SECTION 6

ENGINEERING, ECONOMICS, STRUCTURES AND INNOVATIONS

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Feasibility of Zantedeschia aethiopica (Calla Lily) Production

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Nature of Work: As first introduced in USDA hardiness zone 8, the Z. aethiopica variety of the Calla Lily was used predominantly as a "funeral" flower (1). This use provided a stable demand base with low risk. Despite this association, local florist/growers have found they can use the cut Calla for naturalistic arrangements and the foliage as decorative filler. Now, containerized Callas have been introduced to the market, and the Aethiopica has emerged as a flower that makes a bold "statement" (1). Many writers describe the Calla as a "stunning houseplant" (5). The new image and the application are not really new, but are a resurgence of former uses from the 1 950's when the Calla was frequently used as art deco style (4).

The purpose of this study was to estimate costs and returns from 2 scenarios of small scale Calla production: (A) production of potted Callas in 1, 2 and 3 gallon containers, and (B) production of cut flowers from 7 gallon containers (4). The large containers are stock plants rather than final products.

Reported experience among growers interviewed indicates that the Aethiopica basically is a low maintenance plant in terms of insect and disease problems, so production risk is minimal. Production of potted Callas and cut flowers above the needs of the funeral trade involves additional risk. Negative reaction to these relatively new and untested products might occur in some market segments because of the "funeral flower" image (1,3). However, selling to a combination of the funeral trade demand and expanding demand using these alternative products is a possible risk reduction strategy.

When produced as an enterprise in an ongoing business, managerial time and overhead expenses are shared with other crops. Direct production costs were determined using standard budgeting procedures (2), as specified in table 1. Activities were specified from production experience of the senior author. Input prices and rates, including potting mix, fertilization rates, chemicals and others, were gathered through personal interviews, product lists, personal experience and selected literature.

Two phases of potting, separated by about 2 weeks, provided fresh plant material (4). In October, the bulbs were size-sorted and 1 or 2 bulbs per pot were planted (based on bulb and pot size) in a media mix that included phosphate fertilizer. Hand planting assured that each bulb was setting stem-end upward. A slow-release fertilizer was placed on top of the media. Pots then were moved to the greenhouse. Because the bulbs are sensitive to over-watering, they were watered by hand, and a daily inspection occurred at the same time. The entire greenhouse was treated periodically with insecticide and fungicide. Additional detail about calculation of production costs is provided in footnotes to table 1.

As part of an ongoing business, some costs were not included explicitly, though it is recognized that they are real costs. These included interest charges, greenhouse depreciation and maintenance, insecticides, fungicides, and utility costs.

Product prices were collected at local garden centers, and those used were in the midrange of price observations. Assumptions used for calculating cut flower revenue are provided as a footnote to table 2. We assume that flowers are retailed by a florist at a list price of $4.00 per stem, and the industry's standard 60% markup was used to reach the $1.60 wholesale price. Stem price does vary considerably, influenced by bloom size and time of year. Sale of potted Callas began at first bloom, 75 to 90 days after planting, and was assumed to last 8 weeks.

Results and Discussion: Retail value of 1, 2, and 3 gallon pots exceeds estimated production cost by $1.00, $3.00, and $4.60. The margins are not large, but at this activity level the investment and risk are minimal in dollar terms. Garden centers sometimes handle products that provide low margins to provide customers a complete selection.

Cut Callas appear to be profitable, with gross sales of $6912.00 or $138.24 per pot compared to estimated production cost of $33.25. However, this product is more expensive to install and maintain compared to potted Callas. Production risks are greater because of the longer growing season, and the loss proportion is not well established and might be revised with additional experience.

This analysis does not indicate either the most profitable combination of pot sizes and cut flower stock plants, or Callas as a proportion of total production, because margins and demands by product are not available. It does suggest that returns to limiting resources such as greenhouse space or labor might be increased by Callas.

Significance to Industry: The ornamental plant grower must choose a combination of products, some for established markets and some as new products. Accurate information helps evaluate feasibility and the elements of risk for new enterprises. Cost estimation provides one kind of information. Output and sales estimates also help decide whether new enterprises are worthy of greenhouse time and space. A combination of cost and revenue estimates, and market demand for these new products, is needed for decisionmaking.

Literature Cited

1. Spencer, E. The Incredible Calla. March 1989. Florist's Review.

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3. Tripp, K. and J.C. Raulston. Plant Profiles Promote Plants to the Public. SNA Research Conference Proceedings, 37th Annual Report. 1992.

4. Personal interviews with local growers.

5. McNair, J. All About Bulbs. Ortho Books, San Francisco, CA., 1981.

Table 1. Production Cost Totals for Calla Lily

production materials	price (unit)	1 gallon	2 gallon	3 gallon	7 gallon
		dollars			
pots	50 count	12.75	16.50	24.50	75.00
soil mix*	$19.00(yd)	5.48	10.95	16.42	76.67
superphosphate	$1.89(lb)	0.38	0.76	1.13	6.43
fertilizer•	$1.60(lb)	0.80	1.60	2.40	13.60
bulbs○	$2.10(each)	105.00	105.00	210.00	315.00
planting labor■	$6.00(hour)	40.00	40.00	40.00	120.00
maintenance	$6.00(hour)	48.00	48.00	48.00	576.00◘
harvest labor	$6.00(hour)	24.00	24.00	24.00	480.00◘
total cost		236.41	246.81	366.45	1662.70
cost per pot		4.75	4.95	7.35	33.25

*standard soil mix; •fertilizers portioned by volume of mix; ○ 1, 1, 2, and 3 bulbs were used as pot size increased; ■ planting and maintenance labor assumed equal for 1, 2, and 3 gallon pots; harvest labor for pots 1/2 hour per week, 8 weeks; ◘harvest and maintenance labor for cut flowers 1/2 hour per day over a 32 week season.

Table 2. Revenue from Sales of Calla Lily Products.

Pot Size	Price	Items Sold	Total Sales
1 gallon	$ 5.75	50	$287.00
2 gallon	$ 7.95	50	$397.00
3 gallon	11.95	50	597.00
cut flowers	1.60	4320	$6912.00

Cut flower: (3 blooms/week)(50 pots)(32 weeks)($1.60/stem)(10% loss) = $6912.00. 1, 2, and 3 gallon pots sold at retail, cut flowers are wholesaled to own or outside florist shop.

Development of an Air-Pruning Tray With Detactable Screen

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North Carolina/ Taiwan

Nature of Work: To increase greenhouse space utilization and improve seedling uniformity and growth, many growers produce containerized seedlings under greenhouse environment. To further improve container-grown seedlings/plugs and their suitability to automatic transplanting, root air-pruning techniques have been developed to eliminate root-tangling/ root-bound for superior growth both in the trays and after transplanting. This paper presents and discusses a newly designed self-watering seedling/ plug tray with a detachable bottom screen to utilize root air-pruning.

Each tray cell has open top and open bottom. The detachable screen secures to the lower portion of the seedling tray to contain the growth media and to provide air-pruning of plant roots. This screen accelerates root branching for growing superior seedlings/plugs and can be conveniently removed from the seedling tray for easy removal of the individual seedlings/ plugs from the bottom. Once the detachable screen is removed and the air-pruning tray is laid in the index frame of fully automatic transplanter, it becomes an integral component of the transplanter to be indexed for automated transplanting (Huang, 1983).

