Agricultural Extension Service
The University of Tennessee

NURSERY FIELD PRODUCTION

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GETTING STARTED

The nursery industry is a very wonderful and exciting business. The production of plants for profit has the potential of providing many personal and financial rewards. However, as with many other farming enterprises that appear to be very simple on the surface, the nursery business is very complex and requires a great deal of knowledge and skill not only in production, but also in labor management and marketing.

The nursery industry is very diverse. It is a business, and like any other business, the probability of success depends on imagination, determination, planning, and good management of the five major resources.

Since nursery plants are agricultural crops, a great deal of risk is also involved from uncontrollable factors, such as the weather. Premature freezes, late freezes, flood, drought, wind, ice damage, insect, disease and theft are all potential problems. Producers generally experience some losses each year. Genus diversification, irrigation, and multiple farms offers some protection.

Invest time studying books, extension publications and trade magazines before deciding to invest money starting a nursery business. Visit experienced, successful nursery producers and observe their layout and inventory. Ask what they would do differently.

Nursery production is viewed by many as an alternative crop to failing traditional farm enterprises. However, many potential producers do not realize the skill and knowledge required to produce a quality nursery crop in the field.

Production of nursery stock is both an art and a science. Many skills are best developed through observation followed by practice, not only from reference books. If possible, work at a successful nursery to get a feel for the seasonal and day-to-day activities and production practices used.

A successful nursery producer needs a knowledge of plants, soils, fertilizers, pesticides, irrigation, machinery, pruning, harvesting methods, overwintering techniques, packing and shipping practices, etc. It is not just casting seed to the wind and watching the trees and profits grow.

Beginning nursery producers can benefit from the resources and assistance provided by the University of Tennessee Agricultural Extension Service, Small Business Admin., local and state nursery associations, the Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service, SCS), Farm Service Agency (formerly Farmer's Home Administration and Agricultural Stabilization & Conservation Service, or ASCS). There is help available, if enough calls are made and if you have patience.

The Tenn. Dept. of Agr. (TDA) requires a $100 annual certification program. Contact your local Ext. office or the TDA Nashville office (615-837-5148) to learn how to contact your local TDA nursery inspector. A copy of the issued plant certificate (also referred to as a plant license) must accompany each wholesale plant sale regardless of size.

One crucial item that is often under-estimated is the amount of money that is required to produce a salable plant. A thorough financial plan must be made prior to construction to see if capital is available to make the nursery a success. It is very important to know your own cost of production. If you simply set your selling prices from other producers catalogs, you may be selling your plants below your cost.

The University of Tennessee Agricultural Extension Service has management specialists who are available to help you determine your production costs of the various nursery crops. Labor is the most expensive item in the nursery,

and can be the most challenging to manage.

WHAT SHOULD I GROW?

Consider the question, "What plants can I sell and to whom do I sell them?" There are thousands of plants from which to choose. Not only must a producer choose what plants to grow, but a producer needs to be able to predict the market needs 3-10 years ahead, to allow lead time for the propagation and (growth) production of the mass numbers of plants.

A good marketing program could help create a demand for a particular plant but change comes very slow in the nursery and landscape industry. A general rule is to produce about 70% of the tried and true plants such as sugar maple, dogwoods, pin oak, 'Andorra' juniper, 'Manhattan' euonymus etc., and 30% of the plants that appear to have a bright future such as clethra, fothergilla, deciduous holly, serviceberry, sourwood, hostas, Japanese maples; and improved, disease resistant cultivars of redbud, dogwood, red maple, sweetgum, crabapple, hibiscus, hydrangea, crapemyrtle, magnolia, viburnum, etc.

To whom will the plants be sold? Generally, retail garden centers sell common varieties such as red azaleas and white dogwoods, (the tried and true plants); while landscapers sell named cultivars such as 'Cloud Nine' or 'Cherokee Brave' dogwood.

If the target audience is the landscape trade, then more emphasis should be placed on growing quality cultivar named plants. Landscapers are usually more knowledgeable of the desirable traits possessed by some of the selected cultivars.

Unfortunately, the ordinary home gardener's knowledge is generally limited to selecting pink or white dogwoods; or pink, white, or purple azaleas; and they usually are not as willing to pay for; or are uneducated to benefits such as disease resistance, better bloom, improved fall foliage color, etc., provided by the improved cultivars.

In order to learn what plants to grow, one could: 1) contact as many potential customers as possible and ask their opinion on what plants are in constant demand, short supply or have potential for their market; 2) observe the most commonly used plant material going into new landscapes; 3) broker (buy & sell without growing) while noting which plants are in constant demand, over planted, short supply, or which plants quality is difficult to find.

Once the crops to be grown have been selected; propagation, production and potential insect and disease information should be gathered. There is a large resource pool from which to draw general information on the production of nursery crops.

However, there are very few crops in the nursery industry that have written cookbook recipes for production. If available at all, the information is usually scattered in many different places and many contradictions will be found. After all, there is more than one way to propagate or produce a quality plant. That is one reason why no two nurseries are just alike.

It is best to concentrate on only one aspect of production (propagation, container, field, Pot-N-Pot) when first getting into the business. Consider buying liners until the business is running smoothly and only then consider producing some of your own liners, if thought to be advantageous. However, one could start a liner nursery and concentrate on that aspect of the business and sell liners rather than landscape size plants.

Marketing is an extremely important part of the nursery business and should be given equal status and attention to production. Marketing efforts should begin as soon as the commitment has been made to start a nursery business. Producers should begin to attend nursery meetings, trade shows, retail and landscape contractor meetings, during the first year of production, if not before.

Proximity to other nurseries can be an advantage. Through cooperative buying, marketing, shipping, and sharing of technology and equipment, costs can be reduced. A common practice among nurseries that are close, is to pool plants to make up shortfalls in numbers, sizes or species to fill orders.

There are three major areas in which nursery producers compete: price, quality and service (delivery). It is very difficult to compete with larger nurseries on production costs. Therefore, new

competition must strive to produce higher quality plants and provide better service.

Another area in which smaller nurseries can compete is by doing something a little different in marketing or in inventory. Smaller nurseries can fill a niche market by producing specialty nursery crops. These are crops that are not in large enough demand to warrant high volume production or plants that require special skills and handling.

Some specialty nursery crops might include dwarf conifers, wildflowers, ferns, groundcovers, large container specimen plants for patios, native plants, bonsai, topiary, espaliers, rare or collector plants, new introductions, or crops which may require special seed handling, pruning, production, or propagation skills.

Remember that dealing in specialty plants requires a larger market area to reach potential buyers. This market is often accessed by mail order catalogs and classified ads in garden publications.

A well landscaped sales and office area should be included in the plan to show horticultural knowledge and appreciation and pride in the profession as well as exhibit plants for potential customers in an attractive display.

NURSERY FIELD PRODUCTION

Traditional nursery production in Tennessee is in the field. One of the older methods of production is still fairly common in the Irving College community of Warren County. Because the spring flowering shrubs root fairly easy, they are commonly rooted in the field. These "field stuck cuttings" are lined out in rows for ease of cultivation. Branches are gathered in the winter, tied into bundles, sawed 6-8 inches long and stored outside in damp sand. The pencil size dormant cuttings are stuck in rows during late winter, so close that they nearly touch.

Many species are more commonly stuck into propagation ground beds, 4 x 48 feet in size. Shade cloth is supported by bows of concrete reinforcement wire cut 6.5 feet long. During rooting, clear poly keeps the mist and humidity from being blown away. Beds are checked hourly when first stuck. A 24 hour time clock turns the mist system on in the morning and off in the late afternoon. Each bed has another time clock that controls the frequency and duration of the mist, (5 seconds every 10 minutes).

Seed are planted in the fall (Oct - Nov), in late winter (Feb-March) or spring (April - May), depending on the species, producer goals, experiences, soil moisture and time. Seed are planted in rows and covered with sawdust to prevent the soil from crusting and allow better seedling emergence.

Dogwood berries are picked in the fall, cleaned and planted in November. They germinate and emerge the following April. Late frosts and Damping-Off disease will kill a percentage of the crop each spring. The seedlings will grow 12 to 30 inches tall the first growing season and be dormant budded in the seedling row during August of their first growing season. They are root pruned in November.

The cultivar bud begins to grow the following March or April. The understock top is pruned off. They will grow 1-4 feet during their second growing season depending on cultivar, moisture, and ability of producer to adequately spray to prevent powdery mildew. These budded liners will be barerooted sometime between the fall and spring.

Callery pear seedlings are transplanted into rows in late winter or early spring to be June or dormant budded into Bradford, Cleveland Select, Aristocrat, etc., during the same growing season. The callery pear understock top is cut off the following March and the cultivar bud is fitted with a Gro-straight to immediately turn the new buds growth vertical, preventing a crooked trunk or "dogleg". The early Bradfords had the crook before producers learned how to avoid it.

Many small liners are raised in rows; undercut; lifted bareroot; graded; tied in bundles by species, size and grade; stored in a packing shed or cold storage; kept or sold; planted in the field at a wider spacing to be dug 3-7 years later balled and burlapped (B&B).

SITE EVALUATION OF A NEW FIELD

Nursery soils must be well drained internally, as well as on the surface. A deep soil, free of

large rocks, which holds together when dug as a soil ball is essential. Soils that will not ball can be used to grow crops harvested bareroot.

