SECTION 6
ENGINEERING, ECONOMICS, STRUCTURES AND INNOVATIONS

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Adapting MacRapid Plant Selector Software for Student/Customer Self-Instruction

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Nature of work: First exposure to a wide range of plant materials can be a confusing experience for the student or landscape customer. The student's dilemma is being introduced to a number of new plants every time class meets, while the customer must usually make their decisions based on plant sizes typically found in nurseries or garden centers.

To aid the students in better understanding the capabilities (size, form, etc.) of plants and to aid in learning to identify via distinguishing characteristics (leaf size and shape, flower, fruit, bark, etc.) these same plants, the authors investigated various plant material software programs that featured plant material of the Southeastern United States. The search concentrated on finding a software package that offered the widest range of pictorial images of these same plants. The plants were to be woody ornamentals both native and regionally adapted. Ease of use and the ability to add information to the program were equally important considerations.

After investigating several options, the MacRAPID©[1] program from Clemson University was purchased. The program contains information (images) pertaining to 877 species of woody ornamentals on the Videodisc, "Encyclopedia of Landscape Plants" developed by Videodiscovery (800) 548-3472. The use of a Macintosh computer and the Hypercard software program plus the videodisc player and a video color monitor greatly facilitates the locating of individual plants. MacRAPID as the software program is known is written in Hypercard which explained in the simplest manner is a card filing system. In this system, each plant is located on a specific card containing pop-up buttons which reveal images from the videodisc or in the case of adaptations made by the authors, reveals information stored as fields and hidden until needed so that there is enough room on the card to access all stored information and images.

Results and Discussion: MacRAPID can be searched alphabetically by scientific or common name. By utilizing the file screen and the mouse, all plants beginning with the selected letter can be called up. The plant of choice can then be highlighted and all images of that particular plant can be viewed by manipulation of the Hypercard program. See Figure 1.

The screen for each individual plant (visible on the computer monitor) can be utilized in several ways. By use of the mouse, one can bring up the image noted in any of the larger 18 buttons on the bottom half of the screen. These images are displayed on another receiver, a color monitor.

To go to another plant, flick on the appropriate hand and the program will move one plant up or down the alphabet. By clicking on the FIND PLANT button and then typing in the desired plant name, the program will shift to the appropriate plant and to the first image regarding that plant. The Quit button will end the program.

Since some species have information (images) for all eighteen buttons, it was necessary to manipulate the Hypercard program so that a stack or window could be superimposed on any particular screen. The windows was superimposed over the center six buttons and the six right hand buttons. This window was keyed by a *new* button located in the upper right-hand corner of the screen and labeled SHOW UGA PLANTS. See Figure 2. When information was no longer needed, the window could be canceled by a second *new* button in the same area labeled HIDE.

The information as to location of plants on the University of Georgia campus was compiled in a MS-DOS program. PC-FILE.[2] To transfer this information to a Mac program an ASCII file was necessary.

An ASCII (American Standard Codes for Information Interchange) file is a text format which doesn't have any codes written into it so that information can be transferred between systems. The ASCII file for this stage of the program development had just a listing of the buildings but was grouped and alphabetically listed by genus species and cultivar.

This file was opened using Word Perfect and the text was copied from the ASCII file and pasted into a field on Hypercard at the back of the "MacRAPID Plants" file. It took several cards for information to be completely transferred.

Once all the buildings for a particular plant had been copied and pasted on the "SHOW UGA PLANTS" field the process was repeated for the next plant so on until all the buildings had been assigned to the relevant plants. The resulting field is a scrolling field which means that one can scroll through the information to any point that is required. The *HIDE* button then hides the field so that other information can be examined.

Significance to Industry: With this program as a tutorial, the students in plant identification courses can pictorially review plant form and any other esthetic characteristic in addition to reviewing leaf size and shape as well as other common identifying characteristics. Then via the new location button determine one or more sites on campus where specimen(s) might be viewed or limb samples gathered. For the student designer, the same information would be useful, but rather than bringing in limb samples observing a plant in several site exposures might be more meaningful. For the Retail Nurseryman or Garden Center Operator locations in town where attractive plantings or specimen plants are located would be helpful to their customers in addition to seeing the video image.

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Potential of SPAD-502 Chlorophyll Meter for Deterination of Leaf Greenness

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Nature of Work: The list of red maple *(Acer rubrum* L.) selections continues to expand with more than 48 cultivars readily available (4). Evaluations in the past have been limited by accessibility to multiple cultivars of red maple grown to maturity in a single location. No delineation among red maple cultivars with regard to summer leaf color has been reported. Attempts to rank red maple cultivars by a subjective greenness index was found to be a relative and nonquantitative method for determining cultivar specific differences in levels of leaf greenness. Also, perceptions of leaf greenness were found to change from month to month (data not shown). Isozyme analysis (5) has been shown to be a reliable method to establish cultivar identities, however this method is largely unavailable and too complicated to be a practical means for rapid cultivar comparisons.

The SPAD-502 Chlorophyll Meter (Minolta Camera Co., Ltd., Japan) is becoming a functional tool for plant evaluation. Use of chlorophyll meters to assess levels of leaf greenness is widely accepted for agronomic crops. With a measuring area of 2 x 3 mm, it is possible to measure even small leaves in which leaf tissue analysis of chlorophyll or nutrients is difficult. Meter values are not dependent on, or affected by ambient light levels (1,3).

Based on this, a study to characterize the summer foliage color on select red maples in a nonsubjective way was conducted. Methods included leaf greenness evaluations with a SPAD-502 Meter for measurement of the total chlorophyll (CHL) content of leaves, and extraction of CHL from fresh foliage after Inskeep and Bloom (2) using N,N-Dimethylformamide (DMF).

The selections evaluated were: 'Autumn Blaze', 'Franksred' ('Red Sunset'®), 'Karpick', 'Morgan' (also known as 'Indian Summer' or 'Embers'), 'Northwood', 'October Glory', 'Redskin', 'Scarsen' ('Scarlet Sentinel™), 'Schlesingeri', and a group of red maple seedlings. All trees were grown under the same conditions, on their own root systems in Camp Hill, Ala., in a Cecil gravelly sandy loam soil. Selections were planted in 1988 in a randomized complete block design with 5 blocks of 2 plants per selection per block for a total of 10 trees per selection. Drip irrigation was supplied to each tree based on net evaporation from a class A pan. The trees were planted on a 30 x 35 foot spacing and were fertilized with one pound of nitrogen per inch of trunk diameter annually in March prior to bud break.

Fresh leaves were collected at random from each of 10 trees for each cultivar. Immediately, 5 circles were drawn on the back of each leaf. SPAD measurements were taken within these circles and averaged for each of the 10 leaves. A paper hole punch (0.31 cm2) was used to remove discs within these circles from each leaf. The discs were weighed and placed in sealed test-tubes containing 5 ml DMF. The tubes were placed in a revolving rack at 4°C, in the dark, for 24 hours for the extraction process. Extracts were assayed with a Beckman Model 25 Double Beam Spectrophotometer.

Results And Discussion: Much like isozyme analysis, determinations of leaf greenness by extractable CHL proved to laborious, slow, and costly. However, an advantage of this method over the SPAD Meter was determination of the actual CHL A and B ratio, which may prove useful in photosynthesis studies. Actual correlations for extracted CHL and SPAD values across cultivars were good, $r = 0.67$, with cultivars generally holding the same, or similar rank for each method (Table 1). Others have found similar results on horticultural crops (1,3).

SPAD-502 Meter values confirmed indications from subjective evaluations of leaf greenness differences in red maples. The cultivars 'Franksred', 'Northwood', and Morgan had the highest average SPAD values at 49.85, 49.85, and 47.28, respectively (Table 1). The lowest SPAD values were on 'Redskin', 'Autumn Blaze', seedlings, and 'October Glory' at 40.48, 39.28, 38.15, and 37.85, respectively.

Significance to Industry: Our results indicate that within cultivars of red maple grown under the same conditions, the SPAD502 is reliable tool for ranking specific differences in leaf greenness in a consistent manner. Our results indicate use of a SPAD-502 Meter may aid the originator of new or developing cultivars in determinations of relative leaf greenness in a nonsubjective manner. In cultivars which have recognized standard selections, comparisons may be drawn which would quantify differences in the response of cultivars to nutritional and environmental conditions.

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Table 1. Leaf greenness as determined by chlorophyll extraction and SPAD-502 Chlorophyll Meter for select red maple cultivars and seedlings in 1993.

