# WEST TEXAS NURSERY OPERATIONS

Denise L. Word and Robert J. Fewin [1/]

Abstract.--An overview of windbreak seedling production at the Texas Forest Service West Texas Nursery is presented. Included is a brief analysis of the climate and soils of West Texas and windbreak planting stock requirements which influence nursery production procedures and objectives. The production of 107,000 containerized conifers in a 1,500 square foot glass greenhouse and 467,000 bare-root hardwoods in a 5 acre field nursery are emphasized.

Additional keywords: Trickle irrigation, greenhouse cooling system, two crop rotation, bullet container, polystyrene container.

The specific need for windbreak plantings in the arid and semiarid regions of Texas are comparable to those throughout the Great Plains. Windbreaks are planted to protect homesteads and agricultural land from damaging winds, they provide protection for livestock and habitat for many species of wildlife.

The occurrence of windbreaks in West Texas is not as common as other portions of the Great Plains. The lack of windbreaks does not reflect landowner attitude toward tree plantings because from 1940 to 1978 the Texas Forest Service shipped over 12 million seedlings from its East Texas nursery to the western part of the state. The problem has been that bare-root seedlings produced in East Texas do not perform well under the extremes in growing conditions of West Texas.

Diversity of soils and climate of the region present innumerable challenges to the landowner establishing tree plantings. In general, the soils range in texture from sands to heavy clays from south to north with depths ranging from 2 to 48 inches of soil over caliche rock or zones of high calcium carbonate accumulation. Annual precipitation ranges from 10 to 20 inches from west to east. The most noted characteristics of the region, which contribute significantly to the success or failure of tree plantings, are the high winds and drought conditions during the late February and early March tree planting season. In order to overcome the adverse climatic and edaphic conditions and to insure reasonable planting success, the landowner must use planting stock specifically adapted to the region.

The Texas Forest Service took a major step toward providing landowners with adapted planting stock in April 1978 when the first greenhouse crop of containerized windbreak conifers was sown. The greenhouse is part of the Texas Forest Service West Texas Nursery complex (office-greenhouse-lath house) located at the Texas A&M University Agricultural Research and Extension Center, Lubbock, Texas. The following year field production of bare-root hardwoods

[1/] Nursery Specialist and Silviculturist, West Texas Nursery, Texas Forest Service, Lubbock, Texas.

was initiated on a 5 acre site located at the High Plains Research Foundation Halfway, Texas, 35 miles north of Lubbock.

## WINDBREAK PROGRAM AREA

The West Texas Nursery windbreak program is concentrated in a 69 county area (Figure 1). Historically, the greatest number of windbreak plantings have been made in this region because it is predominately farmland with soils that are highly susceptable to wind erosion. Sales and distribution of windbreak seedlings in the remaining portion of the state are handled by Indian Mound Nursery located in central East Texas.

## GREENHOUSE PRODUCTION OF CONIFERS

The greenhouse is a 30 by 50 foot glass structure. The basic operating procedure and internal components are patterned after Dr. Richard Tinus' work at Bottineau, North Dakota on greenhouse production of containerized conifers. The environmental parameters manipulated to enhance rapid terminal growth of conifers are extended photoperiod, humidity, fertilization and temperature.

A unique feature of the greenhouse is the cooling system which employs lava rock rather than aspen pads or manufactured materials as the cooling element. Figure 2 illustrates the design of the cooling system.

The cooling system which is positioned at the south end of the greenhouse includes: (1) 24 inch motorized louvers across the end of the greenhouse at bench height; (2) one layer thick bed of 1 inch diameter lava rock spread on galvanized wire shelf attached to the outside of the greenhouse at eave height (7 foot); (3) a misting system over the lava rock; and (4) a concrete floor below the lava rock which slopes to a sump. Two 42 inch exhaust fans located at the north end of the greenhouse provides suction air flow. A saran shade cloth (55% shade) is stretched over the exterior of the greenhouse for added temperature control.