Steep slopes, wet areas, rock out-croppings, and shallow soils should be avoided. A county soil survey map is available from the local Natural Resources Conservation Service. It will indicate the soil type, soil depth, depth of fragipan, response to lime and fertilizer, ability to drain, ability to supply moisture, and primary uses. This is extremely useful information. A list of the best soils and soils to avoid for several counties are presented in the Appendix.

The steepness of the slope is important when considering tractor safety, potential irrigation practices, and potential soil erosion. Are there low areas which may create frost pockets where cold air settles? (Plant the more cold hardy species here.)

Check what the property taxes are for the proposed site. Are there any liens? Check the zoning restrictions; investigate future plans for the surrounding land. Build permanent structures and greenhouses far enough from the road to allow for future widening of the road; to avoid relocation expenses.

Will any heavy industries in the area pollute the air or water, adversely affecting plant growth? Check water which may wash on to the property. Could the water contain harmful pesticide residues, nematodes, or diseases? Pesticide residues and/or nematodes from upstream can be brought in with flood waters and spread out over a bottom field.

Existing buildings can be modified and be very useful; cheaper than building new ones at today's prices. But sometimes, it is better to tear down or move buildings rather than force them into an unworkable design.

It would be wise to learn and study the cropping history of the site for the previous ten years. A soybean history reflects the possibility of soybean cyst nematode, which is a quarantined pest. Soil or plants grown in soil infested with soybean cyst nematode cannot legally be moved. A nematode sample taken any month would determine their presence. A nematode is a microscopic, parasitic worm, that attacks plant roots.

Members of the *Prunus* family, (peach, plum, and cherry) and also tomatoes, pepper, tobacco, and okra may increase a root knot nematode population. Root knot nematodes will attack most of the major nursery crops in varying degrees. Sample the soil June through November, since these nematodes die during the colder months and their population does not rebuild until June.

A nematode analysis by the University of Tennessee Agricultural Extension Service Diagnostic Lab costs $5.00 and may require 2 weeks. Contact your local UT Agricultural Extension Service office for an instruction sheet and form. A soil test sample can be prepared at the same time by dividing the sample if properly taken.

Inquire as to the herbicides used in the previous two years. Rates and method of application (broadcast vs. band) are important. Certain herbicides may persist, such as Atrazine, AAtrex, Scepter and Classic depending on rate, method of application, rainfall since application, and how recently it was applied. Persistent herbicides may damage roots of young nursery liners planted the following spring.

Aerial photos and topographical maps may be available from the Farm Service Agency (formerly ASCS) or possibly the Natural Resources Conservation Service (NRCS) (formerly SCS) office in the county where the land is located. These can be extremely useful during the planning phase.

Be aware of potential weed problems. Develop a plan to gain control of the specific weeds. Survey the fields for problem weeds such as johnsongrass, bermudagrass, briars, thistle, nutsedge, ragweed, fescue, orchard-grass, sicklepod, etc. It is wise to eliminate perennial grasses and weeds prior to planting. Fescue fields converted to nursery crops are frequently infested with ragweed the first few years.

If the land is obtained in time, or if all of the acreage is not planted the first year, plan on building the soil by planting a Sorghum-sudangrass hybrid, such as Sudex, to be plowed into the soil to increase the organic matter content of the soil.

Land must be near major roads so the nursery stock can be hauled to market. It is convenient to

load large plants directly onto a semi-trailer in the field, and avoid an extra move. Inspect bridges, curves, low tree branches and wires to avoid a last minute surprise.

EQUIPMENT NEEDS

While some nurseries may have every item listed below, many items would be considered a luxury by others.

A **60 or > hp tractor**; consider 4-wheel drive, cab - for soil prep, transplanting with larger transplanter, operate air blast sprayer, 8 to 12' rotary cutter, add front end loader perhaps.

A **35 hp tractor**; consider 4-wheel drive, cab — for operating smaller transplanter, air blast sprayer, 6' rotary cutter, add front end loader perhaps.

A **15 to 25 hp tractor**; consider 4-wheel drive. Narrowness is primary importance for cultivation, mowing, sidedressing fertilizer, spraying between the rows. Should be no wider than 40" for use in 5' middles.

If producing bareroot stock: A **high clearance, off-center tractor** is good to cultivate, fertilize, root prune and dig. A 1-bottom plow, disc, side-dressing buckets, undercutter blade are optional.

Depending on the size of liners planted: **1 to 3 transplanters** may be required: One for small liners with a 4" shoe opening; a larger model with a 12-18" shoe; and one that can handle the $20 west coast liners with an 18-24" shoe. The shoe is the metal foot that opens a soil slit or furrow to receive the roots.

A **pick-up truck**
A **ton truck**

For digging/harvesting B&B: **a skid-steer or articulating loader**
After 3rd year of B&B production; **a mechanical spade to dig 20 to 24" balls** will be required.
Depending on sizes produced: **a spade to dig 28 and 32" balls** may be required after year 4 or 5.
(See Harvesting chapter for details and prices.)
To harvest bareroot, a side-band digger mounted on tool bar for 3-point hitch of 65hp tractor.

For soil prep. prior to planting: plow, disk, chisel plow, Rotavator, etc. Narrow disk, cultivator, tiller, etc., to keep middles weed clean.
Air blast sprayer
Back-pack sprayers
50 gallon sprayer: boom, handgun, spray arm mounted on front bumper to band spray; 1/4 quarter cut-off valve mounted on fender.
Rotary cutters: a 3 to 4' for row middles; a 6 to 12' mower; consider a bat-wing.

Multiple wagons to haul B&B from field. Must be strong, extra support, (3-axle), extra ply tires.
A clover seed drill
Misc. mechanic, electrical, plumbing tools; chains.
Assorted nsy. hand tools: hoes, hand pruners, Loppers, pole pruner.
Environmist $3700 mounted
Mechanical lifting devices to load B&B balls.

LAYOUT

Surprisingly, roadways, field borders, fence rows, wooded areas, and areas too steep to cultivate can easily account for 30-40% of a nursery field in middle Tennessee, leaving only 60-70% of the space available for production.

Run rows across the slope to reduce the speed of water run-off and resulting erosion whenever possible. The NRCS may be able to assist in laying the rows out on contour, but contact them early to avoid delays in planting.

A field is divided into blocks, separated by 10-12 foot wide grassed roadways. Primary roads in a nursery field need to be 15-20 feet wide. Roadways are used by trucks, tractors, and harvesting machines to perform the various maintenance, planting and harvesting tasks.

The number of rows in a block is affected by:

1. The distance that one prefers to carry heavy balls out of the block. Trees from the middle row of a 9 row block must be carried across 4 rows to

the nearest roadway to be loaded. A ball may weigh 100 pounds or more. Labor must also be careful not to step in previously dug holes.

2. The distance an air blast sprayer can effectively penetrate foliage to control insects and diseases. Ten or 12 rows of shade trees might be effectively sprayed, while only 6-8 rows of needle evergreens (pine, hemlock, arborvitae, etc.) could be effectively sprayed. Thorough coverage is required to control spider mites on a dense, sheared 6 foot hemlock. While the spray mist may be seen traveling 50 feet or more, it may not penetrate the back sides of the hemlock in the fourth row over. The miticide must be blown through the foliage.

3. Steeper slopes require additional and wider sod strips (roadways) to reduce the speed of run-off water and to catch (filter) soil particles from the blocks above.

SPACING

Nursery plants, like all commodities, become scarce or too plentiful from time to time. Following good demand, the supply dwindles until supply catches up; then the demand may diminish, creating an oversupply. Frequently new producers with little knowledge and experience enter the industry during those reduced supply periods. Too much planting can lead to an oversupply in 3-5 years. When new producers can't find a market and can't sell their products easily, they tend to dump their products and get out.

Large quantities of plants dumped on the market at a low price cheapens the product and hurts the entire nursery industry for everyone. Buyers tend to suspect that the regular price was inflated all along, while it could actually have been a break-even price.

The most common and one of the most expensive mistakes new nursery producers make is planting liners too close together in very narrow rows. Many are unable to get their equipment down the middles by the third summer. The field becomes over-grown with weeds and is often abandoned. Evergreen plants, such as hemlock and Foster holly develop a narrow base due to the lack of sunlight reaching the lower branches. Over-population drastically affects quality.

Some new producers plant close on purpose, believing more plants per acre will equate to a greater profit. They plan to maintain the unwanted vegetation in the middles with a tiller or lawn mower. They also plan to dig every other plant early which would allow additional space for the remaining half. Good ideas, but I have witnessed more failures than successes.

New producers frequently have a full time job, may not have nursery experience, lose motivation during the heat of the summer, every other plant may not become salable, and the new producer may not find a market for his inventory.

All plants do not grow equally with straight, full, well branched trunks and canopies. Some plants will be unsalable. Crowded plants compete for moisture, nutrients and sunlight; creating more low quality plants. A chain saw may be the only remedy after a point.

Inexperienced, new producers assume that the more trees planted per acre will naturally equate into more profit per acre; that they will produce only salable plants, with good heads (no culls), that can be harvested row run with no injury, that the market will be good when they get there and that a buyer is waiting for what they have, whose check will be good.

A new producer does not know when or to whom the plants will be sold. If sales don't do well, a wider spacing will allow the plants to survive another year or two until sold without jeopardizing quality.

