs used to compute total production and marketing costs must be periodically made to adequately cover cost increases due to inflation.

Each production system is different and it is misleading to suggest that the results shown in this paper are the same or similar to those of any other producer. However, these results support the findings of other workers.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The objective of this study was to develop an accurate means of determining total production and marketing cost incurred in propagating a woody ornamental cutting in Middle Tennessee. Production and marketing costs were computed for Juniperus horizontalis 'Plumosa Compacta Youngstown' (Youngstown Andorra juniper), Ilex crenata 'Hetzii' (Hetz Japanese holly) and Euonymus alatus 'Compactus' (dwarf winged euonymus). A form developed by Oregon State University was modified for production and marketing practices used by propagators in Middle Tennessee. The form considered five cost categories: (1) cuttings (before sticking), (2) rooting and growing cuttings, (3) overhead, (4) operating capital interest and (5) trade-back. Three Middle Tennessee commercial propagators contributed data to this study.

The production and marketing cost of a salable rooted cutting are as follows: Andorra juniper--18 to 34 cents, Hetz holly--20 to 43 cents, dwarf winged euonymus--10 to 40 cents. Production and marketing costs were affected by (1) number of cuttings produced, (2) spacing interval between cuttings in the rooting bed, (3) survival percentage of cuttings and (4) overhead costs for the operation.

Cash and non-cash costs as percentages of total cost were determined. Cash costs as a percentage of total production and marketing costs for the species ranged from 61 to 79%. Non-cash costs ranged from 21 to 39% of total cost.

Labor expense was the major cost in the total production and marketing cost. Labor cost ranged from 30 to 53% of total cost for the three species grown by the three propagators. Labor time devoted to each crop was influenced by: (1) the species rooted, (2) efficiency of workers and/or supervisors and (3) length of production cycle.

Accurate and simple cost determination techniques are needed for all phases of the nursery industry. Additional cost computation forms should be developed for both container and field production of woody ornamental plant material in Tennessee. Since small personal computers are becoming economically feasible to many nurserymen, emphasis should be placed on the development of computer programs for cost computation. The programs must supply the grower with accurate and informative data which will assist in making decisions on production system alternatives and product mix. More information on production and marketing costs is necessary if growth of the nursery industry is to continue.

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APPENDICES

APPENDIX A

COST COMPUTATION TECHNIQUE

Instructions on Using the "Computing Costs of Plant Propagation" Form

This form has been developed for use by plant propagators to determine propagation costs for a single species of cutting. The form consists of five main sections. Section I is for determining the cost of cuttings before they are stuck. Sections II, III, and IV are for determining costs incurred while rooting and growing cuttings to a salable size. Section V brings the costs determined in Sections I through IV together for a total cost per rooted (salable) cutting.

The following points should be thoroughly understood before using the form:

1. The plant propagator should use only those subsections (A, B, C, etc.) and individual costs (1, 2, 3, etc.) that apply to the production system in use. All others should be ignored.

2. The wage rate should include not only the base wage per hour, but also the cost of benefits (social security, worker's compensation, insurance, etc.) broken down as an <u>hourly</u> cost. A government study (Chamber of Commerce, 1981) revealed that the employer's share of legally required payments (social security tax, worker's compensation, unemployment compensation) in 1980 amounted to 8.9% of the basic wage. For example, if the basic employee wage was $3.50 per hour, the employer must use a wage rate of $3.82 ($3.50 + $.32) to accurately reflect the labor cost.

Percentages for additional employee benefits, such as pensions, insurance, and sick leave are shown in Table A-1. These figures should serve as guidelines in the computation of hourly labor cost.

3. The escalation of prices on petroleum products may require adjustment in the $.25 mileage rate. If adjustments must be made, the following average annual costs should be included when computing the new mileage rate: gasoline/oil, insurance, maintenance/repair (include parts and labor). The summation of these costs divided by the average annual mileage will determine the proper mileage rate to be charged.