The galvanized wire shelf that supports the lava rock is 5 foot wide and extends the full width of the greenhouse. The area below the shelf down to the concrete floor is enclosed with fiberglass and sealed so air must pass through the wet lava rock before entering the greenhouse. The principle of the lava rock system is the same as aspen pads. The rock is porous with a high water retention capacity and large enough for air to be pulled through with little resistance.

The effectiveness of the system during summer months is dependent upon ambient humidity as is the case with evaporative type cooling systems. Greenhouse temperature can be maintained 12 to 15 degrees fahrenheit below outside temperature during summer months when ambient humidity is 30 percent and less.

### General Production Procedures

Conifers produced in the greenhouse include: Arizona cypress (*Cupressus arizonica* L.); eastern redcedar (*Juniperus virginiana* L.); ponderosa pine

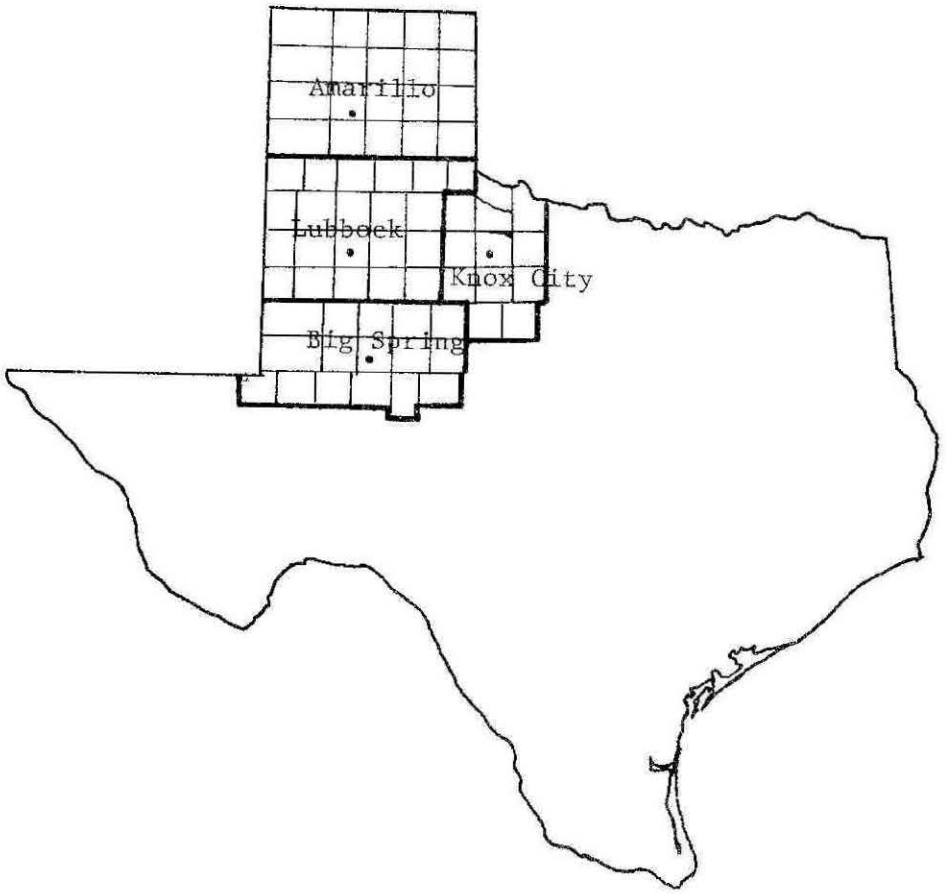



Figure 1.--The 69 counties in the arid and semiarid region of Texas included in the Texas Forest Service West Texas Nursery windbreak program.