Close spacing also makes weed control, mechanical harvest, disease and insect control more difficult. If mechanical digging is attempted in narrow rows, the machine must move slowly down the row. When the tree is selected, the driver must pivot the machine. He may scrape two trees behind the machine in this operation. While digging one, 1-3 adjacent plants may be damaged. Narrow row, side mount diggers are on the market today helping to avoid this problem. They are manufactured locally.

The anticipated plant size to be dug, any intermediate harvests, and the type of harvest

(hand or mechanical) are the primary considerations to determine in-the-row spacing.

A general rule is to plant trees 3 feet apart for each inch of anticipated trunk diameter. For 2-inch trees sold balled and burlapped, the in-the-row spacing should be 5 to 6 feet, with 9 to 12 feet between rows. Middles should be at least 4 feet wider than the widest piece of equipment to be used in the middles.

A popular practice within the industry to conserve space is to plant short term crops between long term crops that are planted in wide middles. A row of flowering shrubs can be planted between two rows of Southern Magnolia for example.

Don't plant within 50 feet of a wood line, due to sunlight and root competition. Don't plant too close to a fence, brush pile, or building that will prevent a tractor from being able to work.

If land is not limited the first few years, space wider. This will be better for the plants, allow faster machine work, and could allow present equipment to be utilized without the costly expense of buying new narrow equipment.

Wider spaced plants will not be shaded and will have longer and stronger lower side branches. Therefore, a normal shape will be achieved. Also, it will be easier for labor to walk around a plant when they prune, shear, spray or dig.

"Remember, it is not how many you plant per acre, but how many you sell". . . and collect for that leads to success, according to Dr. Carl Whitcomb. Over-crowding of trees or shrubs results in poor form and low quality. These plants will be unsalable to the discriminating buyer.

FERTILITY BEFORE PLANTING

Soil test to determine the pH (degree of soil acidity or alkalinity), available phosphorus (P), potassium, (K), calcium (Ca) and magnesium (Mg). The University of Tenn. Agriculture Extension Service soil lab charges $9.00 for these tests and the results are returned within 7-10 days. The $6 basic test is pH, P and K.

Contact your local county extension office for assistance in soil sampling, mailing boxes and instruction sheets. Proper soil sampling and testing will provide a recommendation that will save money by:

1. avoiding excessive and wasteful use of fertilizers,

2. adjusting the soil pH for optimum growth of the intended ornamental crop. If the pH is already too high for the specified crop, suggestions will be made as to ornamental crops that can tolerate or benefit from the higher pH.

3. maximizing plant growth.

Sample blocks before they are replanted. Soil samples can be collected any month of the year, when time is available. Samples can be taken during the summer or fall, from blocks that will be cleared during the winter.

Broadcast the recommended lime, phosphate and potassium anytime prior to planting. This is much better for the crop than side dressing all of the nutrients. Bulk blended phosphate and potash is cheaper than a complete bagged fertilizer containing nitrogen, phosphate, and potash and can be spread by the fertilizer dealer or the producer with a dealer provided buggy. Dealer provided buggies are also available for the producer to spread small quantities of lime with a tractor.

It is much easier and more beneficial to the crop to apply fertilizer to a field prior to planting than after the fact. Some elements move very slowly in the soil, such as calcium, sulfur, phosphorus and potassium. These elements should be incorporated. If levels of these nutrients are brought up to a high level, all that may be required for the next few years will be a nitrogen source.

Incorporate these fertilizers to a depth of 6 to 10 inches. The major objective is to provide the optimum nutrients to establish a good root system. If the roots are healthy, the top will grow.

The amount of fertilizer required depends on the amount of nutrients that are already present in

the soil. If the soil test indicates a low level of available phosphorus or potassium, add about 150 pounds each of actual phosphate and potash per acre. If an 0-20-20 analysis fertilizer is used, 750 pounds of actual fertilizer would be required (150 lbs/acre divided by 0.20). If the test shows a medium level of these nutrients then half as much fertilizer would be required.

The amount of sulfur or lime required to adjust pH depends on the current pH, the particular soils' buffering capacity, and the pH requirements of the plant to be grown. Producers should test for calcium and magnesium to see if levels are adequate and if a proper balance exists between the two. Too much of either one of these elements may inhibit the uptake of the other resulting in a deficiency.

Research on hemlocks has shown that a ratio greater than 10:1 (calcium to magnesium) may cause a magnesium deficiency. It is important to specify the crop being grown so that proper recommendations can be made.

PLANTING

The word "liner" is a common nursery term applied to a plant which is ready to be "lined out" in the field or planted into a container for further growth. A liner could have been produced as a cutting (asexual propagation) or as a seedling (sexual propagation); bed grown or field grown; bareroot or potted; 6 inches to 6 feet tall.

The heart of any liner is the root system. A large healthy fibrous, well branched root system is essential. A good top is also important, and it should be straight, stocky, well branched, etc. A top can not live without good roots. The term "mop head" is a good description of what a desirable fibrous root system should look like.

The roots of a 2 year old liner are enhanced greatly by a procedure called "root pruning" practiced by some nurseries in November or December of the first year. The roots are undercut by a spade or blade. The resulting root growth is much more branched and the plant has a better chance for successful establishment in the landscape or as a liner to be grown-on.

A reliable source of quality liners is essential. Some nurseries specialize in the production of liners. Many field nurseries grow some of their own liners. They may do this to produce better quality than they are able to buy, to grow new or scarce cultivars not yet available in sufficient numbers, to sell for added income, or to have the liners available on short notice in order to transplant into the field when the soil moisture conditions become favorable.

It is difficult to be highly proficient in both field production and propagation. It is difficult to manage all of the tasks to be accomplished and start or complete these tasks when they should be done.

Regardless of the source, liners should be graded by size, and planted by size for appearance and uniform growth and harvesting. Inferior liners should be discarded. The best liners will produce the best plants and provide the highest profits.

Some root pruning is almost always necessary. All cuts should be made cleanly with a sharp instrument. Periodically wipe the blade with alcohol or a 10 percent solution of household bleach. Extra long roots should be shortened to stimulate branching and facilitate planting.

Avoid cutting too many fibrous roots off. If the root mass is too large to be planted with the present transplanter, then buy or borrow a larger transplanter rather than cut too many roots off and risk liner death.

Many producers feel that dipping liner roots into a water holding hydrophilic polymer such as Terrasorb prior to planting insures survival if rain does not come quickly.

Fall planting regained some popularity during the drought cycle of the 1980's in middle Tennessee because spring and summer rainfall was nonexistent. Fall planting is preferred in Tennessee for early plant establishment and better survival and growth during the first growing season, with or without irrigation.

A problem with fall planting is the possibility of winter freezing and thawing which can heave a liner out of the soil. The roots of the liner dry and die, when exposed to the wind and sunlight. Therefore, some producers try to avoid heaving by planting a potted liner, a large liner, and/or planting deeper.

But planting too deep is a major cause of stress and death of some plants in the nursery. It is not recommended for any species, but dogwoods, hemlocks, ericaceous plants, white pines, and yews are especially sensitive.

A liner has many opportunities to dry out from the time it is lifted from the soil, until it is planted back into the soil. The ideal time frame would be to plant the same day the liner is lifted, but this is seldom possible. A root system can dry out quickly. The tiny root hairs are the most critical.

Liners that are being bare rooted from a row or a bed can be damaged quickly by the drying action of sunlight and wind. As the digging operation progresses, strive to keep the roots covered, and put them in storage as soon as possible.

Cover the roots when transporting the plants from the field. Moisten the roots as often as is necessary to avoid drying.

Liners should be planted at the same depth at which they were previously grown in the field or container. Potted liners can become pot-bound or root-bound. Any major root mass should be tore or cut away. Even a thin layer of circling roots should be cut through to force branching.

New transplants should be watered-in immediately after planting. Young plants will require water during periods of low rainfall. Supplemental irrigation is necessary to ensure establishment and optimum growth.

Many revised pre-emergent herbicide labels recommend delaying application to freshly planted fields until after a good settling rain. The fear is that injury could occur if a new planting is immediately sprayed with a pre-emergent herbicide, followed by a rain that might carry the chemical to the roots through the fluffy, loose soil.

IRRIGATION

Irrigation is the redistribution of previous precipitation. Water is taken from storage, pressurized with a pump for delivery through pipe and spread with sprinklers. (A lake, pond, stream or well is considered storage.)

Uniformity of coverage is important. Therefore, the design should take into account all factors that affect coverage characteristics. This includes pumps, pipes, fittings, topography and sprinklers.

Irrigation is needed when rainfall is insufficient. If production with irrigation is about the same as it would be with good rainfall, then irrigation is providing insurance. If production with irrigation can be increased to a point higher than that achieved under average moisture conditions then irrigation can function as a production tool.

Three resources must be available before irrigation can be successful. These are water, time and capital. As mentioned above, there must be an adequate supply of water. One acre inch requires approximately 27,000 gallons. Run an irrigation suitability test ($28-50) on any water considered for irrigation use, before using it.

Time is required to determine when to irrigate, to move the set-ups, to check for leaks, and make repairs, etc. Mechanization in irrigation has helped to reduce the man-hour requirements, but the cost to irrigate can be substantial.

The initial investment may approach the value of the land. The annual cost could be as great as all the other inputs to produce the crop. However, irrigation has proven to be a necessary production tool for liner production, to insure the survival of liners during their first year in the field, and for high value crops.

In general, the rate of application (inches per hour) increases as the sprinkler size increases. The application rate can be increased until it approaches the infiltration rate of the soil. This can be accomplished with larger sprinklers or by placing sprinklers closer together.