For instance, if the annual average mileage for a company vehicle is 5,000 miles and the annual costs are as follows--

Gasoline/oil	$1,200
Insurance	200
Maintenance/repair	200
Total	$1,600

the mileage rate is $.32 ($1,600 ÷ 5,000 miles).

4. The interest rate should be adjusted to the current market situation in order to reflect adequately the costs of the rate of interest. The current interest rate at banks, credit unions, or other financial institutions is satisfactory. The rate should be expressed as a decimal value (for example, 12% = .12).

5. Estimates are usually sufficient to supply the information required to compute each specific cost. The plant propagator should make estimates using knowledge acquired during the last production cycle.

TABLE A-1. Percentage of basic wage for employee benefits, by type of benefit, 1980.[a]

Type of benefit	Percentage of basic wage
Pension, insurance, and other agreed-upon payments (employer's share only)	
a. Pension plan premiums and pension payments not covered by insurance type plan (net)	5.4
b. Life insurance premiums; death benefits; hospital, surgical, medical, and major medical insurance premiums, etc. (net)	5.8
c. Short-term disability	0.4
d. Salary continuation or long-term disability	0.3
e. Dental insurance premiums	0.3
f. Discounts on goods and services purchased from company by employees	0.1
g. Employee meals furnished by company	0.2
h. Miscellaneous payments (compensation payments in excess of legal requirements, separation or termination pay allowances, moving expenses, etc.)	0.1
Paid rest periods, lunch periods, wash-up time, travel time, clothes-change time, get-ready time, etc.	3.5
Payments for time not worked	
a. Paid vacations and payments in lieu of vacation	4.9
b. Payments for holidays not worked	3.4
c. Paid sick leave	1.3
d. Payments for State or National Guard duty; jury, witness and voting pay allowances; payments for time lost due to death in family or other personal reasons, etc.	0.3
Other items	
a. Profit-sharing payments	1.2
b. Contributions to employee thrift plans	0.3
c. Christmas or other special bonuses, service awards, suggestion awards, etc.	0.4
d. Employee education expenditures (tuition refunds, etc.)	0.2
e. Special wage payments ordered by courts, payments to union stewards, etc.	0.1

[a]Adapted from Employee Benefits, 1980, U.S. Chamber of Commerce, Washington, D.C., Bulletin 6503.

THE FORM SHOULD BE REVIEWED SEVERAL TIMES BEFORE ATTEMPTING TO COMPUTE THE COSTS OF PRODUCTION. This review will aid in understanding the form and its application.

COMPUTING COSTS OF PLANT PROPAGATION

This form is for use by plant propagators in determining their propagation costs.[a] It consists of five sections. Section I is for determining cost of cuttings before they are stuck. Sections II, III, and IV are for determining costs in rooting and growing cuttings to a salable size. Section V brings costs of all sections together for a total per cutting cost at salable size.

	Costs		
	Cash	Non-Cash	Total
I. COST OF CUTTING (BEFORE STICKING)			
A. Cuttings taken from plants away from nursery or from other than stock plants			
1. Labor (time) getting to and from source of cuttings; hours[b] _____ x wage rate $_____ =	$___		
2. Labor (time) for taking cuttings; hours[b] _____ x wage rate $_____ =	$___		
3. Miles traveled _____ x $.25 =	$___		
4. Materials (tools, bags, ties, labels, markers, etc.); .00007 x number of cuttings _____ =	$___		
5. Refer to Section V.D. (page 8) for cost determination of rooted cuttings used in trade for supply of unrooted cuttings			
A. SUBTOTAL, COST OF CUTTINGS	$___		$___
B. Cuttings from stock plants (maintained stock block)			
1. Market value of stock plants (this species) $_____ ÷ life of plant _____ = annual depreciation =		$___	
2. Maintenance of stock block			
a. Fertilization			
Labor, hours[b] _____ x wage rate $_____ + cost of fertilizer $_____ =	$___		
b. Irrigation			
(1) Labor, hours[b] _____ x wage rate $_____ =	$___		
(2) Depreciation: (original cost[c] $_____ - salvage value[d] $_____) ÷ 10-year life =		$___	
(3) Interest: (original cost[c] $_____ + salvage value[d] $_____) ÷ 2 = $_____ x interest rate[e] _____ =		$___	
c. Pest control			
(1) Herbicide labor, hours[b] _____ x wage rate $_____ = $_____ + material cost $_____ = total $_____			
(2) Hand weeding labor, hours[b] _____ x wage rate $_____ = total $_____			
(3) Insecticide labor, hours[b] _____ x wage rate $_____ = $_____ + material cost $_____ = total $_____			
(4) Fungicide labor, hours[b] _____ x wage rate $_____ = $_____ + material cost $_____ = total $_____			
Total of herbicides, hand weeding, insecticides, and fungicides =	$___		