Both air-pruning tray and the detachable screen were designed to be reusable and made from commercial grade plastic. The tray was made using vacuum forming process forlight weight and low price and the screen is made using injection molding process for durability. The cell size was designed to be optimal to handle seedlings/plugs for majority of field and greenhouse crops.

Results and Discussion: The air-pruning tray system is used to grow vigorous-seedlings with properly oriented roots which saturate the entire growth media within the cell space in a minimum period of time. It is of utmost importance that tray cells be optimally sized to provide a minimum space for growth media for production of uniform and vigorous seedlings/ plugs (Huang, 1983; Huang and Kato, 1985; Huang and Liang, 1987). Also the air-pruning tray is self watering for seedlings/plugs in the tray cells. As shown in Figure 1, the overall dimensions of the tray is about 1' x 2' with 10 x 20 or 200 cells. The surrounding sides in the tray are about 3/16 in. (5 mm) higher than the top of individual cells in the tray. Therefore, water can be held around the each cell for self watering from the top of cell maintaining a uniform temperature and moisture level in the individual cells throughout the whole tray. The bottom screen was designed to fit the air-pruning tray at three outer edges. One short edge was left open so that the screen could slide in and out of the tray. There are many advantages for growing air-pruned seedlings/plugs, such as eliminating root tangling and binding in a tray cell, establishing properly oriented roots in a tray cell for future root development after transplanting, accelerating root branching, providing vigorous growth, low mortality and uniform stands, savings on growth media, energy and fertilizer, and adapting to fully automatic transplanting.

Figure 2 shows the growth performance of okra, cucumber and tomato in the air-pruning trays and conventional (non-air-pruning) trays. The statistical analysis of the results in average leaf number indicated that air-pruned seedlings grew significantly better than non-air-pruned seedlings. Seedling establishment and the growth performance depend to a large extent on the rapidity in the root system development. The air-pruned roots were similar to brush hairs, properly oriented downward, which are ready for producing new roots as soon as the seedling is transplanted. However, the non-air-pruned roots were spiraling and many are forced to grow upward, which would hinder the root development after transplanting. Therefore, seedling production can be optimized based on the plant species, a minimum time requirement for properly oriented root saturation in a cell, and cell size.

Significance to Industry: (1) Improvement of seedling/plug quality and productivity. (2) Increased plant growth and yields for agricultural, forestry and horticultural crops. (3) Full automation of seedling transplanting process. (4) Savings growth media, fertilizer, land, energy and labors. (5) Savings on greenhouse facilities and associated equipment.

Literature Cited:

1. Huang, B.K. 1983. Systems engineering in precision automatic transplanting. AMA 14(1):11-19.

2. Huang, B.K. and A. Kato. 1985. Effects of container types on germination and seedling growth. Proc. 30th SNA Research Conf., Atlanta, GA, 30:79-85.

3. Huang, B.K. and P. Liang. 1987. Effects of air-pruning on cutting and seedling growth in container tree propagation. Proc. 32nd SNA Research Conf., Atlanta, GA, 32:134-139.

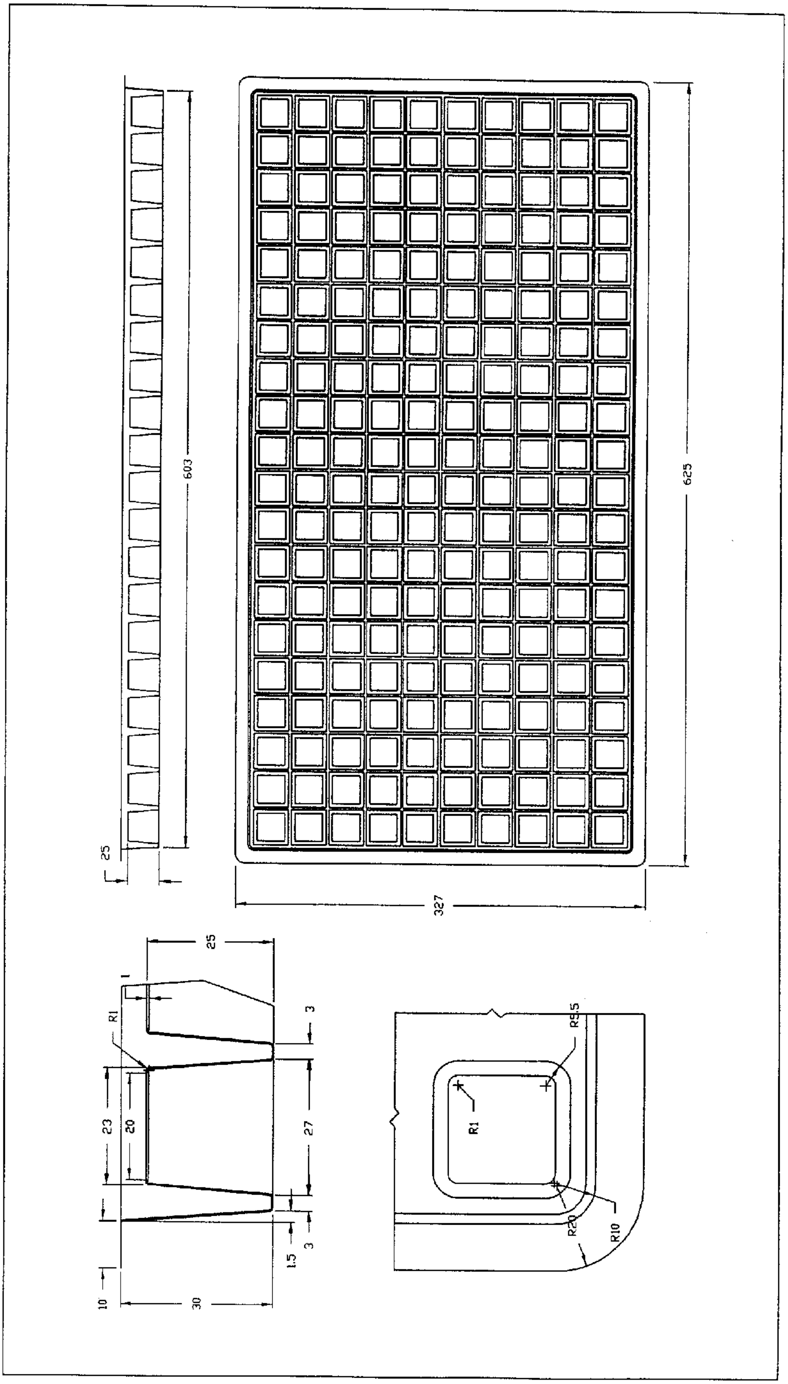

Figure 1. Top and side views of air-pruning tray illustrating shape and size of individual cell.