Cultivar/seedling	Total CHL extracted[Z]	SPAD-502 meter values[Y]
Autumn Blaze	4.180 abcd[x]	39.28 d
Franksred	5.200 a	49.85 a
Karpick	4.820 abc	43.93 c
Morgan	5.047 ab	47.28 ab
Northwood	4.835 abc	49.85 a
October Glory	3.630 cd	37.85 d
Redskin	4.065 bcd	40.48 d
Scarsen	4.687 abc	44.60 bc
Schlesingeri	4.665 abc	44.35 bc
Seedling	3.630 d	38.15 d

[Z] Total chlorophyll (CHL) reported in mg/g of fresh weight.
[Y] Units for SPAD-502 Leaf Greenness Meter are independent values, not percentages.
[x] Mean separation within columns by Duncan's Multiple Range Test, P = 0.05.

Cost and Effectiveness of broadcast treatment of Talstar® for control of Imported Fire Ants

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Nature of Work: Talstar® (bifenthrin) 0.2G T & O was applied 21 June 1993 to one acre blocks in the MSU Horticulture Research and Teaching Arboretum, Mississippi State University, for the control of Imported Fire Ants. Treatments consisting of 0.4 pounds aia, 0.2 pounds aia, and 0.1 pound aia were applied with a cyclone seeder. Approximately one-half acre inch of rain was received within twenty four hours after application.

Results and Discussion: A survey of each block January 24, 1994 did not reveal any IFA mounds in any block. Each block was surveyed again June 12, 1994. There were 11 IFA mounds found in 0.2 #ai/A block, 19 mounds found in 0.1 #ai/A block, and 5 mounds found in the 0.4 #ai/A block (TABLE B). It was observed that in some instances where mounds were found, soil had been added to the area after the TalstarX treatments had been made.

Significance to Industry: Presently, the Federal Imported Fire Ant Regulations for field grown nursery stock prescribes a treatment of Dursbans (chlorpyrifos) at 6 # ai/A and Amdro® or Award® applied at 1.5 pound per acre. The exposure period is 30 days and the certification period is 12 weeks (120 days) for this approved treatment (TABLE A). Talstar® 0.2G cost $1.03 per pound. The treatment cost of applying 200 pounds to Block C was $206.00 per acre, 100 pounds to Block A was $103.00 and 50 pounds to Block B was $51.50 (TABLE B). The cost of application of Talstar® 0.2G ranged from $51.50 to $206.00. This compares to the approved USDA treatment of $220.21 per acre. The wholesale price of one gallon nursery stock has remained relatively constant over the past 10 years while production cost have increased. Nursery growers in the IFA regulated area must seek means to reduce production costs to remain competitive with nurseries outside the regulated area. The currently approved regulatory treatment does not provide an “IFA free nursery - for Field grown nursery stock".

TABLE A: USDA, APHIS,PP&Q Approved Treatment - IFA Control for Field Grown Nursery Stock

Treatment	Rate	Cost/pound	Cost/Treatment
Amdro®	1.5# bait/A	$7.15	$10.73
Dursban ®(2.3G)	6# ai/A	$0.81	$209.48
		Total Cost/A	**$220.21**
Award®	1.5# bait/A	$7.60	$11.40
Dursban® (2.3G)	6# ai/A	$0.81	$209.48
		Total Cost/A	**$220.88**

TABLE B: TALSTAR® 0.2 G T&O TREATMENTS - JUNE 21, 1993

Rate of Talstar® 0.2 G T&O	Rate per acre	IFA mounds found 1/24/94	IFA mounds found 06/12/93	Talstar® 0.2G cost/ pound	**Treatment cost/ acre**
0.1 #ai/A (Block B)	50 pounds	0	19	$1.03	$51.50
0.2 #ai/A (Block A)	100 pounds	0	11	$1.03	$103.00
0.4 #ai/A (Block C)	200 pounds	0	05	$1.03	$206.00

Developing A Computerized Plant Selector Program

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Nature of Work: The potential applications for computers in the green industry have expanded far beyond the territories of word processing, spread sheets, and even desktop publishing. Computers now serve as reference sources and educational tools. A recent program developed for higher education has potential applications in the nursery industry as well.

The plant selector program was developed in the University of Georgia's School of Environmental Design in 1992 - 93, and began to be used by classes in the spring of 1993. Information on plants in the program was derived from textbooks from highly respected authorities (Armitage, Dirr, Odenwald, etc.), as well as from personal observations. The program contains information on trees, shrubs, groundcovers, herbaceous perennials, and annuals. It is designed for use on Macintosh computers, using a database program called FileMaker Pro 2.0. It functions much like an electronic textbook, but uses checkboxes rather than text to display the characteristics of each plant. For each plant in the program, information is provided via the checkboxes on size, primary use, texture, flowers, flower fragrance, fall foliage color, fruit, bark character, form, salt tolerance, sun and soil requirements and tolerances, hardiness zones (using the new USDA map), and range of native habitat. Program users can utilize the computer mouse to select which combination of the abovementioned features are desired for a particular situation. When a search is begun, the computer searches the database and displays the list of plants that meet all of the selected criteria. Tools within the program allow the user to expand or narrow the search. Records of individual plants can also be browsed, just like a textbook. Passwords installed in the program prevent users from modifying the record of any plant, but provide access to the author to do so or to add new plants to the database.

The development of a computerized plant selector program is not new. Commercial programs have been available for several years (1). Three items set this program apart from those developed commercially. First, special emphasis is given to native plants. Users can select plants native to the U.S., the Southeast, Georgia, and any of the primary physiographic regions of Georgia. Second, differentiation is made as to the degree of impact of various ornamental features. Flowers, fall foliage color, fruit, and bark character are all differentiated into extremely, somewhat, slightly, and not showy categories. Flower fragrance is also differentiated by its degree of impact. This makes a great deal of sense when one considers the impact that the fragrance of a southern magnolia has upon the landscape versus that of a daffodil. Flowers with a malodorous smell are also differentiated from the others so that the impact of a Washington Hawthorn or Chinese Photinia won't be confused with that of a gardenia. Third and foremost, the program also contains photographic images of the individual plants revealing selected ornamental attributes. The photographs are digitized color slides, designed to remind or educate the program user of some of the best features of a particular plant. They are not necessarily intended for identification purposes.

The program is constantly upgraded. Currently, approximately 500 species and selected cultivars are included. New plant records require about 2 minutes of time to enter. The biggest need at the present time is the acquisition of quality slides of many of the plants. The author is trying to be very selective about the quality of the visual images.

Results and Discussion: The program was designed as a tool for completing studio assignments for upper level landscape architecture students at the University of Georgia. It is also being shared with the horticulture department at the University. Students and faculty in landscape architecture have been using it for four quarters now, and highly praise its versatility and ease of operation. But the use of a program such as this is not confined to higher education. It has tremendous potential in the nursery industry as well.

Significance to Industry: No longer is the computer just a tool for managing inventory, accounts, payrolls, and word processing. Utilization of recently developed software programs such as this allows the computer to function as a valuable sales and educational tool in the nursery. Educating employees as well as customers about the potential applications, characteristics, and features of plant materials leads to a more fully satisfied customer and, in turn, expanded sales.

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Use of Employee Empowerment to Enhance Profitability in a Retail Nursery/Landscape Firm

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Nature of Work Traditional management structure is based on theoretical span of control. Each manager has a set of subordinates. The number of managerial layers is based on size of the organization. Thus, the larger organization inherently has more distance between where work is done and where decisions are made. Large organizations have more personnel in staff functions. Financial review of projects is an example. Approvals may be needed from several levels of management and staff before decisions can be made or actions taken. Problems related to product quality, productivity, and responsiveness of the firm to its customers' needs, have been attributed to this distance. Consumers have been taught that quality at a moderate price is available from some suppliers. When that performance is demanded from all firms, prices are driven down. Firms need to reduce cost through increased productivity while maintaining quality. Many firms have turned to their employees to enhance competitiveness through productivity gains.

In large companies, "entrepreneurial drive is held in check ... by the .. hierarchical structure of the organization and the way one must report and get things approved" (2). Decisions tend to be passed up the structure and made at relatively high levels, so most employees have no input into decisions.

Decentralization has been one response to these rigidities. Creation of profit centers with autonomous managers were an attempt to establish small business creativity, decision-making skills, and entrepreneurship within large businesses. Another response by many large firms has been to remove layers of management (flatten the structure). This action has been forced by the downsizing theme during the past decade. Flatter structures should enhance productivity by timlier decisions and reduced response time.