[a] A modified version of a form developed by the Oregon State University Agricultural Extension Service, Corvallis, Oregon.

[b] Hours x number of men x number of times.

[c] Includes materials and labor.

[d] The money the system could be sold for now.

[e] Current annual interest rate; see instructions, #4.

	Costs		
	Cash	Non-Cash	Total
d. Miscellaneous maintenance costs			
(1) Pruning, shaping, disbudding: hours[b] _____ x wage rate $_____ =	$___		
(2) Establishment costs (if applicable) per plant $_____ ÷ life of plant in years _____ = $_____ x number of plants in block _____ =		$___	
(3) Other miscellaneous costs	$___	$___	
3. Land			
(Assessed value $_____ x .02)[f] = taxes per acre $____ x acres in block _____ = tax charge =		$___	
4. Labor for taking cuttings			
a. Time getting to and from stock block: hours[b] _____ x wage rate $_____ =	$___		
b. Time for taking cuttings: hours[b] _____ x wage rate $_____ =	$___		
5. Materials (tools, bags, labels, markers, sprayers, etc.); .00015 x number of cuttings _____ =	$___		
B. SUBTOTAL, COST OF CUTTINGS	$___	$___	$___
C. Cuttings purchased			
1. Price per cutting $_____ x number of cuttings _____ =	$___		
2. Postage, freight and/or transportation cost	$___		
3. Labor, if any, to pick up cuttings: hours[b] _____ x wage rate $_____ =	$___		
4. Miles traveled, if any, to pick up cuttings: miles _____ x $.25 =	$___		
C. SUBTOTAL, COST OF CUTTINGS	$___		$___
D. Overhead			
1. Labor management: 20% of hired labor costs for cuttings (A.2., B.4. and/or C.3. x .20) =	$___		
2. Operation management: 15% of cash costs (total cash costs from A, B and/or C x .15) =	$___		
D. SUBTOTAL, COST OF CUTTINGS	$___		$___
I. TOTAL COSTS (summation of subtotals A, B, C and D)	$___	$___	$___

II. COST OF ROOTING AND GROWING CUTTINGS

The following cost headings could apply to either a portion of a house used for propagation, to the entire house, or to a range of houses, including the associated equipment and buildings, whichever unit is most convenient for cost computation, for the entire year.

A. Facilities, equipment and supplies		
1. Greenhouse		
a. Depreciation[g] (10-year life)		$___
b. Interest[h]		$___

[b] Hours x number of men x number of times.

[f] Assessed value is estimated at 25% of full market value; taxes are estimated at a rate of 2% of assessed value per year.

[g] [Original cost (including labor) - salvage value] ÷ useful life in years.

[h] [Original cost (including labor) + salvage value] ÷ 2 x interest rate.