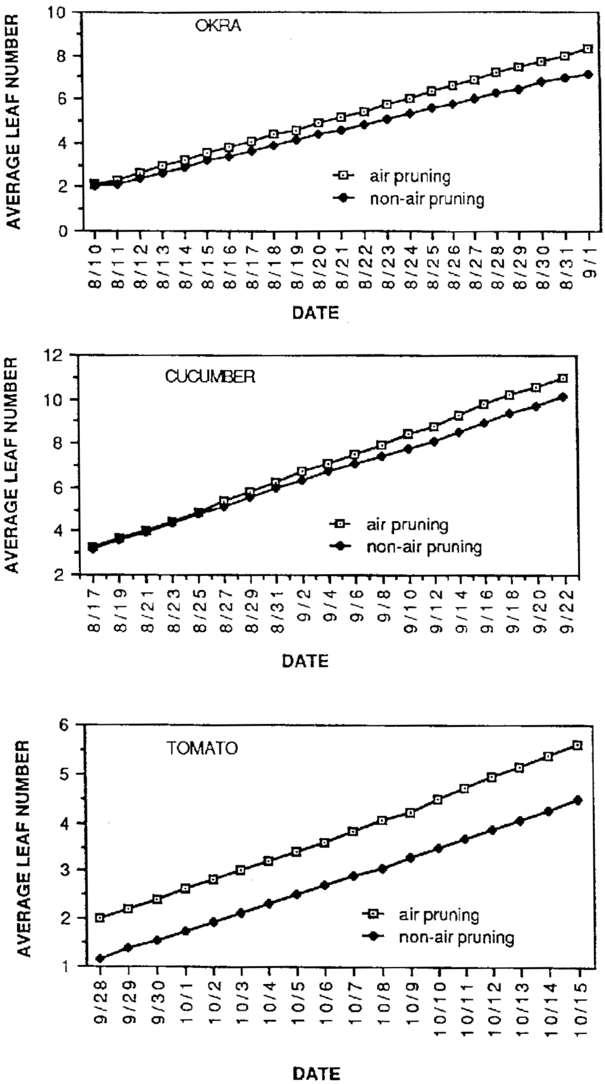

Figure 2. Growth comparison between air-pruned seedlings and non-air pruned seedlings for okra, cucumber, and tomato.

Computer-Controlled Transplanting of Air-Pruned Seedlings/Plugs

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North Carolina

Nature of Work: Transplanting operations for both greenhouse and field crops remain a major bottleneck in the production systems of vegetables, trees and various floriculture and field crops. Many attempts have been made worldwide to develop fully automated transplanters and seedling production system, but none of the dry-land fully automatic transplanters and automated seedling culturing systems have been adopted and implemented by the industry.

Although computer integrated transplanting systems have been studied for sometime, little progress have been made in the application due to the limitation of conventional transplanting method. The root air-pruning technique has provided a very effective transplanting method to utilize the technology of computer control for fully automated transplanting. With the recent development of air-pruning tray, an impulse vacuum transplanting method with computer control can be effectively applied. The purpose of this paper is to present the design and analysis of fully automatic transplanting system which takes full advantage of air-pruning techniques.

Results and Discussion: The transplanting system utilizes air-pruning trays and pneumatic means to achieve seedling pulling and transplanting in one simple operation. The trays are placed in the X-Y indexing frame and the air-pruned seedlings can be automatically transplanted using an impulse vacuum force until all seedlings in the tray are emptied. A coaxial cylinder vacuum system generates impulse vacuum force to transfer the seedling from tray to pots or to the field. A built-in computer controls the seedling transplanting process. The impulse suction force is the key factor in pulling the air-pruned seedlings from the tray and eject to planting area in a very short period of time. The magnitude of suction force is determined by the varying rate of vacuum chamber in a coaxial cylinder. The force pulling down seedling from a tray is the result of pressure difference between vacuum chamber and atmosphere. Due to the high speed impulse actions of pneumatic cylinder and of pulling the seedlings from the tray bottom openings the entire system dynamics can best be analyzed using computer simulation to predict the system performance.

Seedling block dynamics can be analyzed for three distinct periods. The first period is the instant, Δ **t**, the seedling block is dislodged from the tray cell. During this period the atmospheric pressure is applied to the open area of cell top. As soon as the seedling block is dislodged the atmospheric pressure will be applied to the open area of cell bottom or the bottom area of seedling block, and therefore, the second period is from dislodging of seedling block to reach the flexible door. The third period is shooting-out of seedling block from the door to reach the ground. The forces acting onto the seedling block for each period can be defined as F1, F2, and F3, as follows;

$$Fl = p2*Act*[1-A*L/(A*L+v*\sim t*A2*A2*3.14/4)]+Ws-Rf \qquad (1)$$

$$F2 = p2*Acb*[1-A*L/(A*L+v*t*A2*A2*3.14/4)] +Ws-Rf-a*Acb*vs \qquad (2)$$

$$F3 = Ws-a*Acb*vs \qquad (3)$$

in which

Act is the open area of a tray cell top,
Acb is the open area of a tray cell bottom,
A is the cross-sectional area of drop tube,
L is the length of drop tube,
Δ L is the fraction of seedling block displacement at the instance of dislodging,
Ws is the weight of a seedling block,
Rf is the friction force acting on the seedling block while it is dropping,
vs is the velocity of seedling block while it is dropping.

According to the Newton's second law,

$$dvs/dt = F/ms \qquad (4)$$

where F is the forces (F1, F2, and F3) acting on the seedling block, ms is the mass of a seedling block and dvs/dt is the acceleration of seedling block.

The energy change of seedling block is the kinetic energy increment and potential energy decrement. The kinetic energy, KE, can be written as

$$KE = ms*vs*vs/2 - ms*vs0*vs0/2 \qquad (5)$$

and potential energy, PE, can be written as

$$PE = Ws*(h - h0) \qquad (6)$$

where vs0 is the initial velocity of seedling block, h0 is the initial position of seedling block at transplanter bearing plate.
As the seedling block reaches the ground surface plastic deformation occurs for the block and soil at the impact. The kinetic energy, ms*vs*vs/2, will be absorbed by the deformation as the seedling block velocity, vs, approaches zero. The impact energy can be adjusted by the height of transplanter bearing plate and the impulse vacuum system. Δ

The initial conditions for the simulation are: vs=0, dvs/dt=0, h0=0, **L**=1mm

Figures 2, 3, 4, and 5 respectively show total force acting on the seedling block, and the resulting acceleration, velocity, and displacement of seedling block versus time for 50, 60, and 70 activating pressures. There is distinct increase in force and acceleration from the first period to second period due to increased area after the seedling block is dislodged. After the seedling block is shot out from the flexible door (third period) the gravitational acceleration continues to act on the seedling block until it reaches the ground.

Significance to Industry: (1) The new seedling transplanting system in conjunction with air-pruning technique would achieve fully automatic transplanting for both greenhouse and field crops. (2) Computer-controlled transplanting would provide significant labor savings, high efficiency and new standard for growers.

Literature Cited

1. Huang, B.K. 1983. Systems engineering in precision automatic transplanting. AMA 14(1):11-19.

2. Huang, B.K. and P. Liang. 1987. Effects of air-pruning on cutting and seedling growth in container tree propagation. Proc. 32nd SNA Research Conf., Atlanta, GA, 32:134-139.

