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The Economics of Producing Nursery Crops Using the Pot-in-Pot Production System: Two Case Studies

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Introduction

The pot-in-pot (PIP) production system for nursery crops and Christmas trees is gaining popularity among nurseries. PIP reduces production time, allows crops to be overwintered where they grow, and uses trickle irrigation. There are many advantages to the PIP system, and practical experience indicates that many plants grow better. PIP production combines the advantages of both above-ground container production and in-ground production.

With the pot-in-pot system, a container (the "socket pot") is placed permanently in the ground so that 3 to 4 inches of the container lip protrudes above the ground. Then, a second container, the "insert pot" that contains the plant in a soilless medium, is placed into the socket pot. The advantages of this production system are that pot-in-pot:

- insulates the root zone from extreme temperature variations
- allows in-place overwintering
- decreases production time from liner to finished product
- reduces water usage with trickle irrigation
- eliminates the need for staking to prevent blow over
- offers year-round harvest capability
- reduces labor cost associated with in-field harvesting
- prevents root loss associated with in-field harvesting
- offers light-weight shipping compared to ball and burlapped plant material

With the container placed inside the socket pot, plant roots are insulated from both low, root-killing temperatures during the winter months and high container temperatures during the summer months. This allows the roots to continue to grow at a faster pace, which also shortens production time for some plants. Although overhead irrigation can still be used for PIP, trickle irrigation can reduce water use and thus be both more economical and more environmentally sound. PIP also eliminates a major problem with above-ground container production, i.e. blow over.

Several factors make PIP as attractive as the field production methods. First is the reduced labor needed at harvest. To harvest a PIP-grown plant, simply lift the insert pot out of the socket pot. No digging or refilling a hole is necessary. The container uses light-weight soilless media, making it easier to handle and cheaper to ship. There is also less chance of damage to the root ball compared to a ball and burlapped plant. There are, however, some perceived disadvantages of the PIP system, including:

- the higher initial cost of installation
- a potential problem of drainage
- root elongation into the socket pot and surrounding soil, making plant removal difficult and reducing plant quality
- inner and outer containers may stick together, making removal difficult

- the bottom of the insert pot may sag, causing an uneven base
- the plant may be exposed to winter wind's drying effects
- the limited flexibility in spacing plants

The initial cost of implementing the system — costs of the socket pots, insert pots, irrigation systems, equipment rentals for land preparations and hole excavation, and labor expenses — is the primary disadvantage of PIP. However, keep in mind that this is a one-time expense. Over time, the reduction in labor cost associated with PIP production, combined with a shortened production time, should make up for the initial investment.

Because of the limited information currently available regarding the economics of producing nursery crops using the pot-in-pot production system, this publication presents two case studies summarizing the most recent research in this area. The first, conducted at the University of Florida, compares pot-in-pot to bag-to-pot production systems. The second, conducted at Auburn University, compares the costs of producing three species using in-ground, above-ground, and pot-in-pot production systems. These two cases were selected to depict the diverse situations in which pot-in-pot production occurs.

Case #1: A Comparison of Pot-in-Pot and Bag-to-Pot Production Systems (research conducted by John Haydu, University of Florida)

Introduction to the Case

Among producers of field grown ornamental plant material, pot-in-pot (PIP) production systems are gaining favor as alternatives to in-ground growbag and above-ground container production. PIP may be viewed as a "compromise" technology lying somewhere between these two production methods. Benefits of in-ground tree production are its ability to promote root growth, obtain large caliper size and generally foster overall plant hardiness. A potential downside is establishment-related problems, such as unacceptable plant loss or excessively long establishment periods, that often surface after plants have been sold. Containerized production has been a relatively recent industry response to overcome some of the more serious establishment-related problems. Although this procedure avoids the "harvesting" step encountered with growbags, it does have other difficulties such as root stress from temperature extremes, inadequate moisture levels in containers because of evaporation, and frequent plant blowover during windy conditions. Both root stress and low moisture levels reduce tree growth rates. Wind blowover is costly since it requires securing trees and shrubs either individually with ropes or trellis structures or allocating labor time for cleaning up after storms.

To address problems associated with above-ground container and growbag field production, the PIP system was developed (Parkerson, C.H. 1990. "A new field-type nursery operation," Proc. Int. Plant Prop. Soc. 40:417–419). The PIP method buries a "socket pot" or moat pot into the ground, and the containerized plant is then secured inside this pot. Since the black, heat absorbing containers are submerged below ground level, heat and windthrow problems are reduced considerably (Ruter, John M. 1993. "Growth of three species produced in a Pot-in-Pot Production System," South. Nurs. Assoc. Res. Conf., 38:100–102). Although PIP appears to be promising from a production standpoint, the considerable cost of the moat pot has caused many growers to question the financial benefits of this system. Proponents assert that PIP must be viewed as a long-term investment, claiming that the moat pot can be functional for 15 or more years. Therefore, even though initial costs may be high, financial returns will be positive over time. The purpose of this research was to establish the economic benefits and costs of the PIP system over a 10-year period and compare it to a “bag-to-pot” (BTP) production method. Although initially more costly than a strictly in-ground growbag production system, the BTP approach appears to be a feasible option for reducing establishment related problems.

Study Approach

Data for this study were obtained in late 1996 from a large, well-established and successful tree nursery in central Florida. This particular nursery was selected for the study for several reasons — it consistently produces high quality plant material; it uses both the BTP and PIP production methods; it has a sophisticated and versatile record keeping system that tracks all production and inventory; and management’s willingness to share financial information.