Improved productivity and higher quality are important competitive factors. Deming (1) is credited with moving Japan to leader status in both factors. Quality can be enhanced by active involvement in decision-making by employees and/or teams, since they are most familiar with the process. Employee teams may be given responsibility for studying tasks and process, recommending refinements to enhance both quality and efficiency. This responsibility requires that employees have more information, and systems are redesigned to provide the needed product cost data. They must understand their job, their inter-relationships with other team members, and with other segments of the production process. By having decision responsibility and an appropriate reward system, they are expected to be more motivated, and to work more intelligently and more efficiently. In this system, managers and supervisors take on the role of facilitating rather than directing. Training expenditures are used to acquire a more knowledgeable workforce.

This organizational structure is called employee empowerment. The concepts were developed in large organizations, and have received less attention in smaller, labor-intensive firms. Nursery industry firms are relatively small and typically have few management layers. In this example case, a landscape/retail nursery firm has used empowerment partly to achieve its control function, to increase productivity, and to maintain quality. Advantages and drawbacks of employee empowerment are illustrated.

Results and Discussion: THE FIRM The case firm sells landscape design and installation, retail sales of various plants, lawn maintenance, and has some greenhouse and outdoor plant production. The firm was established in 1981 by a horticulturalist whose husband became involved with the financial management in 1985. In hired management, two individuals called managers but acting as foremen, were in charge of landscape and nursery activities. However, decisions were made by the family. The firm positioned itself as a top quality, full service company. Through 1990, the local economy expanded rapidly and the firm rose with this tide of economic good fortune. Area homes and commercial properties were enhanced aesthetically. However, growth began to slow and the market for the firm's products declined. Potential customers became more price conscious, a change reflected in a decline in the middle income residential business. A group of relatively untrained individuals began to bid and get residential installation contracts previously held by the case firm. These competitors, whose overhead consisted of a truck and shovels, priced their jobs considerably below the old market price. Meanwhile, retail plant sales declined as the result of competition from mass merchants. These economic conditions and the nature of competition continue to face the firm.

In 1989, divorce left the owner again in full control of the firm. With limited experience in directing an entity of this size, managers were given wide authority to act in the firm's name. They purchased equipment, determined personal and crew overtime, and hired additional employees as needed to complete jobs. It was assumed that these managers were aware of the importance of controlling costs and would act in the firm's best interests. Led by the owner, sales increased, but costs increased faster, generating a cash loss in 1991 (net income included depreciation) and a substantial increase in capital indebtedness (Table 1). Salary and associated costs amounted to almost 50% of gross income. In discussions about how to restore profitability, these managers refused any responsibility for losses, would not agree to changes in and additions to their responsibilities, and resigned.

In 1992, a part-time financial consultant was hired and new managers were hired, a new position for maintenance was added, and profit centers with budgets were designated. The new managers were better educated than their predecessors, and made decisions about planning, scheduling and recruiting resources. In terms of policy, it was agreed that (1) impact of decisions on profitability was provided to managers through access to financial statements; (2) a monthly budget review meeting would be held; (3) half of budget savings in a center would be retained for distribution at the manager's discretion; and (4) that managers would write bids on most jobs while the owner would do designs and bids on the large landscape projects. Profitability was restored, but problems persisted. Monthly meetings exposed mistakes rather than building team spirit. Though the owner thought that expectations of the new plan had been well communicated, managers had no input and little incentive to work toward its success. At another level, these managers did not want the level of responsibility implied in this structure. All resigned.

In 1993, new managers again were hired and further efforts were made to assure their knowledge and acceptance of the structure. Further, the owner took a stronger lead in acquiring new business, and appeared at and consulted with managers on job sites. Managers were encouraged to use the owner as a consultant, and still had decision-making authority, the profit-sharing incentive, and access to the balance sheet. At year-end, the firm was within budget, had a small loss after depreciation, continued debt reduction, and an improved working relationship between owner and managers. Because of the competitive situation, the firm has downsized and carefully evaluates the kind of jobs it can do profitably on a job-by-job basis.

This example of empowerment moved relevant decision-making closer to the worksite, and illustrated that not all employees will be successful in this environment. Its initial application was imprecise in this case, with negative impacts on the firm's financial position, but eventually did provide a control mechanism. Few changes were made for 1994; managers make day-to-day decisions; the owner consults as needed on individual jobs; the profit-sharing incentive has been retained for motivation. Labor expense as a percentage of revenue declined to less than 40%, and would have been lower but for a one-time assessment for workers' compensation insurance. The firm is again solvent (debt/asset ratio of .69), and was able to consolidate loans to improve cash flow.

Table 1. Selected Items from Balance Sheet and Income Statements, 1990-93.

Item	1993	1992	1991	1990
Current assets	65,200	75,278	68,761	82,479
Fixed Assets	46,762	63,543	70,005	49,191
Current liabilities	26,444	24,197	21,589	9,757
Other liabilities	50,519	92,728	121,833	90,689
Equity	34,999	21,896	(4,657)	31,224
Revenue	337,719	359,155	445,258	376,837
Sales expense	236,817	294,481	402,579	296,272
General expense	65,552	68,029	78,559	69,934
Net income	(3,257)	(3,354)	(35,881)	10,631
Debt/asset ratio	.69	.84	1.03	.76

Significance to Industry: The competitive conditions faced by this retail/landscape firm are both regional and national. Industry leaders have discussed the issue of stagnant or declining prices. Economic theory suggests that an increase in demand or decrease in supply is needed to increase price. Customers of landscape plant firms have found that quality plant material at discount store prices is available. Firms are searching for ways to more efficiently meet customer demands. The appropriate firm level response is to consider adoption of cost-saving innovations that either reduce cost or increase quality. These are technological advances in refinement of production processes, and changes in managerial structure. Using the creativity of employees is a step toward that goal. Both competitive and quality standards may benefit.

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Development of Automated Multiple Potting and Transplanting Systems

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Nature of Work: Mechanization and automation are as important for nurserymen as it is for any other field of agriculture (Peng et al., 1993). This is because there is a tremendous amount of labor involved in the operation of a nursery, and the growers have to contend with the problems of scarcity of labor and overall labor costs just as any other business. One particular labor intensive area is that of transferring or transplanting relatively young and small plants from their initial rooting container to a larger plant container for further growth and development.

Currently, the single potting machines are commercially available. The equipment sequentially fills a pot one by one with soil mix or growth media. However, plant transfer and transplanting are generally done by hand, and are time consuming and very inefficient. As a practical matter, the use of manual labor to transplant such plants severely limits the development of more efficient potting machines and the capacity of a nursery for handling such transfer or transplanting operation.

The purpose of this study was to design and develop an automated multiple potting and transplanting machine which integrates potting and transplanting operations using matrix transfer method to increase the operational efficiency. The new approach and system design are discussed in detail to provide nurserymen a guideline to automate their greenhouse operation.

Results and Discussion: A greenhouse structure is provided with a rail-type conveyor designed to receive a series of mobile pallets (Huang, 1994) with pot grids in which a series of plant pots is inserted within the respectiveframes of the pot grid (Figure 1). The soil-mix filling station includes a bridge-type frame structure that extends over the pair of conveyer rails. The multiple potting device may be moved from one rail system to an adjacent rail system. The device comprises surrounding sidewall hopper and a bottom having a series of openings. Soil packer assembly is movably mounted (up and down) on a U-shaped carrier frame within the hopper structure designed to receive soil-mix. The packer assembly includes a rotating cylindrical packer that is provided with a internal drive motor that is designed to drive the same in the direction of arrow. To power the soil packer assembly from right to left, there is provided a cable drive assembly consisting of a powered shaft with a pair of pulleys and cables that extend and trained around a pair of idler pulleys and connect to the U-frame. To control the movement the multiple potting system is provided with a pair of microswitches. When Uframe engages the powered shaft switch located at the leftmost to shut off the shaft motor, the rotating energy of the packer assembly will alone move the same from left to right. On the other hand, when the U-frame engages the rightmost switch, the shaft motor is turned on and as a result the entire soil packing assembly is caused to move from right to left. As the soil-mix within the hopper is packed into the pots below, the rotating packer reaches the ends of U-frame turning on a switch to activate the filled pallet to move to transplanting position and the empty pallet to filling position. Then the positioning switch activates both packing assembly and filling of hopper with optimum amount of soil-mix.

To explain the matrix plant transfer and transplanting operation, a supply tray is provided with 96 plant cells and the plant transfer system is designed to transfer 24 plants at a time. At first position, a selected matrix of 24 plants overlies 24 openings and filled pots under the 24 drop tubes. Once in this first position, the vacuum device is actuated causing all 24 overlying plants to be pulled from the supply tray downward through the respective drop tubes and pneumatically shot into the 24 underlying receiving pots.