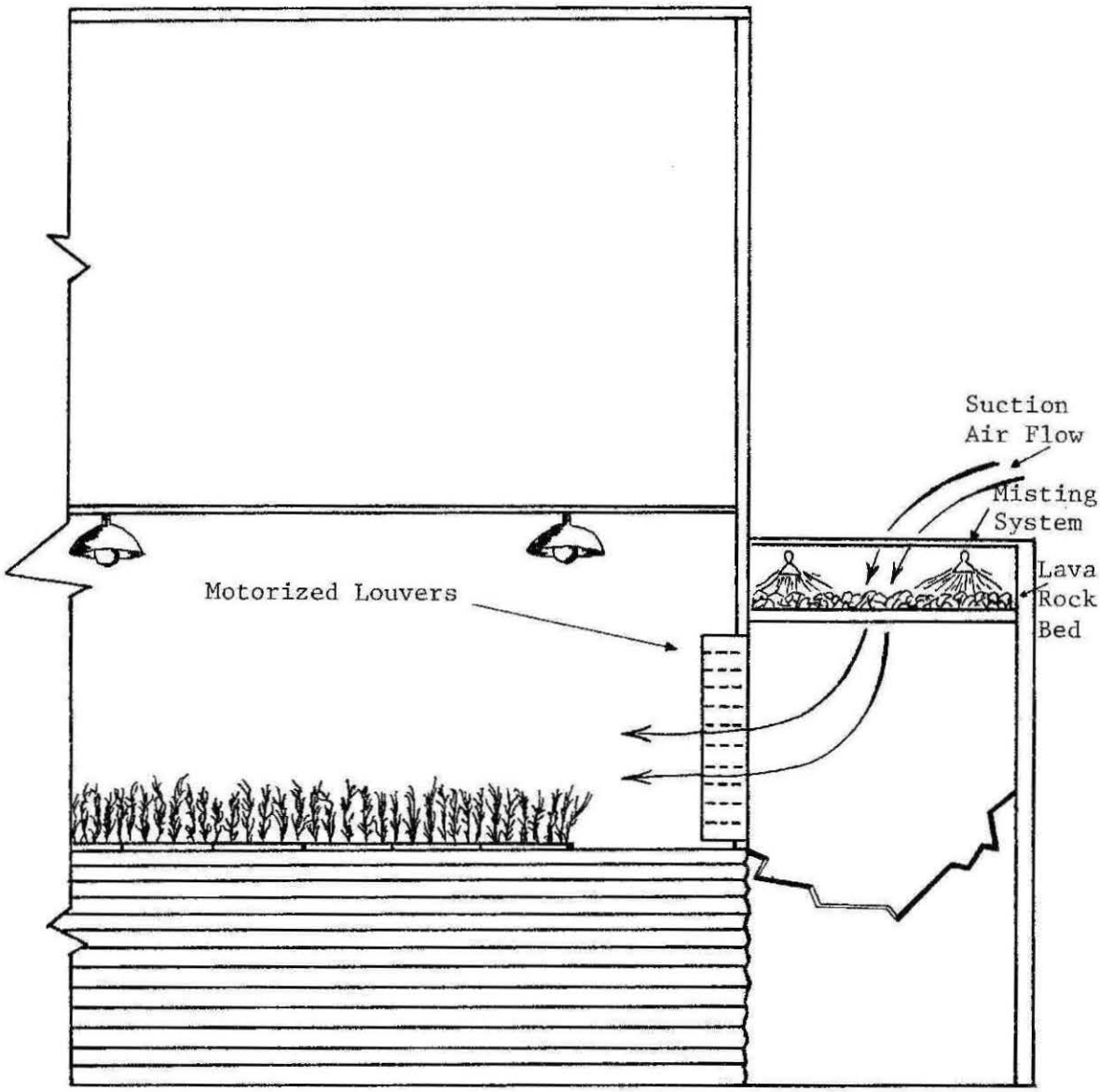



Figure 2.--A schematic side view of the greenhouse illustrating the basic design and function of the lava rock cooling system.

(Pinus ponderosa var. ponderosa Laws.) and Austrian pine (Pinus nigra Arnold). These introduced species perform well in West Texas once they are established.

Grading Standards--Stem caliper has proven to be the most reliable indicator of seedling quality because it generally reflects the degree of root development. The most desirable containerized conifer for planting in West Texas has a stem caliper of at least 3/16 inch at the root collar and a 6 inch top on the pines and an 8 inch top on cypress and redcedar.