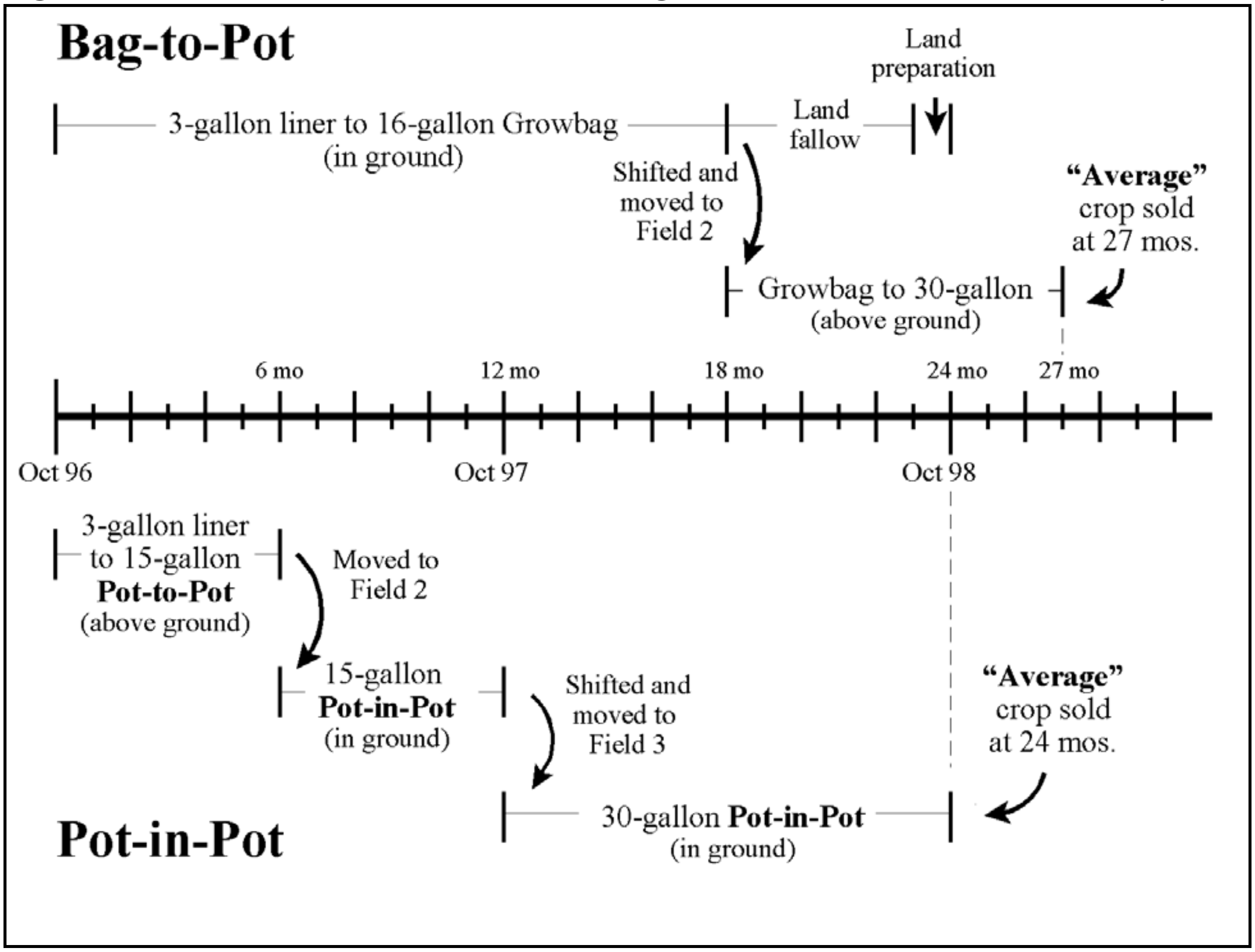
In this study, cost and growth data were confined to live oaks since they represent an “average” tree in terms of production time and expense. Expenses were organized under three categories: 1) initial installation costs of each system; 2) direct costs of production, from initial establishment to harvest; and 3) indirect costs, including administrative, overhead, management and supervisor salaries. Installation and direct costs were determined from the nursery’s financial records. Indirect costs were estimated using the University of Florida’s *Nursery Business Analysis Program*, a computerized financial service offered to Florida’s nursery and greenhouse industry. Historical financial information from participating central Florida field and container nurseries was used to estimate indirect costs as a percentage of total costs. Each expense category and total expenses were calculated on a per tree basis. The sales price used in calculating net returns in this study was the actual price charged by this nursery.

Results

The production process for live oaks for the pot-in-pot and bag-to-pot systems are presented in Figure 1. As shown in the diagram, each method uses multiple field areas at various stages in the production process. The PIP system employs an “upcanning” procedure whereby trees are “stepped-up” from smaller to larger containers once optimal size has been reached. Actually three separate phases come into play. In the first phase (October 1996 in the diagram below) a 3-gallon liner is repotted or “stepped-up” to a 15-gallon container. All containers are packed tightly together (8,712 trees per acre) above ground, in a “pot-to-pot” fashion for six months. In April 1997 these same containers are relocated into the 15-gallon PIP system where they remain for six more months. In October 1997 the trees are stepped-up to the 30-gallon PIP area where they remain for one additional year. At roughly 24 months the trees are ready for sale.