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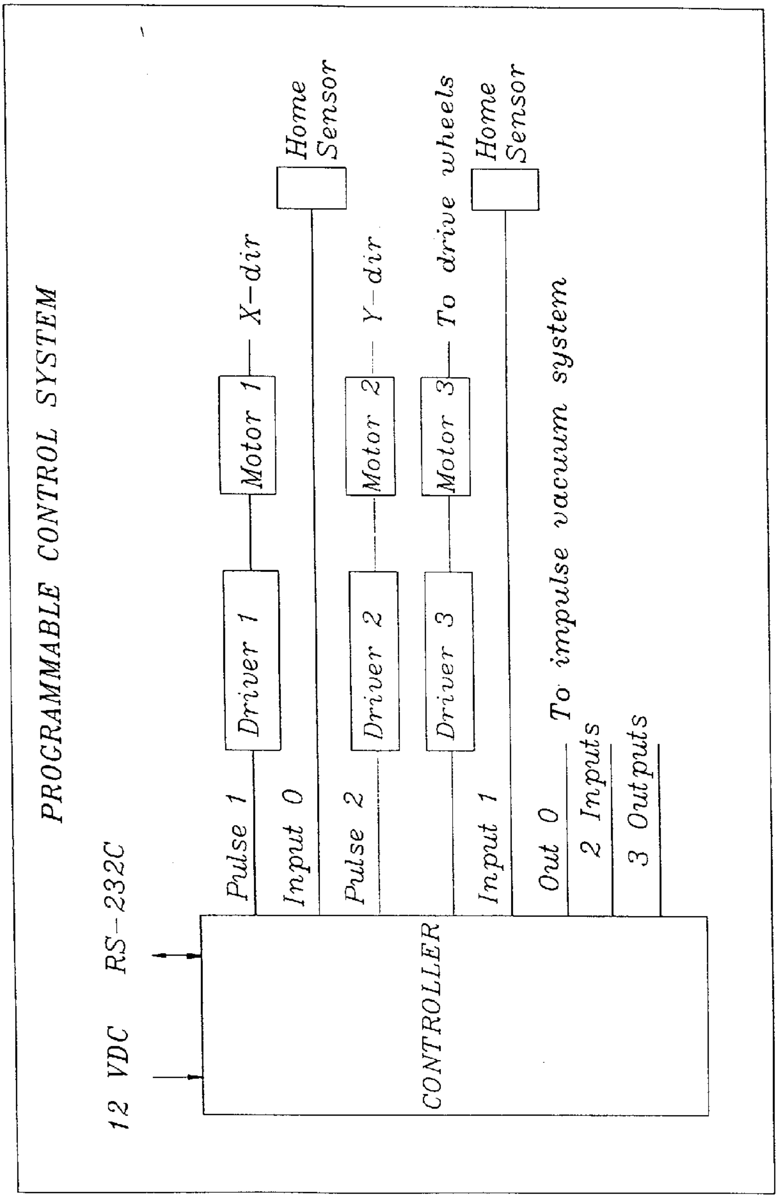

Figure 1. Programmable control system for indexing, transferring, and transplanting operations.

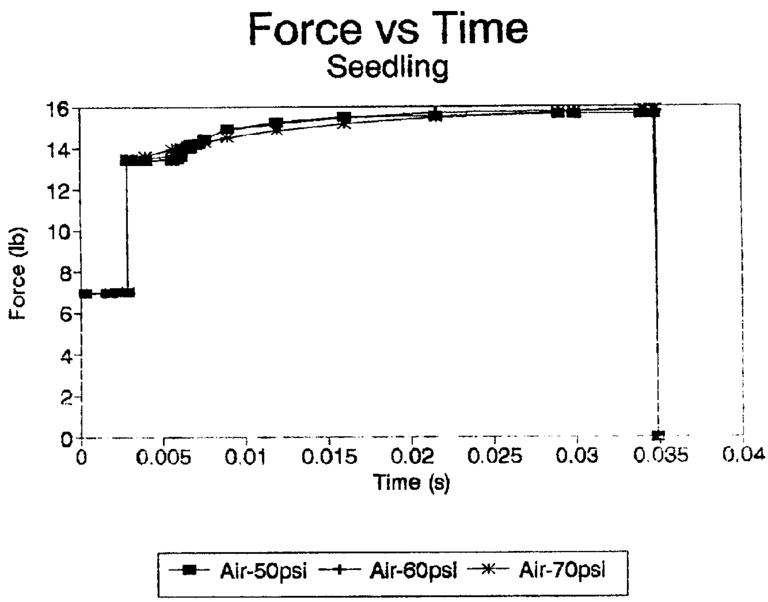

Figure 2. Forces acting on seeding block versus time curves for 50, 60, and 70 psi activating pressures.

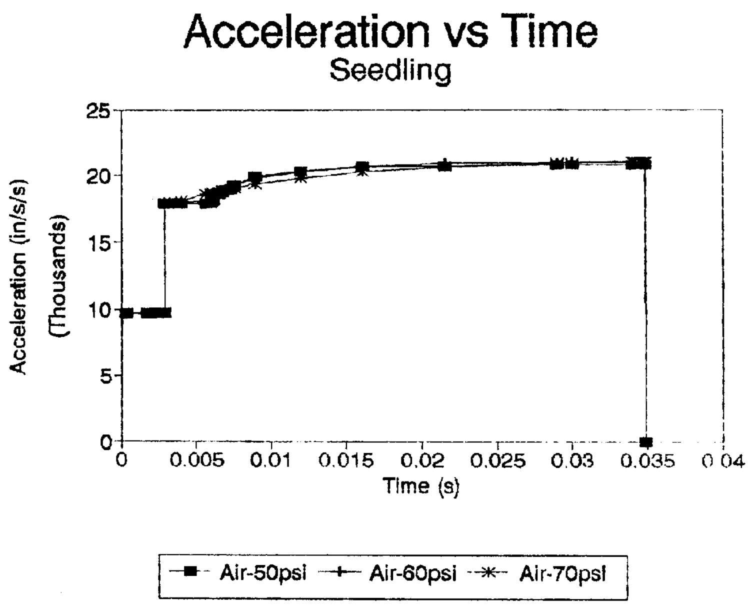

Figure 3. Seeding block acceleration versus time curves for 50, 60, and 70 psi activating pressures.

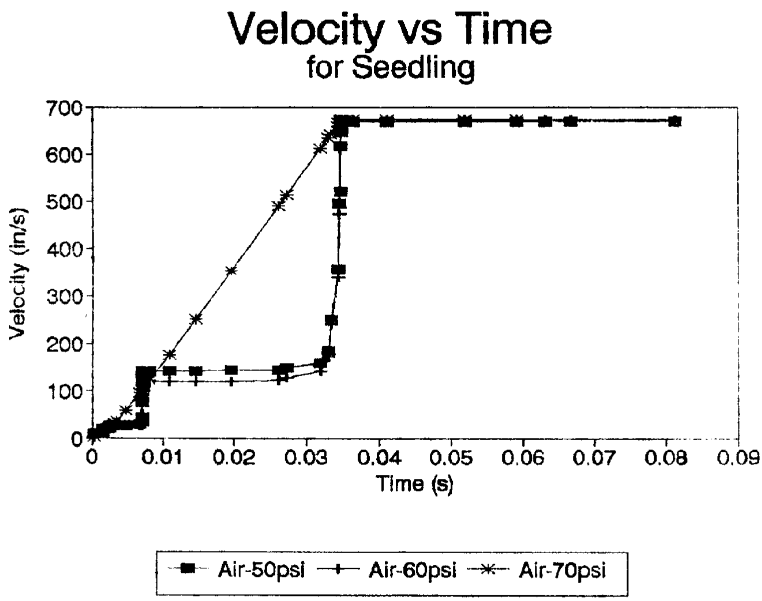

Figure 4. Seeding block speed versus time curves for 50, 60, and 70 psi activating pressures.