The usual spacing of sprinklers in a solid set arrangement is about 50% of the diameter that the sprinkler wets (wetted diameter). They may be slightly closer (40%) along the lateral and slightly further apart (60%) between laterals.

The hand-moved lateral is lower in cost but higher in labor requirements. It can be used in a wide variety of land and crop conditions.

Traveling guns offer a degree of mechanization over the hand-moved systems. This reduces labor but increases the energy requirements. Travel

lanes of sod must be provided. Each lane needs a minimum width of eight feet travel space. The lanes are separated by 100-350 feet of irrigated land depending upon sprinkler size.

Drip (trickle) irrigation is the frequent, slow application of water to the soil. This is done through mechanical devices called emitters that are located at selected points along water delivery lines. Most drip lines are placed on the soil surface but they can be buried at shallow depths for protection from rodents and cultivation equipment.

Advantages of Drip Irrigation:

1. Reduces water volume needed
2. Water placement to roots
3. Less energy for pumping
4. Promotes even soil moisture
5. No wind interference
6. Easily automated
7. Can inject chemicals
8. Can work while watering
9. Low labor once installed
10. Adaptable to various spacings.

Disadvantages of Drip Irrigation:

1. Clean water is required to prevent clogging
2. High initial labor for assembly and layout
3. Above ground damage by equipment
4. Insect and rodent damage
5. Roots may seek emitter openings
6. Time to check for clogged emitters and rodent damage.

Pumps: There are pumps for all needs. It is important to match the pump to the job. The manufacturer can provide test information on their pumps upon request. Look for gpm, psi and efficiency. The highest efficiency is around 75 percent. High efficiency conserves fuel.

The most frequently used type of pump for irrigation is the centrifugal pump. This pump can be obtained in a wide range of gpm and psi. The horsepower match to the pumping requirement (efficiency) is important.

Electric motors need to be sized about 5% more than the pump. Internal combustion engines should have about 25% more power than required by the pump.

Pipes: Sizing pipe is important. Water moving through a pipe loses some pressure due to friction. Care must be taken to prevent excessive pressure loss. A good rule-of-thumb is to select a pipe large enough to keep the pressure loss in 100 feet of pipe less than 1 psi (1 psi = 2.3 feet).

PRUNING

Pruning is a necessary management tool used to produce quality landscape specimens. Pruning must be done throughout the production cycle. Producers must exercise caution to prevent over-pruning in some instances. Excess leaf removal from young plants will delay the production cycle by reducing plant growth. Never remove too many lower branches from a tree at one time. The exact height to prune up to can only be decided by the buyer.

Research has proven that the presence of lower branches increases a plant's caliper. This is helpful when selling by caliper and not by height. Branches should be removed one year prior to the anticipated sale, to allow time for healing. However, nursery producers don't always know what size or which year a plant will sell, so, unfortunately, they are very reluctant to follow this recommendation.

Don't try to shave the branches off whenever the pruning is done. Close pruning will remove the cells that are responsible for the healing process. A slight protuberance is preferred, but not a stub.

Shade and specimen trees usually require a straight central trunk (or leader). Young tree liners may need to be staked the first year or two if they are not strong enough to remain upright. However, an effort should be made to encourage tree liner producers to strive for stem strength and caliper, with less emphasis on height.

A wider spacing, less nitrogen, balanced nutrition and lower foliage/branches left on are the contributing ingredients of stem strength and caliper. Rigid staking prevents movement. Research has proven that caliper size and stem strength are greatly enhanced by movement. Metal rods allow more movement than a heavy

wooden stake.

Tobacco sticks, bamboo sticks, and metal rods of varying lengths and diameters are commonly used, with a Max-Tapener to tie the tree to the stake, periodically, throughout the growing season.

A common practice is to grow seedling shade trees in the field for 1 to 2 years and then cut them back to 1-3 inches above the soil in March. The established root systems are able to grow new trunks fast and straight. They are referred to as "cut-backs".

Many broad-leaved evergreen shrubs require shearing at least once and often 2-3 times a year. Shearing results in a more compact growth habit. Lateral branches developed with each pruning develop a tight canopy.

Upright shrubs such as Nellie R. Stevens Holly and Foster Holly should be allowed to develop a central leader. They should not be sheared flat across their top. The secret to a quality Foster Holly seems to be multiple shearings each year, after the first or second year of growth.

Research from North Carolina indicates that an extra foot of vertical growth can be gained on hemlocks over a four year period. Select one central leader and never prune it until it reaches market height. Perform multiple shearings per year as needed. Hemlocks are sold by height and height means profit.

Maples are difficult to grow with a straight central leader, because they have opposite buds. Anytime the bud of the central leader is damaged, a fork develops rapidly, producing two leaders and a poor quality tree, or a cull. Unfortunately, the central leader is damaged frequently by a shoot boring caterpillar in April, by birds, deer browsing, wind, and occasionally by a producer cutting the top out, trying to stimulate (develop) scaffold branches where none existed.

One of the forks must be removed as soon as it is noticed. Leave the straightest, and healthiest, or the branch on the southwest side (prevailing wind side). If it is caught in the bud stage (prior to the buds in question growing), merely cut the damaged leader back just above the buds and remove one of the buds.

A careful worker can usually accomplish this with one diagonal cut made through the stem with a hand pruner, removing one bud with the stem portion being cut off.

Effort and labor can be reduced by using timely pruning practices. If young buds and leaves are removed from a young trunk while rubbing the hand down the stem, the more laborious procedure of cutting a branch off with a knife or hand pruner is avoided later. Many pruning tasks can be performed when the ground is too wet to support machinery to perform other tasks.

On budded plants, once the bud is observed to be alive in the spring, the understock top is cut off. On Bradford pears for example, the callery pear understock top is cut off, and the Bradford bud is fitted with a Gro-straight to prevent a crooked trunk or "dogleg".

The numerous tops must be removed from the field because of the many thorns on the rootstock. The thorns are capable of causing flat tires. Pitch forks and by-hand use to be the only way to remove the tops from the field.

Technology has accelerated some tasks. Some producers have adapted silage choppers to cut the callery pear top off high and grind the top and thorns up in one pass. Then the final cut is made precisely above the bud with sharp hand pruners or tractor pto generated pneumatic hand pruners, which reduce fatigue
and increase speed, but stooping is still required.

INSECTS, DISEASES, and WEEDS

The presence of quarantined pests, such as Japanese beetles (JB) or fire ants complicate production and shipping. Check with your local TDA nursery inspector to learn the requirements. Action is required in order for other states to accept our product. Our TDA did not create the requirements, but must enforce them to guarantee our market. In 2000, producers were required to band spray Marathon on either side of the rows to be harvested and shipped to JB free states. Spraying was required in May, June or July with a TDA rep present. The sprayer had to be calibrated and certified to apply a minimum of 88 gallons of

water per acre. The chemical cost was more than $800 per acre with additional application costs.

Throughout the production season, producers need to be alert for insect, disease and weed problems. Insect and disease problems can usually be controlled with little plant damage when detected early.

Producers or hired scouts need to check leaves, stems and roots. Roots of slow growing or slightly off-color plants should be examined for grub feeding damage, root rot, being planted too deeply (or cultivation throwing soil to the plants). The disc that throws soil to the row can be replaced with a smaller diameter disc.

A few species with routine annual problems should be routinely sprayed on a preventive basis. Examples would be dogwood borers and black knot on plum. High-quality ornamentals must be free of insects, disease and their disfiguring symptoms.

Observe the "comfort index" of 140 when spraying most emulsifiable formulations denoted by EC to avoid foliar burn during hot humid days. The temperature plus the relative humidity should add up to less than 140 when the spraying is done to reduce the likelihood of burn.

Weed control is an essential requirement in the field nursery operation. Perennial weeds should be removed prior to planting with continuous cultivation or post-emergent herbicides. Weeds can be prevented after planting with pre-emergent herbicides. Weeds which escape or perennial weeds which reoccur can be sprayed with post-emergent herbicides or mechanically removed. Use extreme caution when using non-selective post-emergent herbicides, such as Roundup.

Cultivation between rows on closely spaced plantings provides good weed control. A weed control program should be developed prior to planting. The program should be initiated immediately after planting and continue throughout the early life of the crop.

North Carolina research proved that a weed free strip in the row is essential for maximum production. The width of the weed free strip should be increased as the plants grow, but is not as critical through the harvest years.

The clean row can be achieved by cultivation or herbicides or a combination of the two practices. A grass sod middle does not interfere with the growth of the ornamentals in the row, as long as the clean row is wide enough. So, if the soil is likely to wash away on steeper slopes, mow the middles rather than cultivate them.

Herbicides are either pre-emergent or post-emergent. Examples of pre-emergent herbicides are Casoron, Devrinol, Barricade, Gallery, Goal, Kerb, Pendulum, Pennant, Princep (Simazine), Surflan, and Treflan. Examples of post-emergent herbicides are Envoy, Finale, Fusilade T/O, Gramoxone, Roundup and Vantage.

Envoy, Fusilade and Vantage are selective for grass. Finale, Gramoxone and Roundup are non-selective, and will kill or damage most plants sprayed. Finale and Roundup are systemic, while Gramoxone is contact. Gramoxone will produce results in less than 12 hours. Roundup may require 14 days.