Bag-to-pot uses a two-stage procedure. Initially a 3-gallon liner is planted directly into a 16-inch field-planted growbag where it remains for 18 months. At that point the trees are “harvested” from the ground, removed from the growbag, and potted into 30-gallon containers for several more months of “root regeneration.” This differs from the more common industry practice of selling plants directly from the growbags, although they too are given a recovery period for root growth. Under this nursery’s BTP method, total time required for the “average” live oak to attain market size is 27 months, three months longer than PIP. How long a producer actually waits for root regeneration is clearly an individual decision affected by many factors both internal and external to the business. Given its particular economic situation (financial structure, market niches, geographic location), this nursery carefully balances the tradeoffs between space efficiency, product quality (including successful establishment rates) and value, as reflected in price. The correct relationship among these variables determines the potential profitability a firm can expect. However, each nursery must decide what those key variables are and the balance necessary to provide the greatest financial return.

Figure 1. Live Oak Production Processes for Bag-to-Pot and Pot-in-Pot Production Systems



Since this nursery uses sequential production stages, installation expenses were spread over several locations (three for PIP; two for BTP). As shown in Table A1, installation activities were categorized into three areas: (1) land preparation — cleaning, discing and grading fields; (2) preparing the production system — designing field layout, marking holes to be dug, auguring the holes, laying the irrigation systems, and constructing trellises for tree support; and (3) installing the production system — laying the moat socket containers or growbags. The rigid, injected mold pots are initially planted so that 3–4 inches remain out of the ground to allow for settling and to ensure that the pot's lip remains above the ground surface to prevent soil and debris from filling the permanent container after strong winds or rain storms.

From the data in Table A1, it is evident that the cost of moat pots are significant, accounting for 70–80 percent of total cost of the PIP system. In contrast, installation cost for the BTP system is limited to labor and, therefore, is relatively minor.

Table A1. Installation Costs for Live Oaks Using BTP and PIP Production Methods

Installation Activities for Bag-to-Pot and Pot-in-Pot Systems	Cost per Tree			
	Bag-to-Pot		Pot-in-Pot	
	16 inch	30 Gallon	15 Gallon	30 Gallon
1) Land Preparation [a]	$0.07	$0.08	$0.07	$0.07
2) Preparing production system [b]	2.16	3.24	2.37	2.37
3) Installing production system [c]				
a) Labor	0.30	(–)[d]	0.45	0.45
b) Materials	1.75	(–)[d]	6.67	14.00
Total	**$4.28**	**$3.32**	**$9.56**	**$16.89**

[a] Consists of cleaning, discing and leveling fields.
[b] Includes "strawing," augering, installing irrigation (polyethylene tubing, emitters and labor) and trellis construction (wire, posts, saddle straps, earth anchors and labor).
[c] Labor activities involve laying out a field with 12' x 2.5' diamond set spacing of 1,452 trees/acre. Materials include only the moat socket pots (PIP) and growbags.
[d] 30-gallon container costs for BTP are included in Table A2.

Production expenses include a "shift" cost, general production expenses, and maintenance activities (Table A2). Shift costs refer to expenses incurred when plants are initially placed into containers or growbags or stepped-up to the next production phase. These costs include labor, containers, soil, fertilizer at potting and 3-gallon liners. General production entails all the expenses associated with production — including fertilization, pest management and irrigation. Maintenance activities refer primarily to support functions — including maintaining irrigation equipment, picking up after storms, consolidating trees after sales, accounting for idle time, and general clean-up around the nursery. As mentioned earlier, all production expenses have been divided into phases for both PIP and BTP. Two observations are noteworthy. First, shift costs account for the greatest share of expenses in both phases and production systems. This is largely due to the costs associated with the liners and containers or growbags. Second, production expenses are similar between the two systems.

Roughly two years (one growing cycle) are required to obtain a "ready to sell" 30-gallon live oak in central Florida. Total expenses for two production cycles are shown in Table A3. These figures are actually "direct costs," that is, only those items that were directly related to production are included. Indirect costs, such as administrative and overhead expenditures, are not part of these estimates but will be discussed below.

Table A2. Production Costs for Bag-to-Pot and Pot-in-Pot Systems for Live Oaks in Two Phases

Production Activity	Cost per Tree	
	Bag-to-Pot	**Pot-in-Pot**
Phase 1[a]		
1) Shift cost [b]	$7.80	$11.42
2) General production [c]	1.82	2.68
3) Maintenance activities [d]	5.41	4.20
4) **Subtotal – Phase 1**	**$15.03**	**$18.30**
Phase 2[e]		
1) Shift cost to 30 gallon [f]	$7.85	$7.05
2) General production [c]	5.88	5.51
3) Maintenance activities [d]	4.67	4.67
4) **Subtotal – Phase 2**	**$18.40**	**$17.23**
Total Cost– Phases 1+2	**$33.43**	**$35.53**

[a] For PIP, phase 1 includes: a) six months above ground "pot-to-pot" in 15-gallon containers (October – March) with 8,712 trees per acre (TPA) and; b) six months (April – September) "pot-in-pot" with 968 TPA. Phase 1 of BTP involves 18 months in 16-inch growbag. Both systems assume 4% loss rate.
[b] For PIP, includes a 3-gallon liner, labor, 15-gallon containers in Phase 1, soil and fertilizer at potting. For BTP, includes only 3-gallon liners, labor and fertilizer at potting since field growbag is already installed.
[c] Includes stakes for 15-gallon container, fertilizer (materials and labor), pest management (materials and application of insecticides, fungicides and herbicides for both "out-of-pot" and "in-pot" weed control) and non-maintenance labor activities involved in delivering water to trees.
[d] Includes staking (on/off), hand weeding, pruning and tipping, storm pick-up, consolidation of trees, irrigation maintenance, idle time and general clean-up. For BTP system in Phase 1, also includes trellis removal cost.
[e] Phase 2 involves the "step-up" to final 30-gallon container size for both PIP and BTP in the beginning of the second year with 968 TPA. Assumes 2% loss rate.
[f] Includes cost for 30-gallon container, soil, fertilizer at potting and labor for both PIP and BTP.