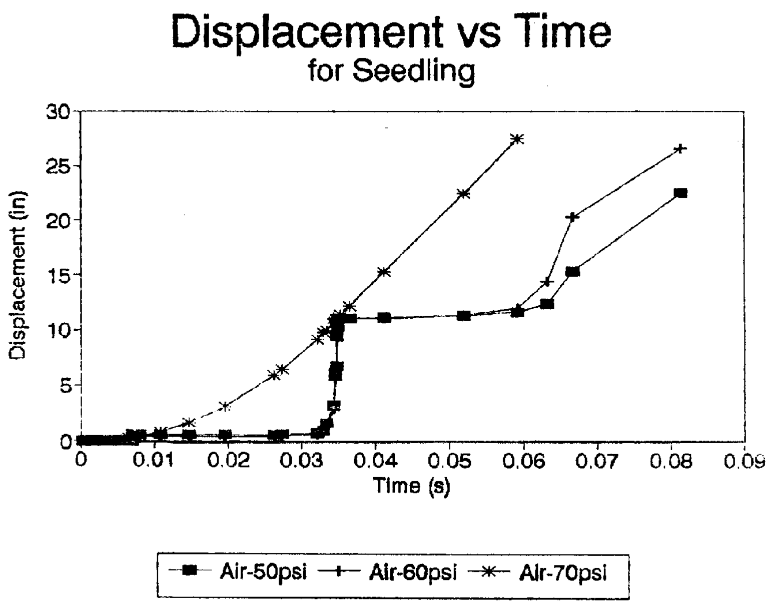

Figure 5. Seeding block displacement versus time curves for 50, 60, and 70 psi activating pressures.

Labor: Comparative Advantage or Cost Disadvantage

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Nature of Work: Effective management of any business, especially labor intensive businesses such as those in the nursery industry, requires a thorough knowledge and understanding of costs, especially those which account for a significant portion of the total operating expenses, excluding cost of goods sold. Labor cost is an important consideration for the nursery business, especially in evaluating competitive opportunities. Knowing what labor really costs, not just the wage rate, is necessary for evaluating alternative nursery activities, evaluating and compensating labor performance, determining the appropriate level of automation, and evaluating the purchase of labor saving equipment. The true cost of labor is not always obvious nor quantifiable; some factors that influence the true cost of labor to the manager are questionable or indirect.

Since the true cost of labor to the manager, or the real income to the employee, involves more than cash wages paid, or received, managers of landscape nurseries need a management tool that will permit a systematic approach to estimating these important costs. Also, accurate job cost estimations are crucial to successfully managing the resources entrusted to the manager. Identification of measures of labor performance efficiency and effectiveness as well as the obvious and questionable costs of labor aid in the micromanagement of the firm as well as policy development for the industry.

Results and Discussion: A nursery's employee labor force is one of the few things in the daily operation of a production nursery that does not come with written instructions. At the same time, the costs of labor and labor supervision can account for a hefty proportion of the nursery's total expenses. To the employee, the labor cost is the gross direct wage minus any noted deductions that translates into the employee's net paycheck. To the management, the labor costs are much higher, reflecting both the direct expense of employees and indirect or questionable costs.

To calculate the real direct cost of an employee, a labor cost estimation worksheet (Table 1) is presented which accounts for the direct wage costs, mandatory wage costs (employer contributions, such as state and federal withholdings or taxes), value of fringe benefits, and hours paid but not worked. The resulting hourly wage is much higher than the direct cash wage that the employee typically associates as the cost of labor. The items listed in the labor cost estimation worksheet are all real costs of labor on an employee-basis.

There are also some indirect or questionable costs of labor (Table 2). These costs, although not directly quantifiable on an employee-basis, are also labor costs of doing business in a production nursery. Examples of these questionable labor costs include the costs of employee recruitment, hiring, training, and evaluation; employee supervision; recordkeeping; mistakes and reworks; frustrated management; and compliance with labor and employee (or employer) law changes, ranging from employee certification to OSHA to EPA to the ADA. These costs are not incrementally quantifiable to address, such as the costs on the labor cost estimation worksheet; nonetheless, these costs do accrue and impact the total labor expenses.

Labor evaluation, as mentioned earlier, is a labor cost, but the measurement of labor performance by various representative ratios or relationships can be used to determine if a nursery has a relative labor comparative advantage. Comparative advantage utilizes physical measurements that are quantifiable, and these measures may or may not be economic in the sense of using dollars as the basic evaluator. Examples of labor evaluators (Table 3) include sales per employee; labor expenses per employee; size of the labor force; employer satisfaction with employee performance (output); employee satisfaction with job and/or working conditions; cost of labor as a percent of sales; and cost of rework per employee. Some of the employee evaluators, the measurement tool is subjective, i.e., satisfaction gradients. Once the evaluation tools and guidelines are identified, management's role becomes one of personnel manager to determine if the resulting values are satisfactory for the firm, satisfactory relative to the industry and competing nurseries, and suitable or appropriate measurement devices for the nursery's labor force. For those values that encompass sales as a consideration, several nursery industry reports (i.e., MN and regional survey data) and business economic indicator reports (i.e., Robert Morris & Associates annual data by SIC codes) offer average values or indicators for comparison. It is then management's responsibility to improve the ratios or values, as results will be transferrable to a labor cost, either directly or indirectly.

Significance to Industry: A production nursery is a labor intensive business, and the cost of labor becomes a genuine economic concern to managers and investors. The hourly wage rate, as noted by employees, is not the true cost of labor. Not only are there direct expenses, as noted in the labor cost estimation worksheet, but also indirect labor costs as a result of labor performance, efficiency and effectiveness. All of these costs impact the cash flow, profits and net income, and profitability of the nursery.

Although labor may be seen most frequently as strictly a cost of doing business, there are labor evaluation measurements to view labor as a comparative advantage, rather than a cost disadvantage. Published reports can be used to generate comparison guideline values to see how an individual nursery compares with firms of like-size, the competition, and the industry. Management strategies can then be developed to improve the use of the nursery's labor force so that the focus is not just on the labor costs or expenses.

Table 1. **Form for Estimating Employee Labor Costs**

Labor Cost Estimation Worksheet Date ____________

Name: ________________________________ Title: ______________________________

Cost Item: Cost to Employer:

Direct Wage Costs:
1 - Total Regular Hours: (hours/week _____ x number of weeks _____) = _____ hours
Overtime Hours: (hours/week _____ x number of weeks _____) = _____ hours
2 - Cash Wages (hours _____ x $ __________ /hour) = $ _______________
3 - Overtime Wages (hours _____ x $ __________ /hour) = $ _______________
4 - Cash Bonuses ($ __________ or % _____) = $ _______________
5 - Total Adjusted Cash Wages (total lines 2 through 4) = $ _______________

Mandatory Wage Costs:
6 - Employer's Share of Social Security (% _____) = $ _______________
7 - Federal Unemployment Insurance = $ _______________
8 - State Unemployment Insurance = $ _______________
9 - Worker's Compensation = $ _______________
10 - Other ______________________________ = $ _______________
11 - Total Value of Mandatory Costs (total lines 6 through 10) = $ _______________