To continue the transfer of plants, the supply tray is actuated so as to move the entire tray one plant cell increment to the left. This allows 24 additional plants to be appropriately aligned over the respective drop tubes. By the same process described above, a second set of 24 plants/plugs are shot into the set of 24 pots that underlie drop tubes. After this, the indexing frame is again actuated and is moved one plant cell increment downward. There, a third set of 24 plant/plugs are appropriately aligned over 24 drop tubes for transfer. Finally, after the transfer of the third set of 24 plants/plugs, the indexing frame is actuated again and moved one plant cell increment to the right. In this position, the final or fourth set of 24 plants/plugs are appropriately aligned for transfer to underlying pots. Once this final set of 24 plants/plugs has been transferred, then the empty plant tray is removed from the indexing frame and a new loaded plant tray is placed within the indexing frame. Test results showed that by modifying their culture practice growers could use their available trays to achieve improved plant/plug growth and matrix transferring and transplanting.

For those growers or nurserymen who already have a commercially available potting machine, the operating efficiency can be greatly increased by automatically ganging a few filled pots on the conveyor for automated transplanting. A commercially available potting machine normally includes a frame structure for supporting a conveyor that is designed to receive and convey plant pots. A grate structure for retained and holding the various pots on the conveyor can be added. The pots are first conveyed underneath the hopper where, through a conventional pot filling process, the respective pots are filled with soil-mix. Once the pots have been filled they are conveyed sequentially underneath the series of drop tubes that form a part of the plant transfer system. In the manner described above plants/plugs are induced from the respective plant tray cells and pass through the respective drop tubes to where the plants/plugs are received by the pots or containers. Once the plants/plugs have been automatically planted into the respective pots they are transferred to a collecting, greenhouse or packing area.

Significance to Industry: The development of an automated multiple potting and transplanting machine to integrate potting and transplanting operations would aid overcoming the current bottleneck in the nursery operation. Nursery and greenhouse growers can use the design information and guidelines to improve their equipment to increase their operational efficiency on greenhouse facilities and associated equipment.

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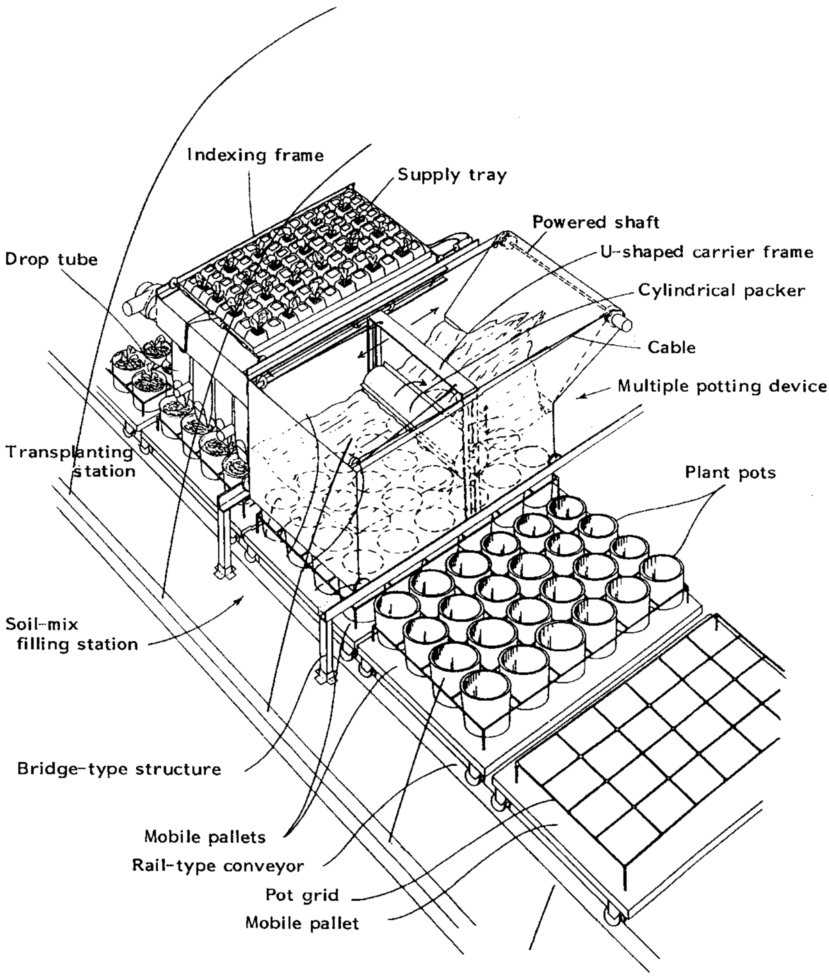

Figure 1. Perspective view of automated multiple potting and transplanting system.

Impact Dynamics of Seedlings/Plugs in an Automated Transplanting System

Jianhua Gao and Lei Cui
North Carolina/Florida

Nature of Work: Due to the high speed transplanting process in an impulsive transplanting system in conjunction with root-air-pnuning techniques and the inherent complexity of impact dynamics, understanding the characteristics of impact dynamics becomes critically important. The analysis of impact dynamics was performed with an elasto-plastic model and a computer simulation was used to investigate factors involved in the process, including impulsive interaction between seedlings/plugs and ground formation and deformation. This work is important to nursery industry and growers in improving seedling/plug quality and productivity as well as in enhancing full automation of seedling transplanting process and savings on energy, labor, greenhouse facilities and associated equipment.

Results and Discussion: The key parts of an impulsive transplanting system are an index frame controlled by a computer and an impulsive vacuum system generating a suction force in a vacuum chamber. An automatic door on the bottom of the vacuum chamber is closed for suction force and opened for seedlings/plugs dropping through a path in the center of the vacuum chamber to a container or field.

Seedling Dynamics The seedling dynamics and the interaction between the seedling block and soil are important considerations in the process of transplanting. To remove the seedling from the germinating cell, a suction force is applied on the seedling from bottom to overcome the friction between the seedling block and the wall of germinating cell. Then the seedling block drops down to a container or field under gravity. The characteristics of seedling dynamics is significant to evaluate the impact between a seedling block and top soil in a container or field, to improve the performance of impulse vacuum system and to protect the seedling against damage of root ball. The dynamical equation of a seedling block at the moment of being dislodged is a function of an acting force, the weight of the seedling block, the resistance and the mass of the seedling block. The resistance is not a constant and is inversely proportional to displacement of the seedling due to the contact stress in the germinating cell. The contact stress is reduced gradually to zero during the short period that the seedling block is being removed from the cell. A force is applied on the top of the seedling block and the force afler the seedling is dislodged is increased. An additional force is applied on the cylindrical surface of the seedling block; there is also a pressure difference between inside the vacuum chamber and outside the vacuum chamber. Normally, the pressure outside of vacuum chamber is equal to atmospheric pressure (14.7 psi). When the volume of the vacuum chamber is changed, the variety of pressure inside of the vacuum chamber can be expressed as a function of the initial volume of the vacuum chamber and the volume of the vacuum chamber at a subsequent time. When the seedling block is dislodged and passes the upper neck of the dropping path, the vacuum disappears but the seedling continually drops with gained acceleration to the soil.

Elasto-Plastic Model The analysis of the interaction between the seedling and the soil to an impulsive vacuum system constitutes a factor of fundamental importance to evaluate the automated transplanting system. The inherent complexity in the behaviors of seedling soil block and top soil during transplanting process has led to develop a general mathematical model for the analysis of the interaction other than the test in a specific field. The mechanical properties of the seedling soil blocks are oflen heterogeneous and orthotropic due to the roots bound in the soil blocks. The classical theories of elasticity and plasticity are commonly employed in the analysis of this kind of problem. An elasto-plastic model discussed here will not describe directly the soil stress-strain relations for either seedling block or soil. The best that can said of the model of soil-seedling block interaction is that it provides a useful description of certain features under the conditions of transplanting operation. The response or character of the model is typified by the dynamical deflection. An elasto-plastic model, as shown in Figure 1, illustrates the situation of impact on the soil in a container or field. Since the both the seedling block and top soil are not rigid, spring stiffness k_1 and k_2 are used to represent the elastic properties of seedling block and top soil, respectively. C is a system damping coefficient. The damping force in the system is independent of the elastic properties of the springs. The springs and damper work in compression and ideally become elasto-plastic system to simulate the deformations of both seedling block and top soil as the collision occurs.