In the first cycle, total costs are roughly 50% more for the PIP system, but they fall sharply in the second cycle ($5.00 less per tree than BTP). This difference is explained by the effect installation costs have on total (direct) expenses for the two systems. Once installed, the PIP production method is estimated to have a usable life of 10–15 years. On the other hand, a growbag system must be replaced with each production cycle. Although installation costs for BTP are only about one-fourth of installation costs for PIP, over time these costs add up.

Table A3. Summary of Annualized Costs for Bag-to-Pot Versus Pot-in-Pot Production Systems for Live Oaks over Two Crop Rotations (Four Years)

Production Period	Cost Category – Per Tree Expenses					
	Installation		Production		Total	
	BTP[a]	PIP[b]	BTP	PIP	BTP	PIP
Year 1	$4.28	$9.56[c]	$15.03	$18.30	$18.99	$27.86
Year 2	3.32	16.89[d]	18.40	17.23	20.85	34.12
Total Cycle 1	**7.60**	**26.45**	**33.43**	**35.53**	**41.03**	**61.98**
Year 3	4.28	0	15.03	18.30	18.99	18.30
Year 4	3.32	0	18.40	17.23	20.85	17.23
Total Cycle 2	**7.60**	**0**	**33.43**	**35.53**	**41.03**	**35.53**

[a] Growbag field production systems replaced every second year after each new planting.
[b] Assumes PIP production systems good for 10 years.
[c] Installation costs using a 15-gallon moat pot.
[d] Installation costs using a 30-gallon moat pot.

In Table A4, indirect costs were estimated at 40 percent of total costs (direct + indirect) from the University of Florida's *Nursery Business Analysis Program*. As defined here, indirect costs include administrative and overhead, management and supervisor salaries, and "other" indirect costs. The latter category includes such items as fuel, equipment, parts and labor to repair equipment, marketing costs, and health care and workers' compensation. In cycle 1, total costs were larger for PIP because of installation expenses. Conversely, total costs in cycle 2 were slightly larger for BTP. These higher costs were due in part to the absence of installation expenses for PIP (after cycle 1) and the small, additional installation cost for BTP.

The next objective in this study was to compare the profitability of the two production systems. This is accomplished by subtracting total cost per tree from the sales price (Table A5). The value used in this example ($90.00) is the nursery's current selling price for a 30-gallon live oak. From this, the nursery also provides a 10-percent discount to preferred customers, which leaves a rounded-off price of $80 for simplicity. Two final adjustments should be mentioned. First, both current and discounted present values (DPV) were calculated. The old saying, "A bird in the hand is worth two in the bush" makes a lot of sense when applied to money. Essentially it means that cash today is worth more than cash in the future. Inflation and risk (uncertainty about the future) are two important factors that decrease the future value of money. Secondly, total costs for the BTP method have been increased by 12.5 percent to account for the additional three months of production time (24 versus 27 months). The far right hand column in Table A5 shows profitability for 2 production cycles (4 years). In the first cycle, profits are positive for BTP but negative for PIP due to installation costs. By the end of cycle 2, the financial picture changes considerably — because there are no installation expenses for PIP, it has become more than twice as profitable per tree as BTP.

Table A4. Annualized Costs of Production for Live Oak on a per Tree Basis

Production Cycle	Costs Per Tree	
	Bag-to-Pot	Pot-In-Pot
Cycle 1 (2 years)		
1) Direct Costs [a] 2) Indirect Costs [b] 3) Total Costs (24 months)	\$41.03 \$22.28 \$63.31	\$61.98 \$23.68 \$85.66
Cycle 2 (2 years)		
1) Direct Costs [a] 2) Indirect Costs [b] 3) Total Cost (24 months)	\$41.03 \$22.28 \$63.31	\$35.53 \$23.68 \$59.21

[a] Includes installation and production costs (right hand "Total" column, Table A3).
[b] Indirect costs estimated from University of Florida's *Nursery Business Analysis Program*, a business and financial management program used to estimate economic performance of Florida's nursery and greenhouse industry. Total indirect costs (IC) estimated at 40% of total costs (TC), excluding installation costs (i.e., DC=.6TC or DC/0.6=TC). Specifically, \$33.43÷ 0.6 = \$55.72; IC = (1-.6TC) = (\$55.72 – \$33.43 = \$22.28).

Table A5. Cost, Prices and Profits for Bag-to-Pot and Pot-in-Pot Live Oaks over a Two-cycle (Four-Year) Production Period

Cycle and Production System	Financial Category – Per Tree					
	Total Cost		Price [a]		Profit	
Cycle 1	Current [b]	DPV [c]	Current [b]	DPV [c]	Current [b]	DPV [c]
Bag-to-Pot [d]	\$71.22	\$58.83	\$80.00	\$66.08	\$ 8.78	\$7.25
Pot-in-Pot	\$85.66	\$70.75	\$80.00	\$66.08	(\$5.66)	(\$4.67)
Cycle 2						
Bag-to-Pot	\$71.22	\$48.64	\$80.00	\$54.64	\$ 8.78	\$6.00
Pot-in-Pot	\$59.21	\$40.30	\$80.00	\$54.64	\$20.79	\$14.34

[a] Local price for a 30-gallon live oak is roughly \$90.00. Assumes a 10% discount given to preferred customers.
[b] Current value of money in 1996 dollars.
[c] Discounted present value of money, where $DPV = CVM/(1+r)^n$ and CVM = current value of money, r = interest or discount rate and n = number of years. Interest rate assumed is 10 percent.
[d] Assumes growbag method requires 27 months or 12.5% longer than PIP. Total cost then is calculated as \$63.31*1.125 = \$71.22.