	Costs		
	Cash	Non-Cash	Total
c. Annual maintenance[c]	$____		
d. Insurance	$____		
e. Shading			
(1) Shading compound cost	$____		
(2) Labor for applying and removing shading compound, hours[b] _____ x wage rate $_____ =	$____		
(3) Shade covering (such as Saran shade cloth)			
(a) Depreciation[g] (5-year life)		$____	
(b) Interest[h]		$____	
(c) Labor for annual putting up and taking down, if applicable: hours[b] _____ x wage rate $_____ =	$____		
2. Miscellaneous buildings (head house, working shed, shade house, storage buildings, etc.) and concrete/asphalt pads and docks			
a. Depreciation[g] (20-year life)			
Depreciation $_____ x % figure[i] (_____), which equals the percentage of this crop to your total business =		$____	
b. Interest[h]			
Interest $_____ x % figure[i] (_____), which equals the percentage of this crop to your total business =		$____	
c. Annual maintenance[c]	$____		
d. Insurance	$____		
3. Propagation benches and/or beds			
a. Depreciation[g] (5-year life)		$____	
b. Interest[h]		$____	
c. Annual maintenance[c]	$____		
d. Insurance	$____		
4. Heating system for greenhouse and/or winter protection (insulation)			
a. Depreciation[g] [2-year (microfoam) up to 10-year (heater) life]		$____	
b. Interest[h]		$____	
c. Annual maintenance[c]	$____		
d. Insurance	$____		

[b] Hours x number of men x number of times.

[c] Includes materials and labor.

[g] [Original cost (including labor) - salvage value] ÷ useful life in years.

[h] [Original cost (including labor) + salvage value] ÷ 2 x interest rate.

[i] Total number of cuttings stuck of this species ÷ total nursery production of rooted cuttings.

	Costs		
	Cash	Non-Cash	Total
5. Heating system for benches, beds and/or flats			
a. Depreciation[g] (5-year life)		$___	
b. Interest[h]		$___	
c. Annual maintenance[c]	$___		
6. Mist system			
a. Depreciation[g] (5-year life)		$___	
b. Interest[h]		$___	
c. Annual maintenance[c]	$___		
7. Propagation flats			
a. Depreciation[g] (2-year life)		$___	
b. Interest[h]		$___	
c. Annual maintenance[c]	$___		
d. Annual replacement cost due to destruction	$___		
8. Miscellaneous equipment			
a. Trucks, tractors, tillers, etc.			
(1) Depreciation[g] (10-year life)			
Depreciation $___ x % figure[i] (____), which equals the percentage of this crop to your total business =		$___	
(2) Interest[h]			
Interest $____ x % figure[i] (____), which equals the percentage of this crop to your total business =		$___	
(3) Annual maintenance[c]	$___		
(4) Insurance	$___		
b. Hand trucks and carts, hand tools, sprayers, dibble or marking boards, soil sterilization and fumigation equipment, shears, cutting dip tanks or containers, knives, media mixing equipment, etc.			
(1) Depreciation[g] (2-year life)			
Depreciation $____ x % figure[i] (____), which equals the percentage of this crop to your total business =		$___	
(2) Interest[h]			
Interest $____ x % figure[i] (____), which equals the percentage of this crop to your total business =		$___	
(3) Annual maintenance[c]	$___		
(4) Insurance	$___		

[c] Includes materials and labor.

[g] [Original cost (including labor) - salvage value] ÷ useful life in years.

[h] [Original cost (including labor) + salvage value] ÷ 2 x interest rate.

[i] Total number of cuttings stuck of this species ÷ total nursery production of rooted cuttings.

	Costs		
	Cash	Non-Cash	Total

Housing and equipment costs should only be charged for that portion of the year and that portion of the house allocated to that crop of cuttings. For example, a crop of cuttings occupying 1/2 of the house for six months, followed by two three-month crops or one six-month crop of cuttings, would be charged 1/4 of these costs (1/2 of house for 1/2 of year). If, however, the house is vacant for the rest of the year after the first six-month cutting crop is out, all of these costs should be charged to that six-month crop.