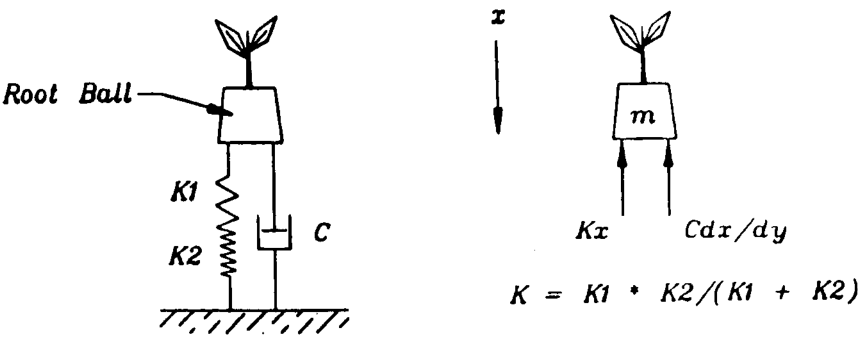

Figure. 1. An Elasto-Plastic Model

Computer Simulations and Discussion The simulation of interaction between seedling block and top soil which are deformable bodies is of importance to transplanting process. An analysis of the interaction problem for elastic bodies generally requires the determination of stresses and strains within the individual bodies in contact and the distribution of displacements and stresses at the contact regions. In fact, actual behaviors of seedling blocks and top soil are very complicated and show a great variety when subjected to different conditions. It is essential to develop simple mathematical models for practical applications In soil mechanics, Hooke's law has been used for long time to describe the general behavior of soil media under short term working load conditions, but it fails to predict the behavior and strength of a soil interaction problem near ultimate strength condition, because plastic deformation at this load plays a major role while the elastic deformation becomes of less importance. Under the impulsive conditions the elasto-plastic model may be idealized to describe the soil- seedling block system behaviors. The values of major parameters used in the simulations are listed as follows:

Top area of seedling block	A_{top} = 3.14*0.5*0 5 (jn)^2
Bottom area of seedling block	A_{bom} = 3.14*0.625*0.625 (jn)^2
Weight of seedling block	W = 0.025 (lb)
Diameter of vacuum chamber	D = 4 (in)
Diameter of dropping path	d = 1.25 (in)
Air cylinder stroke	S=2(in)
Average speed of air cylinder	Vc = 80 (in/sec.)
Coefficient of system damping	C=0.075, 0.1, or O.125
Spring stiffness	k = O. 1
Distance of seedling drop	L = 18 (in)
Length of upper neck	L1 = 0.5 (in)

Under the acting of impulsive suction force, the dislodged velocity of seedling block is gained in a very short period, then keeps a near constant speed until dropping to a container or ground. The maximum speed is about 100 in/sec. The time spent in the dropping path is about 0.18 sec. Corresponding to the velocity, the displacement of seedling block is almost straight lines before it reaches to the soil with the damping coefficient C = 0.125, the displacement of seedling block is close to a perfect straight line. The acceleration of seedling blocks reaches to 22500 in/s2 in 0.001 second and then rapidly drops to zero when the seedling blocks are dislodged from tray cells. The deceleration of seedling blocks is determined by the formation of top soil. The sofler the top soil, the greater the soil is compressed and the less impact force. In general, the seedling block can stand bigger load in compression than that in tension. A suction force will generate tensive strain in a seedling block and an impact force will produce compressive strain. Since the suction force is moderate, which is limited by the atmosphere pressure, and the formation of top soil is adjustable, normally sofl, the seedling block is under protection in the impulsive transplanting system from strain point of view. The volume of vacuum chamber is the major parameter to determine the magnitude of force applied on the seedling block.

Significance to Industry: The analysis of impact dynamics is important to an impulsive transplanting system in improving machine performance and enhancing plant quality. The results of the analysis indicate that the performance of the transplanting system demonstrates explicitly impulsive dynamical characteristics during transplanting operations and the force is uniformly distributed on the seedling block. The total force applied on a seedling block is limited by atmospheric pressure to prevent the root balls of seedlings from the possible damage. The elasto-plastic model discussed in the paper is effective for the analysis of deformation for both top soil and seedling block without tedious calculation of the stress and strain.

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Optimal Analysis of Planting Tray Cells

Jianhua Gao and Jianghong Yu
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Nature of Work: The change from producing a plant in the field to growing it in a container has greatly increased in the last two decades. A tray cell is the base for plants to grow and it provides nutrient, water and aeration for the germination of seeds and the development of roots. A designed shape of cell will physically constrain the distribution of the roots of seedlings and the utilization of growing supplies (fertilizer, water, light and etc.) since the seedling is growing in the confined space. The root system of the container-grown plant is much more important than the top growth. If a seedling has a good, well-grown, active root system it will soon grow a top to match the provision of sufficient water and fertilizer assimilated through the root system. Many studies have indicated that the quality of root development in a tray significantly effects the plant production after the seedling is transplanted to a pot or the field. The growth performance depends to a large extent on the rapidity in the root system development.

Results and Discussion: As an air-pruning tray is applied for the planting, the first root reaches to the opening bottom of the cell and touches on air, thus the root stops at the opening bottom and the second root is branched from the top of the main root and extends to the lower part of the wall of a cell. Due to the restriction of the wall, the root grows downwards and eventually reaches to the bottom of the cell and stops. In the same way, all branched roots grow in different directions downwards to the bottom of cell. Ideally, the whole root system should be like a mushroom shape and evenly distribute in all directions.

Geometrical Structures of Cells Various cell structures can be used for planting trays, Figure 1. An optimal shape of tray cells should match with a proper orientation of the root systems of the seedlings and provide necessary growth conditions for the seedling growth. For the convenience of the analysis, one unit (or 1 " x 1") is used for the reference areas. The volume of a cell will determine the total growing medium contained. The bigger the volume is, the more the growing medium is used. Unnecessarily big size means the waste of fertilizer and increase in expense. Assuming all cells have same height (one unit or 1"), the inclination of the wall is 10° for all tapered and pyramided cells. From the root development point of view, the bottom section is the most significant area since the distribution of root system has bigger cross section area on the bottom of root than that on the top. Therefore, bottom area is chosen as a reference section for the purpose of comparisons.

The volumes of different cells with same area of reference section indicate the inverted-truncated-pyramid shape has the largest volume and the tnuncated-taper shape has the smallest volume. The growing medium used in the inverted-truncated-pyramid shape tray cells will be 2.2 times of that used in the tnuncated-taper shape. The surface area around a cell is the boundary of a root system.

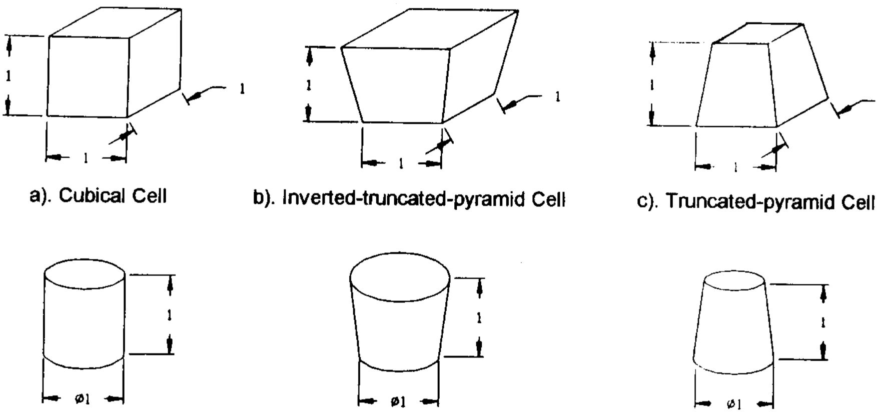

Figure 1. Cell Structures

There is a solid bottom side for the conventional tray cell while the air-pruning tray cell has an open bottom with an attached mesh screen to prevent the dropping of growing medium in the cell. Since many researchers have shown that the growth of seedling in an air-pruning cell is superior to that in a conventional cell, thus only are air-pruning cells discussed hereinafter. The inverted-truncated-pyramid shape has the largest surface area and the truncated-taper shape has the smallest area. The bigger surface area results in the more raw material needed to make that cell at manufacturing.

Optimal Density of Growing Medium in a Planting Tray Cell Roots use large amounts of oxygen, and to supply this, the medium needs a minimum of 20 percent to 30 percent[3] by volume of large pores in conventional trays, but this factor is less important for air-pruning trays because the open top and bottom of the cell would provide enough oxygen. However the water evaporation from both top and bottom is another consideration for air-pnuning trays. The water in a loose medium will drain quickly under gravity. Water available for seedling growth is held in smaller pores which do not drain under gravity. The uniform density of growing medium in the tray cell will have many advantages for the root development, one of which is to provide equal conditions for the development of all branched roots. Otherwise, the roots will be easy to spread out in the low-density area and difficult in the tight area, which causes the non-uniform distribution of root system and wastes the fertilizer.