Barricade, Pendulum, Pennant and Surflan are the more commonly used pre-emergent grass herbicides; Princep (Simazine) and Gallery are the more commonly used pre-emergent broadleaf herbicides. Surflan + Princep and Barricade + Gallery are two common tank mixes.

Normally, 2 or 3 applications of pre-emergent herbicides are required per year, because most of the labeled rates will last 90 days. Generally, the best times are early spring (Feb. 1 to March 15) and during the fall leaf drop (Sept. 1 to Oct. 15). If pre-emergent herbicides are applied May - October, all weed vegetation must be removed first.

Princep should not be used on any nursery crops their first year in the field, (except at the low rate of 1 quart per acre according to the label). Pre-emergent herbicides may not be needed during the harvest years. Always follow the label, and read it each time as changes are constantly occurring.

Pre-emergent herbicides must be activated by a half inch of rain, equal irrigation or shallow (1-2 inches) mechanical incorporation. The period of time that they will wait varies from 4 hours to 30 days, according to their labels. Treflan must be disced into the soil within 4 hours.

Devrinol must be incorporated or irrigated into

the soil within 48 hours. Surflan and Gallery will lay and wait 21 days, according to their label. But DowElanco researchers have suggested that a third is lost every 7 days without complete activation. The lack of summer rainfall is why pre-emergent herbicides sometimes don't work. They don't get activated.

Spray post-emergent herbicides onto dry foliage, and try to schedule a time when no rain is expected for 24 hours. But Envoy, Fusilade T/O, and Vantage will provide effective control if applied one hour before rain (if all label conditions are met). Glyphosate (Roundup, Jury) can be sprayed six hours before a rain and still be effective.

Check with the local Ext. office if there is a place to turn in empty plastic pesticide containers. They will also know if and when there will be a pesticide turn-in day for unwanted, leaking, old pesticides.

UT Agricultural Extension Service Publications "*Commercial Insect Control for Trees, Shrubs and Flowers*", Pub. 1589; "*Disease Management of Woody Ornamentals in Nursery & Commercial Landscapes*", Pub. 1234; "*Weed Management in Ornamental Nursery Crops*", Pub. 1226; can be obtained at the local Extension office (plus numerous insect & disease fact sheets). These are revised every 1-2 years. Keep a current copy handy.

Look on the lower back of an Ext. publication. PB1234-2M-8/97 (Rep or Rev) is an example. The publication number is 1234; 2,000 were printed August, 1997 and was a reprint or was revised.

ANNUAL MAINTENANCE FERTILIZATION

The standard nursery practice is to band or sidedress the annual maintenance fertilizer applications to avoid excessive stimulation of weed growth between rows.

Root growth begins earlier in the spring than shoot growth. For established plants in the nursery field, maintenance fertilizer applications should be applied 4 to 6 weeks prior to bud break in the spring. To get the maximum benefit from the fertilizer it is very important to make the annual maintenance fertilizer application by mid to late February, and then repeated mid to late June.

Rates are calculated on the amount of nitrogen. A general recommendation is to apply 75 pounds of actual nitrogen per acre to established shade trees twice a year. This represents a total of 150 pounds of actual nitrogen per year. Little growth benefit is realized for additional fertilizer added beyond 150 pounds.

If the available phosphorus and potassium tested high on the soil test, or if more is broadcast to bring it up to the high level, according to the soil test recommendation, then actually, only a nitrogen source is required for the next few years of sidedressing.

But the normal nursery sidedressing equipment can not be adjusted to (apply such small amounts) only apply the recommended 225 pounds Ammonium nitrate (34-0-0) per acre. The average sidedressing equipment will apply too much 34-0-0 and damage small plants.

A nitrogen fertilizer with some phosphate and potash added to dilute the caustic action of the nitrogen, would be safer. If 20-10-10 is the nitrogen source, 375 pounds of actual fertilizer would be required per acre at each application, on shade trees. (75 pounds divided by 0.20)

Dogwoods, conifers and all shrubs should receive no more than 50 pounds of actual nitrogen per acre at each application in February and June. This equals 250 pounds of 20-10-10 per acre at each application (or 150 lbs. of 34-0-0).

NOTE: Following planting, all plants should receive no more than 50 pounds of actual nitrogen per acre the first fertilization. High nitrogen rates could force excessive top growth that cannot be supported by a limited root system.

New fall and winter plantings can be sidedressed in mid to late February, as recommended above. Plantings made after February can be sidedressed two weeks later.

Research has not progressed to the point that everything is known about the fertilization of all the different species and varieties of nursery stock. In fact, very little is known. More research is needed with all the different crops on timing of application, rates, analysis and forms of the various nutrients to use for the different soils in Tennessee.

It is up to the individual producer to fine-tune the fertilizer program. Try some experimentation on your own or with the help of your county extension agent. Remember to experiment on a small scale and not with the whole crop. Be sure to leave an untreated plot for comparison.

The way to achieve "the competitive edge" and stay in business is to always look for an economically feasible and better way to produce a higher quality product.

SOIL CONSERVATION, IMPROVEMENT & STABILIZATION

Nursery producers should take every opportunity to conserve and build their soil, which provides their livelihood.

Run rows across the slope (on the contour) whenever possible to reduce erosion. Band pre-emergent herbicides rather than broadcast them. Mow the middles rather than disc the middles. Disc rather than till the middles, as a tiller destroys soil structure more than a disc.

Never work (plow, disc, cultivate) the soil when it's too wet as this also destroys soil structure. It will dry hard as a brick. Broadcast most of the phosphate and potash fertilizer.

Roadways, travel lanes, grassed waterways, etc. should be planted in fescue. Probably nothing is better than fescue for these non-crop areas, but nothing is worse than fescue in the row where it reduces plant growth. Large pasture no-till drills can be used to establish fescue without plowing and discing mid February to mid March or mid August to mid September.

More and wider grass strips are required on slopes. The proper use of grass strips or grass roadways between blocks can reduce erosion by as much as 45-50%.

Drill Crimson red clover August 1 - September 15 in the middles all years except the first, if the liners are small. The clover may shade out small liners the following spring. Also avoid clover where plants will be cut-back to within a few inches of the soil. Small seed drills are available to keep the seed out of the rows where competition for moisture and nutrients could occur.

Be sure to inoculate the seed each time with the proper clover inoculate, so that the clover roots will be able to fix nitrogen from the atmosphere in their root nodules. The black powder inoculate is the nitrogen fixing bacteria that does the job. An estimated 30-40 pounds of actual nitrogen per acre per year can be received with 6 foot middles.

Benefits include: erosion reduction, grass and weed growth suppression in the middles through June, and support for traffic when the ground might otherwise be too soft. Eventually, after incorporation, the clover improves the soil structure, increases the organic matter, soil nitrogen, and the moisture holding ability of the soil.

A cover crop does not have to be plowed into the soil while in full bloom in order to provide the maximum benefit to the soil. The clover can be allowed to produce seed in May, die down naturally in June, and provide maximum benefits whenever it is incorporated into the soil. Don't work the seed too deep.

Clover should not be planted if there is a known nematode population present, as the nematode population could maintain itself on the clover roots.

Over a period of time, soil structure deteriorates as a result of losing topsoil with the rootballs and running harvesting equipment when the soil is too wet. Poor soil structure then results in reduced growth.

Cover crops can be used in these fields to build the organic matter up in the soil. A green manure crop, such as a Sorghum-Sudangrass Hybrid (Sudex) can be grown.

Sorghum-Sudangrass Hybrids (Sudex) are a good choice because they will not feed any nematodes and supplies a large volume of organic matter. A first cutting could be cut for hay, with the remaining cuttings left to be plowed into the soil in the fall.

Frequent cuttings, an early August plowing, and 2-300 pounds of 34-0-0 broadcast per acre will speed decomposition and reduce spring transplanting problems.

A winter cover crop, such as rye, will add additional organic matter to the soil of vacant blocks to be spring planted. Rye should be fall seeded and plowed down in the spring. Rye could

be drilled into wide middles of existing nursery stock with a drill instead of clover, if desired, and mowed, disced down or sprayed with a selective post-emergent grass herbicide.

HARVESTING

Field nursery stock is usually dug while dormant. Deciduous trees transplant best after losing their leaves. Trees transplanted when dormant initiate and develop roots that supply new spring leaves and stems with moisture.

Harvesting conventionally-grown field nursery stock requires a mechanized tree spade or labor experienced in hand digging. Tree spades can be purchased in a variety of sizes which will dig balls from 15 inches up to 40 inches and larger.

The size of the root ball should be in proportion to the diameter or caliper of the trunk. Spades are normally mounted on the front of a skid-steer machine, but can be mounted on the rear of a regular wheel farm tractor, but with less maneuverability.

The nursery industry measures caliper 6 inches above the soil. Foresters measure caliper 4.5 feet above the soil and refer to it as D.B.H. (Diameter at Breast Height).

The American Nursery & Landscape Association (ANLA), formerly the American Association of Nurserymen (AAN) has sizing guidelines establishing standards for the nursery industry. Landscape contractors and retail nurseries expect root ball sizes to be within the guidelines of the ANLA (AAN). Call the ANLA at 202-789-2900 to order a copy of the “American Standard for Nursery Stock” for about $15 plus shipping.