Growing Media and Sowing Rates--The growing media used in all production phases is a 1:1 mixture of peat and vermiculite. Two seeds per cell are sown with a vacuum seeder. Containers are thinned to one seedling per cell when germination is complete.

Production Stages

In the four years that the greenhouse has been operational, annual production has not remained static. Demand for planting stock has forced production to rapidly progress from one crop per year in 1978 when 23,000 seedlings were produced to the present two crop rotation with 107,000 seedlings being produced annually.

The four fold increase in annual production was not achieved strictly by converting to a two crop system. Additional bench space was added in the isles and eventually a smaller container used during a specific phase of greenhouse production that significantly increased capacity.

One Crop Rotation--The first greenhouse crop of seedlings, Austrian and ponderosa pine, were carried through a 10 month production cycle. The seed was sown on April 20, 1978 in polystyrene box containers that measured 12 x 14 x 8 inches and has 30 cells with a volume of approximately 30 cubic inches per cell. This container has subsequently proven to be ideal for the development of seedlings with the root mass, stem caliper and top height needed for good survival in West Texas. The greenhouse was constructed with 905 square feet of bench space which held 776 polystyrene containers for a total of 23,280 seedling capacity.

During the first stage of production, the seedlings received a high nitrogen fertilizer, extended photoperiod and temperatures maintained near 70° F until November 1, at which time the desired top height had been attained. The seedlings were then subjected to stress to induce bud set. Irrigation and extended photoperiod was terminated and the temperature regime changed to a 78° F day and 68° F night diurnal pattern. Once bud set was evident, irrigation was resumed with a high phosphorus and potassium and low nitrogen fertizer for two months to promote stem caliper and root and bud development. The hardening-off process began on Jaunary 1 when temperature in the greenhouse was reduced 5° every 5 days until it reached ambient temperature. The seedlings were then moved to the lath house in February and subsequently distributed to the landowners in March 1979. The greenhouse crop that followed was the first phase of the two crop rotation.

Two Crop Rotation--The principle of the two crop rotation is that the greenhouse is used exclusively to promote rapid terminal growth. Each crop remains in the greenhouse for 6 months receiving high nitrogen fertilizer, extended photoperiod and 70° F temperatures. Bud set, increase in stem caliper and root volume and hardening-off is accomplished in the lath house. The lath house has 10,000 square feet of growing space and is equipped with an overhead irrigation system.