According to the principles of soil mechanics, one way we can control the density of growing medium in a tray cell is to calculate the soil stress distribution in the cell because the stress is proportionally related to the pressure. The higher density will result in the bigger stress in the soil. When the growing medium is filled into the tray cell, an initial pressure is applied to the surface where the growing medium enters in order to produce proper density of soil and prevent the growing medium dropping from the bottom of a cell. When the pressure comes from top or bottom of the cell, the soil is compressed and it expands to the sides of the cell and transfers the energy to surrounding soil. Since the sides of the cell resist the expansion of the soil, the stress must exist in the soil and its magnitude can be calculated theoretically.

Friction between the Wall of Cells and the Seedling Blocks Friction is a process wherein shear resistance depends on the perpendicular pressure on the cell side surfaces. The shear resistance is proportional to normal pressure on the surface. In our case, the coefficient of friction between soil layers is bigger than that between the tray cell wall (normally, plastic material) and the soil block. The maximum stress of soil in a tnuncated-pyramid stnucture concentrates at the comer and truncated-tapered stnucture has uniform stress distribution at a given cross section.

Initial Pressure and Normal stress in the Truncated-Pyramid Structure After the soil is filled into the cell, the initial pressure is applied on the soil block in order to obtain the proper soil density and hold the soil in the cell. Under gravity, the soil block tends to drop from the cell. The only force to prevent the dropping is the friction between the wall of cell and the surfaces of the soil block if the mesh screen has not been attached to the bottom of tray. The direction of friction is always opposite to the direction of the soil block dropping. The minimum friction can be found from the equilibrium in the direction of soil block dropping and is calculated to be 0.042 lb. Since the friction is the function of the contact stress, therefore the magnitude of minimum initial pressure from top can be expressed in equilibrium as 0.035 ib/in^2.

Initial Pressure and the Normal stress in the Truncated-Tapered Structure The minimum friction can be found from the equilibrium in the direction of soil block dropping and is 0.027 lb. Correspondingly, the magnitude of minimum initial pressure is 0.029 Ib/in^2, The minimum friction to hold the balance in the truncated-pyramid stnucture is larger than that in the truncated-tapered structure on average (0.042 lb > 0.027 Ib), which means that it is more difficult to remove the seedling from the truncated-pyramid structure than from the truncated-taper structure (0.035 Ib/in^2 > 0.029 Ib/in^2).

Water Evaporabon The soil is the reservoir, the supplier, the storehouse for moisture. All the seedling growth processes require that the soil furnish enough water. Root growth is basic for plant development since roots determine the extent of the seedling's ability to absorb water and nutrients when the seedling is transplanted from the tray cell to a pot or field. In dry soil root growth is greatly retarded due to the lack of water supply. A less extensive root system means a smaller absorbing area for mineral nutrients and thus becomes a limiting factor in plant growth. Stunted, dwarfed, and unthrifty plants are the result.

In an extremely wet soil, root growth is also retarded because of restricted aeration. Consequently, an optimal supply of water in the soil is a requisite for maximum root development. Water in deficiency or excess can create problems for growers. A shortage of water during the growing season may have diverse effect on various plants but the end effect is reduced growth. An air-pruning tray needs watering frequently due to the evaporation from the openings. The analysis of water evaporation indicates that the truncated-taper cell has lower evaporating rate and the truncated-pyramid cell has higher evaporating rate.

Significance to Industry: The cells of the planting tray play a very important role in the development of root system. An optimal tray cell will provide optimal conditions for the development of health seedlings, improve the quality of seedlings/plugs, save the energy and raw materials, and reduce cost. The optimal stnucture has many advantages. The major benefits are listed as follows: (1). Best fitting the natural distribution of root system, highly utilizing the space and fully assimilating the fertilizer; (2). Least opening area which reduces the water evaporation; (3). Uniform contact stress and less friction between the wall of structure and the surface of the seedling block. It is easier to remove from tray cell at transplanting and eliminate the possible damage of root system during the processing; (4). Using less raw material to manufacture the trays and reducing extra growth medium to plant the seedlings; (5). Eliminating the root circling and tangling on the both bottom and side and improve the quality of the root system.

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The Green Industry's Interlinkages with Georgia's Economy

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Georgia

Nature of Work: The impact of the horticulture and nursery industry on the Georgia economy was investigated for 1990. This industry was defined to include grass seeds, greenhouse and nursery products, and landscape and horticultural services. The purpose of this paper is to describe the relative size of the horticulture and nursery industry within Georgia and how it is linked to supporting industries through the volume of transactions and the economic impact multipliers. This study is based on IMPLAN, an input-output model developed by the U.S. Forest Service(Alward et al. 1993) and is derived from a study of the Georgia economy by Kriesel. IMPLAN uses the standard input-output technique of accounting for the flow of transactions between the various economic sectors both within and outside Georgia. Thus, IMPLAN presents a snapshot of Georgia's economic structure.

IMPLAN has the capability to analyze 528 industrial sectors and contains data for all states and counties in the United States. For this analysis, these 528 sectors were combined into 42 sectors, of which 24 were food and fiber and 18 represented the rest of the economy. The horticulture and nursery industry was one of the 24 food and fiber sectors. Three basic measures generated by IMPLAN are employment, output, and value added by a sector. The transactions matrix generated by IMPLAN presents the annual sales (in producer prices) of each sector to the other sectors. The transactions matrix is also used to yield multipliers which are used to measure secondary, or "ripple", effects that spread through the economy when an industry experiences an increase in sales to a final demand sector (that is, to households or export markets). This study focuses on three types of multipliers; employment, output, and value added. It should be mentioned that the multiplier used here include the household sector (a type 2 or closed model multiplier).

Results and Discussion: Three measures of economic performance will be discussed; employment, output, and value added. In 1990, the food and fiber system employed 14.8 percent (543,346 out of 3,676,471 workers) of the total. In the food and fiber sectors, the horticulture and nursery sector employed 13,894 people out of a total of 543,346 (2.5%). For comparison, the food services employed 35%, food wholesale and retail employed 16%, wood and paper processing employed 13%, fabric mills and leather employed 7%, processed meat and eggs employed 5%, while other food processing employed 4%. Within production agriculture, the horticulture and nursery sector ranked second behind poultry and egg employment(17,497) and slightly ahead of employment in the "other crops" sector (i.e., hay, fruits and vegetables) which was 13,485 workers.

Output is defined as the total value of all production for a sector during the year. In layman's terms, output can also be thought of as annual gross sales. In 1990, the horticulture and nursery sector generated $588 million out of a total output of $242.7

billion for Georgia. Within production agriculture, this sector ranked third behind the poultry and eggs sector and the "other crops" sector.

Value added is equal to a sector's value of output minus the value of inputs it has purchased from other sectors. Thus, value added contains wages and business profits, and as such it measures a sector's ultimate impact on Georgia's economy. The horticulture and nursery sector had value added of $237 million in 1990 out of a total of $14.91 billion for the food and fiber sectors. Again, within production agriculture, this sector ranked third behind the poultry and eggs sector, and the "other crops" sector.

The linkages between the horticulture and nursery sector and other sectors of the Georgia economy are examined within the context of the transactions matrix. Again this matrix reports a sector's gross sales to other parts of the economy. The transaction matrix used in this analysis can be found in Kriesel's report. Of the $588 million sales by the horticulture and nursery sector, $35.5 million was to the construction sector, $245 million was to the financial and real estate sector, $11 million was to miscellaneous services, $9.9 million was to the recreation and amusement sector, $5.7 million was to the health service sector, $7.2 million was to the education sector, $6.4 million was to the government sector, $16.5 million was to the consumption sector, and $234 million was to the domestic export sector. Thus, 81% of total output for the horticulture and nursery sector went to the real estate and domestic export sectors.

Multipliers are used to measure the secondary effects that spreads through the economy when an industry experiences an increase in sales to a final demand sector such as households, businesses or export markets. A change in sales sets off a series of chain reactions in an economy as production sectors buy and sell goods and services from one another in order to meet the increased demand. The chain reactions cause the total economic effect to be larger than the initial change in final demand. It is important to note that multipliers say nothing about the forward linkages that a sector has through the processing and marketing sectors - multipliers are only concerned with a sector's suppliers. Thus, the ratio of the total economic change to the initial change is the multiplier effect (Coughlin and Mandelbaum).