For example, a 1-1/4 inch caliper shade tree requires a minimum of an 18 inch rootball;
1-1/2 inch – 18 inch diameter root ball
2 inch – 24 inch diameter root ball
2-1/2 inch – 28 inch diameter root ball
3 inch – 32 inch diameter root ball

Mechanical tree harvest is straight forward. The tree spade is moved into position around the trunk. Large spades are forced hydraulically into the ground pruning side roots and tap roots. The entire soil ball, root system and spades are lifted and moved over a burlap-lined wire basket. The root ball is lowered into the basket and the spades removed.

The burlap is wrapped around the top of the soil ball and tied into place. The wire basket is tied across the top and wires crimped tightly to hold the soil around the existing root ball. The plant can be set back into the hole, moved to a holding area, or shipped immediately to the buyer from the field (farm fresh).

A mounted tree spade is a major purchase. A new producer might purchase a spade that will dig 20 to 24 inch balls during the 2nd or 3rd year of production and another spade that will dig 24 to 28 inch balls during the 3rd or 4th year. Reconditioned spades may be purchased for 60% of a new price with a full warranty. A skid steer is the preferred vehicle for mounting, but spades for a 3-point hitch are available for 45hp tractors and larger. They are much slower and more cumbersome to operate, requiring wider plant spacing or more culls are created by the damage caused. A 3-pt. 30" spade might be $10,000 mounted.

A Caretree 32" spade mounted on a Bobcat complete, cost approximately $40,000. A truck and trailer will be required to haul it between farms or for service. Approximate costs of different items, as of Nov, 2001:
a Caretree spade to dig 20" balls – $6,100
a Caretree spade to dig 24" balls – $7,600
a Caretree spade to dig 30" balls – $8,800
a Caretree spade to dig 32" balls – $9,700
a Bobcat – $27,000; tracks - $2500; rear stabilizer - $1300; bucket & or forks to load with.

Plants may be dug out of season because of customer demand. New growth must be hardened-off before they are dug. Anti-transpirants (Vapor Gard, Wilt Pruf) may be applied 2-3 days prior to digging to minimize moisture loss. Trees are best harvested in early morning and moved to a shady area beneath an irrigation sprinkler.

Plants should be hardened-off for 1-2 weeks prior to being shipped to the buyer. The hand stripping of foliage (only after buds have formed) is a drastic, but effective and proven way to move a plant out of season, safely.

The root-control bag or "Gro Bag" is a recent innovation in the production field, to allow year

round harvest. Liners are planted in root-control bags placed in the ground. Natural field soil is used. Roots grow through the bag and then are pinched off by the fabric as they increase in size. New roots proliferate inside the bag.

"Gro Bags" can be used successfully in sandy or clay soils, which might not hold a ball of soil otherwise. The bag must be peeled off the rootball, however, requiring great effort; eliminating all of the roots that escaped the bag. The root control bag has not been widely accepted and is still in trials.

THE POT-N-POT (PNP) PRODUCTION SYSTEM

PNP is an intriguing new horticultural production system, allowing a containerized plant to be grown while nested inside of another container (referred to as the socket or holder pot), which is buried up to its' rim. The sunken containers require much less irrigation water than conventional containers, being watered individually with one spray stake per container, with no waste, no run-off. A collection pond and gravel is not required. The most important and essential ingredient in PNP is an excellent well drained soil, what field producers would call good dogwood or peach soil. Refer to the Appendix.

PNP containers do not blow over, eliminating a tremendous amount of labor. Staking is required for some of the tall and weak stemmed plants, following potting, just as would be required if field planted.

They are insulated from the cold by Mother Earth, requiring no overwintering structures, just like field grown plants. (Over-wintering protection would depend upon the pots sunken to the rim and a tight soil seal around the rim. That seal is also critical to prevent surface water from entering the hole.)

Traditional field producers dig and ship their products October - April. Their income is limited to what they can dig and ship in 7 months. Landscapers frequently become desperate for large plants during the summer months. They frequently require plants larger than common container sizes.

Field producers are frequently begged to summer dig, which can be disastrous. Also, long time customers have recently been expressing strong desires to purchase a greater percentage of their purchase as container grown plants.

Market demand has been a major reason for traditional nursery field producers to try PNP. Other reasons include: to avoid costly summer digging, to stimulate late summer cash flow, to be able to ship plants anytime, even when it is too wet to dig, to speed-up harvest (labor is scarce), and to capture the large container market of shade and ornamental plants.

One producer reported that his customers liked the advantage of buying large container plants as needed, without having to tie-up capital and maintain a large inventory of B&B trees that must be received before the digging season ends.

Large field-grown liners can be potted during the winter and sold after one growing season in the container, in most instances. A nursery may produce 2-3 sizes of PNP; which may include 5, 7, 10, 15, 20, and 25 gallon
containers. The most common sizes currently produced are 7 and 15 gallon.

One of the major concerns regarding PNP has been start-up costs, particularly since 2 containers must be purchased in the beginning for each plant. It was assumed that PNP had a higher initial capital investment requirement, along with higher fixed and variable costs compared to conventional container and field production.

An Auburn study compared the 3 production systems and found that PNP was the cheapest system to build from scratch, with each growing on 10 acres.

A conservative cost estimate of $7.50 per unit for PNP, compared to $2.50 per unit for aboveground container production, (1993 data, not including land). An in-house study at H. Stanford Roberts Nursery Inc. in Newton, PA, indicated that overwintering costs were $0.86 per square foot for PNP compared to $1.21 to $1.45 for conventional overwintering practices under poly.

PNP requires a higher degree of management than traditional field production, but less than conventional container production. It requires a daily commitment that field producers are not accustomed to. Irrigation lines should be walked

daily to check for leaks and clogged emitters, etc.

The PNP system mimics traditional field production more than traditional container production. Because PNP is done in the field, field producers can relate to it better. For instance, 6 x 4 is a common spacing with PNP. It is more in line with field production spacing than container production.

Another similarity is the management of the floor vegetation. Generally in field production, the middles are mowed and herbicides are banded down the row. Many of the PNP producers have adopted a similar practice.

In field production, inclement weather can force field labor home without pay. A field producer with some PNP (or conventional containers or propagation) can shift the labor to potting, sticking cuttings, pruning or various maintenance tasks when the soil is to soft or the weather too inclement to perform typical field tasks.

The PNP Production System is a viable complement to traditional field-grown nursery stock and even a viable alternative to traditional field production.

From a survey, we learned that traditional field producers consider harvesting PNP easy, while conventional container producers consider harvesting PNP to be more difficult than containers sitting on gravel. Everyone agreed that the species that 'root out'
excessively, such as birch and willow, are difficult.

Roots of certain species readily grow through the drainage holes of both pots and then anchor into the surrounding soil (gaining moisture and nutrients from the native soil, but increasing labor to cut the roots with a spade slipped down the outside of the holder pot.)

We also learned that almost half of the current PNP producers have experienced some standing water in some of the socket pots, during periods of excessive moisture. This has happened on well-drained soils, where it should not have.

Don't auger the holes when the soil is too wet, or let the auger stay in the hole too long and glaze the inside of the hole, creating a bowl that will hold water. Prevent surface water from entering the hole by mounding and packing the soil around the socket pot.

PNP provides a cooler root system than conventional containers in the summer (91 degrees vs. 102 degrees); and a well insulated root system in the winter. Temperatures in the western quadrant of the containers aboveground were 23 degrees warmer than their PNP counterparts.

The importance of keeping media temperatures below 100 degrees is well-documented, however, media temperatures of 136 degrees have been recorded in aboveground #7 black containers.

Media temperatures on a January morning with an air temperature of 25 degrees were 5 degrees warmer for plants being grown PNP. At Tifton, GA, in February 1996, over 5 days and a record low of 13 degrees; the minimum temperatures in the aboveground containers dropped to a low of 18 degrees, compared to 31 degrees for PNP. The PNP plants had less temperature fluctuation than the plants grown aboveground. It is amazing that plants survive when their roots are 26 degrees at dawn and 109 degrees by 3 pm.

Caution: Plants produced PNP generally have more white roots on the exterior of the rootball at the container-media interface than plants grown aboveground. Since media temperatures are generally greatest within 1 inch of the container wall, and a significant portion of the roots of a PNP plant are in this area, PNP plants are more susceptible to lethal high temperature damage during post-production handling.

To reduce potential heat-stress at the point of sale, Lancaster Farms in Virginia shrink-wraps its PNP containers in white poly before shipping. The white poly reflects solar radiation and thereby reduces media temperatures.

SUMMARY

Approximately 47% of the U.S. population lives within 800 miles of Tennessee. Tennessee's climate, soils, rainfall, and topography are conducive to nursery production. Labor has become a major limiting factor since the late 80's. The market is there for the innovative marketer of

quality stock.

Starting a field nursery requires large amounts of capital. Fixed costs include the price of the land, grading, road construction, and buildings. There must be an area to store plants and supplies. A heated greenhouse, a poly covered quonset house, or ground beds are required to produce rooted cuttings.

Equipment needs include tractors, a loader, and a truck. A flatbed truck, wagons or trailers are needed to haul balls in from the field. Additional equipment may include a Rotavator, various tillage and cultivation equipment, sprayers from back-packs to air-blast, transplanters for 6 inch and 6 feet trees, and a tree spade. A reliable source of water and an irrigation system could be essential some years.

Variable costs also can be quite high. A manager will be required as well as several laborers on large nurseries. Variable costs include fertilizer, lime, liners, and interest on operating capital. In 1987, $5,000 to $7,000 per acre were needed to establish nursery stock on existing land. About $2,000 to $3,500 per acre was necessary to maintain crops each year until harvest.