Value of Fringe Benefits:
12 - Insurance - Life = $ _______________
Dental = $ _______________
Health = $ _______________
__________ = $ _______________
13 - Retirement (employer's contribution) = $ _______________
14 - Uniform (purchase/rental/cleaning) = $ _______________
15 - Educational/Training Expense = $ _______________
16 - Transportation
(miles/day _____ x number of days _____ x rate _____) = $ _______________
17 - Other ______________________________ = $ _______________
18 - Other ______________________________ = $ _______________
19 - Total Value of Fringe Benefits (total lines 12 through 18) = $ _______________

20 - Total Labor Costs (total lines 5 + 11 + 19) = $ _______________

21 - Hours Paid For But Not Worked = __________ hours
Holidays (_____ hours); Vacation (_____ hours); Sick Leave (_____ hours)

22 - Total Hours on the Job (line 1 minus total line 21) = __________ hours

23 - Total Costs/Hour On The Job (line 20 divided by line 22) = $ _______________

Table 2. **Examples of Labor Costs (Obvious and Questionable)**

Cost Item	Obvious	Questionable
Cash Wage	yes	
Overtime Wage	yes	
Cash Bonus	yes	
Social Security	yes	
Unemployment Insurance (federal and state)	yes	
Workers' Compensation	yes	
Personal Insurance (life, hospitalization, dental, etc.)	yes	
Retirement Contribution	yes	
Education or Training Expense, including Certifications	yes	
Paid Holidays and Vacation Days	yes	
Transportation Reimbursements	yes	
Employee Turnover		yes
Employee Recruitment (job announcements, job descriptions, time spent, etc.)		yes
Selection and Hiring (interviews, reference checks, skills testing, trial period)		yes
Recordkeeping and Administration of Employee Records		yes
Attitudes and Perceptions of Company, Industry, Job		yes
Frustrated Management		yes
Supervision		yes
Mistakes/Reworks/Goofs/Miscues		yes
Retooling/Retreading		yes
Local Unemployment Rate and Competition for Jobs		yes
Policy and Regulatory Changes (costs increase as firm size increases)		yes
Employee Anticipation of Quitting, Retiring, or Being Fired (gearing down)		yes

Table 3. **Labor Performance Efficiency and Effectiveness Measures**

Sales Related	Labor Force Related
Sales per employee	Size of labor force
Sales per greenhouse/block to which	full-time
employees are assigned	seasonal
Cost of goods sold	part-time
Cost of rework per employee	family
Cost of labor as percent of sales	FTEs
Ratio of saleable to not saleable	$\frac{\text{\# wks/yr employed}}{52} \times \frac{\text{\# hrs/wk worked}}{40}$
	Employee satisfaction
	Employer satisfaction
	Labor expenses per employee

The Economic Impact of Turfgrass Maintenance in Tennessee

John R. Brooker, Morgan D. Gray, J. Eric Carson, and Thomas J. Samples
Tennessee

Nature of Work: Urbanization of the United States population has contributed to development and expansion of the turfgrass industry [Cockerman and Gibeault]. Most of the expansion has occurred since World War II and is attributable to increases in leisure time, discretionary income, population, and demand for amenities. In 1965, the national turfgrass industry was estimated to be a $4.3 billion a year industry. By 1982, the industry increased to nearly $25 billion. If adjusted to 1992 dollars by the Consumer Price Index for all items, the national turfgrass industry amounted to $36.3 billion.

The primary objective of this study was to estimate the annual contribution of the turfgrass industry to the state's economy. Because this was the first comprehensive survey of the turfgrass industry in Tennessee, a secondary objective was to provide a benchmark describing the structural characteristics of the turfgrass industry in Tennessee.

Four procedural steps were used to accomplish the objectives of this study. 1) Identification of the various components to be included as part of the Tennessee turfgrass industry and determination of the population within each of these components. 2) Determination of the appropriate sampling procedure and the resulting sample size for each component of the turfgrass industry. 3) Collection of the required turf-maintenance expense information from each component of the turfgrass industry. 4) Estimation of the total amount spent for turfgrass maintenance, total value of turfgrass equipment, and total acreage of turfgrass maintained in Tennessee.

Results and Discussion: Eighteen major components of the turfgrass industry were identified (Table 1). Information was collected from lawn-care companies; however, the results are not included because expenditures to lawn-care companies was collected from each component. Where possible, identification of all known entities within a particular component were obtained from published lists (airports, private cemeteries, commercial establishments, cities, colleges/universities, counties, golf courses, health institutions, parks, state highway roadsides, and schools). Telephone books representing all 95 counties in Tennessee were used to develop list frames for churches, single-dwelling homes, multiple dwellings (apartments and condominiums), and lawn-care companies.

A complete census was attempted for airports, registered cemeteries, motels/hotels, golf courses, institutions, lawn-care companies, municipalities, parks, roadsides, schools, and sod producers. For churches, homes, and industrial firms, a simple random sampling technique was used. The sample size was based on the decision to strive for a precision level of ±5 percent for churches, industrial facilities, and multiple dwellings, and ±2.5 percent for homes, with a 95 percent confidence level for all four components. A higher level of precision was desirable for the homes component because of the fact that in other states this one component accounted for about two-thirds of the total estimate of annual lawn-care expenditures. None of the studies published in other states presented information regarding means and standard errors. Without this information, a binomial distribution was assumed for the determination of sample sizes. While other important information was desired, the basic question of the survey was whether a lawn was maintained, i.e., yes or no. Hence, a binomial distribution is logical, and perhaps even more importantly, is conservative, because other distributions would permit the use of smaller sample sizes to attain the same level of precision. Mail surveys were used to gather information from participants in each component. The questionnaires were designed to collect information on the area of turfgrass maintained, the annual expenditures for equipment repairs, supplies, fertilizers, chemicals, irrigation, and labor, and several questions regarding turfgrass problems and maintenance practices.

The total turfgrass maintenance value for all 18 components was estimated to be $360.4 million (Table 1). The total turfgrass acreage was estimated at 889,382 acres (Table 2). From a dollar perspective, the single-dwelling homes component was first and golf courses second, accounting for 61.5 percent and 10.6 percent of the total, respectively. When compared to the 1991 Tennessee total crop production value of $953.9 million, turf maintenance expenditures in the Tennessee turfgrass industry equal slightly more than one-third of the total cash receipts for all crops.

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2. Tennessee Agricultural Statistics Service. *Tennessee Agricultural Statistics: 1992.* USDA-NASS and TDA: Nashville, TN. 1992.

Table 1. Populations identified, survey size, and response rate for various components of the Tennessee Turfgrass Industry, 1991.

Component	Population Size	Sample Size	Number Mailed	Response Rate
	number			percent
Airports	89	89[a]	89	37.1
Cemeteries	176b	176[a]	176	26.1
Churches	7,649	380[c]	1,000	21.6[d]
Commercial:				
Industrial	5,379	372[c]	l,000	25.8 [e]
Motels/Hotels	1,017	1,017[a]	1,017	23.2
Golf Courses	240	240[a]	240	31.3
Governments:				
City	339	339[a]	339	56.6
County	95	95[a]	95	50.5
Parks	58	58[a]	58	60.3
Roadsides	—	—	--	100.0
Homes:				
Single Dwelling	1,108,320	1,600[f]	6,400	22.8[g]
Multiple Dwelling	1,936	331[c]	1,000	20.1[h]
Institutions:				
Health Agencies	107	107[a]	107	43 9
Hospitals	188	188[a]	188	23.9
Nursing Homes	535	535[a]	535	19.3
Schools:				
City/County	269	269[a]	269	43.5
Colleges/Universities	131	131[a]	131	30.5
Sod Producers	24	24[a]	24	47.6

[a] Complete census attempted.
[b] Registered cemeteries only.
[c] Sample size based on desire for estimate of the percentage of units that “maintain a loan” to be correct within ± 2.5 percent, with 95 percent confidence.
[d] Obtained 56.8 percent of the targeted 380
[e] Obtained 69.4 percent of the targeted 372
[f] Sample size based on desire for estimate of the percentage of single dwelling units that maintain a lawn to be correct within ± 2.5 percent, with 95 percent confidence.
[g] Obtained 91.1 percent of the targeted 1,600.
[h] Obtained 60.7 percent of the targeted 331.