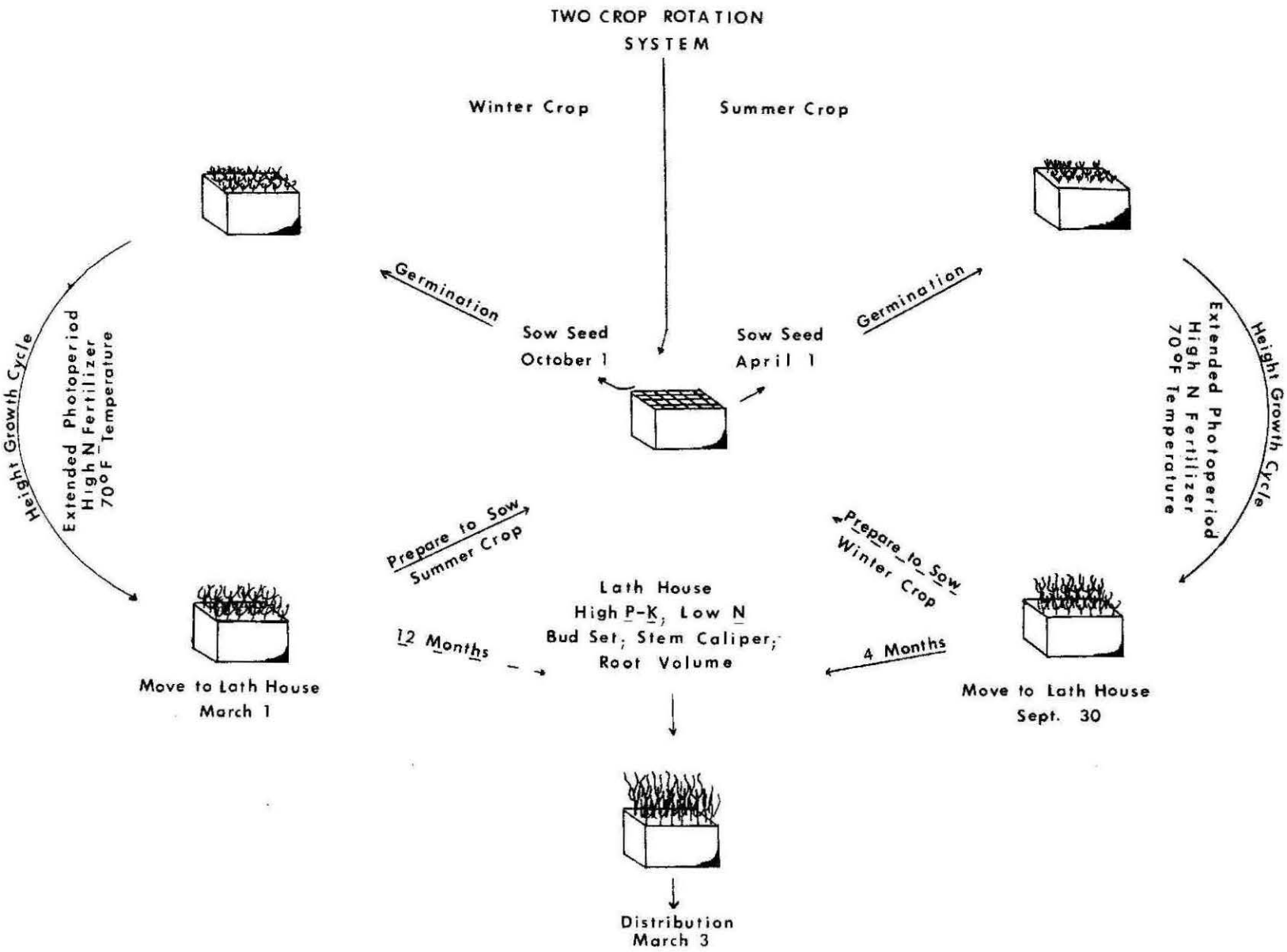
The winter crop is considered the first half of the annual two crop rotation. A simplified production flow diagram of the two crop rotation system is illustrated in Figure 3. Seed is sown on October 1. When germination is complete at three weeks, high nitrogen fertilization and extended photoperiod is initiated with temperatures maintained at 70° F. The seedlings are then moved to the lath house on March 31. The last killing frost occurs around April 1, therefore, the seedlings are covered with plastic at night until buds and woody stem tissue develop. These seedlings remain in the lath house through the summer and winter months, receiving high P-K and low N fertilizer, then distributed to the landowners the following March. Consequently, the winter crop is 18 months from seed when the landowner plants them in the field.

The summer crop is sown on April 1 and the seedlings moved to the lath house on September 30. The first killing frost generally occurs around November 15, which leaves ample time (6 weeks) for the seedlings to set bud and develop woody stem tissue for winter hardiness. Seedlings produced in the summer crop are 11 months old when they are distributed to the landowners in March.

A total of 46,560 seedlings are produced when the polystyrene container is used in the two crop rotation.

The polystyrene container was used in the greenhouse from 1978 to the fall of 1981 when a bullet container was substituted. A tray, which holds 98 bullets, measures 12 x 14 x 7 inches. The volume of a bullet is 10 cubic inches which is one-third the volume of the polystyrene cell. Preliminary testing showed all four conifers could be grown in the bullet to the desired height in six months without root binding. Consequently, the bullet container was used to recharge the greenhouse for the winter crop in October, 1981. There was bench space for 462 trays @ 98 bullets/tray which equals 45,276 seedlings. By converting to the bullet container, seedling production per square foot of bench space was almost doubled. In addition, 12 inch wide side benches were added to each of the 4 isles which further increased the greenhouse capacity by 89 trays or 8,722 seedlings. The current greenhouse capacity is 53,998 seedlings per crop or 107,996 seedlings on a two crop rotation system.