The output multiplier for the horticulture and nursery sector is 2.1156. This means that a $1 million increase in sales causes an additional $1,115,600 in additional output throughout the Georgia economy. An equivalent way to state this is that each million dollars of sales causes a total change of $2.11 million of output throughout the economy. Within production agriculture, only agriculture, forest, and fishing services(2.5838) and tobacco(2.2093) have higher output multipliers.

There are two types of employment multipliers presented. The first is referred to as a simple employment multiplier and measures how many jobs are created in response to a given change in final demand for a sector. The simple employment multiplier for the horticulture and nursery sector is 28.2215. This says that for a $1 million change in final demand, there will be a change of 28 jobs. The second employment multiplier measures how many jobs are created in response to a given change in employment in a sector. This second employment multiplier for the horticulture and nursery sector in Georgia in 1990 was 1.8050. This means that for every new job in the horticulture and nursery sector, an additional 0.8 job is created in other sectors. This is about average for production agriculture.

There are also two types of value added multipliers. The simple value added multiplier is .576. This means that a $1 million change in final demand will result in a $576,000 change in value added (i.e, in wages, profits, etc.) throughout the economy. Of the 12 agricultural production sectors, this sector is ranked seventh. The second value added multiplier measures how the value added directly generated by a sector leads to additional value added in other sectors. This second value added multiplier for the horticulture and nursery sector is 2.7264. This means that for each $1 million of value added generated by the horticulture and nursery sector, another $1,726,400 in wages and profits is generated by the other sectors. This ranks sixth among the food and fiber production sectors.

Significance to Industry: The horticulture and nursery industry is an important component in the economy of Georgia. This study has documented the relative size and interlinkages of this industry to other economic sectors of Georgia. It is important to understand that landscaping and horticultural services are a major component of this sector. In terms of economic impact within the state, the horticulture and nursery sector is the third most important. This is in terms of employment and gross sales. When value added is considered, this sector ranks in the middle of the major food and fiber industries.

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Profitability Sensitivity Within Retail Nurseries, Lawn and Garden Stores

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Nature of Work: Profits (dollars remaining within a specified timeframe after all indebtedness and expenses are paid) are obviously important to managers and owner-operators of retail nurseries, lawn and garden stores. However, profitability (a percentage term measuring returns on net worth, investment or similar expresssions) is of concern to lenders, investors, and other business-oriented observers as a truer measure of a management's success. Profits emanate from the margin management area of the business, primarily the income statement; profitability is a holistic view of the business considering the margin management, asset management, and leverage facets of the retail business.

Consequently, as changes occur (either planned or otherwise), ceteris paribus, how sensitive is the profitability of the firm—i.e., what changes in operations elicit the greater changes in profitability, and by what relative amounts? Using data by S.I.C. categories from the U.S. Bureau of Census and Robert Morris & Associates, a perspective of the average retail nursery, lawn and garden store was developed and formatted into a standard business financial analysis. Changes were then introduced, such as increasing gross margin, or cutting operating expenses, or reducing receivables outstanding, etc., to see what effects on profitability of the firm these changes would induce, from the "base model. "

Results and Discussion: Among retail nursery, lawn and garden stores, selected profit centers (i.e., green goods versus hard goods versus seasonals) are known to generate different levels of profit margins. As the business data is aggregated from publications, these differences disappear as the information is merged across all sales levels, locational and logistical sites or regions, and marketing or merchandising emphases. As a result, selected evaluation criteria, such as net profit margin, may seem biased or even unrealistic. Consequently, caution should be taken to avoid construing the base model extracted and developed from published sources to be an ideal; at best, the base model is a point of departure for comparative analysis.

For presentation purposes, the "average" values are rounded-off for ease of computation. For instance, the average sales figure, excluding sales taxes and applicable finance charges, of $506,058 is rounded-off to $500,000. Similarly, the average values for cost of goods sold, fixed and variable expenses, current and fixed assets, and current and long-term liabilities are also rounded-off, but only minimally .

The profitability results, including net profit margin and return on assets, under each of four scenarios follow:

Base model from averages:

Net profit margin	5.67%
Return on assets	1 4.91%
Profitability (return on net worth)	23.56%

Increase gross margin 1%:

Net profit margin	9.45%
Return on assets	24.85%
Return on net worth	39.27%

Cut expenses 0.5% + increase gross margin 1%:

Net profit margin	9.72%
Return on assets	25.56%
Return on net worth	40.39%

Reduce receivables 5 days + cut expenses 0.5% + increase gross margin 1%:

Net profit margin	9.72%
Return on assets	26.54%
Return on net worth	42.99%

Significance to Industry: Although profits and net profit margin are relevant and important business evaluation criteria, one consideration that is sometimes under-emphasized is the holistic aspect of profitability. In the economic environment of the 1990s, astute managers and owner-operators of retail nursery, lawn and garden stores are increasingly incorporating financial management schematics in their planning and evaluation of the business performance. As a result, they are observing that relatively minor changes, such as cutting total expenses one-half of one-percent, greatly enhance the financial profitability of the retail business, even more so than just profits due to the incorporation of margin management, asset management, and leverage aspects of the business into the profitability performance.

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Research Priorities of Tennessee Nurserymen

Phillip C. Flanagan and R.J. Sauve
Tennessee

Nature of Work: During the 1993 Tennessee Nurserymen's Association (TNA) annual trade show a nursery research survey was given to TNA members exhibiting at the show. Forty seven surveys were completed (out of 68 handed out). Nurserymen were asked to identify the type of operation they had and asked to identify areas of research, from a menu, which they considered important to their operation. TNA members were also asked to provide written comments relating to specific areas of interest.

Results and Discussion: Fifty three percent of the respondents were wholesale growers, with 68 % of those growing only field nursery stock. The remaining 47 % consisted of growers which classified themselves as wholesale/retail, retail, container, field/container, field/greenhouse or container/greenhouse growers (Table 1). Those areas of research which received greater than a 50% response were: field operations, container production, weed control, new plant introductions, marketing and economics (Table 2). Areas of research with less than 50% response were: plant propagation, nursery management, entomology, plant pathology/nematology, water management, soil amendments and engineering/structures (Table

Less than 35% of the respondents took time to write in specific areas of interest for future nursery research. Written comments were well organized and showed solid interest in the following areas: better management/production research, economics of growing in containers, propagation and production of native perennials for both field and container operations, and organic plant production with emphasis on natural fertilizers (and rates) for perennials in containers. Interest was also shown for research on flower bud initiation and formation on *Rhododendron spp.* in pots and field production systems. On the lighter side was one nurseryman who posed this question... 'How to turn $1.00 into $100.00 before my wife can spend it!'.

Significance to Industry: Information obtained from this survey will help direct future researchers into those areas where nurserymen feel there is a need. With this information in hand a researcher will be able to sit down with Tennessee nurserymen and draw more information from them regarding their research desires.

Table 1. Type of nursery operation (68 surveys handed out).

NURSERY RESEARCH SURVEY

1993 TNA TRADE SHOW - NASHVILLE, TN

	NUMBER of RESPONDENTS
Wholesale Growers	
Field	17
Container	3
Field/Container	2
Field/Greenhouse	2
Container/Grnhs	1
Retail Growers	
Container	1
Whls/Retail Growers	
Field	4
Container	1
Field/Greenhouse	5
Container/Grnhs	4
Multiple Activities	7
TOTAL	47

Table 2. Research priorities of Tennessee nurserymen. Percentages based on 47 respondents (68 surveys handed out).

NURSERY RESEARCH SURVEY

1993 TNA TRADE SHOW - NASHVILLE, TN

	%
Field Production	60
Container Production	57
Weed Control	57
New Plants	51
Marketing/Economics	51
Propagation	45
Nursery Management	38
Water Management	32
Entomology	26
Pathology/Nematology	21
Soil Ammendments	19
Engineering/Struct.	4

A Synopsis of Students and Organizations Participating in the Environmental Horticulture Internship Program

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Nature of Work: The Department of Environmental Horticulture initiated a work experience program in 1975 to enable students to receive college credit for practical work experience. The program is listed as ORH 4941, Full-Time Practical Work Experience in Environmental Horticulture. Since its inception, 182 students have registered for this course. Enrollment in the course fluctuates from year to year reflecting a variety of factors including total student numbers in the department, economic conditions, and student's perceived need for practical work experience.

During the summer semester 1994, seventeen students obtained approval to work and receive credit in ORH 4941. This was the largest number of students participating in the program since 1976. The large number of students in the program attracted both academic and industry attention.