The last step of this study was to project potential returns over a 10-year period (5 cycles). Estimates were generated on a per acre basis by assuming production of 950 trees per acre, a reasonable number for this nursery. Results of these calculations are presented in Table A6. Again losses were realized in the first cycle for PIP ($–5,377 current value or $– 4,436 discounted) but are positive thereafter. Profits for BTP are positive throughout the five production cycles but, cumulatively, amount to considerably less than PIP. Specifically, the bag-to-pot method yielded about one-third less per acre than PIP using discounted present values.

Table A6. Expected Returns per Acre for Bag-to-Pot Versus Pot-in-Pot Live Oak over 10 Years

	BTP – Dollar Profits/Acre		PIP – Dollar Profits/Acre	
Production Cycle	**Current [a]**	**Discounted [b]**	**Current [a]**	**Discounted [b]**
Cycle 1 (2nd year)	$8,341	$6,890	($5,377)	($4,436)
Cycle 2 (4th year)	$8,341	$5,697	$19,750	$13,623
Cycle 3 (6th year)	$8,341	$4,705	$19,750	$11,134
Cycle 4 (8th year)	$8,341	$3,896	$19,750	$9,223
Cycle 5 (10th year)	$8,341	$3,220	$19,750	$7,623
Profits @ 10 years	**$41,705**	**$24,408**	**$73,547**	**$37,100**

[a] Current value of money in 1996 dollars. Assumes 950 trees per acre. Per acre profits are calculated by multiplying profits/tree (Table A5) times 950 trees.
[b] Discounted present value of money, where DPV = CVM/$(1+r)^n$ and CVM = current value of money, r = interest or discount rate and n = number of years. Interest rate assumed is 10 percent.

Concluding Case 1 Comment

A bag-to-pot production method using growbags and containers was compared to pot-in-pot production using actual production and financial data from a large central Florida nursery. Results clearly indicate that PIP is a viable and profitable production technology. Although initial investments are much larger for PIP, the potential longevity of the system and ease of use once it is established appear to make it an effective alternative to other production methods. However, it is important to note that results from this study were based on one tree species (live oak) in a single geographic location. Live oak was selected because it represents an “average” in terms of production time and costs. Nurseries interested in this technology, but concerned about the high per acre cost of establishment as well as effects of differences in plant species and climatic conditions, should consider initiating a “pilot test.” Setting up a conservative trial on a small portion of the nursery will allow one to examine the system objectively without imposing significant financial risk to the business.

Case #2: A Comparison of In-ground, Above-Ground, and Pot-in-Pot Production Systems (research conducted by Jeremiah Kichler, John Adrian, and Ken Tilt, Auburn University)

Introduction to the Case

The second case study, based on research conducted at Auburn University, compares the costs of producing three species (Crape Myrtle, Dogwood, and Leyland Cypress) using in-ground, above-ground, and pot-in-pot production systems. This study utilized an economic engineering approach in that model nursery systems were synthesized and costs associated with each system evaluated. While the model nursery systems are all applicable for USDA Plant Hardiness Zones 8 and 9, each of the three production systems modeled have different physical characteristics. For the containerized nurseries, production beds are 8'×100' with 2'×100' walkways between them. This spacing equals to 34,400 square feet of production space per acre. The 1-gallon containers take up 0.64 square feet each, which means 53,750 1-gallon containers could be produced per acre. Three-gallon containers utilize 2.25 square feet, which means 15,288 3-gallon containers could be produced per acre. The 10-gallon containers take up 16 square feet each, which means 2,150 10-gallon plants could be produced per acre.

In the above-ground container nursery, the containers are on top of the ground during the production process. The plants can be easily moved or harvested when needed. In the pot-in-pot nursery, 10-gallon "socket" pots are installed in the ground with 3 or 4 inches of the pot above the ground surface. The plants are put into 10-gallon "insert" pots that are inserted into the 10-gallon "socket" pots. To harvest the plants, the insert pots are taken out of the socket pots. In the in-field nursery, one or two-year liners are purchased and planted into the ground. The trees are assumed to be 8' apart with 9' walkways between them, which means each tree utilizes 72 square feet. An acre is 43,560 square feet, so 605 trees could be produced per acre. To harvest the trees, a tree spade is needed to dig the root ball out of the ground.

Capital Requirements

The initial capital needed to start a nursery depends on the type of nursery because the method of production affects costs more directly than the choice of plant species being grown. Nurserymen are naturally interested in evaluating the alternative nursery types that would provide a feasible economic unit at the most reasonable cost.

Land for the model nurseries synthesized was assumed to be purchased for $3,000 an acre, approximately two times the USDA average value of rural land. The above-ground container and the pot-in-pot nurseries included 15 acres, with 10 acres being used for production. The in-field nursery included 70 acres, with 69 acres used for production. The in-field nursery is bigger because of space requirements for equipment to operate during planting and harvesting; however, fewer plants per acre can be grown when compared to the above-ground and pot-in-pot container nursery systems.

For all three production systems, support facilities were assumed to include an office and machine and supply storage buildings. The office area was assumed to be 400 square feet and was estimated to cost $16,000 or $40 per square foot. The machine storage building was 1,200 square feet and was estimated to cost $14,400 or $12 per square foot. A supply storage building of 1,200 square feet was estimated to cost $24,000 or $20 per square foot. In the above-ground container and the pot-in-pot nurseries, a concrete slab for the purpose of mixing media and putting plants and liners in containers was included. Dimensions of the slab were 35'×55'×.33' with an estimated cost of $1,500. Four greenhouses were included with the above-ground container and the pot-in-pot operations for propagation and overwintering purposes. Each of the greenhouses was assumed to be 30'×96' and had an estimated cost of $6,200 or $2 a square foot.