A. *SUBTOTAL, FACILITIES, EQUIPMENT AND SUPPLIES COST (portion allocated to crop as explained in paragraph above)* $___ $___ $___

If the production cycle is not 12 months, the housing and equipment cost subtotals must be adjusted by using the following formula:

Annual facilities, equipment and supplies cost subtotal ÷ 12 x number of months required to produce the rooted (salable) cutting

Costs in Sections B, C, D, E and F are to apply only to this crop and not to other plants or crops propagated in the same or other houses.

B. Media

1. Component (bark, peat, perlite, vermiculite, pumice, etc.)

a. Annual replacement cost--material $___

b. Labor, hours[b] ____ x wage rate $____ = $___

2. Sterilization and/or fumigation costs

a. Material (fumigant) $___

b. Labor, hours[b] ____ x wage rate $____ = $___

3. Fertilizer and lime, pesticides

a. Material $___

4. Mixing components--fertilizer, lime, pesticides

a. Labor, hours[b] ____ x wage rate $____ = $___

5. Cleaning of benches, beds, flats, pots, etc.

a. Materials (disinfectants, cleaning compounds, etc.) $___

b. Labor, hours[b] ____ x wage rate $____ = $___

B. SUBTOTAL, MEDIA COST $___ $___

C. Preparing and sticking cuttings

1. Preparing cuttings, such as trimming, disbudding, cleaning, etc., labor, hours[b] ____ x wage rate $____ = $___

2. Cutting treatment (soak, dip, dust)

a. Materials (rooting compound, fungicide, insecticide) $___

b. Labor, hours[b] ____ x wage rate $____ = $___

3. Sticking cuttings

Labor for marking, labeling rows and sticking cuttings, hours[b] ____ x wage rate $____ = $___

C. SUBTOTAL, PREPARING AND STICKING COST $___ $___

[b]Hours x number of men x number of times.

	Costs		
	Cash	Non-Cash	Total
D. Culture of cuttings			
1. Labor: for disease and insect control; disbudding, shaping, and pruning; removing diseased and dead cuttings; misting and watering; fertilization; weed control, etc., hours[b] _____ x wage rate $_____ =	$___		
2. Labor: for monitoring and maintaining heating systems (house, benches, beds), temperature, misting system, humidity, plant growth, etc., hours[b] _____ x wage rate $_____ =	$___		
3. Materials (fungicides, insecticides, fertilizers, growth regulators, chemical pinching agents, herbicides, etc.)	$___		
D. SUBTOTAL, CULTURE OF CUTTINGS COST	$___		$___
E. Harvesting cuttings			
1. Labor for digging cuttings; hours[b] _____ x wage rate $_____ =	$___		
2. Labor for packing and labeling cuttings; hours[b] _____ x wage rate $_____ =	$___		
3. Packaging materials			
a. Flats, bands, pots	$___		
b. Plastic film, boxes, paper, bags	$___		
c. Sphagnum, excelsior, vermiculite, etc.	$___		
d. Labels, markers, ties	$___		
E. SUBTOTAL, HARVESTING COST	$___		$___
F. Waste disposal and cleanup			
1. Labor for removal, destroying (burning, tilling, etc.), hauling away trimmings, dead and diseased plants, unsold plants, materials (paper, boxes, plastic film, bags, broken flats, etc.) hours[b] _____ x wage rate $_____ =	$___		
2. Dumping fees	$___		
3. Cleanup of benches, beds, flats, greenhouses, buildings, etc.			
a. Labor, hours[b] _____ x wage rate $_____ =	$___		
b. Materials (for washing, sterilization, etc.)	$___		
F. SUBTOTAL, WASTE DISPOSAL AND CLEANUP COST	$___		$___
G. Utilities (for total nursery operation only, excluding the home and other non-nursery usage)			
1. Electricity	$___		
2. Fuel (gas, oil, LPG, wood, etc.)	$___		
3. Water (metered cost or depreciated cost of well water system)	$___	$___	
4. Telephone	$___		
5. Sewer	$___		

[b]Hours x number of men x number of times.