A disadvantage to the bullet container is that seedlings must be transplanted to the polystyrene container at the end of the six month greenhouse cycle in order to obtain the desired root system. Approximately 690 man hours are required to transplant 53,998 seedlings at a cost of about $3,600.00. However, when considering windbreak conifers are sold for $1.00 per seedling and greenhouse capacity is increased by 30,718 seedlings, there is ample justification for the added cost of transplanting.


TWO CROP ROTATION SYSTEM
Winter Crop
Summer Crop
Germination
Sow Seed October 1
Sow Seed April 1
Germination
Height Growth Cycle
Extended Photoperiod
High N Fertilizer
70°F Temperature
Height Growth Cycle
Extended Photoperiod
High N Fertilizer
70°F Temperature
Prepare to Sow Summer Crop
Prepare to Sow Winter Crop
Lath House
High P-K, Low N
Bud Set, Stem Caliper, Root Volume
12 Months
4 Months
Move to Lath House March 1
Move to Lath House Sept. 30
Distribution March 3

Production Efficiency

All containers are graded to 30 plantable seedlings one week prior to being distributed to the landowners. Height, bud set (pines) and stem caliper of each seedling is measured. Thus far, only 70 percent of the seedlings produced under a two crop rotation system reaches plantable grade within a production year. Five percent are culls and 25 percent are classified as sub-standard and held in the lath house an additional year. Seedlings that fall in sub-standard category are primarily Austrian and ponderosa pine which have less than the minimum 6 inch top height.

Greenhouse sowing shcedules have been altered so that the pines and red-cedar are being produced strictly during the winter crop. This will give them an opportunity to put on a second flush of growth while being held in the lath house during the summer months. This change should improve production efficiency significantly.

The summer crop is devoted almost entirely to Arizona cypress which easily attains the minimum 8 inch height by the end of the greenhouse growing cycle.

## FIELD PRODUCTION OF BARE-ROOT HARDWOODS

The field nursery site measures 360 x 600 feet. It contains 4.95 acres. Approximately 4.5 acres are tillable with a net seedbed area of 2.06 acres. The non-tillable area is a 15 foot border on the east and west boundaries.

The nursery is divided into 8 compartments. Each compartment contains 10 production seedbeds. A seedbed is 2.5 x 345 feet for a total of 8,625 square feet of growing space per compartment.

Annual production targets have increased from 250,000 seedlings in 1979 to the current 467,000 seedlings. The species produced each year include: Russian olive (Elaeagnus angustifolia L.); green ash (Fraxinus pennsylvanica Marsh.); thornless honeylocust (Gleditsia triacanthos L.); mulberry (Morus spp. ); native plum (Prunus angustifolia Marsh.)and bur oak (Quercus macrocarpa Michx.)

General Production Procedures

The nursery site is bordered by open fields which leaves the production beds exposed to the hot, dry west winds. Living barriers of sudax, a hybrid sorghum, are established on the first bed in each compartment. It will attain a mature height of 8 feet in 60 days. Two rows of sudax are sown on each bed at the rate of 15 seeds per linear foot which creates a dense barrier that is effective through the month of October.

Four compartments are used for the production of hardwoods each year while the remaining four compartments are sown to a cover crop. The sowing of seedbeds begins around April 15. Planet Jr. planters are used to sow Russian olive and mulberry while the remaining species are hand sown. Three rows of seedlings, spaced 9 inches apart, are produced on each bed.

Treflan EC herbicide applied at the rate of 3/4# active ingredient per acre gives excellent weed control through most of the growing season. It is applied to the beds and watered into the soil after the tree seed is sown.

The nursery soil is a clay loam that will crust over when it dries inhibiting tree seed germination. Burlap is used to prevent drying of seedbeds during germination.