Table 2. Total turfgrass acreage maintained and maintenance expenditures in Tennessee in **1991.**

	Area Maintained		Maintenance Expenditures	
Component	Acreage	Percent of Total	Dollars	Percent of Total
Airports	10,608	1.2	463,000	0.1
Cemeteries[a]	3,437	0.4	2,173,000	0.6
Churches	13,482	1.5	8,540,000	2.4
Commercial:				
Industrial	28,075	3.2	16,546,000	4.6
Motels/Hotels	4,687	0.5	4,412,000	1.2
Golf Courses	25,990	2.9	38,098,000	10.6
Governments:				
City	42,793	4.8	10,512,000	2.9
County	32,114	3.6	3,779,000	1.1
Parks[b]	9,396	1.1	2,501,000	0.7
Roadsides[c]	60,000	6.7	11,000,000	3.0
Homes:				
Single dwelling	620,659	69.8	221,664,000	61.5
Multiple dwelling[d]	6,450	0.7	20,711,000	5.8
Institutions:				
Health Agencies	1,452	0.2	555,000	0.2
Hospitals	1,997	0.2	4,094,000	1.1
Nursing Homes	1,676	0.2	3,002,000	0.8
Schools:				
City/County	15,290	1.7	3,706,000	1.0
College/Universities	5,161	0.6	4,683,000	1.3
Sod Producers	6.115	0.7	3.975,000	1.1
Total	889,382	100.0	360,415,000	100.0

[a] Registered cemeteries only. Cemeteries maintained by churches included with church values.
[b] State and federal parks
[c] State roadsides only
[d] Apartments and condominiums

A Database of the Plant Materials on the University of Georgia Campus

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Nature of Work: An important mission of the Land Grant system is to conduct research regarding the wise utilization of natural resources while conserving and protecting the environment. An excellent method for achieving this fuller utilization of existing resources. One such endeavor is the recently initiated effort to computer catalogue existing woody plant materials on the University of Georgia campus.

Campus plant material has long been used in the teaching of plant identification courses in the landscape architecture program, the horticulture department, and the forestry school. Other current classroom usages of these resources include drawing, painting and sketching courses, urban forestry, planting design and courses that focus on insect, disease and maintenance problems. Because of the large area encompassed in the typical southern university campus and because of the many varied sites and exposures within that typical campus, a great deal can be determined about plant hardiness and plant adaptability without having to expand research dollars or space. Some modest amount of time is required to compile the data.

Previous efforts to catalogue the diverse plant materials of the University of Georgia campus have been fragmented and uncoordinated. Some teaching programs had located and recorded those plants suitable to their individual foci (1) (2). The University Grounds Department, because of budgetary restraints, had not addressed this issue in a comprehensive manner until 1985. At present their recording system is a combination of mapping in the case of replacement trees and listings by site for landscape projects. The only campus areas where detailed records had been established prior to 1985 and maintained in a useable manner are the Founder's Memorial Garden, established in 1946, and the Horticulture Department's Annual Trial Garden begun in 1982. The Horticulture Department's permanent plantings are primarily herbaceous perennials and in the Founder's Garden monitored by the UGA School of Environmental Design, record keeping has been inconsistent at times. However, the efforts were refocused in the Founder's Garden in 1992. The information regarding those plantings on the campus in general that were established prior to 1985 is being compiled by graduate students through field surveys (3).

Despite the fact that several <u>tree</u> inventory computer programs are commercially available (4), the authors chose to utilize a general purpose database management program, PC-FILE III, version 3.0. PC-FILE III was selected for several reasons: first, because PC-FILE III is fairly versatile regarding database information being imported from or exported to other computers, allowing information to be easily shared among the various departments on campus; second, the UGA Grounds Maintenance Department has now recently completed updating their plans of the UGA Campus to show existing planting areas in addition to buildings, walks, drives and parking areas, implying that at some future date it may be possible to show the general location of plant material rather that just list it by location; third, the PC-FILE program allows for the sorting and retrieving of data in almost any sequence; and fourth, new fields can be added as needed.

Results and Discussion: UGA PLANTS (PC-FILE III) is a MS-DOS program requiring 128 RAM and is capable of storing 32, 767 records, allowing entry of data regarding existing woody, ornamental plant materials including botanical name, common name, location (referenced to a building or major open space), date installed and quantity planted (fig. 1) . Information retrieved can be done by botanical name, common name, location or from any other data entry field.

As noted the program accommodates 32,767 records. These records can be compiled in up to 42 Fields and be manipulated for 10 Sort Control Fields.

Significance to Industry: This program has several applications; first, as a plant material location reference for classroom study and continuing education programs; second, enabling students and green industry professionals to locate and observe several plantings of the same plant (hopefully of approximately the same age) in differing exposures, and differing site circumstances; third, will enable students and professionals alike to observe establishment vigor and growth rates of a wide variety of plant material; fourth, will allow for comparisons to be made among cultivars and in comparison to the species in both trees and shrubs regarding growth rate, form and vigor.

Literature Cited:

1. Hill, Robert J., Class handout, School of Environmental Design, University of Georgia.

2. Dirr, Michael, A., Class handout, Department of Horticulture, University of Georgia.

3. Jaenson, Richard, June 1993, Computer-based Tree Inventories, Grounds Maintenance, Intertec Publishing, Overland Park, KS.

4. Dirr, Micheal, A., 1990, Manual of Wood Landscape Plants: Their Identification. Ornamental Characteristics. Culture. Propagation and Use, Stipes Publishing Co., Champaign, IL.

Figure 1. Sample Database

Genus	Camellia
Species	japonica
Cultivar or Variety	R . L. Wheeler
Common Name	Camellia
Specific Common Name	R.L. Wheeler
Location	Old College
Specific Site	Pres. Club Garden
Number Planted	1
Date Planted	1988
Special Notes	

Marketing Channels Used by Wholesale Ornamental Nurseries

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Nature of Work: The marketing channel is the path taken by a product as it moves from producer to consumer. Alternative channels available to producers of ornamental plants include direct sales to consumers and various wholesale market channels. In this study, the focus was on marketing channels used by wholesale nurseries with the objective of developing a "typical nurseryman" profile to explain market channel choice.

Results and Discussion: To identify and describe marketing practices of wholesale nurseries, a survey instrument developed by researchers in 23 states was used to collect marketing practice information. Conducted by mail in early 1989, a total of 1302 useable responses were received. Further detail about procedures, assumptions and respondent description is provided in Brooker and Turner(l).