	Costs		
	Cash	Non-Cash	Total
6. Garbage service	$___		
G. SUBTOTAL, UTILITY COST [multiply total of 1, 2, 3, 4, 5 and 6 by a % figure[i] (____), which equals the percentage of this crop to your total business]	$___	$___	$___
If the production cycle is not 12 months, the utility costs must be adjusted by using the following formula:			
Annual utility cost for this crop ÷ 12 x number of months required to produce the rooted (salable) cutting			
II. TOTAL, ROOTING AND GROWING COST (summation of subtotals A, B, C, D, E, F and G)	$___	$___	$___
III. OVERHEAD COST (FOR TOTAL NURSERY OPERATION)			
A. Advertising and promotion (includes catalogues)	$___		
B. Dues, licenses and fees	$___		
C. Accounting, bookkeeping and secretarial services (hired and/or self; if self, hours[b] ____ x wage rate $____)	$___		
D. Miscellaneous travel expense (picking up fertilizer, pesticides, other supplies; visiting accountant and/or bookkeeper; miles, meals, lodging in attending tours, association and educational meetings, etc.), mileage at $.25 per mile, other expenses at actual cost	$___		
E. Labor management: 20% of total hired labor costs, includes hired labor for secretarial, accounting and bookkeeping services (III.C. x .20) =	$___		
F. Operation management: 15% of total cash costs of total nursery operation (total of III.A, B, C, D, E x .15) =	$___		
III. TOTAL CASH COST	$___		$___
III. TOTAL OVERHEAD COST [Multiply total cash cost by a % figure[i] (____), which equals the percentage of this crop to your total business]			$___
If the production cycle is not 12 months, the total cash cost must be adjusted using the following formula:			
Annual overhead cost for this crop ÷ 12 x number of months required to produce the rooted (salable) cutting			
IV. OPERATING CAPITAL INTEREST (FOR SECTIONS I, II and III) (Summation of all cash costs of Sections I, II and III ____ x interest rate[j] ____ x [months required to produce the rooted (salable) cutting ____] =		$___	
IV. TOTAL OPERATING CAPITAL INTEREST (SECTIONS I, II and III)			$___
V. CALCULATING COST PER MATURE (SALABLE) ROOTED CUTTING			
A. Total cuttings stuck of this species ____ x cutting survival percentage of this species[k] ____ = number of salable cuttings of this species ____			
B. Sum of total costs of Sections I, II, III and IV			$___
C. Sum of total costs (line B) ____ ÷ number of salable cuttings (line A) ____ = total cost per rooted (salable) cutting =			$___

[b] Hours x number of men x number of times x wage rate.

[i] Total number of cuttings stuck of this species ÷ total nursery production of rooted cuttings.

[j] (Current annual interest rate, see instructions #4) ÷ 12.

[k] Expressed as a decimal, includes culling losses.

	Costs		
	Cash	Non-Cash	Total
D. Cost of rooted cutting used in trade for supply of cuttings [this sub-section is used only if rooted (salable) cuttings are traded back to the original supplier of cuttings in return for the use of his stock plants] [% of crop traded _____ x total number of rooted (salable) cuttings _____ x cost per rooted (salable) cutting _____] =			$____
E. Adjusted cost of rooted (salable) cutting (total costs, line V.B.) _____ - cost of rooted (salable) cuttings (line V.D.) _____ ÷ number of remaining rooted (salable) cuttings _____ =			$____

APPENDIX B

PRODUCTION CYCLES FOR SPECIES STUDIED

SCHEDULE B-1. Standardized production cycle for Youngstown Andorra juniper, Middle Tennessee, 1980[a]

November-December	Take and prepare cuttings for propagation, stick cuttings, cover bed/house for winter protection, mist 6 to 8 weeks or until cuttings are rooted
April	Remove winter protection, perform required cultural practices (weed, water, fertilize)
July	Prune cuttings and continue performing required cultural practices
February-March	Harvest, grade, pack and ship cuttings

[a]The production cycle averaged 18 months in length.