Trickle Irrigation System--Before the first field crop could be sown, an irrigation system had to be installed on the nursery site that was efficient and required little maintenance. The source of water for the nursery site was extended from an underground lawn sprinkler system. A 4 inch PVC underground main distribution water line was extended 600 feet east-west (long axis) through the center of the site. The water well that feeds the system pumps sand, therefore, a sand separator and 200 mesh filter were installed in the main water line. A 2 inch underground distribution line "T's" off and lays parallel with the main water line at 4 locations (Figure 4). The 2 inch lines distribute water to each compartment.

Risers, 1 inch PVC pipe, extend upward from the 2 inch distribution line to a height of 4 inches above ground. The risers are spaced every 5½ feet, which mark the center of each seedbed. Two 1 inch PVC "T's" with ½ inch male adaptors are attached to the top of each riser. Bi-wall drip irrigation tubing is clamped to each male adaptor then laid out over the length of the seedbed. When installation is complete, there are two 170 foot rows of tubing laid out over the surface of a bed on the north and south side of the riser.

The 19 mil. irrigation tubing has laser cut holes spaced at 10 inch intervals. Approximately 3/4 inch of water can be applied to a bed in a two hour period with 8 p.s.i. pressure per riser.

The drip irrigation tubing is very efficient in terms of water utilization. It is re-usable and relative inexpensive costing 4.5 cents per linear foot.