Harvest does not normally begin until three to five years after initial planting. The break-even point occurs five to eight years after the first planting, with new plantings made each year.

In 1984, a McMinnville CPA figured that the average dollar value per acre per year of a nursery field operation was $5721. In 1994, an experienced Warren County nursery producer said that, "A grower needs to turn $2000 per acre per year to be successful."

With proper planning, plant selection, management and marketing; nursery field production can be highly profitable and rewarding.

A COMPARISON OF FIELD, CONVENTIONAL CONTAINER AND POT-N-POT PRODUCTION

A conventional container operation requires less land, a lot of gravel for drainage, a lot of water for overhead irrigation, poly covered quonset houses for winter protection, one employee per acre, a higher degree of management and time to stand plants back up that blow over during every wind.

A field growing operation requires more land, a well drained soil that will hold together when dug as a rootball, and less labor per acre.

A Pot-N-Pot (PNP) operation requires a very well drained soil, no gravel, less water than conventional containers, time to check irrigation, no winter protection, no staking and no blown over containers. Dr. John Ruter's research on 8 woody ornamental species at Tifton, GA, found greater or equal shoot and root dry weight on PNP grown plants compared to conventionally container produced plants.

A container nursery requires less land, but container areas are much more expensive to construct and maintain than field areas.

Approximately 5-10 acres is the size of a small container operation. About 1/3 to ½ of the land will be allocated to roads, buildings, storage areas, etc. About 0.8 square feet is required for each one gallon container. At least one employee per acre of containerized plants is required.

Container production is more labor intensive but offers greater returns per acre than field nurseries. In general, the return on an investment in a container operation can be realized in ½ to 1/3 the time of a field nursery. One can hopefully expect to see return of money invested in four to five years in a container operation.

The most important requirement for any container nursery is the availability of large quantities of high quality water. At least 27,000 to 40,000 gallons are required per acre, for approximately 200 irrigations a year.

A small field nursery is considered to be less than 50 to 70 acres. A field nursery's labor demands vary with the season. A family operation with both husband and wife actively involved in the business, requires about 3 to 4 additional workers during peak times of digging and planting.

Start-up costs for a container operation are much higher than for a field operation (road grader time, gravel, irrigation pipe, pump, pump house, fittings, labor, trenching, containers, media, slow-release fertilizer, minor element package, storage building, blender, potting machine, potting shed, conveyors, tractors to pull numerous wagons, quonset houses, shade cloth, poly for winter, break room, restrooms, etc.).

The major field production costs are for liners, labor, pesticides and harvesting expenses. Harvesting expenses include labor, machinery, pinning nails, burlap, wire baskets, twine, etc. Six foot budded liners from the West coast can be rather expensive; if planted 9x6, means 807 plants per acre at $20 each, or $16,140 for the liners to plant 1 acre.

Labor is the single greatest expense and the greatest problem for any type of nursery business.

The intensity of management for a container nursery is greater than field. Containers can dry out quickly when a pump goes down, if power is lost or if sprinkler heads become clogged or malfunction, etc. Extra parts should be kept on hand to avoid repair delays.

A container nursery requires greater year-round attention and labor than a field nursery. It is hard to be a part time container nursery producer. A container nursery can not be left while on vacation, without having a competent manager.

Field production is a little more forgiving; plants can last more than a day without water, due to the reserve and buffering capacity of the soil. Field grown plants can also tolerate human error better than container grown plants.

The same species of plants that are field grown can be container grown and vice versa. However, some of the more difficult to transplant plants or those plants that do not produce a dense fibrous root system to hold a good ball may be more successfully produced in a container. *Prunus laurocerasus* 'Otto Luyken' is an example.

There are some plants that can be produced more economically in the field versus a container. Larger specimen trees and shrubs are an example. However, there is a niche for producing these types of plants in large containers in order to have year-round availability for planting. These plants command a higher price and the demand trend is currently promising.

A container produced plant affords the option to the grower of shifting a plant to a larger container for sale the next season if it is not sold during the current season. There is a time in the field where plants reach maximum density and must be dug and sold or sacrificed to make room for growth of remaining plants.

Weed control is a major consideration in all nursery production systems. Accurate application rates are more critical for herbicides in containers than they are in the field due to the more open container media with lower cation exchange capacities.

Disease and insect control requires closer attention in the container nursery than the field nursery. Higher plant density and daily overhead wetting of the foliage in a container nursery reduces air movement and creates an environment more conducive to development and spread of diseases.

Container plants are more susceptible to physiological stresses such as heat and cold than field produced nursery stock. Roots in containers are more sensitive to these stresses than the tops. Soil provides an excellent buffer to these extremes, in a field nursery.

Winter protection is a must for container grown plants in Tennessee. Plant roots are more tender than the tops. The roots of only a few plant species will tolerate the extreme cold temperatures in conjunction with the sporadic warm spells.

Plants requiring shade for optimum growth are usually produced in containers under artificial

shade or under the canopy of trees in the nursery. The requirements of shade can sometimes be met through more frequent watering of the containers. However, this practice can also be detrimental.

The major advantage to container grown plants is the ease of harvesting and handling of these plants (which is year round); as opposed to the digging of B&B plants from the field. Field digging must occur regardless of how wet, muddy, or cold it is in order to finish during the narrow window of dormancy.

Container plants can be harvested, shipped, and planted almost any time of the year, whereas with field grown plants, the main harvest is when plants are dormant.

Bare root plants and container plants can easily be handled, stacked and shipped whereas the rootballs of large B&B plants are very heavy and costly to ship, requiring a mechanical loader of some sort.

Container, field and Pot-N-Pot operations each have their own specific requirements for equipment. Container nurseries require specialized equipment for media mixing and handling as well as more transportation equipment for containerized plants and people to manage those plants. A field nursery requires sophisticated harvesting equipment and a hard working labor pool, which is becoming more and more difficult to find.

Quality plants can be grown by either method. The production method selected depends on the market evaluation, plants selected, potential requirements of the plant, site conditions, amount of land available, soil type, slope, irrigation capacity, financial situation of the owner, personal expertise and preferences of the owner.

Appendix

Plant Spacing Chart

This chart gives the number of plants per acre, at various spacings. It assumes no roadways, which are essential. Either axis can be used for the in-row spacing or width of middles (in feet). For example, a 6' middle and a 4' in-row spacing allows 1,815 plants per acre. A 7' middle with 6' between plants allows 1,037 plants per acre.

	1	2	3	4	4.5	5	6	7	8	9	10	12
1	43,560	21,780	14,520	10,890	9,680	8,712	7,260	6,223	5,445	4,840	4,356	3,630
1.5	29,040	14,520	9,680	7,260	6,453	5,808	4,840	4,149	3,630	3,227	2,904	2,420
2	21,780	10,890	7,260	5,445	4,840	4,356	3,630	3,111	2,723	2,420	2,178	1,815
2.5	17,424	8,712	5,808	4,356	3,872	3,485	2,904	2,489	2,178	1,936	1,742	1,452
3	14,520	7,260	4,840	3,630	3,227	2,904	2,420	2,074	1,815	1,613	1,452	1,210
3.5	12,446	6,223	4,149	3,111	2,766	2,489	2,074	1,778	1,556	1,383	1,245	1,037
4	10,890	5,445	3,630	2,723	2,420	2,178	1,815	1,556	1,361	1,210	1,089	908
4.5	9,680	4,840	3,227	2,420	2,151	1,936	1,613	1,383	1,210	1,076	968	807
5	8,712	4,356	2,904	2,178	1,936	1,742	1,452	1,245	1,089	968	871	726
5.5	7,920	3,960	2,640	1,980	1,760	1,584	1,320	1,131	990	880	792	660
6	7,260	3,630	2,420	1,815	1,613	1,452	1,210	1,037	908	807	726	605
7	6,223	3,111	2,074	1,556	1,383	1,245	1,037	889	778	691	622	519
8	5,445	2,723	1,815	1,361	1,210	1,089	908	778	681	605	545	454
9	4,840	2,420	1,613	1,210	1,076	968	807	691	605	538	484	403
10	4,356	2,178	1,452	1,089	968	871	726	622	545	484	436	363
12	3,630	1,815	1,210	908	807	726	605	519	454	403	363	303

Additional handouts/publications are available from Mark Halcomb.