SCHEDULE B-2. Standardized production cycle for Hetz Japanese holly, Middle Tennessee, 1980.[a]

September	Take and prepare cuttings for propagation, stick cuttings, mist 6 to 8 weeks or until cuttings are rooted
December	Cover bed/house for winter protection
March	Remove winter protection
April	Perform required cultural practices (weed, water, fertilize)
July	Prune cuttings and continue performing required cultural practices
September	Prune cuttings and continue performing required cultural practices
November	Cover bed/house for winter protection
February	Remove winter protection
March	Harvest, grade, pack and ship cuttings

[a]The production cycle averaged 18 months in length.

SCHEDULE B-3. Standardized production cycle for dwarf winged euonymus, Middle Tennessee, 1980.[a]

July	Take and prepare cuttings for propagation, stick cuttings, mist 6 to 8 weeks or until cuttings are rooted
August	Perform required cultural practices (weed, water, fertilize)
October	Discontinue fertilization
March	Harvest, grade, pack and ship cuttings

[a]The production cycle averaged seven months in length for growers 1 and 2. Grower 3 used a 24-month production cycle.

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APPENDIX C

SHIPPING DESTINATIONS FOR SPECIES STUDIED

TABLE C-1. Aggregated shipping destination data for Youngstown Andorra juniper cuttings sold by three growers, Middle Tennessee, 1980.

Destination	Percent of sold crop
Tennessee	25.2
Illinois	21.7
New Jersey	15.9
North Carolina	5.9
Ohio	4.6
Kentucky	3.8
Michigan	3.5
Pennsylvania	3.5
Maryland	3.4
Indiana	3.0
South Carolina	2.5
New York	2.1
Other	4.9
Total	100.0

TABLE C-2. Aggregated shipping destination data for Hetz Japanese holly cuttings sold by three growers, Middle Tennessee, 1980.

Destination	Percent of sold crop
Tennessee	39.6
Alabama	18.5
Kentucky	14.7
South Carolina	7.2
Oregon	5.1
Virginia	3.7
New York	3.4
North Carolina	2.2
Indiana	2.0
Other	3.6
Total	100.0

TABLE C-3. Aggregated shipping destination data for dwarf winged euonymus cuttings sold by three growers, Middle Tennessee, 1980.

Destination	Percent of sold crop
Tennessee	22.5
Illinois	17.3
Ohio	8.6
Wisconsin	7.7
New Jersey	7.5
Oregon	5.8
Pennsylvania	5.6
Kentucky	4.5
Michigan	3.2
Iowa	2.3
Minnesota	2.3
West Virginia	2.3
Connecticut	2.0
Other	8.4
Total	100.0

TABLE C-4. Shipping destination and percentage shipped of Youngstown Andorra juniper cuttings sold by grower 1, Middle Tennessee, 1980.

Destination	Percent of sold crop
New Jersey	25.4
Illinois	15.0
Michigan	10.4
Ohio	9.1
Indiana	7.7
North Carolina	7.7
South Carolina	6.8
Tennessee	6.8
Georgia	4.5
Wisconsin	2.9
Missouri	.9
Virginia	.9
Mississippi	.7
New York	.5
Texas	.5
Maryland	.2
Total	100.0

TABLE C-5. Shipping destination and percentage shipped of Hetz Japanese holly cuttings sold by grower 1, Middle Tennessee, 1980.

Destination	Percent of sold crop
Alabama	65.2
North Carolina	10.9
New Jersey	7.6
Missouri	6.5
Indiana	2.2
Mississippi	2.2
Pennsylvania	2.2
Tennessee	2.2
Washington	1.0
Total	100.0

TABLE C-6. Shipping destination and percentage shipped of dwarf winged euonymus cuttings sold by grower 1, Middle Tennessee, 1980.