Market channel choice could be expected to be influenced by factors such as firm age and size, propensity to negotiate, diversification strategies, organizational structure, competitive pressures, and location of the nursery.

Information about market channel use was itemized by the respondent through allocation of total sales as a proportion among retail type sales (to the final consumer) and sales through alternative wholesale channels(to retailers, re-wholesalers, and landscapers). Given the nature of these measurements(values between 0 and l00), a tobit estimation procedure was chosen from the family of limited dependent variable models(2). The tobit model estimates coefficients for the explanatory variables, and standard t-tests are used to evaluate significance. Using the estimated coefficients, a profile of the nurseryman whose percentage of sales through a particular marketing channel was a higher or lower was developed.

The tobit model used was of the general form

MKTCHAN=f(AGE, GSALES, NEG, NUMTM, CORP, COMPET, NORTHE, SOUTHE, WEST),

where MKTCHAN represented the percentage of gross sales through a particular marketing channel. Three wholesale channels were considered; to retail, to rewholesalers, and to landscapers. The retail channel(direct from producer to consumer) was the fourth channel analyzed. Descriptions,means,standard deviations and measurements of the explanatory variables are presented in Table 1. Regional differences were included as dummy variables - estimated coefficients indicated differences from the base (a group of states in the midwest and middle south, defined in Table 1).

Descriptive statistics from the survey are provided (Table l).The average age nursery was 21 years old with sales of $876,000. Respondents indicated that an average of almost 43% of sales were negotiated and discounted from list price. Within the shares of wholesale sales going to alternative wholesale channels, a higher percentage went through landscapers than through retailers or rewholesalers. About 42% of firms were incorporated. About 36% of respondents indicated that degree of competition was one of the most important constraints on firm expansion. The number of respondents from each region was fairly even across the north, middle and south, but was lower in the west.

Alternative models (different dependent variables) provide evidence about firm characteristics that are significantly related to market channel use. In the following discussion, a typical respondent profile is developed based on each model's significant explanatory variables.

(1) WHOLESALE SALES TO RETAILERS: In this model, NUMTM, NORTH-EAST, SOUTHEAST, AND WEST were significant and directly related to changes in the proportion of wholesale sales to retailers, while NEG was significant and inversely related. The other variables did not statistically influence changes in the dependent variable. The results indicate that a firm with a higher proportion of sales to retailers used a higher number of transaction methods, and was located in the northeast, southeast, and west as opposed to the group of midwestern and upper south states used as the base. The higher percentages of wholesale sales to retailers also was associated with a lower level of price negotiation (higher proportion of sales not discounted from list price).

(2) WHOLESALE SALES TO LANDSCAPERS: In this profile, a firm with a higher proportion of wholesale sales to landscapers was associated with incorporated firms with a lower level of price negotiation. Firms located in the southeast and in the west were more likely to have lower percentages of sales to landscapers than those in the base states.

(3) WHOLESALE SALES TO REWHOLESALERS: A firm with a higher proportion of wholesale sales to rewholesalers occurred in association with a higher level of price negotiation, and with firms who identified competition as a limiting factor to firm growth. Compared to the base states, southeast-ern and western firms had higher proportion of sales to rewholesalers , while northeastern firms had lower proportion of sales to rewholesalers.

(4) RETAIL SALES: A firm with a higher proportion of retail sales was more likely to identify competition as a limiting factor to growth, have lower gross sales, a lower proportion of negotiated sales, and fewer transactions methods. A firm located in the southeast or west had significantly lower proportion of retail sales than the base states.

Firm characteristics consistently important in explaining changes in propor-tion of sales across market channels included percentages of sales negotiated, and the number of trade methods used. Regional differences from the base group of states was also important, particularly for the southeast and west, while the northeast was different only for the wholesale sales to retailers and wholesale sales to rewholesalers models. The factor indicating whether the firm thought completion was the most important factor limiting expansion was significant in the wholesale sales to rewholesalers and the retail sales models.

Significance to the Nursery Industry: This study investigated the differ-ent marketing channels utilized by ornamental plant producers. The results of this study indicate that the choice of which marketing channel(s) to utilize are primarily influenced by willingness to negoiate, number of transaction methods used, competitive pressures, and the region of the country where the nursery is located. Other secondary influences include size as measured by gross sales, and organizational structure as measured by incorporation. The profiles developed from this study could be used by current producers to evaluate their present market channel situation.

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2. Madalla, G.S. 1983. Limited-Dependent and Qualitative Variables in Econometrics. Cambridge University Press: Cambridge.

Table 1. Landscape Plant Producers and Factors Hypothesized to Influ-

ence Market Channel Use, 1988.

Variable	Description	Measurement	Mean	Standard Deviation
NEG	% of Sales Negotiated	% (0-100)	42.58	41.46
AGE	Age of Firm	Years	21.52	33.30
GSALES	Gross Sales of Firm	$	876,080	2,507,800
RETAIL	% of Wholesale Sales to Retail	% (0-100)	23.91	35.41
WRET	% of Wholesale Sales to Retail	% (0-100)	28.33	30.23
WREW	% of Wholesale Sales to Re-Wholesalers	% (0-100)	24.23	30.44
WLANDS	% of Wholesale Sales to Landscapers	% (0-100)	37.83	34.90
COR	Firm is Incorporated	0 - No 1 - Yes	.42	0.49
COMPET	Competition cited as Limiting Expansion Potential	0 - No 1 - Yes	.36	0.48
NORTHE	Firm is Located in CN, DE, NY, NJ, ME, or PA	0 - No 1 - Yes	.25	0.43
SOUTHE	Firm is Located in AL, GA, MS, SC, LA, or FL	0 - No 1 - Yes	.32	0.46
MIDDLE	Firm is Located in KY, MI, OH, OK, IL, TN, or AR	0 - No 1 - Yes	.27	0.44
WEST	Firm is located in AZ, CA, or OR	0 - No 1 - Yes	.16	0.36

Table 2. Tobit Parameter Estimates For Market Channels Models.

Factor	Retailers	Wholesale Sales to Landscaper	Re-wholesalers	Retail Sales
INTERCEPT	.0432490 (.010)	44.6236* (9.514)	-17.5556* (-3.650)	61.7047* (9.152)
AGE	.0000200195 (.001)	-.0249248 (-.644)	.0278015 (.738)	.0807416 (1.372)
GSALES	.000000693012 (1.474)	-.000000452440 (-.860)	-.000000162760 (-.321)	-.00000652041* (-3.881)
NEG	-.0620800* (-2.175)	-.0925039* (-2.941)	.125558* (3.993)	-.105837* (-2.307)
NUMTM	8.09605* (5.647)	-2.29416 (-1.452)	11.7659* (7.456)	-21.0156* (-8.792)
CORP	-3.89311 (1.557)	14.5887* (5.283)	-1.65262 (-.602)	-.758498 (-.183)
COMPET	2.29409 (.949)	-1.78413 (-.667)	4.73943* (-1.779)	7.41434* (1.893)
NORTHE	7.79685* (2.400)	-5.01033 (-1.403)	-7.58158* (-2.093)	5.86430 (1.159)
SOUTHE	6.63296* (2.187)	-6.77162* (-2.033)	5.86616* (1.773)	-21.1471* (-4.291)
WEST	12.7513* (3.468)	-18.8089* (-4.596)	13.3720* (3.340)	-23.4106* (-3.803)