Each nursery type included different improvements to the land such as grading, tree removal, roadway construction and the construction of a pond. The above-ground nursery had 12.4 acres of gravel to hold the container plants. Total expense of the gravel was $130,200 ($15 per ton). Drainage was also improved on the nursery at a cost of $2,750. There was a pond dug for irrigation and runoff purposes at an expense of $1,200. Total outlay for improvements was $134,150. Gravel for the pot-in-pot operation was used for walkways between the beds and for roads. The beds were 8'×100' and there were 2'×100' walkways between each of the beds. Gravel used for the walkways cost $10,920 for the 10-acre production area and $24,100 was spent on roadways.

Initial cost for socket pot installation was $27,000, which included pots and labor associated with installation. Landscaping fabric was installed around the pots with 121 rolls used at a cost of $140 per roll or a total cost of $16,940. The in-field nursery did not have nearly so many improvements as compared to the above-ground container and the pot-in-pot production systems. Sixty-nine acres of bahiagrass were planted at a cost of $150 an acre or a total cost of $10,350. One acre of gravel was put down around buildings at a cost of $5,770. The in-field nursery did not have propagation greenhouses or a concrete slab because the trees were purchased and planted into the ground as liners.

Equipment for all three nurseries was assumed to have been bought new. Equipment included a 60 and a 30 hp tractor, two trucks, ten wagons, an irrigation system, sprayers and other miscellaneous equipment and tools. All equipment was the same for all the nurseries except that the in-field nursery also had a plow, disc, transplanter, and tree spade. The plow and the disc were used for land preparation. The transplanter was used for planting liners, and the tree spade was used for harvesting plants. The Leyland Cypress nurseries had a self-propelled shearing machine for pruning. The Crape Myrtle and the Dogwood operations used hand tools to prune trees.

The cost of the irrigation system included the well, pump, pipe, sprinklers, filters and any other equipment that may be needed. The costs for the irrigation system for the containerized nurseries was $30,000. For the in-field nursery, the cost of the irrigation system was $32,000. For the above-ground container and the pot-in-pot nurseries, a misting system was installed in the four propagation houses. Cost of the misting system includes sprinklers, pipe, shut-offs, pump, and any other equipment that may be needed. The cost of the misting system in all the propagation houses totaled $650.

Table B1 shows that the in-field production method costs more to establish than the above-ground and the pot-in-pot production methods. For each method of production, the Leyland

Cypress cost $5,000 more to set-up because of the need for special pruning equipment. For Crape Myrtles and Dogwoods, the in-field method had the highest initial capital requirement: $441,647. The pot-in-pot method was the second highest with $423,763 and the above-ground nursery had the lowest initial capital requirement at $396,012.

However, on a per acre basis, the in-field nursery was the least costly to establish while the pot-in-pot nursery was the most costly. An in-field nursery, producing Crape Myrtles and Dogwoods, costs $6,309 per acre to establish, while one producing Leyland Cypress costs $6,381 per acre to establish. Crape Myrtle and Dogwood above-ground container nurseries cost $26,401 per acre to establish and a Leyland Cypress nursery costs $26,734 per acre. Finally, the pot-in-pot nurseries, with the highest establishment costs, had Crape Myrtle and Dogwood costs of $28,251 per acre and Leyland Cypress at $28,584 per acre.

Table B1. Total and Per Acre Capital Needed to Establish Selected Nursery Systems for Selected Enterprises, Climate Zones 8 and 9, 2000

Production system [a]	Selected enterprises		
	Crape Myrtle	**Dogwood**	**Leyland Cypress**
Above-ground container production			
Total initial capital	$396,012	$396,012	$401,012
Initial capital per acre	$26,401	$26,401	$26,734
In-field production			
Total initial capital	$441,647	$441,647	$446,647
Initial capital per acre	$6,309	$6,309	$6,381
Pot-in-pot production			
Total initial capital	$423,763	$423,763	$428,763
Initial capital per acre	$28,251	$28,251	$28,584

[a] The above-ground container and the pot-in-pot nurseries are represented by 15 acres of land with 10 acres used for production. The in-field nursery had 70 acres with 69 acres used for production.

Annual Fixed Costs

Fixed costs are costs that are incurred even if the nursery does not produce in a given year, and hence they are not under control of the manager in the short run. Fixed costs include such items as depreciation, interest and tax expenses. Other fixed expenses include advertising, maintenance, overhead, salaries and utilities. Depreciation of the buildings and equipment was calculated by subtracting the salvage value of the object from the original cost and then dividing the result by the useful life of the item. Salvage values for all the buildings and equipment were assumed to be 10% of the original cost. Interest cost for equipment was figured by utilizing the average value of the item and multiplying by 9%, the cost of capital. The average value of an object was calculated by adding the original cost of the equipment and its salvage value, then dividing the number by two. Property tax for land was calculated by taking the market value of the land and multiplying by 10%, the assessment rate for agricultural (Class 3 property) land, then multiplying this value by a 30 millage rate (.030).

Salaries for three employees were included in the fixed costs. Each of the three nurseries had a supervisor, one permanent full-time worker and a secretary. Salaries for these individuals were $28,000 for the supervisor, $22,000 for the full-time worker and $17,000 for the salaried person. Employment taxes (FICA and Medicare) were paid by the nursery at 7.65% of the employee's salary. The nursery had $3,000 budgeted for travel and advertising expenses. The travel and advertising allowance pays for the expenses associated with going to trade shows, promotions, and other business trips. Table B2 summarizes total and per acre fixed costs.