Monthly Task Calendar

Different Aspects of the Commercial Nursery Industry is in "Getting Started in the Nsy. Business"

Disease handouts in addition to UT pub and SP's

Black Knot of Plum
Cedar Apple Rust
Crown Gall
Disease Resistant Crabapples
Fireblight
Dogwood Powdery Mildew
Needlecast on Conifers
Packing Shed Disease Prevention
Southern Blight

Insects

Seasonal Appearance of Orn. Insects in Pub. #1589
Decision-making Handbook for Insect & Mite Pests of Orn Plants, UT Pub. #1623
Borer Control in Nsy Grown Dogwood, Ash, Maple & Oak Trees
Crape Myrtle Leaf Beetle
Dormant Oil
Jap Beetle, Impact on Nsy Industry
Maple Tip Borer Control
pH of Spray Water is very Important
Snail and Slug Control
White Fringed Beetle and Larvae
Woolly Apple Aphid on *Malus*

Weed Control

Field Nsy Weed Control	Hydrangea Herbicides
Algae in Nsy Irrigation Ponds	Love Vine or Dodder
Banding Spray Arm for Front Bumper	Modes of Action
Fescue Grass Suppression with Roundup	Mugwort Control
Finale -- A new Post-emergent Nonselective Herb.	Nutsedge Control
The Green Grass Herbicides	Phlox, Grass Control in

Fertility

Optimum Soil pH of Common Nursery Crops	Soil Testing Pays Dividends
pH bar graph, nutrient availability	Timing Lime Applications vs. the Plowing
Ornamentals Tolerant of pH above 7.0 & below 5.0	The Value of Lime to Nursery Production
Ornamentals easily over limed	Summer Seedling Fertilization
	Taxus (Yew) Fertility

Soil Improvement

Benefits of Using Crimson Clover
Clover Substitutes for Nursery Middles
Summer Cover Crops for Nsy Row Middles

Crops

Boxwood	Maple Production & Red Maple cultivars
Christmas Tree Production	Oak Shade Tree Production
Crabapple Production	Peach Tree Production, Commercial
Crape Myrtle Production	Pear Cultivars, Production of ornamental
Dogwood Production	Redbud Production
Fern Production	Rhododendron Production
Flowering Shrub Production	Sourwood, by Dirr / Prod.
Hemlock	Taxus /Yew Production
Holly, Foster #2	Tissue Cultured Maples, Handling, Acclimating & Growing
Hydrangea Production	White Pine Prod.
Skip Laurel Production	

New Plants

Obtaining Grower Rights	*Hibiscus moscheutos* Cultivars
Potential New Plants, by Dirr	Edna Jean Holly
Disease Resistant Apple Cultivars	Mary Nell Holly
Propagation of 'Samurai' Chinafir	Some Newer Magnolias to Grow
Fringetree	Redbud Cultivars
Ginkgo Cultivars, Male	Witch-hazel Seed Propagation
Goldenseal	Yellowwood

Misc.

PNP	Root Pruning Increases Root to Shoot Ratio in Liners
Container Production	Improving the Quality of Shade & Flowering Trees in the Nsy by Pruning
Spacing	Hormones Stimulate Different Plant Parts to Grow in Different Seasons
Overwintering Plants	Prevent Pesticides from Freezing in Storage
Useful Units of Measure	Winter Acclimation, How Plants Gain Antifreeze
Seedbed Mgt.	Index of Ornamentals by Common Name to Botanical Name
	Irrigation
	Cross Connections can cause Water Contamination
	Ten Tips for Laundering Pesticide Soiled Clothing
	DNA Fingerprinting can Catch Plant Thieves
	Striving to Become a Better Manager
	Shipping Facts(balls, truckload, weight)
	Winterizing the Air Blast Sprayer
	Know your costs/ Costs should reflect prices
	Prevent Pesticides from Freezing in Storage

Harvesting

Pre-Dig, Store and Ship in the Spring
Sheared Conifers require larger Rootballs--ANLA Nsy Standards
Nursery Standards, ANLA

Marketing

Patents and Trademarks	The TenneSelect Program
Applying for a Plant Patent	Expanding Tenn's Nsy Mkt Overseas
How to Keep your Customers Satisfied	Dressing Up the Old Catalog
Let Tenn Buyers Guide Market your Plants	Nursery Business begins with Marketing

Nursery Lists

Sources of Budded Liners, Seedlings, & Rooted Liners	Alabama Nursery Propagators
Nursery Sales yards in Middle Tenn	Daylily Producers
Container Producers in Middle Tenn	Phlox Producers
Ornamental Seed Sources	Pine Straw Sources
Sources of Pine, Spruce & Hemlock Liners	

Propagation

Fumigation	**Preventative Fungicide Program for Damping-off in Seedling Rows**
Propagation Bed Const.	**Preventative Fungicide Program for Damping-off in Propagation Beds**

For Landscaping; Thoughts when selling plants for a use

Trees with Good Fall Foliage Color	Plants with Berries or Fruit Persisting into the Fall
Shrubs with Good Fall Foliage Color	Trees & Shrubs with Tolerance to Moist Soil
Fall Flowering Perennials	A List of Shade Tolerant Plants for Trial
Plants with Winter Interest	Shade Tolerant Ground Covers
Small Trees for Business Streets	Under Used Plants with interesting Characteristics
Deciduous Shrubs under 3 Feet	Evergreen or Semi-Evergreen Shrubs under 3 feet Small
Selection Quality Nursery Stock	Flowering Trees that Provide Year Round Interest
	Evergreen Screen for Sun/ Evergreen Screen for Shade
	Should burlap, twine, & wire basket be removed at planting?

Evaluation of Soils for Nursery - Warren County

Very Good	Good	Fair-Drainage	Poor
Cumberland sil	Allen	Captina	Allen cobbly
Etowah sil	Cumberland sicl	Dickson	Baxter >20% slope
Huntington sil*	Etowah cherty	Lindside*	Bodine
Minvale	Hartsells		Bruno
Mountview	Huntington cherty*		Dunning
Sequatchie	Jefferson loam	**Fair-Other**	Elkins
Staser*	Linker		Guthrie
Waynesboro loam	Waynesboro cl	Allen >20% slope	Lawrence
	Whitwell	Baxter cherty	Melvin
		Christian	Ramsey
		Etowah >20% slope	Sango
		Jefferson cobbly	Talbott
		Swain	
		Waynesboro >20% slope	

*Flood potential needs evaluation at each site
sil - silt loam sicl - silty clay loam cl - clay loam

Evaluation of Soils for Nursery - Franklin County

Very Good	Good	Fair to Poor-Drainage	Poor
Cumberland sil	Allen fsl	Capshaw	Allen stony
Cumberland and Etowah sil, loam	Barbourville*	Dickson	Bodine
	Cumberland sicl	Egam*	Bruno
Decatur sil	Cumberland and Etowah sicl	Lindside*	Colbert
Dewey sil	Decatur sicl, sic	Lobelville*	Cotaco
Emory sil*	Dewey cherty	Ooltewah*	Dunning
Hermitage	Dewey sicl		Guthrie
Holston loam	Emery cherty	**Fair to Poor-Other**	Jefferson stony
Huntington*	Ennis*		Lawrence
Mountview sil	Greendale*	Baxter	Melvin
Nolichucky loam	Hartsells	Dellrose	Mimosa
Sequatchie	Holston cl	Dewey sic	Muskingum
Waynesboro loam	Humphreys cherty	Pace cherty	Purdy
	Jefferson fsl, cl	Swain	Robertsville
	Mountview sicl		Talbott
	Nolichucky cl		Taft
	Waynesboro cl		Tyler
	Whitwell		

Evaluation of Soils for Nursery - White and Van Buren Counties

Very Good	Good	Fair to Poor Drainage	Poor
Bewleyville	Allen	Dickson	Atkins
Curtistown	Etowah cherty	Hamblen*	Bodine
Decatur	Greendale*	Sewanee*	Bonair
Emory*	Hartsells	Tilsit	Bouldin
Etowah sil	Jefferson		Christian >20% slope
Lonewood	Minvale cherty		Gilpin
Mountview	Waynesboro cl	**Fair to Poor - Other**	Guthrie
Sequatchie			Melvin
Staser*		Allen >20% slope	Ramsey
Waynesboro loam		Christian	Taft
		Jefferson >20% slope	Talbott
		Nella	
		Welchland	

*Flood potential needs evaluation at each site
fsl - fine sandy loam
sil - silt loam
sicl - silty clay loam
sic - silty clay
cl - clay loam

Evaluation of Soils for Nursery - DeKalb County

Very Good	Good	Fair to Poor Drainage	Poor
Armour	Ennis*	Capshaw	Bodine
Arrington*	Etowah cherty	Dickson	Dowellton
Etowah	Hicks	Egam*	Guthrie
Mountview	Staser cherty*	Lobelville*	Inman
Waynesboro loam	Waynesboro cl	Lynnville*	Mimosa
			Sango
		Fair to Poor - Other	Taft
			Talbott
		Christian	
		Dellrose	
		Fullerton	
		Hampshire	
		Stiversville	
		Tarklin	

*Flood potential needs evaluation at each site cl - clay loam

Evaluation of Soils for Nursery - Coffee County

Very Good	Good	Fair-Drainage	Poor
Armour	Cookeville sicl	Captina	Bodine
Cookeville sil	Greendale cherty*	Dickson	Bruno
Cumberland sil	Etowah sicl	Hamblen*	Dunning
Emory*	Hartsells	Lindside*	Guthrie
Etowah sil	Hermitage cherty	Lobelville*	Lawrence
Hermitage sil	Holston cl	Monongahela	Lee
Holston loam	Huntington cherty*		Mimosa
Humphreys	Mountview sicl	Fair-Other	Muskingum
Huntington sil*	Mountview		Prader
Mountview sil	shallow	Sequatchie cobbly	Purdy
Nolichucky	Nolichucky cl	Baxter	Robertsville
loam	Waynesboro cl	Dellrose	Sango
Pembroke	Whitwell	Pace	Taft
Sequatchie		Swain	Talbott
Staser*			Tyler
Waynesboro			
loam			

*Flood potential needs evaluation at each site

sil - silt loam sicl - silty clay loam cl - clay loam

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Field Nsy Prod-ho 4-2002 Gen file

PRECAUTIONARY STATEMENT

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user.
Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide.
According to laws regulating pesticides, they must be used only as directed by the label.

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Pesticide registrations are continuously being reviewed.
Should registration of a recommended pesticide be canceled, it would no longer be recommended by The University of Tennessee.
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