The objective of this study was to examine selected characteristics of students and employing firms participating in the program during the summer of 1994. The examination would help identify which commodity groupings of the Environmental Horticulture Industry are attracting the most student interest and what types of firms are participating in the program.

Results and Discussion: The largest group of students choose golf courses for their practical work experience while landscape maintenance at major theme parks was the second largest group (Table 1). Only 18% of the students worked in production nurseries. A similar analysis of internships in 1976 showed 77% of 27 students worked in production nurseries. However, as all of the students working at golf courses have spent some of their time maintaining and/or planting shrubs, trees, and annual beds, 82% of students this year have spent some or all of their work experience growing, planting, pruning or controlling pests of landscape plants produced in nurseries. This shift in student interest reflects job opportunities available to graduating seniors with 4 year horticulture degrees. The other student work experiences have remained at similar levels during the past 15 years.

Both academicians and industry personnel have wondered whether students registering for ORH 4941 differed from the rest of the departmental student body. No significant differences were found in age, or grade point average. However, only 17% of the students participating in ORH 4941 where female whereas 32% of the departments students are female.

Another interesting change since 1976 has been the increase of large non-family owned corporations participating in the program. In 1994, 50% of the 16 participating firms were large nonfamily owned corporations whereas in 1976 32% of participating firms were large nonfamily owned corporations.

Significance to Industry: Three major advantages accrue to cooperating firms. They are: (1) ORH 4941 students are motivated workers; (2) Students are a source of information about new technologies and (3) Students with professional work experience can make immediate and positive contributions to the industry.

Literature Cited

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Table 1. Classification of firms participating in the Enviromental Horticulture Internship Program.

Number of Students	Commodity/Activity Grouping	%
5	Golf Courses	29
4	Theme Parks (Landscape Maintenance)	23
3	Woody Nursery	18
2	Landscape Installation	12
1	Botanical Garden	6
1	Retail Garden Center	6
1	Sales/Product Representation Agribusiness Firm	6

Table 2. Selected characteristics of students participating in the internship program.

Students	Number	Age	GPA	% Female	Average Wage	Length of Employment
ORH 4941	17	25	2.92	17	$6.30/hr.	12.5 wks.
Departmental	73	25	2.82	32	N.A.	N.A.

The Impact of Federal Income Tax Code on Marketing Container-Grown Nursery Crops

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Texas

Nature of Work: In today's nursery industry, producers rely on all types of information to make informed decisions regarding their businesses. Federal income tax code is one type of financial information that should not be ignored when making marketing and production decisions. This research addresses the importance of considering tax law when marketing ornamental plants from containerbased production systems.

To assess the impact of taxes on the marketing decision, a deterministic dynamic programming model is developed for a 20 acre nursery in Climatic Zone 9 organized as a sole proprietorship. All cost and production data is obtained from *Southern Cooperative Series Bulletin 341.* Nursery producers usually carry several dozen varieties of plants and shrubs to satisfy the typical customer. The enterprise mix for this study is divided, however, into five cultural groups. It is assumed that Kurume azaleas occupy 25% of the growing area while Andorra junipers, Japanese holly, Crapemyrtles and Red maples occupy 15%, 30%, 10% and 20% of the growing area.

In the model, producers can market some or all of their salable plants in the fall or hold them until spring at which time they must be sold. The decision to retain salable plants in the fall necessitates the consideration of many factors. First, additional production costs are incurred to carry the crop over the winter. Second, personal tax deductions may be lost because they cannot be transferred between years. Third, business losses can be carried over to the next year, but are reduced through discounting in the modes Fourth, an opportunity cost associated with delaying propagation of the next crop is incurred. Fifth, by retaining some or all of a crop, the tax liability on the earnings from the sale of the crop is pushed into the future. This factor effectively lowers the tax liability because of discounting. Sixth, income can be transferred from one year to the next, effectively lowering the tax liability because of the tax brackets embedded within the tax code. Seventh, direct costs of propagating a new crop are pushed into the future. Finally, the discounting of future costs and returns plays an important role.

Spring price premiums (associated with larger sized plants) are built into the model to find the point at which it is optimal to hold all salable plants in the fall in anticipation of a higher spring price. The spring price premium is the minimum percentage increase in the spring price over the fall price required to induce a producer to retain all salable plants in the fall. Of the factors that impact the marketing decision listed above, the first four have a positive impact on the premium required while the next three have a negative impact.. With respect to the last factor, discounting future returns positively impacts the premium while discounting future costs negatively impacts the premium.

In the fall, a producer may have open acreage and plants at various growth stages ranging from all salable to none salable. The model chooses the percentage of salable plants to sell that maximizes cash flow by weighing the future costs and benefits of doing so. If in the fall, for example, 20% of the growing area is open acreage, 40% is immature plants and 40% salable plants, the producer can sell 0%-40% of production. Because the product mix is held constant, if it turns out that it is optimal to sell all salable plants, revenue would be based on sales of 40% of each cultural group. The dynamic nature of the model incorporates provisions of the tax code which allow business losses to be transferred to subsequent years. Carryover business loss affects the fall marketing decision when taxes are considered.

The model also examines the impact of “tax” and “no tax” scenarios. The “no tax” scenario assumes that business earnings are not subject to Federal or State income taxes. The “tax” scenario assumes that the Federal tax code applies to the earnings of the business. For the tax scenario, it is assumed the business is organized as a sole proprietorship. Further, it is assumed the owner is married, has two children and takes the standard deduction along with four personal exemptions. Because the State of Texas (the assumed location of the business) does not have a State income tax, all State income taxes are set equal to zero.

Results and Discussion: Presented in Table 1 are the minimum premiums necessary to induce a producer to retain all salable plants in the fall in favor of selling all plants in the spring under the tax and no tax scenarios. Because of page length limitations, only those premiums associated with retaining all plants (to sell in the spring) are presented. It should be noted that with lower premiums, some portion of the crop may be retained. In looking at the no tax scenario, as the starting price (fall price) increases, the premium falls because carrying charges and the opportunity cost for space are fixed on a per plant basis. For a given starting price, the premiums are constant because under the no tax scenario there are no tax advantages associated with carrying business loss forward. When taxes are introduced into the model, the premium required to induce storage increases over that of the no tax scenario. The additional premium over the no tax scenario for a given carryover business loss and starting price results from the opportunity loss of the personal deduction and the fact that losses in one year can be carried forward to offset earnings in the next year. As the starting price increases, the premium required decreases. Also, as carryover business loss increases, the premium required increases reflecting the opportunity loss associated with not carrying a loss forward (by selling in the fall).

Significance to Industry: The importance of considering the tax consequences of marketing decisions cannot be emphasized enough. As shown in Table 1, the premium required to induce a producer to not sell all salable plants in the fall is significantly higher under the tax scenario when compared to the no tax scenario. As an example, consider a producer with no carryover business loss or spring income who has Crapemyrtles he can sell in the fall for $2.00 per plant. Applying the no tax scenario decision rule implies that the producer would be willing to hold off the sale of all of these plants if offered a spring price of at least $2.25 per plant. This decision ignores, however, the fact that personal deductions are lost if no earnings accrue in the fall. Applying the tax scenario decision rule means that the producer must be guaranteed at least $2.58 per plant in the spring. Otherwise, it is optimal to sell at least a portion of production in the fall.

Table 1. Minimum Premium Required to Induce Storage for a 20 Acre Nursery Organized As a Sole Proprietorship in Climatic Zone 9.

	No Tax Scenario			Tax Scenario		
Carryover Business Loss	Low Price[a]	Medium Price[b]	High Price[c]	Low Price[a]	Medium Price[b]	High Price[c]
$0	21.0%	12.5%	6.0%	29.5%	29.0%	25.0%
$1-$250,000	21.0%	12.5%	6.0%	29.5%	29.0%	25.0%
$250,001-$500,000	21.0%	12.5%	6.0%	29.5%	29.0%	26.0%
$500,001 -$750,000	21.0%	12.5/e	6.0%	29.5%	29.5%	26.5%
$750 001-$1 000 000	21 0%	12 5%	6.0%	29.5%	29.5%	26.5%

[a] Low starting price is $1.60 per plant for Andorra Juniper, Kurume Azalea, Japanese Holly and Crapemyrtle, and $7.20 per plant for Red Maple.

[b] Medium starting price is $2.00 per plant for Andorra Juniper, Kurume Azalea, Japanese Holly and Crapemyrtle, and $9.00 per plant for Red Maple.

[c]High starting price is $2.40 per plant for Andorra Juniper, Kurume Azalea, Japanese Holly and Crapemyrtle, and $10.80 per plant for Red Maple.

Literature Cited

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