Table B2. Total and Per Acre Annual Fixed Costs Associated with Operating Selected Nursery Production Systems and Selected Enterprise, Climate Zone 8 and 9, 2000

	Selected enterprises		
Production system [a]	**Crape Myrtle**	**Dogwood**	**Leyland Cypress**
Above-ground container production			
Total fixed costs	$138,709	$138,709	$139,448
Fixed costs per acre	$9,247	$9,247	$9,297
In-field production			
Total fixed costs	$146,243	$146,243	$153,385
Fixed costs per acre	$2,089	$2,089	$2,191
Pot-in-pot production			
Total fixed costs	$146,074	$146,074	$146,812
Fixed costs per acre	$9,738	$9,738	$9,787

[a] The above-ground container and pot-in-pot nurseries are represented by 15 acres with 10 acres being used for production. The in-field nursery had 70 acres with 69 acres being used for production.

Fixed costs were also figured on a per acre basis. Fixed costs per acre were calculated by taking the total fixed costs and dividing by the number of acres in the nursery. The above-ground container and the pot-in-pot nurseries had 15 total acres and the in-field nursery had 70 total acres. On an acre basis, the pot-in-pot nursery has the highest fixed costs with Leyland Cypress again being slightly more costly to produce. The above-ground container nursery had the second highest fixed costs per acre following the same cost pattern as the pot-in-pot nursery with Leyland Cypress again a little higher per acre. The in-field nursery had the lowest fixed costs per acre for all species.

It was assumed that all three nursery production methods used three-year production cycles. In the above-ground container method, the plants were started in 1-gallon containers in year one. In year two, unsold 1-gallon plants were transferred to 3-gallon containers. In year three, unsold 3-gallon plants were transferred to 10-gallon containers. In the in-field production system, liners were planted in the ground in year one. The trees were kept in the ground until year three. In the pot-in-pot production method, the plants were started in 1-gallon containers in year one. In year two, unsold 1-gallon plants were transferred to 10-gallon containers.

Variable Costs

Variable costs increase or decrease as the production level increases or decreases. Variable costs include such items as chemicals, liners, fertilizers, and fuel. In the above-ground container system, the plants are in 1-gallon containers the first year. In the second year, unsold plants are taken out of the 1-gallon containers and placed in 3-gallon containers. Unsold plants are then transferred to 10-gallon containers in the third year. With the pot-in-pot system, plants are put in 1-gallon containers the first year. One-year old plants are put into 10-gallon "insert" pots in the second year. In the third year, the plants are left in the same 10-gallon "insert" pots until harvest. Variable costs associated with the in-field production system start with land preparation, which includes plowing and discing. After land preparation is complete, liners are planted in the ground with a transplanter. Trees are left in the ground until harvest.

Variable costs associated with machinery and equipment are calculated on a per hour basis. These costs take into consideration repair, fuel and lubrication. The best source for estimating machinery expense is to look at past maintenance records. Repair costs were calculated by multiplying the original cost of the equipment by the repair percentage. That figure was divided by the annual use, which was then multiplied by the useful life. Repair percentage figures range from 13% for the irrigation system to 90% for the tractors. Included in the variable costs was the cost of additional labor that was equivalent to one and one-half employees during the year. Associated with the fixed costs were two salaried employees who dedicated half of their work time, 480 hours per quarter, to plant production. According to the labor schedules, the two salaried employees did not provide enough labor for the production of the plants, but with the additional labor, there was enough labor for production during the peak times. The additional labor was assumed to be paid $7.50 per hour, which included employment taxes. Overwintering costs were also included in the variable costs. This cost included the plastic that was put over the top of the plants after they were pushed together to survive cold weather. Labor costs were included for pushing together and redistributing the plants.

Table B3 summarizes the total and per-acre variable costs for the three types of ornamental trees and the three production methods. It was assumed the above-ground container nurseries started plants in 1-gallon containers in year one. In year two, the 1-gallon plants were transferred to 3-gallon containers. In year three, the 3-gallon plants were put into 10-gallon containers. It was assumed that the in-field nurseries plant liners in the ground in year one and they remained in place until they were harvested in year three. It was assumed the pot-in-pot nurseries started plants in 1-gallon containers in year one. In year two, the 1-gallon plants were transferred to 10-gallon "insert" pots. The 10-gallon plants were kept in the 10-gallon insert pots until harvest in year three.

As shown in Table B4, the in-field productions system had the lowest total variable cost per plant of the three systems over a three-year production cycle. The variable costs of the above-ground and the pot-in-pot methods over a three-year production cycle were similar but the pot-in-pot method was the most expensive to operate.

Table B3. Total and Per Acre Variable Costs Associated with Operating Selected Nursery Production Systems and Selected Enterprise, Climate Zone 8 and 9, 2000

	Selected enterprises		
Production system [a]	**Crape Myrtle**	**Dogwood**	**Leyland Cypress**
Above-ground container production			
Total variable costs	$10,508	$9,835	$9,218
Variable costs per acre	$701	$656	$615
In-field production			
Total variable costs	$5,454	$5,565	$5,345
Variable costs per acre	$78	$79	$76
Pot-in-pot production			
Total variable costs	$10,712	$10,383	$9,649
Variable costs per acre	$714	$692	$643

[a] The above-ground container and pot-in-pot nurseries are represented by 15 acres with 10 acres being used for production. The In-field nursery had 70 acres with 69 acres being used for production.