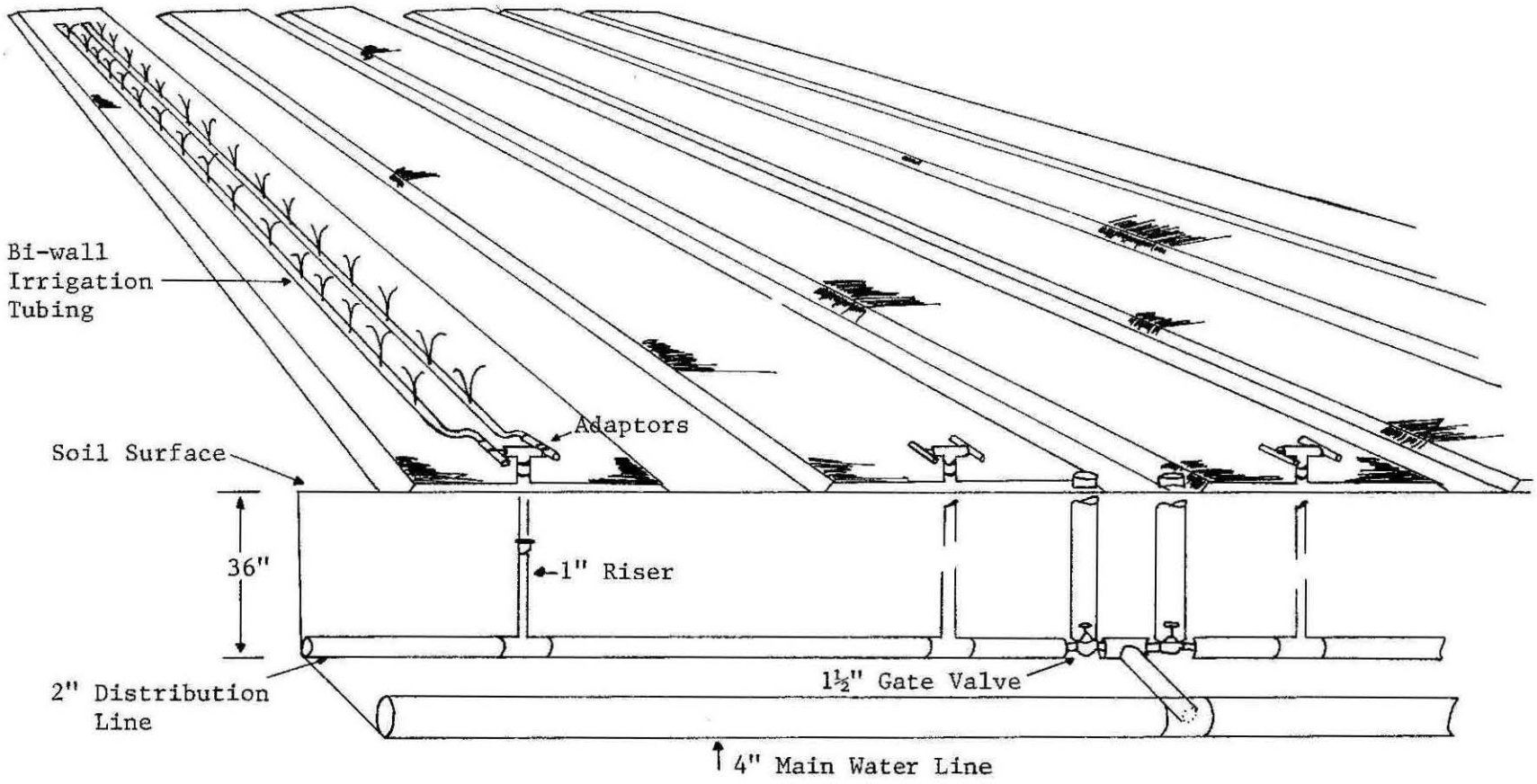
Production Efficiency

The grading standard for hardwood seedlings is a stem caliper of at least 3/16 inch at the root collar and a minimum of 12 inch top height. Normally, 80 percent of the seedlings produced will exceed the minimum growing standard. It is not uncommon to discard seedlings because they are to large. This is particularily true of Russian olive and mulberry.

## SEEDLING DISTRIBUTION

The distribution of bare-root hardwoods and containerized conifers are two different operations, each requiring all available labor and working space to complete. Seldom are there more than five people involved in field nursery and greenhouse operations.

Figure 4.--Schematic of the underground irrigation system installed in the hardwood field nursery.



Bare-root Hardwoods

Field lifting of hardwoods begin the first week of February, weather permitting. Hardwoods are field graded and tied into bundles of 50 seedlings then packed with wet moss in an enclosed trailer and transported to Lubbock where orders are assembled and shipped.

There are two major problems with the lifting and shipping of hardwoods. First, there is considerable distance between the field nursery and headquarters where seedlings are bundled and shipped. Considerable time is devoted to transporting labor and seedlings to and from the field nursery. Second, the lifting season is relatively short...five weeks. Field lifting can be delayed because of snow or freezing conditions in February while bud break can occur in the field nursery the first week of March in species such as Russian olive.

Containerized Conifers

Containerized conifers are distributed to landowners from four locations. Figure 1 gives the location of each pickup station and the counties serviced. The specific distribution sites are state and federal facilities such as an experiment station or Soil Conservation Service office.

Pickup dates are determined before seedling sales begin in September. The landowner is made aware of his pickup date and location when seedlings are purchased and a written reminder is mailed two weeks in advance.

Containerized seedlings are trasnported to three pickup stations... Knox City, Big Spring, and Amarillo. Seedlings arrive at the pickup station the evening before and nursery personnel are on hand the following day to distribute seedlings to landowners and to answer questions. West Texas Nursery is the fourth pickup station where a large percentage of the seedlings are distributed.

The system of distributing containerized conifers has been very successful. A major advantage to the system is nursery personnel have direct contact with the landowner. It is felt that the one-to-one contact has played a major role in the success of the nursery program.

## CONCLUSION

The Texas Forest Service West Texas Nursery has been operational four years. The demand for planting stock has increased dramatically each year. The production of 107,000 containerized seedlings will satisfy demand for a short period of time. Landowners are presently purchasing trees for one and two row homestead windbreaks which on the average require only 90 to 150 seedlings. However, with the growing interest in the planting of windbreaks around the agricultural fields, annual demand will approach 200,000 seedlings within the next 5 to 7 years. Field production of hardwoods will remain constant for the next five years because demand is for containierzed conifers.