Destination	Percent of sold crop
Wisconsin	23.3
New Jersey	17.6
Pennsylvania	10.0
Tennessee	7.6
Minnesota	7.1
Iowa	6.9
Oregon	6.7
Michigan	3.9
Alabama	3.0
Illinois	2.6
Kentucky	2.3
Massachusetts	2.3
New Mexico	2.3
New York	1.6
North Carolina	1.4
Indiana	1.1
Mississippi	.2
Virginia	.1
Total	100.0

TABLE C-7. Shipping destination and percentage shipped of Youngstown Andorra juniper cuttings sold by grower 2, Middle Tennessee, 1980.

Destination	Percent of sold crop
Tennessee	41.4
Illinois	26.1
North Carolina	6.2
Maryland	5.9
Kentucky	4.4
New York	3.8
New Jersey	3.2
Ohio	3.1
Alabama	2.9
Indiana	.9
Pennsylvania	.9
South Carolina	.6
New Hampshire	.3
West Virginia	.3
Total	100.0

TABLE C-8. Shipping destination and percentage shipped of Hetz Japanese holly cuttings sold by grower 2, Middle Tennessee, 1980.

Destination	Percent of sold crop
Tennessee	38.0
South Carolina	17.9
Kentucky	16.0
Oregon	12.7
Virginia	9.3
Indiana	4.2
Ohio	1.5
North Carolina	.4
Total	100.0

TABLE C-9. Shipping destination and percentage shipped of dwarf winged euonymus cuttings sold by grower 2, Middle Tennessee, 1980.

Destination	Percent of sold crop
Tennessee	40.1
Illinois	27.9
Oregon	12.0
Ohio	6.3
Kentucky	3.7
Virginia	2.9
West Virginia	2.7
Indiana	1.3
New Jersey	1.3
North Carolina	1.2
New Hampshire	.3
Washington	.3
Total	100.0

TABLE C-10. Shipping destination and percentage shipped of Youngstown Andorra juniper cuttings sold by grower 3, Middle Tennessee, 1980.

Destination	Percent of sold crop
New Jersey	33.7
Illinois	21.1
Pennsylvania	16.9
Tennessee	12.8
Kentucky	8.4
Nebraska	4.2
Maryland	1.7
North Carolina	.8
Indiana	.4
Total	100.0

TABLE C-11. Shipping destination and percentage shipped of Hetz Japanese holly cuttings sold by grower 3, Middle Tennessee, 1980.

Destination	Percent of sold crop
Tennessee	54.3
Alabama	18.6
Kentucky	18.6
New York	7.7
North Carolina	.8
Total	100.0

TABLE C-12. Shipping destination and percentage shipped of dwarf winged euonymus cuttings sold by grower 3, Middle Tennessee, 1980.

Destination	Percent of sold crop
Tennessee	22.4
Illinois	22.1
Ohio	17.7
Kentucky	6.9
Pennsylvania	5.9
Connecticut	5.1
Michigan	4.9
West Virginia	3.9
New Jersey	3.3
Indiana	2.3
Nebraska	2.0
South Carolina	2.0
Missouri	1.1
Oregon	.2
Virginia	.2
Total	100.0

VITA

Hermon LaFayette Dickerson II was born in Oak Ridge, Tennessee on July 23, 1952. He attended elementary and secondary schools in Oak Ridge and was graduated from Oak Ridge High School in 1970. In 1975 he was awarded a Bachelor of Science degree in Forestry from the University of Tennessee in Knoxville.

In August 1982, he was granted the Master of Science degree from the University of Tennessee, Knoxville, with a major in Ornamental Horticulture and Landscape Design. While working toward the degree he was employed by the University of Tennessee Agricultural Experiment Station as a Graduate Research Assistant in Ornamental Horticulture and Landscape Design.

He and his wife, Debra, have one child, Laura.