Table B4. Annual Variable Costs per Plant for a Selected Nursery System and Selected Enterprise for a Three-year production Cycle, Climate Zones 8 and 9, 2000

Enterprise by production system	Year 1 [a]	Year 2 [b]	Year 3 [c]	Total
Above-ground container production				
Crape Myrtle	$0.82	$1.90	$6.92	$9.65
Dogwood	$1.17	$1.67	$6.96	$9.79
Leyland Cypress	$0.81	$1.55	$6.92	$9.28
In-field production				
Crape Myrtle	$2.01	$0.79	$2.20	$5.00
Dogwood	$2.21	$0.80	$2.20	$5.21
Leyland Cypress	$1.96	$0.77	$2.17	$4.90
Pot-in-pot production				
Crape Myrtle	$0.78	$6.05	$2.01	$8.84
Dogwood	$1.14	$6.04	$2.01	$9.19
Leyland Cypress	$0.80	$6.08	$1.97	$8.85

[a] plants in 1-gallon containers.
[b] plants in 3-gallon containers.
[c] plants in 10-gallon containers.

Net returns per plant were calculated (Table B5) for each of three different ornamental trees in each of the three production methods. The net returns per plant were figured by taking the selling price of the plant and subtracting the total accumulated variable and fixed costs per plant. It was assumed in the above-ground container nursery that the plants were started in 1-gallon containers in year one and in year two unsold 1-gallon plants were transferred to 3-gallon containers. Likewise, in year three, unsold 3-gallon plants were put into 10-gallon containers. In the in-field nursery, liners were planted in the ground in year one where they remained until sold.

If trees from any production system were sold in year one, the assumed price was $3.50. If trees were sold from either the above-ground or in-field nursery in year two, the assumed price was $7.50. If trees were sold in year three, a representative price of $25.00 was used.

Table B5. Net Returns Per Plant for a Three-year Production Cycle for Selected Nursery Systems and Selected Enterprises, Climate Zones 8 and 9, 2000

Enterprises by production system	Year 1	Year 2	Year 3
Above-ground container production			
Crape Myrtle	$2.50	$4.00	$10.36
Dogwood	$2.15	$3.88	$11.90
Leyland Cypress	$2.50	$4.30	$11.71
In-field production [a]			
Crape Myrtle	-$1.95	-$2.17	$9.68
Dogwood	-$2.15	-$2.40	$9.98
Leyland Cypress	-$1.91	-$2.12	$10.30
Pot-in-pot production [b]			
Crape Myrtle	$2.50	-$5.00	$5.97
Dogwood	$2.17	-$4.40	$6.61
Leyland Cypress	$2.50	-$4.20	$7.00

[a] Net returns are negative during years 1 and 2 of in-field production due to no plants being sold until the third year.
[b] Net returns are negative during year 2 of pot-in-pot production due to no sales occurring in year 2 when remaining plants are shifted to larger-sized containers.

Concluding Case 2 Comments

On a per acre basis, the pot-in-pot nursery had the highest capital requirement of the three production systems. The pot-in-pot method required $28,251 per acre to establish, while the above-ground container production method was second highest at $26,401 per acre. The in-field method had the lowest capital requirement per acre ($6,309 per acre) when compared to the other production methods. The reason for the in-field system having the highest total requirement for capital and the lowest requirement on a per acre basis is related to the in-field nursery's 70-acre requirement of space compared to the smaller above-ground and pot-in-pot nursery operations.

Total fixed cost for the three nurseries showed similar results. The pot-in-pot and in-field nurseries had total fixed costs slightly in excess of $146,000 and the above-ground container nursery had total fixed costs of $138,709. Again, the fixed costs were spread over 70 acres for the in-field nursery while the fixed costs were spread over 15 acres in the above-ground container and pot-in-pot nurseries. Therefore, on a per acre basis, the above-ground container and the pot-in-pot nurseries had fixed costs of $9,247 and 9,738 (respectively) and the in-field nursery had fixed costs of $2,089 an acre.

Variable costs associated with each type of nursery showed that the in-field nursery has the lowest total variable costs, ranging from \$4.90 to \$5.21 per tree over a three-year production cycle. The above-ground nursery had higher total variable costs, ranging from \$9.28 to \$9.79 per plant over a three-year production cycle, while the pot-in-pot nursery had total variable costs ranging from \$8.84 to \$9.19 per plant. The reason the containerized nurseries had higher total variable costs was because of increased labor and management costs, as well as costs associated with stepping plants up to larger container sizes.

Summary

Producers looking for alternatives to row crops usually evaluate production of horticultural crops. To do this effectively, the method of production should be determined. Three production methods were discussed in this study: above-ground container, in-field, and pot-in-pot. The above-ground container system may be the easiest for a producer to start. The containerized plants are easy to handle and harvest in the above-ground container method. A beginning producer may not want to invest capital to establish the “socket” pots in the pot-in-pot system. Additionally, after the “socket” pots are established, production/space utilization flexibility is limited and additional capital would be needed for a producer to undo the pot-in-pot system. The in-field method may be better for a producer who wants to put fallow land into production and who is not worried about quick cash flow.

On the basis of profitability, producers may look at cash flows and returns per plant to make their decisions. Budgets developed and presented are to be used only as guidelines because every operation is different. Each producer has not only his/her own special way of doing things, but also a unique asset mix and market conditions. Thus, costs and market access will vary for different operations. A producer may buy used equipment or take certain inputs out or add inputs to the production process. Any kind of agricultural production involves risks because there are many variables that can affect the outcome of any crop so producers must be judicious in their evaluation of alternatives.